MSRDesign

Hight Jackson ASSOCIATES

BENTONVILLE PUBLIC

LIBRARY EXPANSION

BENTONVILLE, AR

Project No. 2021027

Matthew Kruntorad, AIA.
Meyer, Scherer, Rockcastle, LTD
Arkansas License No. 10100

GENERAL CONDITIONS

SPECIFICATIONS

FOR FURNISHING LABOR AND

MATERIALS FOR:

CONSTRUCTION OF

BENTONVILLE PUBLIC LIBRARY EXPANSION

BENTONVILLE, AR

MSR DESIGN

ARCHITECT, A.I.A.

MINNEAPOLIS, MINNESOTA

&

HIGHT JACKSON ASSOCIATES PA

ARCHITECT, A.I.A.

ROGERS, ARKANSAS

PROJECT # 2130

JANUARY 6, 2023

PROJECT MANUAL FOR CONSTRUCTION OF

BENTONVILLE PUBLIC LIBRARY EXPANSION

BENTONVILLE, AR

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BENTONVILLE PUBLIC LIBRARY EXPANSION

BENTONVILLE, AR

The Landscape Architect, Maura Rockcastle, ASLA, PLA, with TEN x TEN has written and/or reviewed the specifications listed below for the above referenced project:

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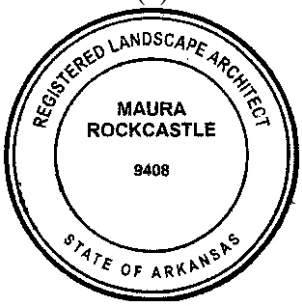

Maura Rockcastle ASLA, PLA
TEN x TEN
Arkansas License No. 9408

SECTION 00 09 00

ENGINEERING INSPECTIONS AND OBSERVATIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Engage and provide a qualified Engineering Inspections and Observations firm to provide Owner and Engineer of Record daily Inspections and Observations and reports in addition to other inspections and observations required in other Specification Sections for the project. Frequency of Inspections and Observations shall be on an as-needed basis.

1. At a minimum the Inspections and Observations Engineer shall witness materials sampling and testing, City Inspections requiring an Owner Representative, and monthly Progress meetings.

2. Engineer of record may be retained at their standard hourly billing rate.

3. A third-party Engineer licensed in the State of Arkansas may be retained to provide the required daily Inspections and Observations.

B. Inspections and Observations Engineer shall report directly to the project Engineer of Record and the Owner.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 00 10 00

STANDARD SPECIFICATION REFERENCE - BENTONVILLE

PART 1 GENERAL

1.1 SUMMARY

A. All materials and construction shall comply with the latest edition of the following standard Specifications and Codes. The following specifications and codes are hereby incorporated by reference to these Project Specifications.

1. City of Bentonville, CITY OF BENTONVILLE: MINIMUM STANDARD SPECIFICATIONS FOR STREET, 2006; available for download at the following website; https://www.bentonvillear.com/DocumentCenter/View/1231/Street-Specifications?bidId=

2. City of Bentonville, CITY OF BENTONVILLE: STANDARD WATER AND SEWER SPECIFICATIONS, 2021: available for download at the following website; https://www.bentonvillear.com/DocumentCenter/View/7691/2021-Bentonville-Water-and-Sewer-Specifications-

3. City of Bentonville, CITY OF BENTONVILLE: BEUD ELETRIC SPECIFICATIONS, 2019: available for download at the following website; http://ar-bentonville.civicplus.com/DocumentCenter/View/100/BEUD-Electric-Specifications-PDF

B. If conflicts exist between the referenced Standard Specifications and other specifications incorporated in these contract documents, the more stringent requirement shall govern.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 00 10 02

ENDANGERED SPECIES ACT COMPLIANCE

PART 1 GENERAL

1.1 SUMMARY

A. Contractor shall comply with all requirements and recommendations of the United States Endangered Species Act and Gold and Bald Eagle Protection Act. All construction activity shall comply with the recommendations and requirements of the US Fish and Wildlife Service for the protection of endangered species. The following documents and codes are hereby incorporated by reference to these Project Specifications.

1. Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.)

2. Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

B. There are NOT known endangered species, or Bald or Golden Eagles present at or near the proposed work areas.

C. If endangered species or Bald or Golden Eagles are encountered during construction the Contractor shall stop work immediately and notify the Owner and Engineer. Contractor shall await direction prior to commencing work activities.

D. Contractor shall conduct a tree removal pre-construction conference to review the trees to be removed.

E. Contractor shall obtain written approval from the City, Owner and Engineer prior to any burning of trees or brush onsite.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 00 10 03

STORMWATER POLLUTION PREVENTION PLAN

PART 1 GENERAL

1.1 SUMMARY

A. Contractor shall comply with all requirements and recommendations of the Arkansas Department of Environmental Quality (ADEQ) Construction Stormwater Discharge Permit. The following documents and codes are hereby incorporated by reference to these Project Specifications.

1. Stormwater Pollution Prevention Plan (SWPPP) for Construction Activities for Small Construction Sites.

2. ADEQ SWPPP General Permit No. ARR150000.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION (Not Used)

END OF SECTION

SECTION 00 10 04

ARKANSAS HISTORIC PRESERVATION PROGRAM REFERENCE

PART 1 GENERAL

1.1 SUMMARY

A. Contractor shall comply with all requirements and recommendations of the Arkansas Department of Heritage, Arkansas Historic Preservation Program and National Historic Preservation Act. The following documents and codes are hereby incorporated by reference to these Project Specifications.

1. National Historic Preservation Act of 1966 (NHPA, Public Law 89-665; 54 U.S.C. 300101 et seq.)

B. There are NOT known historic properties or cultural resources at or near the proposed work areas.

C. If cultural resources or historic properties are encountered during construction the Contractor shall stop work immediately and notify the Owner and Engineer. Contractor shall await direction prior to commencing work activities.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)

END OF SECTION

SECTION 00 72 00

GENERAL CONDITIONS OF THE CONTRACT

PART 1 GENERAL

1.1 SCOPE OF WORK

A. The work included under these Specifications consists of furnishing all items, materials, operations, or methods listed, mentioned, indicated, or scheduled on the drawings and/or in these Specifications, including all labor, materials, equipment, transportation, temporary facilities, services and incidental necessary and required for the construction and completion of the project named in the title page in accordance with contract documents.

1.2 FORM OF SPECIFICATIONS

A. General Conditions and Division 1 (General Requirements) apply to every Division (1 through 33 of these Specifications.

B. These Specifications are of abbreviated form and contain incomplete sentences. Omissions of words or phrases such as “the Contractor shall” “shall be”, “as noted on the drawings”, “according to the drawings”, “a”, “an”, “the”, and “all” are intentional. Omitted words and phrases shall be supplied by inference in the same manner as they are when a “note” occurs on the drawings.

C. All specification instructions are directed to the Contractor and the inclusion of any work by mention, note, or itemization, however brief, implies the Contractor shall provide same, unless specifically directed otherwise. Where a specific Contractor is named, he shall be responsible for and provide work so designated.

D. In specifying an item by manufacturer’s name and/or catalog number, such item is to be provided complete with all the standard devices and accessories as indicated in the latest edition of the manufacturer’s catalog or brochure published at date of invitation to submit proposal, unless specifically stated otherwise.

1.3 AIA GENERAL CONDITIONS

A. AIA Document A201-2017:
“GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION”, 2017 EDITION, 15 Articles, hereinafter referred to as the “AIA General Conditions’, is hereby made a part of this specification, a copy of which is herein attached. Contractor shall consult this document and become intimately familiar with its contents before submitting his proposal.

END OF SECTION

AIA® Document A201® – 2017

General Conditions of the Contract for Construction

(Paragraphs deleted)

TABLE OF ARTICLES

ADDITIONS AND DELETIONS:
The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed. A vertical line in the left margin of this document indicates where the author has added necessary information and where the author has added to or deleted from the original AIA text.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

For guidance in modifying this document to include supplementary conditions, see AIA Document A503™, Guide for Supplementary Conditions.

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(Topics and numbers in bold are Section headings.)

ARTICLE 1 GENERAL PROVISIONS

§ 1.1 Basic Definitions

§ 1.1.1 The Contract Documents

The Contract Documents are enumerated in the Agreement between the Owner and Contractor (hereinafter the Agreement) and consist of the Agreement, Conditions of the Contract (General, Supplementary and other Conditions), Drawings, Specifications, Addenda issued prior to execution of the Contract, other documents listed in the Agreement, and Modifications issued after execution of the Contract. A Modification is (1) a written amendment to the Contract signed by both parties, (2) a Change Order, (3) a Construction Change Directive, or (4) a written order for a minor change in the Work issued by the Architect. Unless specifically enumerated in the Agreement, the Contract Documents do not include the advertisement or invitation to bid, Instructions to Bidders, sample forms, other information furnished by the Owner in anticipation of receiving bids or proposals, the Contractor's bid or proposal, or portions of Addenda relating to bidding or proposal requirements.

§ 1.1.2 The Contract

The Contract Documents form the Contract for Construction. The Contract represents the entire and integrated agreement between the parties hereto and supersedes prior negotiations, representations, or agreements, either written or oral. The Contract may be amended or modified only by a Modification. The Contract Documents shall not be construed to create a contractual relationship of any kind (1) between the Contractor and the Architect or the Architect's consultants, (2) between the Owner and a Subcontractor or a Sub-subcontractor, (3) between the Owner and the Architect or the Architect's consultants, or (4) between any persons or entities other than the Owner and the Contractor. The Architect shall, however, be entitled to performance and enforcement of obligations under the Contract intended to facilitate performance of the Architect's duties.

§ 1.1.3 The Work

The term "Work" means the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by the Contractor to fulfill the Contractor's obligations. The Work may constitute the whole or a part of the Project.

§ 1.1.4 The Project

The Project is the total construction of which the Work performed under the Contract Documents may be the whole or a part and which may include construction by the Owner and by Separate Contractors.

§ 1.1.5 The Drawings

The Drawings are the graphic and pictorial portions of the Contract Documents showing the design, location and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

§ 1.1.6 The Specifications

The Specifications are that portion of the Contract Documents consisting of the written requirements for materials, equipment, systems, standards and workmanship for the Work, and performance of related services.

§ 1.1.7 Instruments of Service

Instruments of Service are representations, in any medium of expression now known or later developed, of the tangible and intangible creative work performed by the Architect and the Architect's consultants under their respective professional services agreements. Instruments of Service may include, without limitation, studies, surveys, models, sketches, drawings, specifications, and other similar materials.

§ 1.1.8 Initial Decision Maker

The Initial Decision Maker is the person identified in the Agreement to render initial decisions on Claims in accordance with Section 15.2. The Initial Decision Maker shall not show partiality to the Owner or Contractor and shall not be liable for results of interpretations or decisions rendered in good faith.

§ 1.2 Correlation and Intent of the Contract Documents

§ 1.2.1 The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work by the Contractor. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all; performance by the Contractor shall be required only to the extent consistent with the Contract Documents and reasonably inferable from them as being necessary to produce the indicated results.

§ 1.2.1.1 The invalidity of any provision of the Contract Documents shall not invalidate the Contract or its remaining provisions. If it is determined that any provision of the Contract Documents violates any law, or is otherwise invalid or unenforceable, then that provision shall be revised to the extent necessary to make that provision legal and enforceable. In such case the Contract Documents shall be construed, to the fullest extent permitted by law, to give effect to the parties' intentions and purposes in executing the Contract.

§ 1.2.2 Organization of the Specifications into divisions, sections and articles, and arrangement of Drawings shall not control the Contractor in dividing the Work among Subcontractors or in establishing the extent of Work to be performed by any trade.

§ 1.2.3 Unless otherwise stated in the Contract Documents, words that have well-known technical or construction industry meanings are used in the Contract Documents in accordance with such recognized meanings.

§ 1.3 Capitalization

Terms capitalized in these General Conditions include those that are (1) specifically defined, (2) the titles of numbered articles, or (3) the titles of other documents published by the American Institute of Architects.

§ 1.4 Interpretation

In the interest of brevity the Contract Documents frequently omit modifying words such as "all" and "any" and articles such as "the" and "an," but the fact that a modifier or an article is absent from one statement and appears in another is not intended to affect the interpretation of either statement.

§ 1.5 Ownership and Use of Drawings, Specifications, and Other Instruments of Service

§ 1.5.1 The Architect and the Architect's consultants shall be deemed the authors and owners of their respective Instruments of Service, including the Drawings and Specifications, and retain all common law, statutory, and other reserved rights in their Instruments of Service, including copyrights. The Contractor, Subcontractors, Sub-subcontractors, and suppliers shall not own or claim a copyright in the Instruments of Service. Submittal or distribution to meet official regulatory requirements or for other purposes in connection with the Project is not to be construed as publication in derogation of the Architect's or Architect's consultants' reserved rights.

§ 1.5.2 The Contractor, Subcontractors, Sub-subcontractors, and suppliers are authorized to use and reproduce the Instruments of Service provided to them, subject to any protocols established pursuant to Sections 1.7 and 1.8, solely and exclusively for execution of the Work. All copies made under this authorization shall bear the copyright notice, if any, shown on the Instruments of Service. The Contractor, Subcontractors, Sub-subcontractors, and suppliers may not use the Instruments of Service on other projects or for additions to the Project outside the scope of the Work without the specific written consent of the Owner, Architect, and the Architect's consultants.

§ 1.6 Notice

§ 1.6.1 Except as otherwise provided in Section 1.6.2, where the Contract Documents require one party to notify or give notice to the other party, such notice shall be provided in writing to the designated representative of the party to whom the notice is addressed and shall be deemed to have been duly served if delivered in person, by mail, by courier, or by electronic transmission if a method for electronic transmission is set forth in the Agreement.

§ 1.6.2 Notice of Claims as provided in Section 15.1.3 shall be provided in writing and shall be deemed to have been duly served only if delivered to the designated representative of the party to whom the notice is addressed by certified or registered mail, or by courier providing proof of delivery.

§ 1.7 Digital Data Use and Transmission

The parties shall agree upon protocols governing the transmission and use of Instruments of Service or any other information or documentation in digital form. The parties will use AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, to establish the protocols for the development, use, transmission, and exchange of digital data.

§ 1.8 Building Information Models Use and Reliance

Any use of, or reliance on, all or a portion of a building information model without agreement to protocols governing the use of, and reliance on, the information contained in the model and without having those protocols set forth in AIA Document E203™–2013, Building Information Modeling and Digital Data Exhibit, and the requisite AIA Document

G202™–2013, Project Building Information Modeling Protocol Form, shall be at the using or relying party's sole risk and without liability to the other party and its contractors or consultants, the authors of, or contributors to, the building information model, and each of their agents and employees.

ARTICLE 2 OWNER

§ 2.1 General

§ 2.1.1 The Owner is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Owner shall designate in writing a representative who shall have express authority to bind the Owner with respect to all matters requiring the Owner's approval or authorization. Except as otherwise provided in Section 4.2.1, the Architect does not have such authority. The term "Owner" means the Owner or the Owner's authorized representative.

§ 2.1.2 The Owner shall furnish to the Contractor, within fifteen days after receipt of a written request, information necessary and relevant for the Contractor to evaluate, give notice of, or enforce mechanic's lien rights. Such information shall include a correct statement of the record legal title to the property on which the Project is located, usually referred to as the site, and the Owner's interest therein.

§ 2.2 Evidence of the Owner's Financial Arrangements

§ 2.2.1 Prior to commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract. The Contractor shall have no obligation to commence the Work until the Owner provides such evidence. If commencement of the Work is delayed under this Section 2.2.1, the Contract Time shall be extended appropriately.

§ 2.2.2 Following commencement of the Work and upon written request by the Contractor, the Owner shall furnish to the Contractor reasonable evidence that the Owner has made financial arrangements to fulfill the Owner's obligations under the Contract only if (1) the Owner fails to make payments to the Contractor as the Contract Documents require; (2) the Contractor identifies in writing a reasonable concern regarding the Owner's ability to make payment when due; or (3) a change in the Work materially changes the Contract Sum. If the Owner fails to provide such evidence, as required, within fourteen days of the Contractor's request, the Contractor may immediately stop the Work and, in that event, shall notify the Owner that the Work has stopped. However, if the request is made because a change in the Work materially changes the Contract Sum under (3) above, the Contractor may immediately stop only that portion of the Work affected by the change until reasonable evidence is provided. If the Work is stopped under this Section 2.2.2, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided in the Contract Documents.

§ 2.2.3 After the Owner furnishes evidence of financial arrangements under this Section 2.2, the Owner shall not materially vary such financial arrangements without prior notice to the Contractor.

§ 2.2.4 Where the Owner has designated information furnished under this Section 2.2 as "confidential," the Contractor shall keep the information confidential and shall not disclose it to any other person. However, the Contractor may disclose "confidential" information, after seven (7) days' notice to the Owner, where disclosure is required by law, including a subpoena or other form of compulsory legal process issued by a court or governmental entity, or by court or arbitrator(s) order. The Contractor may also disclose "confidential" information to its employees, consultants, sureties, Subcontractors and their employees, Sub-subcontractors, and others who need to know the content of such information solely and exclusively for the Project and who agree to maintain the confidentiality of such information.

§ 2.3 Information and Services Required of the Owner

§ 2.3.1 Except for permits and fees that are the responsibility of the Contractor under the Contract Documents, including those required under Section 3.7.1, the Owner shall secure and pay for necessary approvals, easements, assessments and charges required for construction, use or occupancy of permanent structures or for permanent changes in existing facilities.

§ 2.3.2 The Owner shall retain an architect lawfully licensed to practice architecture, or an entity lawfully practicing architecture, in the jurisdiction where the Project is located. That person or entity is identified as the Architect in the Agreement and is referred to throughout the Contract Documents as if singular in number.

§ 2.3.3 If the employment of the Architect terminates, the Owner shall employ a successor to whom the Contractor has no reasonable objection and whose status under the Contract Documents shall be that of the Architect.

§ 2.3.4 The Owner shall furnish surveys describing physical characteristics, legal limitations and utility locations for the site of the Project, and a legal description of the site. The Contractor shall be entitled to rely on the accuracy of information furnished by the Owner but shall exercise proper precautions relating to the safe performance of the Work.

§ 2.3.5 The Owner shall furnish information or services required of the Owner by the Contract Documents with reasonable promptness. The Owner shall also furnish any other information or services under the Owner's control and relevant to the Contractor's performance of the Work with reasonable promptness after receiving the Contractor's written request for such information or services.

§ 2.3.6 Unless otherwise provided in the Contract Documents, the Owner shall furnish to the Contractor one copy of the Contract Documents for purposes of making reproductions pursuant to Section 1.5.2.

§ 2.4 Owner's Right to Stop the Work

If the Contractor fails to correct Work that is not in accordance with the requirements of the Contract Documents as required by Section 12.2 or repeatedly fails to carry out Work in accordance with the Contract Documents, the Owner may issue a written order to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, the right of the Owner to stop the Work shall not give rise to a duty on the part of the Owner to exercise this right for the benefit of the Contractor or any other person or entity, except to the extent required by Section 6.1.3.

§ 2.5 Owner's Right to Carry Out the Work

If the Contractor defaults or neglects to carry out the Work in accordance with the Contract Documents and fails within a ten-day period after receipt of notice from the Owner to commence and continue correction of such default or neglect with diligence and promptness, the Owner may, without prejudice to other remedies the Owner may have, correct such default or neglect. Such action by the Owner and amounts charged to the Contractor are both subject to prior approval of the Architect and the Architect may, pursuant to Section 9.5.1, withhold or nullify a Certificate for Payment in whole or in part, to the extent reasonably necessary to reimburse the Owner for the reasonable cost of correcting such deficiencies, including Owner's expenses and compensation for the Architect's additional services made necessary by such default, neglect, or failure. If current and future payments are not sufficient to cover such amounts, the Contractor shall pay the difference to the Owner. If the Contractor disagrees with the actions of the Owner or the Architect, or the amounts claimed as costs to the Owner, the Contractor may file a Claim pursuant to Article 15.

ARTICLE 3 CONTRACTOR

§ 3.1 General

§ 3.1.1 The Contractor is the person or entity identified as such in the Agreement and is referred to throughout the Contract Documents as if singular in number. The Contractor shall be lawfully licensed, if required in the jurisdiction where the Project is located. The Contractor shall designate in writing a representative who shall have express authority to bind the Contractor with respect to all matters under this Contract. The term "Contractor" means the Contractor or the Contractor's authorized representative.

§ 3.1.2 The Contractor shall perform the Work in accordance with the Contract Documents.

§ 3.1.3 The Contractor shall not be relieved of its obligations to perform the Work in accordance with the Contract Documents either by activities or duties of the Architect in the Architect's administration of the Contract, or by tests, inspections or approvals required or performed by persons or entities other than the Contractor.

§ 3.2 Review of Contract Documents and Field Conditions by Contractor

§ 3.2.1 Execution of the Contract by the Contractor is a representation that the Contractor has visited the site, become generally familiar with local conditions under which the Work is to be performed, and correlated personal observations with requirements of the Contract Documents.

§ 3.2.2 Because the Contract Documents are complementary, the Contractor shall, before starting each portion of the Work, carefully study and compare the various Contract Documents relative to that portion of the Work, as well as the information furnished by the Owner pursuant to Section 2.3.4, shall take field measurements of any existing conditions related to that portion of the Work, and shall observe any conditions at the site affecting it. These obligations are for the purpose of facilitating coordination and construction by the Contractor and are not for the purpose of discovering errors, omissions, or inconsistencies in the Contract Documents; however, the Contractor shall promptly report to the Architect any errors, inconsistencies or omissions discovered by or made known to the Contractor as a request for information in such form as the Architect may require. It is recognized that the Contractor's review is made in the Contractor's capacity as a contractor and not as a licensed design professional, unless otherwise specifically provided in the Contract Documents.

§ 3.2.3 The Contractor is not required to ascertain that the Contract Documents are in accordance with applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, but the Contractor shall promptly report to the Architect any nonconformity discovered by or made known to the Contractor as a request for information in such form as the Architect may require.

§ 3.2.4 If the Contractor believes that additional cost or time is involved because of clarifications or instructions the Architect issues in response to the Contractor's notices or requests for information pursuant to Sections 3.2.2 or 3.2.3, the Contractor shall submit Claims as provided in Article 15. If the Contractor fails to perform the obligations of Sections 3.2.2 or 3.2.3, the Contractor shall pay such costs and damages to the Owner, subject to Section 15.1.7, as would have been avoided if the Contractor had performed such obligations. If the Contractor performs those obligations, the Contractor shall not be liable to the Owner or Architect for damages resulting from errors, inconsistencies or omissions in the Contract Documents, for differences between field measurements or conditions and the Contract Documents, or for nonconformities of the Contract Documents to applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities.

§ 3.3 Supervision and Construction Procedures

§ 3.3.1 The Contractor shall supervise and direct the Work, using the Contractor's best skill and attention. The Contractor shall be solely responsible for, and have control over, construction means, methods, techniques, sequences, and procedures, and for coordinating all portions of the Work under the Contract. If the Contract Documents give specific instructions concerning construction means, methods, techniques, sequences, or procedures, the Contractor shall evaluate the jobsite safety thereof and shall be solely responsible for the jobsite safety of such means, methods, techniques, sequences, or procedures. If the Contractor determines that such means, methods, techniques, sequences or procedures may not be safe, the Contractor shall give timely notice to the Owner and Architect, and shall propose alternative means, methods, techniques, sequences, or procedures. The Architect shall evaluate the proposed alternative solely for conformance with the design intent for the completed construction. Unless the Architect objects to the Contractor's proposed alternative, the Contractor shall perform the Work using its alternative means, methods, techniques, sequences, or procedures.

§ 3.3.2 The Contractor shall be responsible to the Owner for acts and omissions of the Contractor's employees, Subcontractors and their agents and employees, and other persons or entities performing portions of the Work for, or on behalf of, the Contractor or any of its Subcontractors.

§ 3.3.3 The Contractor shall be responsible for inspection of portions of Work already performed to determine that such portions are in proper condition to receive subsequent Work.

§ 3.4 Labor and Materials

§ 3.4.1 Unless otherwise provided in the Contract Documents, the Contractor shall provide and pay for labor, materials, equipment, tools, construction equipment and machinery, water, heat, utilities, transportation, and other facilities and services necessary for proper execution and completion of the Work, whether temporary or permanent and whether or not incorporated or to be incorporated in the Work.

§ 3.4.2 Except in the case of minor changes in the Work approved by the Architect in accordance with Section 3.12.8 or ordered by the Architect in accordance with Section 7.4, the Contractor may make substitutions only with the consent of the Owner, after evaluation by the Architect and in accordance with a Change Order or Construction Change Directive.

§ 3.4.3 The Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. The Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them.

§ 3.5 Warranty

§ 3.5.1 The Contractor warrants to the Owner and Architect that materials and equipment furnished under the Contract will be of good quality and new unless the Contract Documents require or permit otherwise. The Contractor further warrants that the Work will conform to the requirements of the Contract Documents and will be free from defects, except for those inherent in the quality of the Work the Contract Documents require or permit. Work, materials, or equipment not conforming to these requirements may be considered defective. The Contractor's warranty excludes remedy for damage or defect caused by abuse, alterations to the Work not executed by the Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear and normal usage. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

§ 3.5.2 All material, equipment, or other special warranties required by the Contract Documents shall be issued in the name of the Owner, or shall be transferable to the Owner, and shall commence in accordance with Section 9.8.4.

§ 3.6 Taxes

The Contractor shall pay sales, consumer, use and similar taxes for the Work provided by the Contractor that are legally enacted when bids are received or negotiations concluded, whether or not yet effective or merely scheduled to go into effect.

§ 3.7 Permits, Fees, Notices and Compliance with Laws

§ 3.7.1 Unless otherwise provided in the Contract Documents, the Contractor shall secure and pay for the building permit as well as for other permits, fees, licenses, and inspections by government agencies necessary for proper execution and completion of the Work that are customarily secured after execution of the Contract and legally required at the time bids are received or negotiations concluded.

§ 3.7.2 The Contractor shall comply with and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities applicable to performance of the Work.

§ 3.7.3 If the Contractor performs Work knowing it to be contrary to applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of public authorities, the Contractor shall assume appropriate responsibility for such Work and shall bear the costs attributable to correction.

§ 3.7.4 Concealed or Unknown Conditions

If the Contractor encounters conditions at the site that are (1) subsurface or otherwise concealed physical conditions that differ materially from those indicated in the Contract Documents or (2) unknown physical conditions of an unusual nature that differ materially from those ordinarily found to exist and generally recognized as inherent in construction activities of the character provided for in the Contract Documents, the Contractor shall promptly provide notice to the Owner and the Architect before conditions are disturbed and in no event later than 14 days after first observance of the conditions. The Architect will promptly investigate such conditions and, if the Architect determines that they differ materially and cause an increase or decrease in the Contractor's cost of, or time required for, performance of any part of the Work, will recommend that an equitable adjustment be made in the Contract Sum or Contract Time, or both. If the Architect determines that the conditions at the site are not materially different from those indicated in the Contract Documents and that no change in the terms of the Contract is justified, the Architect shall promptly notify the Owner and Contractor, stating the reasons. If either party disputes the Architect's determination or recommendation, that party may submit a Claim as provided in Article 15.

§ 3.7.5 If, in the course of the Work, the Contractor encounters human remains or recognizes the existence of burial markers, archaeological sites or wetlands not indicated in the Contract Documents, the Contractor shall immediately suspend any operations that would affect them and shall notify the Owner and Architect. Upon receipt of such notice, the Owner shall promptly take any action necessary to obtain governmental authorization required to resume the operations. The Contractor shall continue to suspend such operations until otherwise instructed by the Owner but shall continue with all other operations that do not affect those remains or features. Requests for adjustments in the Contract Sum and Contract Time arising from the existence of such remains or features may be made as provided in Article 15.

§ 3.8 Allowances

§ 3.8.1 The Contractor shall include in the Contract Sum all allowances stated in the Contract Documents. Items covered by allowances shall be supplied for such amounts and by such persons or entities as the Owner may direct, but the Contractor shall not be required to employ persons or entities to whom the Contractor has reasonable objection.

§ 3.8.2 Unless otherwise provided in the Contract Documents,

.1 allowances shall cover the cost to the Contractor of materials and equipment delivered at the site and all required taxes, less applicable trade discounts;

.2 Contractor's costs for unloading and handling at the site, labor, installation costs, overhead, profit, and other expenses contemplated for stated allowance amounts shall be included in the Contract Sum but not in the allowances; and

.3 whenever costs are more than or less than allowances, the Contract Sum shall be adjusted accordingly by Change Order. The amount of the Change Order shall reflect (1) the difference between actual costs and the allowances under Section 3.8.2.1 and (2) changes in Contractor's costs under Section 3.8.2.2.

§ 3.8.3 Materials and equipment under an allowance shall be selected by the Owner with reasonable promptness.

§ 3.9 Superintendent

§ 3.9.1 The Contractor shall employ a competent superintendent and necessary assistants who shall be in attendance at the Project site during performance of the Work. The superintendent shall represent the Contractor, and communications given to the superintendent shall be as binding as if given to the Contractor.

§ 3.9.2 The Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the name and qualifications of a proposed superintendent. Within 14 days of receipt of the information, the Architect may notify the Contractor, stating whether the Owner or the Architect (1) has reasonable objection to the proposed superintendent or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 3.9.3 The Contractor shall not employ a proposed superintendent to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not change the superintendent without the Owner's consent, which shall not unreasonably be withheld or delayed.

§ 3.10 Contractor's Construction and Submittal Schedules

§ 3.10.1 The Contractor, promptly after being awarded the Contract, shall submit for the Owner's and Architect's information a Contractor's construction schedule for the Work. The schedule shall contain detail appropriate for the Project, including (1) the date of commencement of the Work, interim schedule milestone dates, and the date of Substantial Completion; (2) an apportionment of the Work by construction activity; and (3) the time required for completion of each portion of the Work. The schedule shall provide for the orderly progression of the Work to completion and shall not exceed time limits current under the Contract Documents. The schedule shall be revised at appropriate intervals as required by the conditions of the Work and Project.

§ 3.10.2 The Contractor, promptly after being awarded the Contract and thereafter as necessary to maintain a current submittal schedule, shall submit a submittal schedule for the Architect's approval. The Architect's approval shall not be unreasonably delayed or withheld. The submittal schedule shall (1) be coordinated with the Contractor's construction schedule, and (2) allow the Architect reasonable time to review submittals. If the Contractor fails to submit a submittal schedule, or fails to provide submittals in accordance with the approved submittal schedule, the Contractor shall not be entitled to any increase in Contract Sum or extension of Contract Time based on the time required for review of submittals.

§ 3.10.3 The Contractor shall perform the Work in general accordance with the most recent schedules submitted to the Owner and Architect.

§ 3.11 Documents and Samples at the Site

The Contractor shall make available, at the Project site, the Contract Documents, including Change Orders, Construction Change Directives, and other Modifications, in good order and marked currently to indicate field changes and selections made during construction, and the approved Shop Drawings, Product Data, Samples, and similar required submittals. These shall be in electronic form or paper copy, available to the Architect and Owner, and

delivered to the Architect for submittal to the Owner upon completion of the Work as a record of the Work as constructed.

§ 3.12 Shop Drawings, Product Data and Samples

§ 3.12.1 Shop Drawings are drawings, diagrams, schedules, and other data specially prepared for the Work by the Contractor or a Subcontractor, Sub-subcontractor, manufacturer, supplier, or distributor to illustrate some portion of the Work.

§ 3.12.2 Product Data are illustrations, standard schedules, performance charts, instructions, brochures, diagrams, and other information furnished by the Contractor to illustrate materials or equipment for some portion of the Work.

§ 3.12.3 Samples are physical examples that illustrate materials, equipment, or workmanship, and establish standards by which the Work will be judged.

§ 3.12.4 Shop Drawings, Product Data, Samples, and similar submittals are not Contract Documents. Their purpose is to demonstrate how the Contractor proposes to conform to the information given and the design concept expressed in the Contract Documents for those portions of the Work for which the Contract Documents require submittals. Review by the Architect is subject to the limitations of Section 4.2.7. Informational submittals upon which the Architect is not expected to take responsive action may be so identified in the Contract Documents. Submittals that are not required by the Contract Documents may be returned by the Architect without action.

§ 3.12.5 The Contractor shall review for compliance with the Contract Documents, approve, and submit to the Architect, Shop Drawings, Product Data, Samples, and similar submittals required by the Contract Documents, in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness and in such sequence as to cause no delay in the Work or in the activities of the Owner or of Separate Contractors.

§ 3.12.6 By submitting Shop Drawings, Product Data, Samples, and similar submittals, the Contractor represents to the Owner and Architect that the Contractor has (1) reviewed and approved them, (2) determined and verified materials, field measurements and field construction criteria related thereto, or will do so, and (3) checked and coordinated the information contained within such submittals with the requirements of the Work and of the Contract Documents.

§ 3.12.7 The Contractor shall perform no portion of the Work for which the Contract Documents require submittal and review of Shop Drawings, Product Data, Samples, or similar submittals, until the respective submittal has been approved by the Architect.

§ 3.12.8 The Work shall be in accordance with approved submittals except that the Contractor shall not be relieved of responsibility for deviations from the requirements of the Contract Documents by the Architect's approval of Shop Drawings, Product Data, Samples, or similar submittals, unless the Contractor has specifically notified the Architect of such deviation at the time of submittal and (1) the Architect has given written approval to the specific deviation as a minor change in the Work, or (2) a Change Order or Construction Change Directive has been issued authorizing the deviation. The Contractor shall not be relieved of responsibility for errors or omissions in Shop Drawings, Product Data, Samples, or similar submittals, by the Architect's approval thereof.

§ 3.12.9 The Contractor shall direct specific attention, in writing or on resubmitted Shop Drawings, Product Data, Samples, or similar submittals, to revisions other than those requested by the Architect on previous submittals. In the absence of such notice, the Architect's approval of a resubmission shall not apply to such revisions.

§ 3.12.10 The Contractor shall not be required to provide professional services that constitute the practice of architecture or engineering unless such services are specifically required by the Contract Documents for a portion of the Work or unless the Contractor needs to provide such services in order to carry out the Contractor's responsibilities for construction means, methods, techniques, sequences, and procedures. The Contractor shall not be required to provide professional services in violation of applicable law.

§ 3.12.10.1 If professional design services or certifications by a design professional related to systems, materials, or equipment are specifically required of the Contractor by the Contract Documents, the Owner and the Architect will

specify all performance and design criteria that such services must satisfy. The Contractor shall be entitled to rely upon the adequacy and accuracy of the performance and design criteria provided in the Contract Documents. The Contractor shall cause such services or certifications to be provided by an appropriately licensed design professional, whose signature and seal shall appear on all drawings, calculations, specifications, certifications, Shop Drawings, and other submittals prepared by such professional. Shop Drawings, and other submittals related to the Work, designed or certified by such professional, if prepared by others, shall bear such professional's written approval when submitted to the Architect. The Owner and the Architect shall be entitled to rely upon the adequacy and accuracy of the services, certifications, and approvals performed or provided by such design professionals, provided the Owner and Architect have specified to the Contractor the performance and design criteria that such services must satisfy. Pursuant to this Section 3.12.10, the Architect will review and approve or take other appropriate action on submittals only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents.

§ 3.12.10.2 If the Contract Documents require the Contractor's design professional to certify that the Work has been performed in accordance with the design criteria, the Contractor shall furnish such certifications to the Architect at the time and in the form specified by the Architect.

§ 3.13 Use of Site

The Contractor shall confine operations at the site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, lawful orders of public authorities, and the Contract Documents and shall not unreasonably encumber the site with materials or equipment.

§ 3.14 Cutting and Patching

§ 3.14.1 The Contractor shall be responsible for cutting, fitting, or patching required to complete the Work or to make its parts fit together properly. All areas requiring cutting, fitting, or patching shall be restored to the condition existing prior to the cutting, fitting, or patching, unless otherwise required by the Contract Documents.

§ 3.14.2 The Contractor shall not damage or endanger a portion of the Work or fully or partially completed construction of the Owner or Separate Contractors by cutting, patching, or otherwise altering such construction, or by excavation. The Contractor shall not cut or otherwise alter construction by the Owner or a Separate Contractor except with written consent of the Owner and of the Separate Contractor. Consent shall not be unreasonably withheld. The Contractor shall not unreasonably withhold, from the Owner or a Separate Contractor, its consent to cutting or otherwise altering the Work.

§ 3.15 Cleaning Up

§ 3.15.1 The Contractor shall keep the premises and surrounding area free from accumulation of waste materials and rubbish caused by operations under the Contract. At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus materials from and about the Project.

§ 3.15.2 If the Contractor fails to clean up as provided in the Contract Documents, the Owner may do so and the Owner shall be entitled to reimbursement from the Contractor.

§ 3.16 Access to Work

The Contractor shall provide the Owner and Architect with access to the Work in preparation and progress wherever located.

§ 3.17 Royalties, Patents and Copyrights

The Contractor shall pay all royalties and license fees. The Contractor shall defend suits or claims for infringement of copyrights and patent rights and shall hold the Owner and Architect harmless from loss on account thereof, but shall not be responsible for defense or loss when a particular design, process, or product of a particular manufacturer or manufacturers is required by the Contract Documents, or where the copyright violations are contained in Drawings, Specifications, or other documents prepared by the Owner or Architect. However, if an infringement of a copyright or patent is discovered by, or made known to, the Contractor, the Contractor shall be responsible for the loss unless the information is promptly furnished to the Architect.

§ 3.18 Indemnification

§ 3.18.1 To the fullest extent permitted by law, the Contractor shall indemnify and hold harmless the Owner, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), but only to the extent caused by the negligent acts or omissions of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, regardless of whether or not such claim, damage, loss, or expense is caused in part by a party indemnified hereunder. Such obligation shall not be construed to negate, abridge, or reduce other rights or obligations of indemnity that would otherwise exist as to a party or person described in this Section 3.18.

§ 3.18.2 In claims against any person or entity indemnified under this Section 3.18 by an employee of the Contractor, a Subcontractor, anyone directly or indirectly employed by them, or anyone for whose acts they may be liable, the indemnification obligation under Section 3.18.1 shall not be limited by a limitation on amount or type of damages, compensation, or benefits payable by or for the Contractor or a Subcontractor under workers' compensation acts, disability benefit acts, or other employee benefit acts.

ARTICLE 4 ARCHITECT

§ 4.1 General

§ 4.1.1 The Architect is the person or entity retained by the Owner pursuant to Section 2.3.2 and identified as such in the Agreement.

§ 4.1.2 Duties, responsibilities, and limitations of authority of the Architect as set forth in the Contract Documents shall not be restricted, modified, or extended without written consent of the Owner, Contractor, and Architect. Consent shall not be unreasonably withheld.

§ 4.2 Administration of the Contract

§ 4.2.1 The Architect will provide administration of the Contract as described in the Contract Documents and will be an Owner's representative during construction until the date the Architect issues the final Certificate for Payment. The Architect will have authority to act on behalf of the Owner only to the extent provided in the Contract Documents.

§ 4.2.2 The Architect will visit the site at intervals appropriate to the stage of construction, or as otherwise agreed with the Owner, to become generally familiar with the progress and quality of the portion of the Work completed, and to determine in general if the Work observed is being performed in a manner indicating that the Work, when fully completed, will be in accordance with the Contract Documents. However, the Architect will not be required to make exhaustive or continuous on-site inspections to check the quality or quantity of the Work. The Architect will not have control over, charge of, or responsibility for the construction means, methods, techniques, sequences or procedures, or for the safety precautions and programs in connection with the Work, since these are solely the Contractor's rights and responsibilities under the Contract Documents.

§ 4.2.3 On the basis of the site visits, the Architect will keep the Owner reasonably informed about the progress and quality of the portion of the Work completed, and promptly report to the Owner (1) known deviations from the Contract Documents, (2) known deviations from the most recent construction schedule submitted by the Contractor, and (3) defects and deficiencies observed in the Work. The Architect will not be responsible for the Contractor's failure to perform the Work in accordance with the requirements of the Contract Documents. The Architect will not have control over or charge of, and will not be responsible for acts or omissions of, the Contractor, Subcontractors, or their agents or employees, or any other persons or entities performing portions of the Work.

§ 4.2.4 Communications

The Owner and Contractor shall include the Architect in all communications that relate to or affect the Architect's services or professional responsibilities. The Owner shall promptly notify the Architect of the substance of any direct communications between the Owner and the Contractor otherwise relating to the Project. Communications by and with the Architect's consultants shall be through the Architect. Communications by and with Subcontractors and suppliers shall be through the Contractor. Communications by and with Separate Contractors shall be through the Owner. The Contract Documents may specify other communication protocols.

§ 4.2.5 Based on the Architect's evaluations of the Contractor's Applications for Payment, the Architect will review and certify the amounts due the Contractor and will issue Certificates for Payment in such amounts.

§ 4.2.6 The Architect has authority to reject Work that does not conform to the Contract Documents. Whenever the Architect considers it necessary or advisable, the Architect will have authority to require inspection or testing of the Work in accordance with Sections 13.4.2 and 13.4.3, whether or not the Work is fabricated, installed or completed. However, neither this authority of the Architect nor a decision made in good faith either to exercise or not to exercise such authority shall give rise to a duty or responsibility of the Architect to the Contractor, Subcontractors, suppliers, their agents or employees, or other persons or entities performing portions of the Work.

§ 4.2.7 The Architect will review and approve, or take other appropriate action upon, the Contractor's submittals such as Shop Drawings, Product Data, and Samples, but only for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. The Architect's action will be taken in accordance with the submittal schedule approved by the Architect or, in the absence of an approved submittal schedule, with reasonable promptness while allowing sufficient time in the Architect's professional judgment to permit adequate review. Review of such submittals is not conducted for the purpose of determining the accuracy and completeness of other details such as dimensions and quantities, or for substantiating instructions for installation or performance of equipment or systems, all of which remain the responsibility of the Contractor as required by the Contract Documents. The Architect's review of the Contractor's submittals shall not relieve the Contractor of the obligations under Sections 3.3, 3.5, and 3.12. The Architect's review shall not constitute approval of safety precautions or of any construction means, methods, techniques, sequences, or procedures. The Architect's approval of a specific item shall not indicate approval of an assembly of which the item is a component.

§ 4.2.8 The Architect will prepare Change Orders and Construction Change Directives, and may order minor changes in the Work as provided in Section 7.4. The Architect will investigate and make determinations and recommendations regarding concealed and unknown conditions as provided in Section 3.7.4.

§ 4.2.9 The Architect will conduct inspections to determine the date or dates of Substantial Completion and the date of final completion; issue Certificates of Substantial Completion pursuant to Section 9.8; receive and forward to the Owner, for the Owner's review and records, written warranties and related documents required by the Contract and assembled by the Contractor pursuant to Section 9.10; and issue a final Certificate for Payment pursuant to Section 9.10.

§ 4.2.10 If the Owner and Architect agree, the Architect will provide one or more Project representatives to assist in carrying out the Architect's responsibilities at the site. The Owner shall notify the Contractor of any change in the duties, responsibilities and limitations of authority of the Project representatives.

§ 4.2.11 The Architect will interpret and decide matters concerning performance under, and requirements of, the Contract Documents on written request of either the Owner or Contractor. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness.

§ 4.2.12 Interpretations and decisions of the Architect will be consistent with the intent of, and reasonably inferable from, the Contract Documents and will be in writing or in the form of drawings. When making such interpretations and decisions, the Architect will endeavor to secure faithful performance by both Owner and Contractor, will not show partiality to either, and will not be liable for results of interpretations or decisions rendered in good faith.

§ 4.2.13 The Architect's decisions on matters relating to aesthetic effect will be final if consistent with the intent expressed in the Contract Documents.

§ 4.2.14 The Architect will review and respond to requests for information about the Contract Documents. The Architect's response to such requests will be made in writing within any time limits agreed upon or otherwise with reasonable promptness. If appropriate, the Architect will prepare and issue supplemental Drawings and Specifications in response to the requests for information.

ARTICLE 5 SUBCONTRACTORS

§ 5.1 Definitions

§ 5.1.1 A Subcontractor is a person or entity who has a direct contract with the Contractor to perform a portion of the Work at the site. The term "Subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Subcontractor or an authorized representative of the Subcontractor. The term "Subcontractor" does not include a Separate Contractor or the subcontractors of a Separate Contractor.

§ 5.1.2 A Sub-subcontractor is a person or entity who has a direct or indirect contract with a Subcontractor to perform a portion of the Work at the site. The term "Sub-subcontractor" is referred to throughout the Contract Documents as if singular in number and means a Sub-subcontractor or an authorized representative of the Sub-subcontractor.

§ 5.2 Award of Subcontracts and Other Contracts for Portions of the Work

§ 5.2.1 Unless otherwise stated in the Contract Documents, the Contractor, as soon as practicable after award of the Contract, shall notify the Owner and Architect of the persons or entities proposed for each principal portion of the Work, including those who are to furnish materials or equipment fabricated to a special design. Within 14 days of receipt of the information, the Architect may notify the Contractor whether the Owner or the Architect (1) has reasonable objection to any such proposed person or entity or (2) requires additional time for review. Failure of the Architect to provide notice within the 14-day period shall constitute notice of no reasonable objection.

§ 5.2.2 The Contractor shall not contract with a proposed person or entity to whom the Owner or Architect has made reasonable and timely objection. The Contractor shall not be required to contract with anyone to whom the Contractor has made reasonable objection.

§ 5.2.3 If the Owner or Architect has reasonable objection to a person or entity proposed by the Contractor, the Contractor shall propose another to whom the Owner or Architect has no reasonable objection. If the proposed but rejected Subcontractor was reasonably capable of performing the Work, the Contract Sum and Contract Time shall be increased or decreased by the difference, if any, occasioned by such change, and an appropriate Change Order shall be issued before commencement of the substitute Subcontractor's Work. However, no increase in the Contract Sum or Contract Time shall be allowed for such change unless the Contractor has acted promptly and responsively in submitting names as required.

§ 5.2.4 The Contractor shall not substitute a Subcontractor, person, or entity for one previously selected if the Owner or Architect makes reasonable objection to such substitution.

§ 5.3 Subcontractual Relations

By appropriate written agreement, the Contractor shall require each Subcontractor, to the extent of the Work to be performed by the Subcontractor, to be bound to the Contractor by terms of the Contract Documents, and to assume toward the Contractor all the obligations and responsibilities, including the responsibility for safety of the Subcontractor's Work that the Contractor, by these Contract Documents, assumes toward the Owner and Architect. Each subcontract agreement shall preserve and protect the rights of the Owner and Architect under the Contract Documents with respect to the Work to be performed by the Subcontractor so that subcontracting thereof will not prejudice such rights, and shall allow to the Subcontractor, unless specifically provided otherwise in the subcontract agreement, the benefit of all rights, remedies, and redress against the Contractor that the Contractor, by the Contract Documents, has against the Owner. Where appropriate, the Contractor shall require each Subcontractor to enter into similar agreements with Sub-subcontractors. The Contractor shall make available to each proposed Subcontractor, prior to the execution of the subcontract agreement, copies of the Contract Documents to which the Subcontractor will be bound, and, upon written request of the Subcontractor, identify to the Subcontractor terms and conditions of the proposed subcontract agreement that may be at variance with the Contract Documents. Subcontractors will similarly make copies of applicable portions of such documents available to their respective proposed Sub-subcontractors.

§ 5.4 Contingent Assignment of Subcontracts

§ 5.4.1 Each subcontract agreement for a portion of the Work is assigned by the Contractor to the Owner, provided that

- **.1** assignment is effective only after termination of the Contract by the Owner for cause pursuant to Section 14.2 and only for those subcontract agreements that the Owner accepts by notifying the Subcontractor and Contractor; and
- **.2** assignment is subject to the prior rights of the surety, if any, obligated under bond relating to the Contract.

When the Owner accepts the assignment of a subcontract agreement, the Owner assumes the Contractor's rights and obligations under the subcontract.

§ 5.4.2 Upon such assignment, if the Work has been suspended for more than 30 days, the Subcontractor's compensation shall be equitably adjusted for increases in cost resulting from the suspension.

§ 5.4.3 Upon assignment to the Owner under this Section 5.4, the Owner may further assign the subcontract to a successor contractor or other entity. If the Owner assigns the subcontract to a successor contractor or other entity, the Owner shall nevertheless remain legally responsible for all of the successor contractor's obligations under the subcontract.

ARTICLE 6 CONSTRUCTION BY OWNER OR BY SEPARATE CONTRACTORS

§ 6.1 Owner's Right to Perform Construction and to Award Separate Contracts

§ 6.1.1 The term "Separate Contractor(s)" shall mean other contractors retained by the Owner under separate agreements. The Owner reserves the right to perform construction or operations related to the Project with the Owner's own forces, and with Separate Contractors retained under Conditions of the Contract substantially similar to those of this Contract, including those provisions of the Conditions of the Contract related to insurance and waiver of subrogation.

§ 6.1.2 When separate contracts are awarded for different portions of the Project or other construction or operations on the site, the term "Contractor" in the Contract Documents in each case shall mean the Contractor who executes each separate Owner-Contractor Agreement.

§ 6.1.3 The Owner shall provide for coordination of the activities of the Owner's own forces and of each Separate Contractor with the Work of the Contractor, who shall cooperate with them. The Contractor shall participate with any Separate Contractors and the Owner in reviewing their construction schedules. The Contractor shall make any revisions to its construction schedule deemed necessary after a joint review and mutual agreement. The construction schedules shall then constitute the schedules to be used by the Contractor, Separate Contractors, and the Owner until subsequently revised.

§ 6.1.4 Unless otherwise provided in the Contract Documents, when the Owner performs construction or operations related to the Project with the Owner's own forces or with Separate Contractors, the Owner or its Separate Contractors shall have the same obligations and rights that the Contractor has under the Conditions of the Contract, including, without excluding others, those stated in Article 3, this Article 6, and Articles 10, 11, and 12.

§ 6.2 Mutual Responsibility

§ 6.2.1 The Contractor shall afford the Owner and Separate Contractors reasonable opportunity for introduction and storage of their materials and equipment and performance of their activities, and shall connect and coordinate the Contractor's construction and operations with theirs as required by the Contract Documents.

§ 6.2.2 If part of the Contractor's Work depends for proper execution or results upon construction or operations by the Owner or a Separate Contractor, the Contractor shall, prior to proceeding with that portion of the Work, promptly notify the Architect of apparent discrepancies or defects in the construction or operations by the Owner or Separate Contractor that would render it unsuitable for proper execution and results of the Contractor's Work. Failure of the Contractor to notify the Architect of apparent discrepancies or defects prior to proceeding with the Work shall constitute an acknowledgment that the Owner's or Separate Contractor's completed or partially completed construction is fit and proper to receive the Contractor's Work. The Contractor shall not be responsible for discrepancies or defects in the construction or operations by the Owner or Separate Contractor that are not apparent.

§ 6.2.3 The Contractor shall reimburse the Owner for costs the Owner incurs that are payable to a Separate Contractor because of the Contractor's delays, improperly timed activities or defective construction. The Owner shall be responsible to the Contractor for costs the Contractor incurs because of a Separate Contractor's delays, improperly timed activities, damage to the Work or defective construction.

§ 6.2.4 The Contractor shall promptly remedy damage that the Contractor wrongfully causes to completed or partially completed construction or to property of the Owner or Separate Contractor as provided in Section 10.2.5.

§ 6.2.5 The Owner and each Separate Contractor shall have the same responsibilities for cutting and patching as are described for the Contractor in Section 3.14.

§ 6.3 Owner's Right to Clean Up

If a dispute arises among the Contractor, Separate Contractors, and the Owner as to the responsibility under their respective contracts for maintaining the premises and surrounding area free from waste materials and rubbish, the Owner may clean up and the Architect will allocate the cost among those responsible.

ARTICLE 7 CHANGES IN THE WORK

§ 7.1 General

§ 7.1.1 Changes in the Work may be accomplished after execution of the Contract, and without invalidating the Contract, by Change Order, Construction Change Directive or order for a minor change in the Work, subject to the limitations stated in this Article 7 and elsewhere in the Contract Documents.

§ 7.1.2 A Change Order shall be based upon agreement among the Owner, Contractor, and Architect. A Construction Change Directive requires agreement by the Owner and Architect and may or may not be agreed to by the Contractor. An order for a minor change in the Work may be issued by the Architect alone.

§ 7.1.3 Changes in the Work shall be performed under applicable provisions of the Contract Documents. The Contractor shall proceed promptly with changes in the Work, unless otherwise provided in the Change Order, Construction Change Directive, or order for a minor change in the Work.

§ 7.2 Change Orders

§ 7.2.1 A Change Order is a written instrument prepared by the Architect and signed by the Owner, Contractor, and Architect stating their agreement upon all of the following:

.1 The change in the Work;
.2 The amount of the adjustment, if any, in the Contract Sum; and
.3 The extent of the adjustment, if any, in the Contract Time.

§ 7.3 Construction Change Directives

§ 7.3.1 A Construction Change Directive is a written order prepared by the Architect and signed by the Owner and Architect, directing a change in the Work prior to agreement on adjustment, if any, in the Contract Sum or Contract Time, or both. The Owner may by Construction Change Directive, without invalidating the Contract, order changes in the Work within the general scope of the Contract consisting of additions, deletions, or other revisions, the Contract Sum and Contract Time being adjusted accordingly.

§ 7.3.2 A Construction Change Directive shall be used in the absence of total agreement on the terms of a Change Order.

§ 7.3.3 If the Construction Change Directive provides for an adjustment to the Contract Sum, the adjustment shall be based on one of the following methods:

.1 Mutual acceptance of a lump sum properly itemized and supported by sufficient substantiating data to permit evaluation;
.2 Unit prices stated in the Contract Documents or subsequently agreed upon;
.3 Cost to be determined in a manner agreed upon by the parties and a mutually acceptable fixed or percentage fee; or
.4 As provided in Section 7.3.4.

§ 7.3.4 If the Contractor does not respond promptly or disagrees with the method for adjustment in the Contract Sum, the Architect shall determine the adjustment on the basis of reasonable expenditures and savings of those performing the Work attributable to the change, including, in case of an increase in the Contract Sum, an amount for overhead and profit as set forth in the Agreement, or if no such amount is set forth in the Agreement, a reasonable amount. In such case, and also under Section 7.3.3.3, the Contractor shall keep and present, in such form as the Architect may prescribe, an itemized accounting together with appropriate supporting data. Unless otherwise provided in the Contract Documents, costs for the purposes of this Section 7.3.4 shall be limited to the following:

.1 Costs of labor, including applicable payroll taxes, fringe benefits required by agreement or custom, workers' compensation insurance, and other employee costs approved by the Architect;

.2 Costs of materials, supplies, and equipment, including cost of transportation, whether incorporated or consumed;

.3 Rental costs of machinery and equipment, exclusive of hand tools, whether rented from the Contractor or others;

.4 Costs of premiums for all bonds and insurance, permit fees, and sales, use, or similar taxes, directly related to the change; and

.5 Costs of supervision and field office personnel directly attributable to the change.

§ 7.3.5 If the Contractor disagrees with the adjustment in the Contract Time, the Contractor may make a Claim in accordance with applicable provisions of Article 15.

§ 7.3.6 Upon receipt of a Construction Change Directive, the Contractor shall promptly proceed with the change in the Work involved and advise the Architect of the Contractor's agreement or disagreement with the method, if any, provided in the Construction Change Directive for determining the proposed adjustment in the Contract Sum or Contract Time.

§ 7.3.7 A Construction Change Directive signed by the Contractor indicates the Contractor's agreement therewith, including adjustment in Contract Sum and Contract Time or the method for determining them. Such agreement shall be effective immediately and shall be recorded as a Change Order.

§ 7.3.8 The amount of credit to be allowed by the Contractor to the Owner for a deletion or change that results in a net decrease in the Contract Sum shall be actual net cost as confirmed by the Architect. When both additions and credits covering related Work or substitutions are involved in a change, the allowance for overhead and profit shall be figured on the basis of net increase, if any, with respect to that change.

§ 7.3.9 Pending final determination of the total cost of a Construction Change Directive to the Owner, the Contractor may request payment for Work completed under the Construction Change Directive in Applications for Payment. The Architect will make an interim determination for purposes of monthly certification for payment for those costs and certify for payment the amount that the Architect determines, in the Architect's professional judgment, to be reasonably justified. The Architect's interim determination of cost shall adjust the Contract Sum on the same basis as a Change Order, subject to the right of either party to disagree and assert a Claim in accordance with Article 15.

§ 7.3.10 When the Owner and Contractor agree with a determination made by the Architect concerning the adjustments in the Contract Sum and Contract Time, or otherwise reach agreement upon the adjustments, such agreement shall be effective immediately and the Architect will prepare a Change Order. Change Orders may be issued for all or any part of a Construction Change Directive.

§ 7.4 Minor Changes in the Work

The Architect may order minor changes in the Work that are consistent with the intent of the Contract Documents and do not involve an adjustment in the Contract Sum or an extension of the Contract Time. The Architect's order for minor changes shall be in writing. If the Contractor believes that the proposed minor change in the Work will affect the Contract Sum or Contract Time, the Contractor shall notify the Architect and shall not proceed to implement the change in the Work. If the Contractor performs the Work set forth in the Architect's order for a minor change without prior notice to the Architect that such change will affect the Contract Sum or Contract Time, the Contractor waives any adjustment to the Contract Sum or extension of the Contract Time.

ARTICLE 8 TIME

§ 8.1 Definitions

§ 8.1.1 Unless otherwise provided, Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work.

§ 8.1.2 The date of commencement of the Work is the date established in the Agreement.

§ 8.1.3 The date of Substantial Completion is the date certified by the Architect in accordance with Section 9.8.

§ 8.1.4 The term "day" as used in the Contract Documents shall mean calendar day unless otherwise specifically defined.

§ 8.2 Progress and Completion

§ 8.2.1 Time limits stated in the Contract Documents are of the essence of the Contract. By executing the Agreement, the Contractor confirms that the Contract Time is a reasonable period for performing the Work.

§ 8.2.2 The Contractor shall not knowingly, except by agreement or instruction of the Owner in writing, commence the Work prior to the effective date of insurance required to be furnished by the Contractor and Owner.

§ 8.2.3 The Contractor shall proceed expeditiously with adequate forces and shall achieve Substantial Completion within the Contract Time.

§ 8.3 Delays and Extensions of Time

§ 8.3.1 If the Contractor is delayed at any time in the commencement or progress of the Work by (1) an act or neglect of the Owner or Architect, of an employee of either, or of a Separate Contractor; (2) by changes ordered in the Work; (3) by labor disputes, fire, unusual delay in deliveries, unavoidable casualties, adverse weather conditions documented in accordance with Section 15.1.6.2, or other causes beyond the Contractor's control; (4) by delay authorized by the Owner pending mediation and dispute resolution; or (5) by other causes that the Contractor asserts, and the Architect determines, justify delay, then the Contract Time shall be extended for such reasonable time as the Architect may determine.

§ 8.3.2 Claims relating to time shall be made in accordance with applicable provisions of Article 15.

§ 8.3.3 This Section 8.3 does not preclude recovery of damages for delay by either party under other provisions of the Contract Documents.

ARTICLE 9 PAYMENTS AND COMPLETION

§ 9.1 Contract Sum

§ 9.1.1 The Contract Sum is stated in the Agreement and, including authorized adjustments, is the total amount payable by the Owner to the Contractor for performance of the Work under the Contract Documents.

§ 9.1.2 If unit prices are stated in the Contract Documents or subsequently agreed upon, and if quantities originally contemplated are materially changed so that application of such unit prices to the actual quantities causes substantial inequity to the Owner or Contractor, the applicable unit prices shall be equitably adjusted.

§ 9.2 Schedule of Values

Where the Contract is based on a stipulated sum or Guaranteed Maximum Price, the Contractor shall submit a schedule of values to the Architect before the first Application for Payment, allocating the entire Contract Sum to the various portions of the Work. The schedule of values shall be prepared in the form, and supported by the data to substantiate its accuracy, required by the Architect. This schedule, unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's Applications for Payment. Any changes to the schedule of values shall be submitted to the Architect and supported by such data to substantiate its accuracy as the Architect may require, and unless objected to by the Architect, shall be used as a basis for reviewing the Contractor's subsequent Applications for Payment.

§ 9.3 Applications for Payment

§ 9.3.1 At least ten days before the date established for each progress payment, the Contractor shall submit to the Architect an itemized Application for Payment prepared in accordance with the schedule of values, if required under Section 9.2, for completed portions of the Work. The application shall be notarized, if required, and supported by all data substantiating the Contractor's right to payment that the Owner or Architect require, such as copies of requisitions, and releases and waivers of liens from Subcontractors and suppliers, and shall reflect retainage if provided for in the Contract Documents.

§ 9.3.1.1 As provided in Section 7.3.9, such applications may include requests for payment on account of changes in the Work that have been properly authorized by Construction Change Directives, or by interim determinations of the Architect, but not yet included in Change Orders.

§ 9.3.1.2 Applications for Payment shall not include requests for payment for portions of the Work for which the Contractor does not intend to pay a Subcontractor or supplier, unless such Work has been performed by others whom the Contractor intends to pay.

§ 9.3.2 Unless otherwise provided in the Contract Documents, payments shall be made on account of materials and equipment delivered and suitably stored at the site for subsequent incorporation in the Work. If approved in advance by the Owner, payment may similarly be made for materials and equipment suitably stored off the site at a location agreed upon in writing. Payment for materials and equipment stored on or off the site shall be conditioned upon compliance by the Contractor with procedures satisfactory to the Owner to establish the Owner's title to such materials and equipment or otherwise protect the Owner's interest, and shall include the costs of applicable insurance, storage, and transportation to the site, for such materials and equipment stored off the site.

§ 9.3.3 The Contractor warrants that title to all Work covered by an Application for Payment will pass to the Owner no later than the time of payment. The Contractor further warrants that upon submittal of an Application for Payment all Work for which Certificates for Payment have been previously issued and payments received from the Owner shall, to the best of the Contractor's knowledge, information, and belief, be free and clear of liens, claims, security interests, or encumbrances, in favor of the Contractor, Subcontractors, suppliers, or other persons or entities that provided labor, materials, and equipment relating to the Work.

§ 9.4 Certificates for Payment

§ 9.4.1 The Architect will, within seven days after receipt of the Contractor's Application for Payment, either (1) issue to the Owner a Certificate for Payment in the full amount of the Application for Payment, with a copy to the Contractor; or (2) issue to the Owner a Certificate for Payment for such amount as the Architect determines is properly due, and notify the Contractor and Owner of the Architect's reasons for withholding certification in part as provided in Section 9.5.1; or (3) withhold certification of the entire Application for Payment, and notify the Contractor and Owner of the Architect's reason for withholding certification in whole as provided in Section 9.5.1.

§ 9.4.2 The issuance of a Certificate for Payment will constitute a representation by the Architect to the Owner, based on the Architect's evaluation of the Work and the data in the Application for Payment, that, to the best of the Architect's knowledge, information, and belief, the Work has progressed to the point indicated, the quality of the Work is in accordance with the Contract Documents, and that the Contractor is entitled to payment in the amount certified. The foregoing representations are subject to an evaluation of the Work for conformance with the Contract Documents upon Substantial Completion, to results of subsequent tests and inspections, to correction of minor deviations from the Contract Documents prior to completion, and to specific qualifications expressed by the Architect. However, the issuance of a Certificate for Payment will not be a representation that the Architect has (1) made exhaustive or continuous on-site inspections to check the quality or quantity of the Work; (2) reviewed construction means, methods, techniques, sequences, or procedures; (3) reviewed copies of requisitions received from Subcontractors and suppliers and other data requested by the Owner to substantiate the Contractor's right to payment; or (4) made examination to ascertain how or for what purpose the Contractor has used money previously paid on account of the Contract Sum.

§ 9.5 Decisions to Withhold Certification

§ 9.5.1 The Architect may withhold a Certificate for Payment in whole or in part, to the extent reasonably necessary to protect the Owner, if in the Architect's opinion the representations to the Owner required by Section 9.4.2 cannot be made. If the Architect is unable to certify payment in the amount of the Application, the Architect will notify the Contractor and Owner as provided in Section 9.4.1. If the Contractor and Architect cannot agree on a revised amount, the Architect will promptly issue a Certificate for Payment for the amount for which the Architect is able to make such representations to the Owner. The Architect may also withhold a Certificate for Payment or, because of subsequently discovered evidence, may nullify the whole or a part of a Certificate for Payment previously issued, to such extent as may be necessary in the Architect's opinion to protect the Owner from loss for which the Contractor is responsible, including loss resulting from acts and omissions described in Section 3.3.2, because of

- **.1** defective Work not remedied;
- **.2** third party claims filed or reasonable evidence indicating probable filing of such claims, unless security acceptable to the Owner is provided by the Contractor;
- **.3** failure of the Contractor to make payments properly to Subcontractors or suppliers for labor, materials or equipment;

.4 reasonable evidence that the Work cannot be completed for the unpaid balance of the Contract Sum;
.5 damage to the Owner or a Separate Contractor;
.6 reasonable evidence that the Work will not be completed within the Contract Time, and that the unpaid balance would not be adequate to cover actual or liquidated damages for the anticipated delay; or
.7 repeated failure to carry out the Work in accordance with the Contract Documents.

§ 9.5.2 When either party disputes the Architect's decision regarding a Certificate for Payment under Section 9.5.1, in whole or in part, that party may submit a Claim in accordance with Article 15.

§ 9.5.3 When the reasons for withholding certification are removed, certification will be made for amounts previously withheld.

§ 9.5.4 If the Architect withholds certification for payment under Section 9.5.1.3, the Owner may, at its sole option, issue joint checks to the Contractor and to any Subcontractor or supplier to whom the Contractor failed to make payment for Work properly performed or material or equipment suitably delivered. If the Owner makes payments by joint check, the Owner shall notify the Architect and the Contractor shall reflect such payment on its next Application for Payment.

§ 9.6 Progress Payments

§ 9.6.1 After the Architect has issued a Certificate for Payment, the Owner shall make payment in the manner and within the time provided in the Contract Documents, and shall so notify the Architect.

§ 9.6.2 The Contractor shall pay each Subcontractor, no later than seven days after receipt of payment from the Owner, the amount to which the Subcontractor is entitled, reflecting percentages actually retained from payments to the Contractor on account of the Subcontractor's portion of the Work. The Contractor shall, by appropriate agreement with each Subcontractor, require each Subcontractor to make payments to Sub-subcontractors in a similar manner.

§ 9.6.3 The Architect will, on request, furnish to a Subcontractor, if practicable, information regarding percentages of completion or amounts applied for by the Contractor and action taken thereon by the Architect and Owner on account of portions of the Work done by such Subcontractor.

§ 9.6.4 The Owner has the right to request written evidence from the Contractor that the Contractor has properly paid Subcontractors and suppliers amounts paid by the Owner to the Contractor for subcontracted Work. If the Contractor fails to furnish such evidence within seven days, the Owner shall have the right to contact Subcontractors and suppliers to ascertain whether they have been properly paid. Neither the Owner nor Architect shall have an obligation to pay, or to see to the payment of money to, a Subcontractor or supplier, except as may otherwise be required by law.

§ 9.6.5 The Contractor's payments to suppliers shall be treated in a manner similar to that provided in Sections 9.6.2, 9.6.3 and 9.6.4.

§ 9.6.6 A Certificate for Payment, a progress payment, or partial or entire use or occupancy of the Project by the Owner shall not constitute acceptance of Work not in accordance with the Contract Documents.

§ 9.6.7 Unless the Contractor provides the Owner with a payment bond in the full penal sum of the Contract Sum, payments received by the Contractor for Work properly performed by Subcontractors or provided by suppliers shall be held by the Contractor for those Subcontractors or suppliers who performed Work or furnished materials, or both, under contract with the Contractor for which payment was made by the Owner. Nothing contained herein shall require money to be placed in a separate account and not commingled with money of the Contractor, create any fiduciary liability or tort liability on the part of the Contractor for breach of trust, or entitle any person or entity to an award of punitive damages against the Contractor for breach of the requirements of this provision.

§ 9.6.8 Provided the Owner has fulfilled its payment obligations under the Contract Documents, the Contractor shall defend and indemnify the Owner from all loss, liability, damage or expense, including reasonable attorney's fees and litigation expenses, arising out of any lien claim or other claim for payment by any Subcontractor or supplier of any tier. Upon receipt of notice of a lien claim or other claim for payment, the Owner shall notify the Contractor. If approved by the applicable court, when required, the Contractor may substitute a surety bond for the property against which the lien or other claim for payment has been asserted.

§ 9.7 Failure of Payment

If the Architect does not issue a Certificate for Payment, through no fault of the Contractor, within seven days after receipt of the Contractor's Application for Payment, or if the Owner does not pay the Contractor within seven days after the date established in the Contract Documents, the amount certified by the Architect or awarded by dispute resolution, then the Contractor may, upon seven additional days' notice to the Owner and Architect, stop the Work until payment of the amount owing has been received. The Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable costs of shutdown, delay and start-up, plus interest as provided for in the Contract Documents.

§ 9.8 Substantial Completion

§ 9.8.1 Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work for its intended use.

§ 9.8.2 When the Contractor considers that the Work, or a portion thereof which the Owner agrees to accept separately, is substantially complete, the Contractor shall prepare and submit to the Architect a comprehensive list of items to be completed or corrected prior to final payment. Failure to include an item on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

§ 9.8.3 Upon receipt of the Contractor's list, the Architect will make an inspection to determine whether the Work or designated portion thereof is substantially complete. If the Architect's inspection discloses any item, whether or not included on the Contractor's list, which is not sufficiently complete in accordance with the Contract Documents so that the Owner can occupy or utilize the Work or designated portion thereof for its intended use, the Contractor shall, before issuance of the Certificate of Substantial Completion, complete or correct such item upon notification by the Architect. In such case, the Contractor shall then submit a request for another inspection by the Architect to determine Substantial Completion.

§ 9.8.4 When the Work or designated portion thereof is substantially complete, the Architect will prepare a Certificate of Substantial Completion that shall establish the date of Substantial Completion; establish responsibilities of the Owner and Contractor for security, maintenance, heat, utilities, damage to the Work and insurance; and fix the time within which the Contractor shall finish all items on the list accompanying the Certificate. Warranties required by the Contract Documents shall commence on the date of Substantial Completion of the Work or designated portion thereof unless otherwise provided in the Certificate of Substantial Completion.

§ 9.8.5 The Certificate of Substantial Completion shall be submitted to the Owner and Contractor for their written acceptance of responsibilities assigned to them in the Certificate. Upon such acceptance, and consent of surety if any, the Owner shall make payment of retainage applying to the Work or designated portion thereof. Such payment shall be adjusted for Work that is incomplete or not in accordance with the requirements of the Contract Documents.

§ 9.9 Partial Occupancy or Use

§ 9.9.1 The Owner may occupy or use any completed or partially completed portion of the Work at any stage when such portion is designated by separate agreement with the Contractor, provided such occupancy or use is consented to by the insurer and authorized by public authorities having jurisdiction over the Project. Such partial occupancy or use may commence whether or not the portion is substantially complete, provided the Owner and Contractor have accepted in writing the responsibilities assigned to each of them for payments, retainage, if any, security, maintenance, heat, utilities, damage to the Work and insurance, and have agreed in writing concerning the period for correction of the Work and commencement of warranties required by the Contract Documents. When the Contractor considers a portion substantially complete, the Contractor shall prepare and submit a list to the Architect as provided under Section 9.8.2. Consent of the Contractor to partial occupancy or use shall not be unreasonably withheld. The stage of the progress of the Work shall be determined by written agreement between the Owner and Contractor or, if no agreement is reached, by decision of the Architect.

§ 9.9.2 Immediately prior to such partial occupancy or use, the Owner, Contractor, and Architect shall jointly inspect the area to be occupied or portion of the Work to be used in order to determine and record the condition of the Work.

§ 9.9.3 Unless otherwise agreed upon, partial occupancy or use of a portion or portions of the Work shall not constitute acceptance of Work not complying with the requirements of the Contract Documents.

§ 9.10 Final Completion and Final Payment

§ 9.10.1 Upon receipt of the Contractor's notice that the Work is ready for final inspection and acceptance and upon receipt of a final Application for Payment, the Architect will promptly make such inspection. When the Architect finds the Work acceptable under the Contract Documents and the Contract fully performed, the Architect will promptly issue a final Certificate for Payment stating that to the best of the Architect's knowledge, information and belief, and on the basis of the Architect's on-site visits and inspections, the Work has been completed in accordance with the Contract Documents and that the entire balance found to be due the Contractor and noted in the final Certificate is due and payable. The Architect's final Certificate for Payment will constitute a further representation that conditions listed in Section 9.10.2 as precedent to the Contractor's being entitled to final payment have been fulfilled.

§ 9.10.2 Neither final payment nor any remaining retained percentage shall become due until the Contractor submits to the Architect (1) an affidavit that payrolls, bills for materials and equipment, and other indebtedness connected with the Work for which the Owner or the Owner's property might be responsible or encumbered (less amounts withheld by Owner) have been paid or otherwise satisfied, (2) a certificate evidencing that insurance required by the Contract Documents to remain in force after final payment is currently in effect, (3) a written statement that the Contractor knows of no reason that the insurance will not be renewable to cover the period required by the Contract Documents, (4) consent of surety, if any, to final payment, (5) documentation of any special warranties, such as manufacturers' warranties or specific Subcontractor warranties, and (6) if required by the Owner, other data establishing payment or satisfaction of obligations, such as receipts and releases and waivers of liens, claims, security interests, or encumbrances arising out of the Contract, to the extent and in such form as may be designated by the Owner. If a Subcontractor refuses to furnish a release or waiver required by the Owner, the Contractor may furnish a bond satisfactory to the Owner to indemnify the Owner against such lien, claim, security interest, or encumbrance. If a lien, claim, security interest, or encumbrance remains unsatisfied after payments are made, the Contractor shall refund to the Owner all money that the Owner may be compelled to pay in discharging the lien, claim, security interest, or encumbrance, including all costs and reasonable attorneys' fees.

§ 9.10.3 If, after Substantial Completion of the Work, final completion thereof is materially delayed through no fault of the Contractor or by issuance of Change Orders affecting final completion, and the Architect so confirms, the Owner shall, upon application by the Contractor and certification by the Architect, and without terminating the Contract, make payment of the balance due for that portion of the Work fully completed, corrected, and accepted. If the remaining balance for Work not fully completed or corrected is less than retainage stipulated in the Contract Documents, and if bonds have been furnished, the written consent of the surety to payment of the balance due for that portion of the Work fully completed and accepted shall be submitted by the Contractor to the Architect prior to certification of such payment. Such payment shall be made under terms and conditions governing final payment, except that it shall not constitute a waiver of Claims.

§ 9.10.4 The making of final payment shall constitute a waiver of Claims by the Owner except those arising from

- **.1** liens, Claims, security interests, or encumbrances arising out of the Contract and unsettled;
- **.2** failure of the Work to comply with the requirements of the Contract Documents;
- **.3** terms of special warranties required by the Contract Documents; or
- **.4** audits performed by the Owner, if permitted by the Contract Documents, after final payment.

§ 9.10.5 Acceptance of final payment by the Contractor, a Subcontractor, or a supplier, shall constitute a waiver of claims by that payee except those previously made in writing and identified by that payee as unsettled at the time of final Application for Payment.

ARTICLE 10 PROTECTION OF PERSONS AND PROPERTY

§ 10.1 Safety Precautions and Programs

The Contractor shall be responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the performance of the Contract.

§ 10.2 Safety of Persons and Property

§ 10.2.1 The Contractor shall take reasonable precautions for safety of, and shall provide reasonable protection to prevent damage, injury, or loss to

.1 employees on the Work and other persons who may be affected thereby;
.2 the Work and materials and equipment to be incorporated therein, whether in storage on or off the site, under care, custody, or control of the Contractor, a Subcontractor, or a Sub-subcontractor; and
.3 other property at the site or adjacent thereto, such as trees, shrubs, lawns, walks, pavements, roadways, structures, and utilities not designated for removal, relocation, or replacement in the course of construction.

§ 10.2.2 The Contractor shall comply with, and give notices required by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities, bearing on safety of persons or property or their protection from damage, injury, or loss.

§ 10.2.3 The Contractor shall implement, erect, and maintain, as required by existing conditions and performance of the Contract, reasonable safeguards for safety and protection, including posting danger signs and other warnings against hazards; promulgating safety regulations; and notifying the owners and users of adjacent sites and utilities of the safeguards.

§ 10.2.4 When use or storage of explosives or other hazardous materials or equipment, or unusual methods are necessary for execution of the Work, the Contractor shall exercise utmost care and carry on such activities under supervision of properly qualified personnel.

§ 10.2.5 The Contractor shall promptly remedy damage and loss (other than damage or loss insured under property insurance required by the Contract Documents) to property referred to in Sections 10.2.1.2 and 10.2.1.3 caused in whole or in part by the Contractor, a Subcontractor, a Sub-subcontractor, or anyone directly or indirectly employed by any of them, or by anyone for whose acts they may be liable and for which the Contractor is responsible under Sections 10.2.1.2 and 10.2.1.3. The Contractor may make a Claim for the cost to remedy the damage or loss to the extent such damage or loss is attributable to acts or omissions of the Owner or Architect or anyone directly or indirectly employed by either of them, or by anyone for whose acts either of them may be liable, and not attributable to the fault or negligence of the Contractor. The foregoing obligations of the Contractor are in addition to the Contractor's obligations under Section 3.18.

§ 10.2.6 The Contractor shall designate a responsible member of the Contractor's organization at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated by the Contractor in writing to the Owner and Architect.

§ 10.2.7 The Contractor shall not permit any part of the construction or site to be loaded so as to cause damage or create an unsafe condition.

§ 10.2.8 Injury or Damage to Person or Property
If either party suffers injury or damage to person or property because of an act or omission of the other party, or of others for whose acts such party is legally responsible, notice of the injury or damage, whether or not insured, shall be given to the other party within a reasonable time not exceeding 21 days after discovery. The notice shall provide sufficient detail to enable the other party to investigate the matter.

§ 10.3 Hazardous Materials and Substances
§ 10.3.1 The Contractor is responsible for compliance with any requirements included in the Contract Documents regarding hazardous materials or substances. If the Contractor encounters a hazardous material or substance not addressed in the Contract Documents and if reasonable precautions will be inadequate to prevent foreseeable bodily injury or death to persons resulting from a material or substance, including but not limited to asbestos or polychlorinated biphenyl (PCB), encountered on the site by the Contractor, the Contractor shall, upon recognizing the condition, immediately stop Work in the affected area and notify the Owner and Architect of the condition.

§ 10.3.2 Upon receipt of the Contractor's notice, the Owner shall obtain the services of a licensed laboratory to verify the presence or absence of the material or substance reported by the Contractor and, in the event such material or substance is found to be present, to cause it to be rendered harmless. Unless otherwise required by the Contract Documents, the Owner shall furnish in writing to the Contractor and Architect the names and qualifications of persons or entities who are to perform tests verifying the presence or absence of the material or substance or who are to perform the task of removal or safe containment of the material or substance. The Contractor and the Architect will

promptly reply to the Owner in writing stating whether or not either has reasonable objection to the persons or entities proposed by the Owner. If either the Contractor or Architect has an objection to a person or entity proposed by the Owner, the Owner shall propose another to whom the Contractor and the Architect have no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area shall resume upon written agreement of the Owner and Contractor. By Change Order, the Contract Time shall be extended appropriately and the Contract Sum shall be increased by the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up.

§ 10.3.3 To the fullest extent permitted by law, the Owner shall indemnify and hold harmless the Contractor, Subcontractors, Architect, Architect's consultants, and agents and employees of any of them from and against claims, damages, losses, and expenses, including but not limited to attorneys' fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance presents the risk of bodily injury or death as described in Section 10.3.1 and has not been rendered harmless, provided that such claim, damage, loss, or expense is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself), except to the extent that such damage, loss, or expense is due to the fault or negligence of the party seeking indemnity.

§ 10.3.4 The Owner shall not be responsible under this Section 10.3 for hazardous materials or substances the Contractor brings to the site unless such materials or substances are required by the Contract Documents. The Owner shall be responsible for hazardous materials or substances required by the Contract Documents, except to the extent of the Contractor's fault or negligence in the use and handling of such materials or substances.

§ 10.3.5 The Contractor shall reimburse the Owner for the cost and expense the Owner incurs (1) for remediation of hazardous materials or substances the Contractor brings to the site and negligently handles, or (2) where the Contractor fails to perform its obligations under Section 10.3.1, except to the extent that the cost and expense are due to the Owner's fault or negligence.

§ 10.3.6 If, without negligence on the part of the Contractor, the Contractor is held liable by a government agency for the cost of remediation of a hazardous material or substance solely by reason of performing Work as required by the Contract Documents, the Owner shall reimburse the Contractor for all cost and expense thereby incurred.

§ 10.4 Emergencies

In an emergency affecting safety of persons or property, the Contractor shall act, at the Contractor's discretion, to prevent threatened damage, injury, or loss. Additional compensation or extension of time claimed by the Contractor on account of an emergency shall be determined as provided in Article 15 and Article 7.

ARTICLE 11 INSURANCE AND BONDS

§ 11.1 Contractor's Insurance and Bonds

§ 11.1.1 The Contractor shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Contractor shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Owner, Architect, and Architect's consultants shall be named as additional insureds under the Contractor's commercial general liability policy or as otherwise described in the Contract Documents.

§ 11.1.2 The Contractor shall provide surety bonds of the types, for such penal sums, and subject to such terms and conditions as required by the Contract Documents. The Contractor shall purchase and maintain the required bonds from a company or companies lawfully authorized to issue surety bonds in the jurisdiction where the Project is located.

§ 11.1.3 Upon the request of any person or entity appearing to be a potential beneficiary of bonds covering payment of obligations arising under the Contract, the Contractor shall promptly furnish a copy of the bonds or shall authorize a copy to be furnished.

§ 11.1.4 Notice of Cancellation or Expiration of Contractor's Required Insurance. Within three (3) business days of the date the Contractor becomes aware of an impending or actual cancellation or expiration of any insurance required by the Contract Documents, the Contractor shall provide notice to the Owner of such impending or actual cancellation or expiration. Upon receipt of notice from the Contractor, the Owner shall, unless the lapse in coverage arises from an act

or omission of the Owner, have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by the Contractor. The furnishing of notice by the Contractor shall not relieve the Contractor of any contractual obligation to provide any required coverage.

§ 11.2 Owner's Insurance

§ 11.2.1 The Owner shall purchase and maintain insurance of the types and limits of liability, containing the endorsements, and subject to the terms and conditions, as described in the Agreement or elsewhere in the Contract Documents. The Owner shall purchase and maintain the required insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located.

§ 11.2.2 Failure to Purchase Required Property Insurance. If the Owner fails to purchase and maintain the required property insurance, with all of the coverages and in the amounts described in the Agreement or elsewhere in the Contract Documents, the Owner shall inform the Contractor in writing prior to commencement of the Work. Upon receipt of notice from the Owner, the Contractor may delay commencement of the Work and may obtain insurance that will protect the interests of the Contractor, Subcontractors, and Sub-Subcontractors in the Work. When the failure to provide coverage has been cured or resolved, the Contract Sum and Contract Time shall be equitably adjusted. In the event the Owner fails to procure coverage, the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent the loss to the Owner would have been covered by the insurance to have been procured by the Owner. The cost of the insurance shall be charged to the Owner by a Change Order. If the Owner does not provide written notice, and the Contractor is damaged by the failure or neglect of the Owner to purchase or maintain the required insurance, the Owner shall reimburse the Contractor for all reasonable costs and damages attributable thereto.

§ 11.2.3 Notice of Cancellation or Expiration of Owner's Required Property Insurance. Within three (3) business days of the date the Owner becomes aware of an impending or actual cancellation or expiration of any property insurance required by the Contract Documents, the Owner shall provide notice to the Contractor of such impending or actual cancellation or expiration. Unless the lapse in coverage arises from an act or omission of the Contractor: (1) the Contractor, upon receipt of notice from the Owner, shall have the right to stop the Work until the lapse in coverage has been cured by the procurement of replacement coverage by either the Owner or the Contractor; (2) the Contract Time and Contract Sum shall be equitably adjusted; and (3) the Owner waives all rights against the Contractor, Subcontractors, and Sub-subcontractors to the extent any loss to the Owner would have been covered by the insurance had it not expired or been cancelled. If the Contractor purchases replacement coverage, the cost of the insurance shall be charged to the Owner by an appropriate Change Order. The furnishing of notice by the Owner shall not relieve the Owner of any contractual obligation to provide required insurance.

§ 11.3 Waivers of Subrogation

§ 11.3.1 The Owner and Contractor waive all rights against (1) each other and any of their subcontractors, sub-subcontractors, agents, and employees, each of the other; (2) the Architect and Architect's consultants; and (3) Separate Contractors, if any, and any of their subcontractors, sub-subcontractors, agents, and employees, for damages caused by fire, or other causes of loss, to the extent those losses are covered by property insurance required by the Agreement or other property insurance applicable to the Project, except such rights as they have to proceeds of such insurance. The Owner or Contractor, as appropriate, shall require similar written waivers in favor of the individuals and entities identified above from the Architect, Architect's consultants, Separate Contractors, subcontractors, and sub-subcontractors. The policies of insurance purchased and maintained by each person or entity agreeing to waive claims pursuant to this section 11.3.1 shall not prohibit this waiver of subrogation. This waiver of subrogation shall be effective as to a person or entity (1) even though that person or entity would otherwise have a duty of indemnification, contractual or otherwise, (2) even though that person or entity did not pay the insurance premium directly or indirectly, or (3) whether or not the person or entity had an insurable interest in the damaged property.

§ 11.3.2 If during the Project construction period the Owner insures properties, real or personal or both, at or adjacent to the site by property insurance under policies separate from those insuring the Project, or if after final payment property insurance is to be provided on the completed Project through a policy or policies other than those insuring the Project during the construction period, to the extent permissible by such policies, the Owner waives all rights in accordance with the terms of Section 11.3.1 for damages caused by fire or other causes of loss covered by this separate property insurance.

§ 11.4 Loss of Use, Business Interruption, and Delay in Completion Insurance

The Owner, at the Owner's option, may purchase and maintain insurance that will protect the Owner against loss of use of the Owner's property, or the inability to conduct normal operations, due to fire or other causes of loss. The Owner waives all rights of action against the Contractor and Architect for loss of use of the Owner's property, due to fire or other hazards however caused.

§11.5 Adjustment and Settlement of Insured Loss

§ 11.5.1 A loss insured under the property insurance required by the Agreement shall be adjusted by the Owner as fiduciary and made payable to the Owner as fiduciary for the insureds, as their interests may appear, subject to requirements of any applicable mortgagee clause and of Section 11.5.2. The Owner shall pay the Architect and Contractor their just shares of insurance proceeds received by the Owner, and by appropriate agreements the Architect and Contractor shall make payments to their consultants and Subcontractors in similar manner.

§ 11.5.2 Prior to settlement of an insured loss, the Owner shall notify the Contractor of the terms of the proposed settlement as well as the proposed allocation of the insurance proceeds. The Contractor shall have 14 days from receipt of notice to object to the proposed settlement or allocation of the proceeds. If the Contractor does not object, the Owner shall settle the loss and the Contractor shall be bound by the settlement and allocation. Upon receipt, the Owner shall deposit the insurance proceeds in a separate account and make the appropriate distributions. Thereafter, if no other agreement is made or the Owner does not terminate the Contract for convenience, the Owner and Contractor shall execute a Change Order for reconstruction of the damaged or destroyed Work in the amount allocated for that purpose. If the Contractor timely objects to either the terms of the proposed settlement or the allocation of the proceeds, the Owner may proceed to settle the insured loss, and any dispute between the Owner and Contractor arising out of the settlement or allocation of the proceeds shall be resolved pursuant to Article 15. Pending resolution of any dispute, the Owner may issue a Construction Change Directive for the reconstruction of the damaged or destroyed Work.

ARTICLE 12 UNCOVERING AND CORRECTION OF WORK

§ 12.1 Uncovering of Work

§ 12.1.1 If a portion of the Work is covered contrary to the Architect's request or to requirements specifically expressed in the Contract Documents, it must, if requested in writing by the Architect, be uncovered for the Architect's examination and be replaced at the Contractor's expense without change in the Contract Time.

§ 12.1.2 If a portion of the Work has been covered that the Architect has not specifically requested to examine prior to its being covered, the Architect may request to see such Work and it shall be uncovered by the Contractor. If such Work is in accordance with the Contract Documents, the Contractor shall be entitled to an equitable adjustment to the Contract Sum and Contract Time as may be appropriate. If such Work is not in accordance with the Contract Documents, the costs of uncovering the Work, and the cost of correction, shall be at the Contractor's expense.

§ 12.2 Correction of Work

§ 12.2.1 Before Substantial Completion

The Contractor shall promptly correct Work rejected by the Architect or failing to conform to the requirements of the Contract Documents, discovered before Substantial Completion and whether or not fabricated, installed or completed. Costs of correcting such rejected Work, including additional testing and inspections, the cost of uncovering and replacement, and compensation for the Architect's services and expenses made necessary thereby, shall be at the Contractor's expense.

§ 12.2.2 After Substantial Completion

§ 12.2.2.1 In addition to the Contractor's obligations under Section 3.5, if, within one year after the date of Substantial Completion of the Work or designated portion thereof or after the date for commencement of warranties established under Section 9.9.1, or by terms of any applicable special warranty required by the Contract Documents, any of the Work is found to be not in accordance with the requirements of the Contract Documents, the Contractor shall correct it promptly after receipt of notice from the Owner to do so, unless the Owner has previously given the Contractor a written acceptance of such condition. The Owner shall give such notice promptly after discovery of the condition. During the one-year period for correction of Work, if the Owner fails to notify the Contractor and give the Contractor an opportunity to make the correction, the Owner waives the rights to require correction by the Contractor and to make a claim for breach of warranty. If the Contractor fails to correct nonconforming Work within a reasonable time during that period after receipt of notice from the Owner or Architect, the Owner may correct it in accordance with Section 2.5.

§ 12.2.2.2 The one-year period for correction of Work shall be extended with respect to portions of Work first performed after Substantial Completion by the period of time between Substantial Completion and the actual completion of that portion of the Work.

§ 12.2.2.3 The one-year period for correction of Work shall not be extended by corrective Work performed by the Contractor pursuant to this Section 12.2.

§ 12.2.3 The Contractor shall remove from the site portions of the Work that are not in accordance with the requirements of the Contract Documents and are neither corrected by the Contractor nor accepted by the Owner.

§ 12.2.4 The Contractor shall bear the cost of correcting destroyed or damaged construction of the Owner or Separate Contractors, whether completed or partially completed, caused by the Contractor's correction or removal of Work that is not in accordance with the requirements of the Contract Documents.

§ 12.2.5 Nothing contained in this Section 12.2 shall be construed to establish a period of limitation with respect to other obligations the Contractor has under the Contract Documents. Establishment of the one-year period for correction of Work as described in Section 12.2.2 relates only to the specific obligation of the Contractor to correct the Work, and has no relationship to the time within which the obligation to comply with the Contract Documents may be sought to be enforced, nor to the time within which proceedings may be commenced to establish the Contractor's liability with respect to the Contractor's obligations other than specifically to correct the Work.

§ 12.3 Acceptance of Nonconforming Work

If the Owner prefers to accept Work that is not in accordance with the requirements of the Contract Documents, the Owner may do so instead of requiring its removal and correction, in which case the Contract Sum will be reduced as appropriate and equitable. Such adjustment shall be effected whether or not final payment has been made.

ARTICLE 13 MISCELLANEOUS PROVISIONS

§ 13.1 Governing Law

The Contract shall be governed by the law of the place where the Project is located.

§ 13.2 Successors and Assigns

§ 13.2.1 The Owner and Contractor respectively bind themselves, their partners, successors, assigns, and legal representatives to covenants, agreements, and obligations contained in the Contract Documents. Except as provided in Section 13.2.2, neither party to the Contract shall assign the Contract as a whole without written consent of the other. If either party attempts to make an assignment without such consent, that party shall nevertheless remain legally responsible for all obligations under the Contract.

§ 13.2.2 The Owner may, without consent of the Contractor, assign the Contract to a lender providing construction financing for the Project, if the lender assumes the Owner's rights and obligations under the Contract Documents. The Contractor shall execute all consents reasonably required to facilitate the assignment.

§ 13.3 Rights and Remedies

§ 13.3.1 Duties and obligations imposed by the Contract Documents and rights and remedies available thereunder shall be in addition to and not a limitation of duties, obligations, rights, and remedies otherwise imposed or available by law.

§ 13.3.2 No action or failure to act by the Owner, Architect, or Contractor shall constitute a waiver of a right or duty afforded them under the Contract, nor shall such action or failure to act constitute approval of or acquiescence in a breach thereunder, except as may be specifically agreed upon in writing.

§ 13.4 Tests and Inspections

§ 13.4.1 Tests, inspections, and approvals of portions of the Work shall be made as required by the Contract Documents and by applicable laws, statutes, ordinances, codes, rules, and regulations or lawful orders of public authorities. Unless otherwise provided, the Contractor shall make arrangements for such tests, inspections, and approvals with an independent testing laboratory or entity acceptable to the Owner, or with the appropriate public authority, and shall bear all related costs of tests, inspections, and approvals. The Contractor shall give the Architect timely notice of when and where tests and inspections are to be made so that the Architect may be present for such

procedures. The Owner shall bear costs of tests, inspections, or approvals that do not become requirements until after bids are received or negotiations concluded. The Owner shall directly arrange and pay for tests, inspections, or approvals where building codes or applicable laws or regulations so require.

§ 13.4.2 If the Architect, Owner, or public authorities having jurisdiction determine that portions of the Work require additional testing, inspection, or approval not included under Section 13.4.1, the Architect will, upon written authorization from the Owner, instruct the Contractor to make arrangements for such additional testing, inspection, or approval, by an entity acceptable to the Owner, and the Contractor shall give timely notice to the Architect of when and where tests and inspections are to be made so that the Architect may be present for such procedures. Such costs, except as provided in Section 13.4.3, shall be at the Owner's expense.

§ 13.4.3 If procedures for testing, inspection, or approval under Sections 13.4.1 and 13.4.2 reveal failure of the portions of the Work to comply with requirements established by the Contract Documents, all costs made necessary by such failure, including those of repeated procedures and compensation for the Architect's services and expenses, shall be at the Contractor's expense.

§ 13.4.4 Required certificates of testing, inspection, or approval shall, unless otherwise required by the Contract Documents, be secured by the Contractor and promptly delivered to the Architect.

§ 13.4.5 If the Architect is to observe tests, inspections, or approvals required by the Contract Documents, the Architect will do so promptly and, where practicable, at the normal place of testing.

§ 13.4.6 Tests or inspections conducted pursuant to the Contract Documents shall be made promptly to avoid unreasonable delay in the Work.

§ 13.5 Interest

Payments due and unpaid under the Contract Documents shall bear interest from the date payment is due at the rate the parties agree upon in writing or, in the absence thereof, at the legal rate prevailing from time to time at the place where the Project is located.

ARTICLE 14 TERMINATION OR SUSPENSION OF THE CONTRACT

§ 14.1 Termination by the Contractor

§ 14.1.1 The Contractor may terminate the Contract if the Work is stopped for a period of 30 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, for any of the following reasons:

- **.1** Issuance of an order of a court or other public authority having jurisdiction that requires all Work to be stopped;
- **.2** An act of government, such as a declaration of national emergency, that requires all Work to be stopped;
- **.3** Because the Architect has not issued a Certificate for Payment and has not notified the Contractor of the reason for withholding certification as provided in Section 9.4.1, or because the Owner has not made payment on a Certificate for Payment within the time stated in the Contract Documents; or
- **.4** The Owner has failed to furnish to the Contractor reasonable evidence as required by Section 2.2.

§ 14.1.2 The Contractor may terminate the Contract if, through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, their agents or employees, or any other persons or entities performing portions of the Work, repeated suspensions, delays, or interruptions of the entire Work by the Owner as described in Section 14.3, constitute in the aggregate more than 100 percent of the total number of days scheduled for completion, or 120 days in any 365-day period, whichever is less.

§ 14.1.3 If one of the reasons described in Section 14.1.1 or 14.1.2 exists, the Contractor may, upon seven days' notice to the Owner and Architect, terminate the Contract and recover from the Owner payment for Work executed, as well as reasonable overhead and profit on Work not executed, and costs incurred by reason of such termination.

§ 14.1.4 If the Work is stopped for a period of 60 consecutive days through no act or fault of the Contractor, a Subcontractor, a Sub-subcontractor, or their agents or employees or any other persons or entities performing portions of the Work because the Owner has repeatedly failed to fulfill the Owner's obligations under the Contract Documents

with respect to matters important to the progress of the Work, the Contractor may, upon seven additional days' notice to the Owner and the Architect, terminate the Contract and recover from the Owner as provided in Section 14.1.3.

§ 14.2 Termination by the Owner for Cause

§ 14.2.1 The Owner may terminate the Contract if the Contractor

.1 repeatedly refuses or fails to supply enough properly skilled workers or proper materials;

.2 fails to make payment to Subcontractors or suppliers in accordance with the respective agreements between the Contractor and the Subcontractors or suppliers;

.3 repeatedly disregards applicable laws, statutes, ordinances, codes, rules and regulations, or lawful orders of a public authority; or

.4 otherwise is guilty of substantial breach of a provision of the Contract Documents.

§ 14.2.2 When any of the reasons described in Section 14.2.1 exist, and upon certification by the Architect that sufficient cause exists to justify such action, the Owner may, without prejudice to any other rights or remedies of the Owner and after giving the Contractor and the Contractor's surety, if any, seven days' notice, terminate employment of the Contractor and may, subject to any prior rights of the surety:

.1 Exclude the Contractor from the site and take possession of all materials, equipment, tools, and construction equipment and machinery thereon owned by the Contractor;

.2 Accept assignment of subcontracts pursuant to Section 5.4; and

.3 Finish the Work by whatever reasonable method the Owner may deem expedient. Upon written request of the Contractor, the Owner shall furnish to the Contractor a detailed accounting of the costs incurred by the Owner in finishing the Work.

§ 14.2.3 When the Owner terminates the Contract for one of the reasons stated in Section 14.2.1, the Contractor shall not be entitled to receive further payment until the Work is finished.

§ 14.2.4 If the unpaid balance of the Contract Sum exceeds costs of finishing the Work, including compensation for the Architect's services and expenses made necessary thereby, and other damages incurred by the Owner and not expressly waived, such excess shall be paid to the Contractor. If such costs and damages exceed the unpaid balance, the Contractor shall pay the difference to the Owner. The amount to be paid to the Contractor or Owner, as the case may be, shall be certified by the Initial Decision Maker, upon application, and this obligation for payment shall survive termination of the Contract.

§ 14.3 Suspension by the Owner for Convenience

§ 14.3.1 The Owner may, without cause, order the Contractor in writing to suspend, delay or interrupt the Work, in whole or in part for such period of time as the Owner may determine.

§ 14.3.2 The Contract Sum and Contract Time shall be adjusted for increases in the cost and time caused by suspension, delay, or interruption under Section 14.3.1. Adjustment of the Contract Sum shall include profit. No adjustment shall be made to the extent

.1 that performance is, was, or would have been, so suspended, delayed, or interrupted, by another cause for which the Contractor is responsible; or

.2 that an equitable adjustment is made or denied under another provision of the Contract.

§ 14.4 Termination by the Owner for Convenience

§ 14.4.1 The Owner may, at any time, terminate the Contract for the Owner's convenience and without cause.

§ 14.4.2 Upon receipt of notice from the Owner of such termination for the Owner's convenience, the Contractor shall

.1 cease operations as directed by the Owner in the notice;

.2 take actions necessary, or that the Owner may direct, for the protection and preservation of the Work; and

.3 except for Work directed to be performed prior to the effective date of termination stated in the notice, terminate all existing subcontracts and purchase orders and enter into no further subcontracts and purchase orders.

§ 14.4.3 In case of such termination for the Owner's convenience, the Owner shall pay the Contractor for Work properly executed; costs incurred by reason of the termination, including costs attributable to termination of

Subcontracts; and the termination fee, if any, set forth in the Agreement.

ARTICLE 15 CLAIMS AND DISPUTES

§ 15.1 Claims

§ 15.1.1 Definition

A Claim is a demand or assertion by one of the parties seeking, as a matter of right, payment of money, a change in the Contract Time, or other relief with respect to the terms of the Contract. The term "Claim" also includes other disputes and matters in question between the Owner and Contractor arising out of or relating to the Contract. The responsibility to substantiate Claims shall rest with the party making the Claim. This Section 15.1.1 does not require the Owner to file a Claim in order to impose liquidated damages in accordance with the Contract Documents.

§ 15.1.2 Time Limits on Claims

The Owner and Contractor shall commence all Claims and causes of action against the other and arising out of or related to the Contract, whether in contract, tort, breach of warranty or otherwise, in accordance with the requirements of the dispute resolution method selected in the Agreement and within the period specified by applicable law, but in any case not more than 10 years after the date of Substantial Completion of the Work. The Owner and Contractor waive all Claims and causes of action not commenced in accordance with this Section 15.1.2.

§ 15.1.3 Notice of Claims

§ 15.1.3.1 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered prior to expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party and to the Initial Decision Maker with a copy sent to the Architect, if the Architect is not serving as the Initial Decision Maker. Claims by either party under this Section 15.1.3.1 shall be initiated within 21 days after occurrence of the event giving rise to such Claim or within 21 days after the claimant first recognizes the condition giving rise to the Claim, whichever is later.

§ 15.1.3.2 Claims by either the Owner or Contractor, where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2, shall be initiated by notice to the other party. In such event, no decision by the Initial Decision Maker is required.

§ 15.1.4 Continuing Contract Performance

§ 15.1.4.1 Pending final resolution of a Claim, except as otherwise agreed in writing or as provided in Section 9.7 and Article 14, the Contractor shall proceed diligently with performance of the Contract and the Owner shall continue to make payments in accordance with the Contract Documents.

§ 15.1.4.2 The Contract Sum and Contract Time shall be adjusted in accordance with the Initial Decision Maker's decision, subject to the right of either party to proceed in accordance with this Article 15. The Architect will issue Certificates for Payment in accordance with the decision of the Initial Decision Maker.

§ 15.1.5 Claims for Additional Cost

If the Contractor wishes to make a Claim for an increase in the Contract Sum, notice as provided in Section 15.1.3 shall be given before proceeding to execute the portion of the Work that is the subject of the Claim. Prior notice is not required for Claims relating to an emergency endangering life or property arising under Section 10.4.

§ 15.1.6 Claims for Additional Time

§ 15.1.6.1 If the Contractor wishes to make a Claim for an increase in the Contract Time, notice as provided in Section 15.1.3 shall be given. The Contractor's Claim shall include an estimate of cost and of probable effect of delay on progress of the Work. In the case of a continuing delay, only one Claim is necessary.

§ 15.1.6.2 If adverse weather conditions are the basis for a Claim for additional time, such Claim shall be documented by data substantiating that weather conditions were abnormal for the period of time, could not have been reasonably anticipated, and had an adverse effect on the scheduled construction.

§ 15.1.7 Waiver of Claims for Consequential Damages

The Contractor and Owner waive Claims against each other for consequential damages arising out of or relating to this Contract. This mutual waiver includes

.1 damages incurred by the Owner for rental expenses, for losses of use, income, profit, financing, business and reputation, and for loss of management or employee productivity or of the services of such persons; and

.2 damages incurred by the Contractor for principal office expenses including the compensation of personnel stationed there, for losses of financing, business and reputation, and for loss of profit, except anticipated profit arising directly from the Work.

This mutual waiver is applicable, without limitation, to all consequential damages due to either party's termination in accordance with Article 14. Nothing contained in this Section 15.1.7 shall be deemed to preclude assessment of liquidated damages, when applicable, in accordance with the requirements of the Contract Documents.

§ 15.2 Initial Decision

§ 15.2.1 Claims, excluding those where the condition giving rise to the Claim is first discovered after expiration of the period for correction of the Work set forth in Section 12.2.2 or arising under Sections 10.3, 10.4, and 11.5, shall be referred to the Initial Decision Maker for initial decision. The Architect will serve as the Initial Decision Maker, unless otherwise indicated in the Agreement. Except for those Claims excluded by this Section 15.2.1, an initial decision shall be required as a condition precedent to mediation of any Claim. If an initial decision has not been rendered within 30 days after the Claim has been referred to the Initial Decision Maker, the party asserting the Claim may demand mediation and dispute resolution without a decision having been rendered. Unless the Initial Decision Maker and all affected parties agree, the Initial Decision Maker will not decide disputes between the Contractor and persons or entities other than the Owner.

§ 15.2.2 The Initial Decision Maker will review Claims and within ten days of the receipt of a Claim take one or more of the following actions: (1) request additional supporting data from the claimant or a response with supporting data from the other party, (2) reject the Claim in whole or in part, (3) approve the Claim, (4) suggest a compromise, or (5) advise the parties that the Initial Decision Maker is unable to resolve the Claim if the Initial Decision Maker lacks sufficient information to evaluate the merits of the Claim or if the Initial Decision Maker concludes that, in the Initial Decision Maker's sole discretion, it would be inappropriate for the Initial Decision Maker to resolve the Claim.

§ 15.2.3 In evaluating Claims, the Initial Decision Maker may, but shall not be obligated to, consult with or seek information from either party or from persons with special knowledge or expertise who may assist the Initial Decision Maker in rendering a decision. The Initial Decision Maker may request the Owner to authorize retention of such persons at the Owner's expense.

§ 15.2.4 If the Initial Decision Maker requests a party to provide a response to a Claim or to furnish additional supporting data, such party shall respond, within ten days after receipt of the request, and shall either (1) provide a response on the requested supporting data, (2) advise the Initial Decision Maker when the response or supporting data will be furnished, or (3) advise the Initial Decision Maker that no supporting data will be furnished. Upon receipt of the response or supporting data, if any, the Initial Decision Maker will either reject or approve the Claim in whole or in part.

§ 15.2.5 The Initial Decision Maker will render an initial decision approving or rejecting the Claim, or indicating that the Initial Decision Maker is unable to resolve the Claim. This initial decision shall (1) be in writing; (2) state the reasons therefor; and (3) notify the parties and the Architect, if the Architect is not serving as the Initial Decision Maker, of any change in the Contract Sum or Contract Time or both. The initial decision shall be final and binding on the parties but subject to mediation and, if the parties fail to resolve their dispute through mediation, to dispute resolution.

§ 15.2.6 Either party may file for mediation of an initial decision at any time, subject to the terms of Section 15.2.6.1.

§ 15.2.6.1 Either party may, within 30 days from the date of receipt of an initial decision, demand in writing that the other party file for mediation. If such a demand is made and the party receiving the demand fails to file for mediation within 30 days after receipt thereof, then both parties waive their rights to mediate or pursue dispute resolution proceedings with respect to the initial decision.

§ 15.2.7 In the event of a Claim against the Contractor, the Owner may, but is not obligated to, notify the surety, if any, of the nature and amount of the Claim. If the Claim relates to a possibility of a Contractor's default, the Owner may, but is not obligated to, notify the surety and request the surety's assistance in resolving the controversy.

§ 15.2.8 If a Claim relates to or is the subject of a mechanic's lien, the party asserting such Claim may proceed in accordance with applicable law to comply with the lien notice or filing deadlines.

§ 15.3 Mediation

§ 15.3.1 Claims, disputes, or other matters in controversy arising out of or related to the Contract, except those waived as provided for in Sections 9.10.4, 9.10.5, and 15.1.7, shall be subject to mediation as a condition precedent to dispute resolution.

§ 15.3.2 The parties shall endeavor to resolve their Claims by mediation which, unless the parties mutually agree otherwise, shall be administered by the American Arbitration Association in accordance with its Construction Industry Mediation Procedures in effect on the date of the Agreement. A request for mediation shall be made in writing, delivered to the other party to the Contract, and filed with the person or entity administering the mediation. The request may be made concurrently with the filing of dispute resolution proceedings but, in such event, mediation shall proceed in advance of dispute resolution proceedings, which shall be stayed pending mediation for a period of 60 days from the date of filing, unless stayed for a longer period by agreement of the parties or court order. **§ 15.3.3** Either party may, within 30 days from the date that mediation has been concluded without resolution of the dispute or 60 days after mediation has been demanded without resolution of the dispute, demand in writing that the other party file for dispute resolution. If such a demand is made and the party receiving the demand fails to file for dispute resolution within 60 days after receipt thereof, then both parties waive their rights to dispute resolution proceedings with respect to the initial decision.

§ 15.3.4 The parties shall share the mediator's fee and any filing fees equally. The mediation shall be held in the place where the Project is located, unless another location is mutually agreed upon. Agreements reached in mediation shall be enforceable as settlement agreements in any court having jurisdiction thereof.

(Paragraphs deleted)

DRAFT

AIA® Document A133™ – 2019 Exhibit B

Insurance and Bonds

This Insurance and Bonds Exhibit is part of the Agreement, between the Owner and the Construction Manager, dated the day of in the year
(In words, indicate day, month and year.)

for the following **PROJECT**:
(Name and location or address)

Bentonville Public Library Expansion
405 S Main Street
Bentonville, AR 72712

THE OWNER:
(Name, legal status, and address)

City of Bentonville Public Library
Hadi Dudley
405 S Main Street
Bentonville, AR 72712

THE CONSTRUCTION MANAGER:
(Name, legal status, and address)

Flintco, LLC
184 E. Fantinel Blvd
Springdale, AR 72762

TABLE OF ARTICLES

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

This document is intended to be used in conjunction with AIA Document A201™–2017, General Conditions of the Contract for Construction. Article 11 of A201™–2017 contains additional insurance provisions.

ARTICLE B.1 GENERAL

The Owner and Construction Manager shall purchase and maintain insurance, and provide bonds, as set forth in this Exhibit. As used in this Exhibit, the term General Conditions refers to AIA Document A201™–2017, General Conditions of the Contract for Construction.

ARTICLE B.2 OWNER'S INSURANCE

§ B.2.1 General

Prior to commencement of the Work, the Owner shall secure the insurance, and provide evidence of the coverage, required under this Article B.2 and, upon the Construction Manager's request, provide a copy of the property insurance policy or policies required by Section B.2.3. The copy of the policy or policies provided shall contain all applicable conditions, definitions, exclusions, and endorsements.

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§ B.2.2 Liability Insurance
The Owner shall be responsible for purchasing and maintaining the Owner's usual general liability insurance.

§ B.2.3 Required Property Insurance
§ B.2.3.1 Unless this obligation is placed on the Construction Manager pursuant to Section B.3.3.2.1, the Owner shall purchase and maintain, from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located, property insurance written on a builder's risk "all-risks" completed value or equivalent policy form and sufficient to cover the total value of the entire Project on a replacement cost basis. The Owner's property insurance coverage shall be no less than the amount of the initial Contract Sum, plus the value of subsequent Modifications and labor performed and materials or equipment supplied by others. The property insurance shall be maintained until Substantial Completion and thereafter as provided in Section B.2.3.1.3, unless otherwise provided in the Contract Documents or otherwise agreed in writing by the parties to this Agreement. This insurance shall include the interests of the Owner, Construction Manager, Subcontractors, and Sub-subcontractors in the Project as insureds. This insurance shall include the interests of mortgagees as loss payees.

§ B.2.3.1.1 Causes of Loss. The insurance required by this Section B.2.3.1 shall provide coverage for direct physical loss or damage, and shall not exclude the risks of fire, explosion, theft, vandalism, malicious mischief, collapse, windstorm. The insurance shall also provide coverage for ensuing loss or resulting damage from error, omission, or deficiency in construction methods, design, specifications, workmanship, or materials.

§ B.2.3.1.2 Specific Required Coverages. The insurance required by this Section B.2.3.1 shall provide coverage for loss or damage to falsework and other temporary structures, and to building systems from testing and startup. The insurance shall also cover debris removal, including demolition occasioned by enforcement of any applicable legal requirements, and reasonable compensation for the Architect's and Construction Manager's services and expenses required as a result of such insured loss, including claim preparation expenses.

§ B.2.3.1.3 Unless the parties agree otherwise, upon Substantial Completion, the Owner shall continue the insurance required by Section B.2.3.1 or, if necessary, replace the insurance policy required under Section B.2.3.1 with property insurance written for the total value of the Project that shall remain in effect until expiration of the period for correction of the Work set forth in Section 12.2.2 of the General Conditions.

§ B.2.3.1.4 Deductibles and Self-Insured Retentions. If the insurance required by this Section B.2.3 is subject to deductibles or self-insured retentions, the Owner shall be responsible for all loss not covered because of such deductibles or retentions.

§ B.2.3.2 Occupancy or Use Prior to Substantial Completion. The Owner's occupancy or use of any completed or partially completed portion of the Work prior to Substantial Completion shall not commence until the insurance company or companies providing the insurance under Section B.2.3.1 have consented in writing to the continuance of coverage. The Owner and the Construction Manager shall take no action with respect to partial occupancy or use that would cause cancellation, lapse, or reduction of insurance, unless they agree otherwise in writing.

THE CONTRACTOR SHALL MAINTAIN BUILDERS' RISK INSURANCE AND SHALL FILE CERTIFICATES OF INSURANCE WITH THE OWNER AS REQUIRED. The limits of such insurance shall be not less that the following:

1. Property Insurance (Builders' Risk) shall be purchased and maintained by the Contractor. Furnish Owner with a copy of the policy. Contractor shall notify Owner at least Fifteen (15) days before policy is terminated. Insurance shall not exclude Owners current and continued occupancy.

§ B.2.3.3 Insurance for Existing Structures
If the Work involves remodeling an existing structure or constructing an addition to an existing structure, the Owner shall purchase and maintain, until the expiration of the period for correction of Work as set forth in Section 12.2.2 of the General Conditions, "all-risks" property insurance, on a replacement cost basis, protecting the existing structure against direct physical loss or damage from the causes of loss identified in Section B.2.3.1, notwithstanding the undertaking of the Work. The Owner shall be responsible for all co-insurance penalties.

ARTICLE B.3 CONSTRUCTION MANAGER'S INSURANCE AND BONDS

§ B.3.1 General

§ B.3.1.1 Certificates of Insurance. The Construction Manager shall provide certificates of insurance acceptable to the Owner evidencing compliance with the requirements in this Article B.3 at the following times: (1) prior to commencement of the Work; (2) upon renewal or replacement of each required policy of insurance; and (3) upon the Owner's written request. An additional certificate evidencing continuation of commercial liability coverage, including coverage for completed operations, shall be submitted with the final Application for Payment and thereafter upon renewal or replacement of such coverage until the expiration of the periods required by Section B.3.2.1 and Section B.3.3.1. The certificates will show the Owner as an additional insured on the Construction Manager's Commercial General Liability and excess or umbrella liability policy or policies.

§ B.3.1.2 Deductibles and Self-Insured Retentions. The Construction Manager shall disclose to the Owner any deductible or self- insured retentions applicable to any insurance required to be provided by the Construction Manager.

§ B.3.1.3 Additional Insured Obligations. To the fullest extent permitted by law, the Construction Manager shall cause the commercial general liability coverage to include (1) the Owner, the Architect, and the Architect's consultants as additional insureds for claims caused in whole or in part by the Construction Manager's negligent acts or omissions during the Construction Manager's operations; and (2) the Owner as an additional insured for claims caused in whole or in part by the Construction Manager's negligent acts or omissions for which loss occurs during completed operations. The additional insured coverage shall be primary and non-contributory to any of the Owner's general liability insurance policies and shall apply to both ongoing and completed operations. To the extent commercially available, the additional insured coverage shall be no less than that provided by Insurance Services Office, Inc. (ISO) forms CG 20 10 07 04, CG 20 37 07 04, and, with respect to the Architect and the Architect's consultants, CG 20 32 07 04.

§ B 3.1.4 Waiver of Subrogation the Commercial General Liability and Automobile Liability policies shall each contain a waiver of subrogation in favor of the Owner, Architect, and their officers, directors, Board Members, employees and agents.

§ B 3.1.5 Subcontractors, Contractor shall cause each subcontractor to purchase and maintain insurance of the types and amounts specified as a minimum. Limits of such coverage may be reduced only upon written agreement of Owner. Contractor shall provide to the Owner copies of certificates evidencing coverage for each subcontractor. Subcontractor's commercial general liability and business automobile liability insurance shall name Owner and Architect as additional insured and have the Waiver of subrogation endorsement added in accord with Article A.3.
§ B .3.1.6 These certificates and the insurance policies required by this Article A.3 shall contain a provision afforded under the policies will not be canceled or allowed to expire until at least 30 days prior written notice has been given to the Owner. Information concerning reduction of coverage on account of revised limits or claims paid under the General Aggregate, or both, shall be furnished by the Contractor with reasonable promptness in accordance with the Contractor's information and belief.

§ B 3.1.7 Failure to file certificates or acceptance by the Owner or Architect of certificates of insurance which do not indicate the specified coverage shall in no way relieve the contractor of his responsibility for maintaining insurance as specified above.

§ B.3.2 Construction Manager's Required Insurance Coverage

§ B.3.2.1 The Construction Manager shall purchase and maintain the following types and limits of insurance from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Construction Manager shall maintain the required insurance until the expiration of the period for correction of Work as set forth in Section 12.2.2 of the General Conditions, unless a different duration is stated below:

§ B.3.2.2 Commercial General Liability

§ B.3.2.2.1 Commercial General Liability insurance for the Project written on an occurrence form with policy limits of not less than Three Million Dollars ($3,000,000) each occurrence, Four Million Dollars ($4,000,000) general aggregate, and Four Million Dollars ($4,000,000) aggregate for products-completed operations hazard, providing coverage for claims including

- **.1** damages because of bodily injury, sickness or disease, including occupational sickness or disease, and death of any person;
- **.2** personal injury and advertising injury;
- **.3** damages because of physical damage to or destruction of tangible property, including the loss of use of such property;
- **.4** bodily injury or property damage arising out of completed operations; and
- **.5** the Construction Manager's indemnity obligations under Section 3.18 of the General Conditions.

§ B.3.2.2.2 The Construction Manager's Commercial General Liability policy under this Section B.3.2.2 shall not contain an exclusion or restriction of coverage for the following:

- **.1** Claims by one insured against another insured, if the exclusion or restriction is based solely on the fact that the claimant is an insured, and there would otherwise be coverage for the claim.
- **.2** Claims for property damage to the Construction Manager's Work arising out of the products-completed operations hazard where the damaged Work or the Work out of which the damage arises was performed by a Subcontractor.
- **.3** Claims for bodily injury other than to employees of the insured.
- **.4** Claims for indemnity under Section 3.18 of the General Conditions arising out of injury to employees of the insured.
- **.5** Claims or loss excluded under a prior work endorsement or other similar exclusionary language.
- **.6** Claims or loss due to physical damage under a prior injury endorsement or similar exclusionary language.
- **.7** Claims related to residential, multi-family, or other habitational projects, if the Work is to be performed on such a project.
- **.8** Claims related to roofing, if the Work involves roofing.
- **.9** Claims related to exterior insulation finish systems (EIFS), synthetic stucco or similar exterior coatings or surfaces, if the Work involves such coatings or surfaces.
- **.10** Claims related to earth subsidence or movement, where the Work involves such hazards.
- **.11** Claims related to explosion, collapse and underground hazards, where the Work involves such hazards.

§ B.3.2.3 Automobile Liability covering vehicles owned, and non-owned vehicles used, by the Construction Manager, with policy limits of not less than One Million Dollars ($ 1,000,000) per accident, for bodily injury, death of any person, and property damage arising out of the ownership, maintenance and use of those motor vehicles along with any other statutorily required automobile coverage.

§ B.3.2.4 The Construction Manager may achieve the required limits and coverage for Commercial General Liability and Automobile Liability through a combination of primary and excess or umbrella liability insurance, provided such primary and excess or umbrella insurance policies result in the same or greater coverage as the coverages required under Section B.3.2.2 and B.3.2.3, and in no event shall any excess or umbrella liability insurance provide

narrower coverage than the primary policy. The excess policy shall not require the exhaustion of the underlying limits only through the actual payment by the underlying insurers.

§ B.3.2.5 Workers' Compensation at statutory limits.

§ B.3.2.6 Employers' Liability with policy limits not less than One Million Dollars ($ 1,000,000) each accident, One Million Dollars ($ 1,000,000) each employee, and One Million Dollars » ($ 1,000,000) policy limit.

§ B.3.2.7 Jones Act, and the Longshore & Harbor Workers' Compensation Act, as required, if the Work involves hazards arising from work on or near navigable waterways, including vessels and docks

§ B.3.2.8 If the Construction Manager is required to furnish professional services as part of the Work, the Construction Manager shall procure Professional Liability insurance covering performance of the professional services, with policy limits of not less than One Million Dollars ($ 1,000,000) per claim and «One Million Dollars ($1,000,000) in the aggregate.

§ B.3.2.9 Construction Manager shall procure Pollution Liability insurance, with policy limits of not less than One Million Dollars ($ 1,000,000) per claim and One Million Dollars ($ 1,000,000) in the aggregate.

§ B.3.3 Construction Manager's Other Insurance Coverage

§ B.3.3.1 Insurance selected and described in this Section B.3.3 shall be purchased from an insurance company or insurance companies lawfully authorized to issue insurance in the jurisdiction where the Project is located. The Construction Manager shall maintain the required insurance until the expiration of the period for correction of Work as set forth in Section 12.2.2 of the General Conditions, unless a different duration is stated below:

§ B.3.3.2 The Construction Manager shall purchase and maintain the following types and limits of insurance in accordance with Section B.3.3.1.
(Select the types of insurance the Construction Manager is required to purchase and maintain by placing an X in the box(es) next to the description(s) of selected insurance. Where policy limits are provided, include the policy limit in the appropriate fill point.)

[X] **§ B.3.3.2.1** Property insurance of the same type and scope satisfying the requirements identified in Section B.2.3, which, if selected in this Section B.3.3.2.1, relieves the Owner of the responsibility to purchase and maintain such insurance except insurance required by Section B.2.3.1.3 and Section B.2.3.3. The Construction Manager shall comply with all obligations of the Owner under Section B.2.3 except to the extent provided below. The Construction Manager shall disclose to the Owner the amount of any deductible, and the Owner shall be responsible for losses within the deductible. Upon request, the Construction Manager shall provide the Owner with a copy of the property insurance policy or policies required. The Owner shall adjust and settle the loss with the insurer and be the trustee of the proceeds of the property insurance in accordance with Article 11 of the General Conditions unless otherwise set forth below:
(Where the Construction Manager's obligation to provide property insurance differs from the Owner's obligations as described under Section B.2.3, indicate such differences in the space below. Additionally, if a party other than the Owner will be responsible for adjusting and settling a loss with the insurer and acting as the trustee of the proceeds of property insurance in accordance with Article 11 of the General Conditions, indicate the responsible party below.)

[X] **§ B.3.3.2.4** Insurance for physical damage to property while it is in storage and in transit to the construction site on an "all-risks" completed value form.

[X] **§ B.3.3.2.5** Property insurance on an "all-risks" completed value form, covering property owned by the Construction Manager and used on the Project, including scaffolding and other equipment.

[ ] **§ B.3.3.2.6 Other Insurance**
(List below any other insurance coverage to be provided by the Construction Manager and any applicable limits.)

Coverage	Limits

§ B.3.4 Performance Bond and Payment Bond
The Construction Manager shall provide surety bonds, from a company or companies lawfully authorized to issue

Payment and Performance Bonds shall be AIA Document A312™, Payment Bond and Performance Bond, or contain provisions identical to AIA Document A312™, current as of the date of this Agreement.

§ B .3.4 Revised Language:
Construction Manager shall pay premium for and furnish Two (2) copies of a Performance Bond, and a Labor and Material Payment Bond in full amount of the contract sum to cover faithful performance of the contract and payment of all obligations arising thereunder, within seven (7) calendar days after signing contract. Furnish bonds in accordance with application laws of the State of Arkansas. Labor and Material Payment Bond coverage for project shall be maintained for a period of not less than one (1) year after substantial completion. A Warranty Bond shall be furnished in full amount of the contract sum to cover faithful performance of the contract and payment of all obligations for an additional year beyond Labor and Material Payment Bond coverage.

§ B 3.4.1 Furnish Owner, through the Architect, with two (2) copies each of required bonds.

§ B .3.4.2 Furnish Owner, through the Architect, with two (2) copies of the signed "Contractor's and Resident Local Agents Affidavit of Qualification, attached.

§ B .3.4.3 The Construction Manager shall require the attorney-in-fact who executes the required bonds on behalf of the surety to affix thereto a certified and current copy.

ARTICLE B.4 SPECIAL TERMS AND CONDITIONS
Special terms and conditions that modify this Insurance and Bonds Exhibit, if any, are as follows:

« None»

SECTION 01 00 00

GENERAL REQUIREMENTS AND PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General intention.

B. General Method of Procedure.

C. Applicable State and Local Law

D. Fire Protection Verification

E. Restoration.

F. Erosion Control.

1.2 GENERAL INTENTION

A. Contractor shall completely prepare site for building operations, including demolition of existing items where noted, furnish labor and materials and perform work for an Addition to the Bentonville Public Library, as required by drawings and specifications.

B. Visits to the site by Bidders may be made only by appointment with the Construction Manager.

C. In some instances, it may have been impracticable to detail all items in specifications or on drawings because of variances in manufacturer's methods or of multiple methods of achieving specified results. In such instances Contractor will be required to furnish all labor, materials, drawings, services and connections necessary to produce systems or equipment which are completely installed, functional, and ready for operation by personnel in accordance with their use. Contractor and each subcontractor is to perform work to comply with standard practices of his or her trade or profession.

D. Offices of HIGHT/JACKSON/ASSOCIATES/P.A., as Architects, will render certain technical services during construction. Such services shall be considered as advisory to the Owner and shall not be construed as expressing or implying a contractual act of the Owner without affirmations by the Owner or his duly authorized representative.

1.3 GENERAL METHOD OF PROCEDURE

A. Working space and space available for storing materials shall be verified with the Owner prior to construction.

B. Workmen are subject to rules of the Owner applicable to their conduct.

C. Execute work so as to interfere as little as possible with normal functioning of Owner as a whole, including operations of utility services, fire protection systems and any existing equipment, and with work being done by others. Use of equipment and tools that transmit vibrations and noises through the building structure, are to be limited to the time that the building is not occupied. Do not store materials and equipment in other than assigned areas.

D. Contractor shall furnish Architect with a schedule of approximate phasing dates on which the Contractor intends to accomplish work in each specific area of site, building or portion thereof.

E. If work is scheduled to be performed on Saturdays, Sundays or holidays the Contractor shall provide written notification to the Architect indicating dates on which work will be performed. Notification shall be a minimum of 48 hours before the work date commences.

F. Building will be occupied during performance of work, but areas of alterations will be vacated as required. Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in Owner operations will not be hindered. Contractor shall permit access to Owner personnel through construction areas. Contractor to provide temporary means of protected access to all occupied areas of alteration during the construction period.

G. When an area of the building is turned over to Contractor, Contractor shall accept entire responsibility thereof.

H. Contractor shall maintain in operating condition existing fire protection and alarm equipment. In connection with fire alarm equipment Contractor shall make arrangements for pre-inspection of site with Fire Department.

I. Existing Utilities: Before construction can begin, contractor shall have all existing underground utility line locations in affected construction area verified and located by one-call service, if this service exists. In addition, consult Owner and/or utility companies. In Arkansas the one-call phone number is 1 800-482-8998. Contractor is to provide written proof that contact with utility companies and any private utilities such as telephone companies that the Owner may have contracted with. Provide a statement that contact has been made with Owner's personnel, all utility companies, and that all utility lines have been located to the best of their knowledge and ability. It shall be the responsibility of the contractor to relocate all existing utilities which conflict with the proposed improvements shown on the drawings.

J. Utilities Services: Maintain existing utility services for building at all times. Provide temporary facilities, labor, materials, equipment, connections, and utilities to assure uninterrupted services. Where necessary to cut existing water, steam, gases, sewer, air pipes, or conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (except telephone), they shall be cut and capped at suitable places where shown; or, in absence of such indication, where directed by Architect/Engineer.

1. All such work required in connection with telephone systems shall be done by Owner's Telephone Company at Contractor's expense.
2. No utilities service such as water, gas, steam, sewers or electricity, or fire protection systems and communications systems may be interrupted without prior approval of Owner.
3. Contractor shall submit a request to interrupt any such services to Owner 48 hours in advance of proposed interruption. Request shall state reason, date, exact time of, and approximate duration of such interruption.

K. Abandoned Lines: Any existing utility lines such as wires, cables, pipes and the like, which are to be abandoned but are not required to be entirely removed, shall be sealed, capped or plugged.

L. To minimize interference of construction activities with flow of traffic comply with the following:
1. Keep roads, walks and entrances to grounds, to parking and to occupied areas of buildings clear of construction materials, debris and standing construction equipment and vehicles.

M. Protection: Provide following protective measures:
1. Wherever existing roof surfaces are disturbed they shall be protected against water infiltration. In case of leaks, they shall be repaired immediately upon discovery.
2. Temporary protection against damage for all portions of existing structures and grounds where work is to be done, materials handled and equipment moved and/or relocated.
3. Protection of interior of existing structures at all times, from damage, dust and weather inclemency. Wherever work is performed, floor surfaces that are to remain in place shall be adequately protected prior to starting work, and this protection shall be maintained intact until all work in the area is completed.
4. Dampen debris to keep down dust and provide temporary dust proof barrier partitions in existing structures where necessary. Equip barrier partitions with hinged doors for access. Blank off ducts and diffusers to prevent circulation of dust into occupied areas during construction.

N. Staging and construction traffic
1. To be discussed and determined at preconstruction meeting.

1.4 APPLICABLE STATE LAWS

A. Contractor and all subcontractors of all trades present on site shall comply with state and local laws and ordinances while present on public property.

B. **Absolutely no tobacco or e-cigarette use is permitted in building or on the project site.**

1.5 FIRE PROTECTION VERIFICATION

A. Contractor to be responsible for verifying existing fire alarm and fire sprinkler system (if systems currently exist) and coordinating with new addition or remodel as required by current state and local building code requirements.

B. If any changes to the contract during construction occurs that involves work to any addition, or remodel, of this project, or work in an adjacent building, Contractor to be responsible for verifying and adding onto, altering or updating existing fire alarm or fire sprinkler system to meet state and local current code requirements and verified by representative of the local fire department having jurisdiction.

1.6 RESTORATION

A. Remove, cut, alter, replace, patch and repair existing work as necessary to install new work. Except as otherwise shown or specified, do not cut, alter or remove any structural work, and do not disturb any ducts, plumbing, steam, gas, or electric work without approval of Architect/Engineer. Existing work (walls, ceilings, partitions, floors, mechanical and electrical work, lawns, paving, roads, walks, etc.) disturbed or removed as a result of performing required new work, shall be patched, repaired, reinstalled, or replaced with new work, and refinished and left in as good condition as existed before commencing work. Existing work to be altered or extended and that is found to be defective in any way, shall be reported to Architect before it is disturbed. Materials and workmanship used in restoring work shall conform in type and quality to that of original existing construction, except as otherwise shown or specified.

B. Upon completion of contract, deliver work complete and undamaged. Damage caused by Contractor or Contractor's workmen to existing structures, grounds, and utilities or work done by others shall be repaired by Contractor and left in as good condition as existed prior to damaging.
   1. At Contractor's own expense, Contractor shall immediately restore to service and repair any damage caused by Contractor's workmen to existing piping and conduits, wires, cables, etc., of utility services or of fire protection systems and communications systems (except telephone) which are indicated on drawings and which are not scheduled for discontinuance or abandonment.
   2. Restoration work required by damage to telephone systems shall be done by Owner's Telephone Company at the Contractor's expense.

C. Consequential damage to Owner's existing equipment or building contents in the existing building or on site as a result of work being performed will be replaced at Contractor's expense.

D. Consequential damage to existing building or site components as a result of work being performed will be repaired or replaced at Contractor's expense.

1.7 EROSION CONTROL

A. The site work contractor is to comply with the provisions of the Arkansas Water and Air Pollution Control Act (Act 274 of 1949, as amended, AR Ann. 8-4-101 et seq.), and the Federal Clean Water Act 33 U.S.C. 1251 et seq. which safeguards the storm water runoff to all receiving waters, i.e., streams, lakes and oceans by limiting effluent, erosion and

other conditions. Application for permitting and monitoring requirements will be required through the state where the work is being performed. State of Arkansas, Storm Water Section NPDES, PO Box 8913, Little Rock, AR 72214 Phone 501/-682-0628.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 11 00

SUMMARY OF WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract Description.

B. Description of the work.

C. Owner supplied Products.

D. Contractor use of site and premises.

E. Future work.

F. Work sequence.

G. Site security and encumbrances.

H. Owner occupancy.

I. Permits and fees

1.2 CONTRACT DESCRIPTION

A. Contract Type: Construction Management, AIA Document A133-2019, Construction Manager as Constructor.

1.3 DESCRIPTION OF THE WORK

A. The work under this contract will include all work as shown on drawings and specifications and shall include all work required to complete the project **with exception of the following:**
   1. Specialty library equipment.
   2. Phones.
   3. Computers.
   4. Signage (Interior and exterior)
   5. Furniture.

B. Items noted NIC (Not in Contract), will be supplied and installed by Owner.

C. Any damage done to existing grade, drives, paving areas, building pads, or other areas in which grading has been performed by others under previous contract, shall be repaired to specifications.

D. Building Contractor shall be given the mass grading certification, which is required by the Site Grading contract. Building Contractor may elect to perform some grade verification for his own benefit, but shall be responsible for any costs associated with his verification. Building contractor shall acknowledge is writing that he accepts the existing site as graded. If any discrepancies are discovered at a later time, notify Architect immediately.

E. Contractor is responsible for familiarizing himself with the entire project; for expediting and completing all phases of the project in accordance with the Contract Documents; and is solely responsible for work completed by other trades under his contract.

F. Contractor is responsible for coordinating items furnished and installed by owner.

1.4 OWNER SUPPLIED PRODUCTS

A. Owner's Responsibilities:
   1. Arrange for and deliver Owner reviewed Shop Drawings, Product Data, and Samples, to Contractor.
   2. Arrange and pay for Product delivery to site.
   3. On delivery, inspect Products jointly with Contractor.
   4. Submit claims for transportation damage and replace damaged, defective, or deficient items.
   5. Arrange for manufacturers' warranties, inspections, and service.

B. Contractor's Responsibilities:
   1. Review Owner reviewed Shop Drawings, Product Data, and Samples. Verify owner supplied products fit where product is to be installed or placed.
   2. Receive and unload Products at site; inspect for completeness or damage jointly with Owner.
   3. Handle, store, install and finish Products.
   4. Repair or replace items damaged after receipt.

1.5 CONTRACTOR USE OF SITE AND PREMISES

A. Limit use of site and premises to allow construction and remodeling in accordance with contract and construction documents.

1.6 WORK SEQUENCE

A. Construct Work to accommodate Owner's occupancy requirements during the construction period, coordinate construction schedule and operations with Owner.

B. Properly prepare all work to receive subsequent work or finish. Notify Architect if any work is unsatisfactory to receive such subsequent work or finish and receive his instructions before proceeding. Failure to make such notification by trade applying work over unsatisfactory materials will constitute his acceptance or responsibility for making the necessary corrections.

C. Contractor to take photographs of Critical areas of work and other items as deemed necessary when asked to do so by Architect/Engineer. Refer to Section 01 32 33.

1.7 SITE SECURITY

A. Contractor is responsible for securing the site at all times to prevent loss of property or injury to persons present at site. Such responsibility shall remain with the Contractor until all work is completed.

B. Refer to Section 01 50 00 for temporary construction fencing requirements.

1.8 SITE ENCUMBRANCES

A. Contractor will remove and/or relocate all interfering sheds, concrete slabs, driveways, curbs, walks, trees, footings, etc., prior to construction.

B. Contractor shall maintain utilities in operation on temporary basis till near the end of construction when finished utilities shall be completed.

C. Contractor will cut grass and weeds before starting of project and dispose of same.

D. Provide barriers at drip line of trees to keep traffic off of root system. Trim branches to clear equipment.

1.9 ACCESS TO PROPERTY

A. Provide and maintain access to property for all trades.

B. Access for workmen and delivery of materials and equipment to immediate construction working areas within building is to be coordinated with the Owner. Provide unobstructed access to building areas required to remain in operation. Use hoist or lift wherever practical to move equipment and materials to levels above the ground floor. Hoist or lift is to be removed from premises at completion of construction.

C. Access by Contractor and his personnel through occupied portions of buildings is not permitted within the occupied building area except along designated routes verified by the Owner.

1.10 OWNER OCCUPANCY

A. Building will be occupied during performance of work, but areas of alterations will be vacated as required. Contractor shall take all measures and provide all material necessary for protecting existing equipment and property in affected areas of construction against dust and debris, so that equipment and affected areas to be used in Owner operations will not be hindered. Contractor shall permit access to Owner personnel through construction areas. Contractor to provide temporary means of protected access to all occupied areas of alteration during the construction period.

1.11 PERMITS AND FEES

A. Contractor to be responsible for verifying and obtaining written list of all permits, fees, etc. from local, county, state, and federal (if applicable) governing bodies that will apply to this project. Contractor is responsible for paying for these permits and fees.

B. Building Permit - Contractor secure and pay for city building permit if required by City.

C. Special Permits/Fees – Contractor and/or subcontractors shall be responsible for securing and paying for all special permits, licenses and fees that may be required by local, state, or federal laws as may be applicable to the review, installation or certification of their systems and materials or required for installation of such materials.

D. Connection Fees - Contractor and/or subcontractors shall be responsible for securing and paying for all fees and associated costs for review of, and connection to public utility services.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 21 13

CASH ALLOWANCES

PART 1 GENERAL

1.1 SCOPE

A. The following allowances are stated for the purpose of stabilizing each bid and for establishing an amount of credit to purchase the identified items. Each price stated shall include F.O.B. Job site delivery, tax included unless noted otherwise, but shall not include Contractor markup and installation as they are to be included in the bid and/or Contract. Cash Allowances Are to be included as part of the bid price.

1.2 ALLOWANCE CREDIT

A. Any unused allowance money will be returned to the owner. Unused materials shall be returned for credit, which will be given to the owner, after installation has been completed and accepted. When it is not economically practical to return material for credit, prepare and deliver all unusable material for storage by Owner. It will be the contractor's responsibility to dispose of unused material that the owner has indicated he does not want.

1.3 ITEMS

A. Section 08 71 00 - Finish Hardware
   1. Provide an allowance of FIVE THOUSAND and no/100 Dollars ($5,000.00) for furnishing F.O.B. job site additional or changing of finish hardware during construction, not including sales tax. Door hardware sets specified in Section 08 71 00 to be included in contract price.

B. Section 09 68 00 - Carpeting
   1. Provide an allowance as follows for furnishing F.O.B. job site carpeting as shown including sales tax.
      a. CPT-3 (Modular Carpet Tile): Allowance of TWENTY-TWO Dollars ($22.00) per square yard for replacing existing carpet tile.

C. Unforeseen Conditions
   1. Provide an allowance of FIFTEEN THOUSAND DOLLARS ($15,000.00) for unforeseen conditions. Allowance is to be used by Owner and Architect. Allowance is to be tracked as a line item on the pay application. Any unused funds are to be returned to the Owner per final Change Order.

END OF SECTION

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Measurement and payment criteria applicable to portions of the Work performed under a unit price payment method.

B. Defect assessment and nonpayment for rejected work.

1.2 AUTHORITY

A. Measurement methods delineated in the individual specification sections complement the criteria of this section. In the event of conflict, the requirements of the individual specification section govern.

B. Take all measurements and compute quantities. The Architect/Engineer will verify measurements and quantities.

C. Assist by providing necessary equipment, workers, and survey personnel as required.

1.3 UNIT QUANTITIES SPECIFIED

A. All labor and material shall be provided as shown in construction documents, unless otherwise noted. Pricing for unit quantities referenced in the individual specification sections are for bidding and in cases of unusual conditions of change in scope of work.

B. If the actual Work requires more or fewer quantities than those quantities indicated, provide the required quantities at the unit sum/prices contracted. Quantities and measurements supplied or placed into the work shall be verified by a third party and approved by the Architect/Engineer prior to proceeding with work. The cost for work performed by the third party to verify quantities shall be paid for by Contractor, unless noted otherwise.

C. Each Unit Price shall include all costs incurred to the contractor for the particular item the Unit Price provides for.

1.4 MEASUREMENT OF QUANTITIES

A. Measurement Devices:
   1. Weigh Scales: Inspected, tested and certified by the applicable state Weights and Measures department within the past year.
   2. Platform Scales: Of sufficient size and capacity to accommodate the conveying vehicle.
   3. Metering Devices: Inspected, tested and certified by the applicable State department within the past year.

B. Measurement by Weight: Concrete reinforcing steel, rolled or formed steel or other metal shapes will be measured by handbook weights. Welded assemblies will be measured by handbook or scale weight.

C. Measurement by Volume: Measured by cubic dimension using mean length, width and height or thickness.

D. Measurement by Area: Measured by square dimension using mean length and width or radius.

E. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.

F. Stipulated Sum/Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.

1.5 PAYMENT

A. Payment Includes: Full compensation for all required labor, Products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.

B. Final payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities accepted by the Architect/Engineer multiplied by the unit sum/price for Work which is incorporated in or made necessary by the Work.

1.6 DEFECT ASSESSMENT

A. Replace the Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of the Architect/Engineer, it is not practical to remove and replace the Work, the Architect/Engineer will direct one of the following remedies:
   1. The defective Work may remain, but the unit sum/price will be adjusted to a new sum/price at the discretion of the Architect/Engineer.
   2. The defective Work will be partially repaired to the instructions of the Architect/Engineer, and the unit sum/price will be adjusted to a new sum/price at the discretion of the Architect/Engineer.

C. The individual specification sections may modify these options or may identify a specific formula or percentage sum/price reduction.

D. The authority of the Architect/Engineer to assess the defect and identify payment adjustment is final.

1.7 NONPAYMENT FOR REJECTED PRODUCTS

A. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected Products.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 26 00

MODIFICATION REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittals.

B. Documentation of change in Contract Sum/Price and Contract Time.

C. Change procedures.

D. Construction Change Directive.

E. Stipulated Sum change order.

F. Unit price change order.

G. Time and material change order.

H. Execution of change orders.

I. Correlation of Contractor submittals.

1.2 RELATED SECTIONS

A. Document 00 72 00 - General Conditions - AIA: Governing requirements for changes in the Work, in Contract Sum/Price, and Contract Time.

B. Document 00 73 00 - Supplementary General Conditions - AIA: Percentage allowances for Contractor's overhead and profit.

C. Section 01 33 00 - Submittals: Schedule of values.

D. Section 01 60 00 - Material and Equipment: Product options and substitutions.

E. Section 01 77 00 - Contract Closeout: Project record documents.

1.3 SUBMITTALS

A. Submit name of the individual authorized to receive change documents, and be responsible for informing others in Contractor's employ or Subcontractors of changes to the Work.

B. Change Order Forms: AIA G701. Change Order.

1.4 DOCUMENTATION OF CHANGE IN CONTRACT SUM/PRICE AND CONTRACT TIME

A. Maintain detailed records of work done on a time and material basis. Provide full information required for evaluation of proposed changes, and to substantiate costs of changes in the Work.

B. Document each quotation for a change in cost or time with sufficient data to allow evaluation of the quotation.

C. Provide additional data to support computations:
   1. Quantities of products, labor, and equipment.
   2. Taxes, insurance, and bonds.
   3. Overhead and profit.
   4. Justification for any change in Contract Time.
   5. Credit for deletions from Contract, similarly documented.

D. Support each claim for additional costs, and for work done on a time and material basis, with additional information:
   1. Origin and date of claim.
   2. Dates and times work was performed, and by whom.
   3. Time records and wage rates paid.
   4. Invoices and receipts for products, equipment, and subcontracts, similarly documented.

1.5 CHANGE PROCEDURES

A. The Architect/Engineer will advise of minor changes in the Work not involving an adjustment to Contract Sum/Price or Contract Time as authorized by AIA A201, 2017 Edition, Paragraph 7.4 by issuing a Field Order, AIA Form G708, Supplemental Instructions, AIA Form G710 or Hight Jackson Associates Architect's Supplemental Instructions.

B. The Architect/Engineer may issue a Proposal Request which includes a detailed description of a proposed change with supplementary or revised Drawings and specifications, and change in Contract Time for executing the change with a stipulation of any overtime work required. Contractor will prepare and submit an estimate within 10 calendar days unless instructed otherwise.

C. The Contractor may propose a change by submitting a request for change to the Architect/Engineer, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, and the effect on the Contract Sum/Price and Contract Time with full documentation. Document any requested substitutions in accordance with Section 01 60 00.

1.6 CONSTRUCTION CHANGE DIRECTIVE

A. Architect/Engineer may issue a document, signed by the Owner, instructing the Contractor to proceed with a change in the Work, for subsequent inclusion in a Change Order.

B. The document will describe changes in the Work, and will designate method of determining any change in Contract Sum/Price or Contract Time.

C. Promptly execute the change in Work.

1.7 STIPULATED SUM CHANGE ORDER

A. Based on Proposal Request and Contractor's fixed price quotation or Contractor's request for a Change Order as approved by Architect/Engineer.

1.8 UNIT PRICE CHANGE ORDER

A. For predetermined unit prices and quantities, the Change Order will be executed on a fixed unit price basis.

B. For unit costs or quantities of units of work which are not predetermined, execute Work under a Construction Change Directive.

C. Changes in Contract Sum/Price or Contract Time will be computed as specified for Time and Material Change Order.

1.9 TIME AND MATERIAL CHANGE ORDER

A. Submit itemized account and supporting data after completion of change, within time limits indicated in the Conditions of the Contract.

B. Architect/Engineer will determine the change allowable in Contract Sum/Price and Contract Time as provided in the Contract Documents.

C. Maintain detailed records of work done on Time and Material basis.

D. Provide full information required for evaluation of proposed changes, and to substantiate costs for changes in the Work.

1.10 EXECUTION OF CHANGE ORDERS

A. Execution of Change Orders: Architect/Engineer will issue Change Orders for signatures of parties as provided in the Conditions of the Contract.

1.11 CORRELATION OF CONTRACTOR SUBMITTALS

A. Promptly revise Schedule of Values and Application for Payment forms to record each authorized Change Order as a separate line item and adjust the Contract Sum/Price.

B. Promptly revise progress schedules to reflect any change in Contract Time, revise sub schedules to adjust times for other items of work affected by the change, and resubmit.

C. Promptly enter changes in Project Record Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 29 76

APPLICATIONS FOR PAYMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for payment.

1.2 RELATED SECTIONS

A. Document 00 72 00 - General Conditions - AIA: Progress payments and final payment.

B. Section 00 73 00 - Supplementary General Conditions

C. Section 01 31 00 - Coordination and meetings:

D. Section 01 32 36 – Construction Progress Schedules: Submittal procedures.

E. Section 01 77 00 - Contract Closeout: Final payment.

1.3 FORMAT

A. AIA G702 - Application and Certificate for Payment and AIA G703 - Continuation Sheet.

B. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   3. Scheduled Values.
   4. Previous Applications.
   5. Work in Place and Stored Materials under this Application.
   6. Authorized Change Orders Listed separately.
   7. Total Completed and Stored to Date of Application.
   8. Percentage of Completion.
   9. Balance to Finish.
   10. Retainage.

1.4 PREPARATION OF APPLICATIONS

A. Present required information in typewritten form or on electronic media printout.

B. Execute certification by signature of authorized officer.

C. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored Products.

D. List each authorized Change Order as an extension on AIA G703 - Continuation Sheet, listing Change Order number and dollar amount as for an original item of Work.

E. Prepare Application for Final Payment as specified in Section 01 77 00.

1.5 SUBMITTAL PROCEDURES

A. Submit three copies of each Application for Payment.

B. Submit three copies of **updated** construction schedules with each Application for Payment.

C. Submit three copies of Certificate of Insurance for items stored off-site with each Application for Payment.

D. Submit delays caused as a result of adverse weather, strikes, etc. Include backup with each pay application. Provide project superintendent's weather log for project with each pay application. If no delay days occurred during the last pay period provide statement on transmittal or letter stating that no delay days occurred. Delay days for Saturday and Sunday and Holidays will not be approved unless prior notice has been given and accepted by Architect. Approved delay days will not result in increase in completion time unless days exceed anticipated delay days as set forth under Supplementary General Conditions.
   1. Submit as part of the pay application a monthly updated CPM work schedule as required in Section 01 32 36.
   2. Monthly Progress Report
      a. Refer to Section 01 31 00, paragraph 1.7 for details.
   3. Updated and currently in force proof of insurance. (The proof of insurance needs to be only be filed during the month of renewal, however, a lapsed Insurance Certificate will result in Pay Application being held as incomplete)
   4. Failure to submit any of the above required items will result in pay application being held until submissions are complete.

E. Payment Period: Submit at intervals stipulated in the Agreement.

F. Submit with transmittal letter as specified for Submittals in Section 01 33 00.

1.6 SUBSTANTIATING DATA

A. When Architect/Engineer requires substantiating information, submit data justifying dollar amounts in question.

B. Provide one copy of data with cover letter for each copy of submittal. Show application number and date, and line item by number and description.

C. Include the following with the application when substantiating data is asked for:
   1. Current available construction photographs of item in question.
   2. Record documents for review by the Owner which will be returned to the contractor.
   3. Affidavits attesting to off-site stored products.

4. Construction progress schedules, revised and current.
5. Other data and information as required or asked for by Architect.

D. Partial Lien Waivers: If directed by Owner or Architect, the Contractor may be required to submit partial lien waivers of subcontractors and suppliers accompanying payment request applications to show proof that he has made percentage of progress payment as shown on previous payment request application. If partial lien waivers are asked for, Contractor must submit them for review and approval. If he has not submitted them, or if a subcontractor or supplier has not been paid for the previous pay periods, the current pay application will be not be processed until partial lien waivers are received and approved, or until justification is accepted by Owner and Architect as to the reason payment was withheld for the subcontractor or supplier on previous payment applications.

1.7 PROOF OF INSURANCE FOR MATERIALS STORED OFF SITE.

A. Payments will only be processed for materials stored off site that are stored in a bonded or insured warehouse. If materials are stored off site on a secure open-air site, material must be insured. Payment claims for materials stored off site must be accompanied with an itemized list of materials establishing value, proof that the materials are insured, and a receipt of storage from a bonded warehouse. Upon payment of materials stored, title to the material shall be to the Owner. All expenses incurred in storage of materials will be paid by the contractor.

1.8 RETAINAGE

A. In making partial payments for the work, there shall be retained **Five (5%) percent**
B. of the estimated amount for labor and materials until final completion and acceptance of all work covered in the contract. Retainage shall be paid to the Contractor in the final payment if all conditions of the contract documents have been met including completed close-out documents and as-built drawings

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 31 00

COORDINATION AND MEETINGS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination and project conditions.
B. Pre-construction meeting.
C. Field engineering
D. Progress meetings.
E. Pre-installation meetings.
F. Equipment electrical characteristics and components.
G. Examination.
H. Preparation.
I. Schedule and Reports

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals, and Work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.

C. Coordinate space requirements, supports, and installation of mechanical and electrical Work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.

D. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

E. Coordinate completion and cleanup of Work of separate sections in preparation for Substantial Completion and for portions of Work if designated for Owner's partial occupancy.

F. After Owner occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

1.3 FIELD ENGINEERING

A. Contractor shall locate and protect survey control and reference points.

B. Control datum for survey is shown on Drawings.

C. Verify setbacks and easements; confirm drawing dimensions and elevations.

D. Provide field engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.

1.4 PRECONSTRUCTION MEETING

A. Owner, through Architect/Engineer will schedule a meeting after Notice of Award.

B. Construction Manager shall conduct meeting.

C. Attendance Required: Owner, Architect/Engineer, Prime Contractor, Major Subcontractors, Representatives of Governmental or other regulating Agencies.

D. Agenda:
1. Execution of Owner-Contractor Agreement.
2. Submission of executed bonds and insurance certificates.
3. Submission of list of Subcontractors, schedule of values, and progress schedule.
4. Designation of personnel representing the parties in Contract, and the Architect/Engineer.
5. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, and Change Order procedures.
6. Scheduling and coordination of prime contractors.
7. Inspection procedures.
8. Shop drawings and Submittals, Grouping of Submittals
9. Critical areas of the work
10. Reports, testing and scheduling activities of a Geotechnical Engineer.
11. Use of premises by Owner and Contractor.
12. Owner's requirements and occupancy.
13. Construction facilities and controls.
14. Temporary utilities.
15. Procedures for maintaining record documents (As-Builts).
16. Requirements for start-up of equipment.
17. Inspection and acceptance of equipment put into service during construction period.
18. Contract closeout procedures, Substantial Completion, Final inspection, warranties, and manuals.
19. Other items as deemed necessary by the Architect or owner.

E. Contractor to record minutes and distribute copies within two days after meeting to participants, with copies to Architect/Engineer, Owner, participants, and those affected by decisions made.

1.5 PROGRESS MEETINGS

A. Contractor will schedule and administer meetings with assistance of Architect throughout progress of the Work at monthly intervals unless different interval is approved by Architect.

B. Contractor will schedule and make arrangements for meetings, prepare agenda with copies for participants, preside at meetings. Schedule comments from Architect on agenda. Architect to approve schedule.

C. Contractor shall provide written copies of previous items of discussion, resolution of same, and any new outstanding issues to be addressed.

D. Attendance is required by the following people:
   1. General Contractor's Project Manager and Job Superintendent
   2. Project Manager and Field Foreman for each trade currently working on the site.
   3. Project Manager of any trade who will be mobilizing on site during the next thirty (30) days.
   4. Representative of Major Suppliers
   5. Owner/Architect/Engineer as appropriate to address agenda items.

E. Agenda:
   1. Review minutes of previous meetings.
   2. Review of Work progress.
   3. Field observations, problems, and decisions.
   4. Identification of problems which impede planned progress.
   5. Review of submittals schedule and status of submittals.
   6. Review of off-site fabrication and delivery schedules.
   7. Maintenance of progress schedule.
   8. Corrective measures to regain projected schedules.
   9. Planned progress during succeeding work period.
   10. Coordination of projected progress.
   11. Maintenance of quality and work standards.
   12. Effect of proposed changes on progress schedule and coordination.
   13. Contractor to present outline work schedule for the next month.
   14. Other business relating to Work.

F. Contractor to record minutes and distribute copies within two days after meeting to participants, with copies to Architect/Engineer, Owner, participants, and those affected by decisions made.

1.6 PRE-INSTALLATION MEETING

A. When required in individual specification sections, convene a pre-installation meeting at the site prior to commencing work of the section.

B. Require attendance of parties directly affecting, or affected by, work of the specific section.

C. Notify Architect/Engineer four days in advance of meeting date.

D. Prepare agenda and preside at meeting:
   1. Review conditions of installation, preparation and installation procedures.
   2. Review coordination with related work.

E. Attendance Required: Contractor's Project Manager, Job superintendent, major Subcontractors and suppliers, Owner, Architect/Engineer, as appropriate to agenda topics for each meeting.

1.7 PROGRESS REPORTS

A. The Contractor shall submit monthly progress reports to the Architect, attached to his request for payment, showing each major item of the work, the current percentage of completion, and whether ahead or behind schedule. Any delays beyond the contractor's control, such as adverse weather conditions, strikes, etc., that delay the project completion are to be documented and submitted each month along with the progress report. Orders for all materials, except those requiring a decision by the Owner, must be placed within thirty (30) days after award of the contract and evidence of such orders furnished to the Architect. For order of materials requiring Owner decision, such as color, texture, etc; these orders will be placed as soon as possible after selection. Contractor is responsible for notifying the Architect when delaying selection will cause delays in completion. <u>These requirements will be considered mandatory prior to any approval of monthly pay request by the Architect.</u>

B. Include the following items as additional requirements of the monthly report.
   1. Updated schedule
   2. All meeting minutes for month
   3. Updated submittal schedule
   4. RFI log (all logs should contain date submitted to Architect, Date returned and Status)

1.8 OWNER'S ACCESS TO CONSTRUCTION

A. In addition to the Architect, the Owner shall be allowed to provide on-site representation as he deems necessary. Contractor and all subcontractors are to allow access to this (these) Individual(s) identified during the pre-construction conference, or by later correspondence from the Architect.

   Note: The Architect shall remain the sole responsible party for making selections, determining colors and/or textures, and directing changes in the scope or corrections to the work covered by this contract. **NO EXCEPTIONS!**

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 32 33

CONSTRUCTION PHOTOGRAPHS & DOCUMENTATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Photography.

B. Electronic Photographic Digital Images

C. Technique.

D. Submittals.

1.2 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work: Stages of the Work.

B. Section 01 77 00 - Contract Closeout: Project record documents.

1.3 PHOTOGRAPHY

A. Have available a digital camera of sufficient quality to produce photographs of site and construction throughout progress of work when required or asked for by Architect or Owner. Contractor must have means of electronically transferring images from job site and office via e-mail to Architect/Engineer.

B. If Architect elects to view an observation such as footing or slab preparation via photos taken by Contractor, placement will not take place until Architect/Engineer reviews and issues observation and comment of photos.

C. Take photographs of critical areas asked of the Architect/Engineer.
Such areas might be:
1. Excavations.
2. Foundations.
3. Structural framing.
4. Enclosure of building.
5. Other items as asked for.

1.4 IMAGES

A. Full color.

B. Size: Appropriate to show detail required.

C. Identify each image in electronic file name. Identify name of Project, and date of view.

D. Deliver electronic images to Architect immediately for his/her review and retention in job files.

1.5 VIEWS

A. Consult with Architect/Engineer for instructions on views required.

1.6 SUBMITTALS

A. Deliver e-mail images for each requested installation.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 32 36

CONSTRUCTION PROGRESS SCHEDULES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Format.

B. Content.

C. Revisions to schedules.

D. Submittals.

1.2 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work: Work sequence.

B. Section 01 29 76 - Applications for Payment: Application for payment.

C. Section 01 33 00 - Submittals: Shop drawings, product data,

1.3 FORMAT

A. Prepare schedules as a horizontal bar chart with separate bar for each major portion of Work or operation, identifying first work day of each week.

B. Scale and Spacing: To provide space for notations and revisions.

C. Sheet Size: Multiples of 11 x 17 inches.

1.4 CONTENT

A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

B. Identify each item by specification section number.

C. Identify work of separate stages, and other logically grouped activities.

D. Show critical path for sequencing of trades and materials.

E. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

F. Coordinate content with schedule of values specified in Section 01 29 76.

1.5 REVISIONS TO SCHEDULES

A. Indicate progress of each activity to date of submittal, and projected completion date of each activity.

B. Identify activities modified since previous submittal, major changes in scope, and other identifiable changes. Show on schedule by either variations of shading or patterns so the difference is apparent.

C. Provide narrative report to define problem areas, anticipated delays, and impact on Schedule and report corrective action taken or proposed and its effect.

D. Provide separate schedule of submittal dates for shop drawings, product data, and samples, including dates when submittals will be required from Architect. Show decision dates for selection of finishes.

1.6 SUBMITTALS

A. Submit initial schedules on or before pre-construction conference. After review, resubmit required revised data within ten (10) days.

B. Submit revised Progress Schedules with each Application for Payment. Pay request will not be processed without revised schedule submittal. Submit one copy for each copy of the Application for payment.

C. Submit a computer generated horizontal bar chart with separate line for each section of Work, identifying first work day of each week.

D. Show complete sequence of construction by activity, identifying Work of separate stages and other logically grouped activities. Indicate the early and late start, early and late finish, float dates, and duration.

E. Indicate estimated percentage of completion for each item of Work at each submission.

F. Indicate submittal dates required for shop drawings, product data, samples, and product delivery dates, including those furnished by Owner and required by Allowances.

G. Show critical path if sequence of work is dependant on certain items or trades completing their work in order for the project to be completed on time.

1.7 DISTRIBUTION

A. Distribute copies of reviewed schedules to Project site file, Subcontractors, suppliers, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 33 00

SUBMITTALS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Submittal procedures.

B. Proposed Products list.

C. Product Data.

D. Shop Drawings.

E. Samples.

F. Design data.

G. Test reports.

H. Certificates.

I. Manufacturer's instructions.

J. Manufacturer's field reports.

K. Warranties

L. Erection drawings.

1.2 RELATED SECTIONS

A. Section 01 40 00 - Quality Control: Manufacturers' field services and reports.

B. Section 01 77 00 - Contract Closeout: Contract warranties, bonds, manufacturers' certificates, and closeout submittals.

1.3 REFERENCES

A. AGC (Associated General Contractors of America) publication "The Use of CPM in Construction - A Manual for General Contractors and the Construction Industry".

1.4 GENERAL SUBMITTAL PROCEDURES

A. Transmit each submittal with AIA Form G810. Or Architect/Engineer accepted form.

B. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.

C. Identify Project, Contractor, Subcontractor or supplier; pertinent drawing and detail number, and specification section number, as appropriate.

D. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of Products required, field dimensions, adjacent construction Work, and coordination of information is in accordance with the requirements of the Work and Contract Documents. **Contractor shall review submittal before submitting to Architect.** Architect will not review submittal until Contractor has shown proof of review.

E. **Group submittals of like type together such as Plumbing submittals, HVAC submittals, Masonry submittals, Structural submittals, etc.** Review of single submittals of like types will be subject to delay until remaining submittals related to that being submitted are received by Architect.

F. Architect will review submittals and if applicable, forward to Consultant(s) for review. Upon review, Architect or consultant shall stamp each set of submittals indicated review status or required action, if any. This stamp, in no way relieves the Contractor of meeting the requirements and/or intent of the specifications. Architect's review of shop drawings and submittals is for intent and general compliance with contract documents. All other criteria are the sole responsibility of the General Contractor and his supplier.

G. Schedule submittals to expedite the Project, and deliver to Architect/Engineer at business address. Coordinate submission of related items.

H. Where colors and/or patterns are to be selected, or specifications include cash allowances by Architect, request such selections and materials in ample time for procurement.

I. For each submittal for review, allow 15 days excluding delivery time to and from the Contractor. However, Architect will make every effort to return submittals in a timely manner.

J. Identify variations from Contract Documents and Product or system limitations which may be detrimental to successful performance of the completed Work.

K. Provide space for Contractor and Architect/Engineer review stamps on front of submittal, minimum space of 4" x 8" on right hand border.

L. When revised for resubmission, identify all changes made since previous submission. Similar procedure is to be followed when resubmitting.

M. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report any inability to comply with requirements.

N. Submittals not requested will not be recognized or processed.

1.5 ELECTRONIC SUBMITTAL PROCEDURE

A. **All product data sheets, shop drawings, and miscellaneous submittal information are to be submitted electronically via email, FTP site, or other acceptable electronic submittal means. Please note that at Architect's discretion for large shop drawing submittals, a hard copy would need to be submitted along with electronic submittal. Architect will advise contractor of such submittals.**
   1. Contractor shall perform initial review and have comments and review stamp included on electronic submittal or shop drawings. **Please note that this is mandatory. Submittals and shop drawings will not be reviewed by Architect until Contractor reviews them and notes any comments or corrections required.**
   2. Submit for Architect's review.
   3. After review, electronic copy will be sent back to Contractor with any comments and markups, including review stamp status. If comments require re-submittal of all or partial original submittals or shop drawings, correct and resend for final approval or for Architect's record copy.
   4. Contractor to list specification section related to each item submitted. This shall include product data and shop drawings.

B. Items to be included in electronic submittals (As required by each product or item specification section):
   1. Product data
   2. Shop drawings
   3. Design data
   4. Test reports
   5. Certificates
   6. Manufacturer's instructions
   7. Warranties
   8. Erection drawings
   9. Any other information pertinent to product or item.

1.6 PRODUCT DATA

A. Product Data for Review:
   1. Submitted to Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
   2. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01 77 00 - CONTRACT CLOSEOUT.

B. Product Data for Information:
   1. Submitted electronically for the Architect/Engineer's knowledge as contract administrator or for the Owner.

C. Product Data for Project Closeout:
   1. Submitted for the Owner's benefit during and after project completion.

D. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

E. Indicate Product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

F. After review distribute in accordance with the Submittal Procedures article above and provide copies for record documents described in Section 01 77 00 - CONTRACT CLOSEOUT.

1.7 SHOP DRAWINGS

A. Shop Drawings for Review:
   1. Submitted to Architect/Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.
   2. After review, produce copies and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01 77 00 - CONTRACT CLOSEOUT.

B. Shop Drawings for Information:
   1. Submitted electronically for the Architect/Engineer's knowledge as contract administrator or for the Owner.

C. Shop Drawings for Project Closeout:
   1. Submitted for the Owner's benefit during and after project completion.

D. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.8 SAMPLES

A. Samples for Review:
   1. Submit actual samples to Architect/Engineer for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

B. Samples for Information:
   1. Submit actual samples for the Architect/Engineer's knowledge as contract administrator or for the Owner.

C. Samples for Selection:
   1. Submitted to Architect/Engineer for aesthetic, color, or finish selection.
   2. Submit samples of finishes from the full range of manufacturers' current standard colors, textures, and patterns for Architect/Engineer selection.
   3. After review, produce duplicates and distribute in accordance with SUBMITTAL PROCEDURES article above and for record documents purposes described in Section 01 77 00 - CONTRACT CLOSEOUT.

D. Submit samples to illustrate functional and aesthetic characteristics of the Product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.

E. Include identification on each sample, with full Project information.

F. Submit the number of samples specified in individual specification sections; one of which will be retained by Architect/Engineer.

G. For each job-finished material (i.e. Masonry, Stucco, concrete, paint and other finishes), prepare a sample panel as called for in individual sections. Obtain Architect's approval before installing balance of such work. Architect may require additional panels or samples. Contractor shall follow same procedure for Architect's approval. Subsequent work shall be in accordance with the approved sample panels.

H. Reviewed samples which may be used in the Work are indicated in individual specification sections.

I. Samples will not be used for testing purposes unless specifically stated in the specification section.

1.9 DESIGN DATA

A. Submit electronically for the Architect/Engineer's knowledge as contract administrator or for the Owner.

B. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.10 TEST REPORTS

A. Submit for the Architect/Engineer's knowledge as contract administrator or for the Owner. All test reports to immediately be sent to Architect for his/her review.

B. Submit test reports for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.11 CERTIFICATES

A. When specified in individual specification sections, submit certification by the manufacturer, installation/application Subcontractor, or the Contractor to Architect/Engineer, in quantities specified for Product Data.

B. Indicate material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.

C. Certificates may be recent or previous test results on material or Product, but must be acceptable to Architect/Engineer.

1.12 MANUFACTURER'S INSTRUCTIONS

A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Architect/Engineer for delivery to Owner in quantities specified for Product Data. A copy of such information will be included in appropriate section of Close-Out Documents.

B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.13 MANUFACTURER'S FIELD REPORTS

A. Submit reports for the Architect/Engineer's benefit as contract administrator or for the Owner.

B. Submit report within 15 days of observation to Architect/Engineer for information.

C. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

1.14 WARRANTIES

A. Submit product or system warranty for each product submitted on. Warranties shall accompany shop drawings and submittals. Warranty must be at least a minimum specified in individual sections, but not less than one year from date of substantial completion. Warranties will also be required as part of record documents. Refer to Section 01 77 00.

1.15 ERECTION DRAWINGS

A. Submit electronically, drawings for the Architect/Engineer's benefit as contract administrator or for the Owner.

B. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the contract documents.

C. Data indicating inappropriate or unacceptable Work may be subject to action by the Architect/Engineer or Owner.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 35 16

ALTERATION PROJECT PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products and installation for patching and extending Work.

B. Transition and adjustments.

C. Repair of damaged surfaces, finishes, and cleaning.

1.2 RELATED SECTIONS

A. Section 01 73 29 - Cutting and Patching:

B. Section 01 50 00 - Construction Facilities and Temporary Controls: Temporary enclosures, protection of installed work, and cleaning during construction.

C. Section 02 41 19 - Minor Demolition for Remodeling: Removal and storage of products to be reinstalled by this section.

PART 2 PRODUCTS

2.1 PRODUCTS FOR PATCHING AND EXTENDING WORK

A. New Materials: As specified in product sections; match existing Products and work for patching and extending work.

B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing Work as a standard.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that demolition is complete and areas are ready for installation of new Work.

B. Beginning of restoration Work means acceptance of existing conditions.

3.2 PREPARATION

A. Cut, move, or remove items as necessary for access to alterations and renovation Work. Replace and restore at completion.

B. Remove unsuitable material not marked for salvage, such as rotted wood, corroded metals, and deteriorated masonry and concrete. Replace materials as specified for finished Work.

C. Remove debris and abandoned items from area and from concealed spaces.

D. Prepare surface and remove surface finishes to provide for proper installation of new work and finishes.

E. Close openings in exterior surfaces to protect existing work and salvage items from weather and extremes of temperature and humidity. Insulate ductwork and piping to prevent condensation in exposed areas.

3.3 INSTALLATION

A. Coordinate work of alterations and renovations to expedite completion to accommodate Owner occupancy.

B. Remove, cut, and patch Work in a manner to minimize damage and to provide a means of restoring Products and finishes to original specified condition in accordance with Section 01 73 29.

C. Refinish visible existing surfaces to remain in renovated rooms and spaces, to specified condition for each material, with a neat transition to adjacent finishes in accordance with Section 01 73 29.

D. In addition to specified replacement of equipment and fixtures restore existing plumbing, heating, ventilation, air conditioning, and electrical systems to full operational condition.

E. Recover and refinish Work that exposes mechanical and electrical work exposed accidentally during the work.

F. Install Products as specified in individual sections.

G. Any utility line serving existing mechanical or building equipment that is to remain in operation and is required to be temporarily removed because of the remodeling process or interference with new items to be installed shall be logically re-routed to provide continued utility service to the effected equipment. It will be the contractor's responsibility to obtain Architect's approval and coordinate rerouting and reconnection to equipment. There will be no extra cost involved with the removal, rerouting and reconnection of these utility lines.

3.4 TRANSITIONS

A. Where new Work abuts or aligns with existing, perform a smooth and even transition. Patch Work to match existing adjacent Work in texture and appearance.

B. When finished surfaces are cut so that a smooth transition with new Work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Architect/Engineer.

3.5 ADJUSTMENTS

A. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.

B. Where a change of plane of 1/4 inch or more occurs, submit recommendation for providing a smooth transition for Architect/Engineer review.

C. Trim existing doors as necessary to clear new floor finish. Refinish trim as required.

D. Fit work at penetrations of surfaces as specified in Section 01 73 29.

3.6 REPAIR OF DAMAGED SURFACES

A. Patch or replace portions of existing surfaces that are damaged, lifted, discolored, or showing other imperfections.

B. Repair substrate prior to patching finish.

3.7 FINISHES

A. Finish surfaces as specified in individual Product sections.

B. Finish patches to produce uniform finish and texture over entire area. When finish cannot be matched, refinish entire surface to nearest intersections.

3.8 CLEANING

A. In addition to cleaning specified in Section 01 77 00, clean Owner occupied areas of work.

END OF SECTION

SECTION 01 40 00

QUALITY CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality assurance - control of installation.

B. Cleaning during construction

C. Tolerances

D. Protection

E. References and standards.

F. Mockup.

G. Inspecting and testing laboratory services.

H. Architect/Engineer Construction Observation Notices

I. Required Special Inspections

J. Required Pre-Installation Meetings

K. Manufacturers' field services.

L. Tobacco Use

1.2 RELATED SECTIONS

A. Section 01 33 00 - Submittals: Submission of manufacturers' instructions and certificates.

B. Section 01 60 00 - Material and Equipment: Requirements for material and product quality.

C. Section 01 75 00 - Starting of Systems.

1.3 CRAFTMANSHIP

A. Each trade to perform work and install products, following best standards of their industry. Work not in conformance with industry standards and quality will not be tolerated and will be subject to rejection.

1.4 QUALITY ASSURANCE - CONTROL OF INSTALLATION

A. Monitor quality control over suppliers, manufacturers, Products, services, site conditions, and workmanship, to produce Work of specified quality.

B. Furnish, apply, install, connect, erect, clean, and condition manufactured articles, materials, and equipment per manufacturer's printed directions, unless otherwise indicated or specified. Comply with manufacturers' instructions, including each step in sequence.

C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. Secure Products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement. All attachment devices and materials shall be as required to secure materials together or to other materials and to secure work of other trades.

H. Manufacturer's printed directions must be on job prior to and during installation of materials and equipment.

I. Make allowance for ample expansion and contraction for all building components subject to same.

J. Each trade shall provide sleeves, recesses and openings in their work as required to receive work of other trades.

K. Make field check of actual building dimensions before fabricating products.

L. Where proper fit of work depends upon close tolerances of manufactured products, furnish manufacturer with necessary templates to insure proper fit of all components.

M. Install materials only when conditions of temperature, moisture, humidity, and condition of adjacent building components are conducive to achieve the best installation on results.

N. Erect, install and secure building components in a structurally sound and appropriate manner. Where necessary, temporarily brace, shore, or otherwise support members until final connection or installation. Brace walls and other structural elements to prevent damage by wind and construction operations. Leave temporary bracing, shoring or other structural supports in place as long as necessary for safety and until structure is strong enough to withstand all loads involved.

O. Where construction consists of a series of courses of units, assemble units in best acceptable manner to provide structurally sound installation, waterproof where exposed to exterior. Accurately plumb and level all courses and verify levels of frequent courses with instruments.

P. Handle materials in manner to prevent scratching, abrading, distortion, chipping, breaking or other disfigurement.

Q. Unless indicated, fabricate and install materials true to line, plumb and level. Leave finished surfaces smooth and flat or of smooth contour where indicated, free from wrinkles, warps, scratches, dents and other imperfections.

R. Provide quality of workmanship not less than the commercially accepted standards of that trade.

S. Where obviously of best practice, furnish materials in longest practical lengths and largest practical sizes to avoid unnecessary jointing. Make all joints secure.

T. Where fabrics, plastics and other such items join, make seams tight, secure and inconspicuous.

U. Scribe and/or otherwise neatly fit materials to adjoining materials.

V. Consult Architect for mounting height or position of any unit not specifically located.

W. Mix no more materials than can be used before materials begin to "set". Mix no partially "set" batch with another. Clean tools and appliances prior to mixing materials to avoid contamination.

X. Conduct work in a manner to avoid injury to previously placed work.

Y. Do not disturb materials requiring curing time until appropriate curing time has transpired.

Z. Vertical & Horizontal Penetrations and Sleeves:
   1. Contractor is responsible for the layout, placement and identification of all necessary sleeves or penetrations needed to complete his work.
   2. All penetrations are to be fire stopped (where penetrating smoke and fire rated barriers) and sealed watertight prior to completion of contractor's work.
   3. All vertical sleeves or penetrations are to extend one and one half (1 ½") above the floor, slab, or housekeeping pad and be sealed watertight.

AA. Coordinate plumbing fixtures and valves with all toilet accessories to obtain proper clearances, and meet ADA Guidelines at accessible locations.

BB. Contractor to be responsible for coordinating items or equipment provided by owner so that proper space and clearances are provided in newly installed work. Notify owner if conflicts are found.

CC. During construction, if any material or product is damaged, it shall be repaired to Architect's satisfaction. If repair is not satisfactory, material or product will be replaced at no additional cost to owner.

DD. Where masonry is installed, all vertical and horizontal joints to align according to bond types. Where differing masonry types are installed in same wall, joints are to align between each masonry unit type unless noted otherwise.

EE. Where electrical conduit & wire, plumbing piping, fire sprinkler piping and mechanical ductwork are exposed, each trade is to install items neatly and coordinated with work of other trades. Where multiple electrical conduits or pipes protrude through walls or space, they are to be evenly spaced apart and routed in same plane. **Do not install below finished ceiling elevation unless shown otherwise**. At exposed structure locations conduit to exit wall at top of wall at coursing directly below roof supporting bond beam. Ductwork shall be routed logically and will be installed to provide neat, clean and aligned appearance, both vertically and horizontally.

FF. Any exposed exterior or interior plywood sheathing to be covered with temporary or permanent weather barrier within 24 hours following sheathing installation to prevent exposure to moisture or sunlight. Gypsum sheathing to be covered with temporary or permanent weather barrier within minimum time allowed by sheathing manufacturer.

GG. No plywood roof decking will be left exposed to moisture and sunlight. Weather barriers are to be installed immediately following installation of roof deck.

HH. Schedule work so that installed weather barriers at roofs and walls are not exposed to moisture, wind, or sunlight any longer than what the weather barrier manufacturer allows. Replace any weather barrier damaged by these elements.

II. No items including millwork and ceiling grid are to be installed against or on walls prior to the final coat of paint being applied.

1.5 CLEANING DURING CONSTRUCTION

A. Contractor to keep building and site reasonably free of debris during construction, including mud and dirt inside building. Provide means for keeping mud and clay off of floors that are to remain unfinished or clear sealed only.

B. If a floor sweep product is used, use only a wax base product. **Oil base products are not to be used.** Verify with floor covering and adhesive suppliers and obtain approval of floor sweep product so that warranty is not jeopardized.

1.6 DUST CONTROL DURING CONSTRUCTION

A. Contractor to keep dust on site to a minimum the entire duration of construction by means of regular watering. This will include dust created by grading operations, vehicular traffic, and wind. Also comply with SWPPP requirements.

B. Contractor to sprinkle work with water during demolition operations to minimize dust. Provide hoses and water connections for this purpose.

1.7 MATERIALS STORAGE

A. Limit site storage for construction materials in a central, secured area, within the boundaries of construction area. Assume full responsibility for protection of same.

1.8 APPROPRIATE MATERIALS

A. No materials containing asbestos fibers shall be allowed in any construction materials used in this project. General Contractor shall provide written certification to this effect at the end of the project. Certification shall be included in the project close-out documents. Refer to Section 02 26 23.

B. Should the General Contractor or any subcontractors discover materials that must be disturbed and are suspected in containing asbestos fibers or hazardous material, immediately notify the Architect. No disruption of such materials shall be attempted.

1.9 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Architect/Engineer before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

1.10 PROTECTION

A. Protect installed materials to prevent damage until substantial completion and comply with individual specification sections pertaining to protection of finished products.

B. No gypsum board, batt insulation, or materials prone to damage by moisture, mold and/or mildew will be installed prior to enclosing and drying in of building.

C. During construction, if any material is damaged after installation as a result of moisture, mold and/or mildew, it shall be replaced immediately.

D. Prior to installation and/or application of interior finishes, building will be completely enclosed, dried in and conditioned continually to meet minimum temperature and humidity requirements for finished product installation/application.

1.11 REFERENCES AND STANDARDS

A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid

requirements are specified or are required by applicable codes. Contractor is to be familiar with all standards pertaining to project.

B. Conform to reference standards at date of invitation to bidders.

C. Obtain copies of standards when required by the Contract Documents.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from the Architect/Engineer before proceeding.

F. Neither the contractual relationship, duties, nor responsibilities of the parties in Contract nor those of the Architect/Engineer shall be altered by the Contract Documents by mention or inference otherwise in any reference document.

1.12 REFERENCES

A. Reference to technical society, organization or body is made in these specifications in accordance with but not limited to the following:

DBA	ARKANSAS DEPARTMENT OF BUILDING AUTHORITY MINIMUM STANDARDS & CRITERIA
AIA	AMERICAN INSTITUTE OF ARCHITECTS
ACI	AMERICAN CONCRETE INSTITUTE
ADA	THE AMERICANS WITH DISABILITIES ACT
AEC	ARKANSAS ENERGY CODE
AFGG	ARKANSAS FUEL GAS CODE
AFPC	ARKANSAS FIRE PREVENTION CODE
AIEE	AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AMC	ARKANSAS MECHANICAL CODE
APC	ARKANSAS PLUMBING CODE
ASHRAE	AMERICAN SOCIETY OF HEATING, REFRIGERATING, AND AIR-CONDITIONING ENGINEERS, INC.
ASME	AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ASTM	AMERICAN SOCIETY FOR TESTING MATERIALS
AWSC	AMERICAN WELDING SOCIETY CODE
AWI	ARCHITECTURAL WOODWORK INSTITUTE
IBC	INTERNATIONAL BUILDING CODE
IMC	INTERNATIONAL MECHANICAL CODE
IPC	INTERNATIONAL PLUMBING CODE
NBFU	NATIONAL BOARD OF FIRE UNDERWRITERS
NBS	NATIONAL BUREAU OF STANDARDS
NEC	NATIONAL ELECTRIC CODE
NFPA	NATIONAL FIRE PROTECTION ASSOCIATION
OSHA	OCCUPATIONAL SAFETY & HEALTH ACT OF 1970
UL	UNDERWRITERS' LAB

1.13 MOCK-UP

A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.

B. Accepted mock-ups shall be a comparison standard for the remaining Work.

C. Where mock-up has been accepted by Architect/Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so.

D. Wall Mock-Ups: Construct mock-ups of wall assemblies in "cut-away view, showing each step and material or the assembly (i.e. Stud wall, sheathing, weather barrier, thru-wall membrane flashing, cavity insulation system, and wall finish material). Also show typical weather barrier installation(s) at wall openings. Refer to sheet A201 for drawing of mock up for more information.

1.14 TESTING SERVICES

A. Furnish materials and equipment that have been properly inspected and tested in accordance with accepted industry standards. Make field or laboratory tests where specified herein, the costs of such being paid for by the contractor, unless specifically stated otherwise. FOR TESTING PAID FOR BY CONTRACTOR, THE PROPOSED TESTING LABORATORY/ENGINEER MUST BE APPROVED BY THE ARCHITECT NO LATER THAN 10 DAYS PRIOR TO BID OPENING. If certain tests are to be paid for by others, General Contractor will remain responsible for scheduling and coordinating their tests at appropriate times.

B. Should such test or visual observation indicate failure of the materials or construction to meet requirements of the drawings and or specification, Contractor is to make additional tests as directed by the Architect, until compliance has been achieved. If such work should fail to comply, Contractor shall replace it at his expense. Charges for this additional testing will be paid for by the Contractor.

C. Testing and source quality control may occur on or off the project site. Perform off-site testing as required by the Architect/Engineer or the Owner.

D. Reports will be submitted by the independent firm to the Architect/Engineer and Contractor at the same time, indicating observations and results of tests and indicating compliance or noncompliance with Contract Documents.

E. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

F. Testing does not relieve Contractor to perform Work to contract requirements.

1.15 NOTICE FOR ARCHITECT/ENGINEER OBSERVATION

A. Whenever specifications require the contractor to have any part of work observed and approved by the Architect, THE CONTRACTOR SHALL GIVE THE ARCHITECT A MINIMUM 24 HOURS NOTICE as to when that part of the work will be ready for observation. No part of weekends or holidays shall be counted as part of the required hours of notice. If schedule of work has changed after notification, immediately notify Architect to inform him of change. The following is a partial list of items requiring Construction Observation. This is a general listing; your specific project may not contain some of the items listed. Refer to each individual specification section for additional observation requirements:
   1. **Sanitary Sewer Line**: 24 hr 10' standpipe, proper bedding, proper clearances from water lines
   2. **Domestic Water Line**: 24 hr city wall pressure or 75 psi air pressure test, proper bedding, proper clearance from sanitary sewer lines.
   3. **Footing Inspections**: Count rebar and sizes, clearances, clean trenches, proper supports, proper clearances for drain lines & conduit
   4. **Cast In Place Concrete**: (retaining walls, stem walls, pedestals) water stops are in place, count rebar and size.
   5. **Below Grade Water Proofing Membranes**: Inspection of surfaces, laps, lapping over top of footing prior to any backfill, or protection board being applied.
   6. **Slab on Grade**: vapor barrier, taping, extension to adjacent pours, wire mesh placement, proper supports, concrete slab depth, termite spray application (dyed)
   7. **Floor or Roof Deck**: structural engineer / architect is to inspect welds and side-lap fasteners
   8. **Slab on Deck**: wire mesh placement, proper supports, block-outs
   9. **Wall and Above Ceiling**: correct insulation, mechanical and electrical engineers are to inspect conduits, ducts etc. prior to closing in walls.
   10. **Masonry**: Mason to prepare mock sample for review prior to starting masonry on job site
   11. **EIFS**: check substrate prior to EIFS coating
   12. **Gas Line**: 15psi, 24hr or as required by governing jurisdiction if more stringent.
   13. **Thru Wall Flashing**: Inspection of surfaces, laps, termination bar installed and sealed, alignment with masonry face.

1.16 REQUIRED SPECIAL INSPECTIONS

A. When required by local or governing jurisdiction, contractor will arrange with testing company, special inspections in accordance with Chapter 17 of the International Building Code. Contractor is to pay for special inspections.

1.17 REQUIRED PRE-INSTALLATION MEETINGS

A. When noted in individual Specification Sections, on-site pre-installation meetings will be scheduled and held by Contractor prior to installation of system, product or material. Installation of items is not to begin until meeting is held. Each specification Section should state the persons that are required to attend each meeting.

1.18 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or Product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications of observer to Architect/Engineer 30 days in advance of required observations.
C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

D. Refer to Section 01 33 00 - SUBMITTALS, MANUFACTURERS' FIELD REPORTS article.

1.19 TOBACCO USE

A. **Absolutely no tobacco or e-cigarette use is permitted inside new or existing building areas throughout construction of project.**

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify that utility services are available, of the correct characteristics, and in the correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

1.2 USE CHARGES

A. General: Installation and removal of and use charges for temporary facilities shall be included in the Contract Sum unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to, Owner's construction forces, Engineer, testing agencies, and authorities having jurisdiction.

B. Water and Sewer Service from Existing System: Water from Owner's existing water system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

C. Electric Power Service from Existing System: Electric power from Owner's existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations.

1.3 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, vehicle circulation, and parking areas for construction personnel.

B. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

C. Fire-Safety Program: Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

D. Moisture-and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold.

E. Dust- and HVAC-Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust-control partitions at each phase of work.

2. HVAC system isolation schematic drawing.

3. Location of proposed air-filtration system discharge.

4. Waste-handling procedures.

5. Other dust-control measures.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and] ICC/ANSI A117.1.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.1 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Common-Use Field Office: Of sufficient size to accommodate needs of Owner, Engineer, Construction Manager, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office clean and orderly. Furnish and equip offices as follows:

1. Furniture required for Project-site documents including file cabinets, plan tables, plan racks, and bookcases.

2. Conference room of sufficient size to accommodate meetings of 10 individuals. Provide electrical power service and 120-V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 4-foot-square tack and marker boards.

3. Drinking water and private toilet.

4. Heating and cooling equipment necessary to maintain a uniform indoor temperature of 68 to 72 deg F.

5. Lighting fixtures capable of maintaining average illumination of 20 fc at desk height.

2.2 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. HVAC Equipment: Unless Owner authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.

2. Heating Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.

3. Permanent HVAC System: If Owner authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of 8 at each return-air grille in system and remove at end of construction.

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shutoff. Configure to run continuously.

PART 3 EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.3 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, Owner, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.

B. Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to municipal system as directed by authorities having jurisdiction.

C. Water Service: Install water service and distribution piping in sizes and pressures adequate for construction.

D. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.

E. Temporary Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed.

1. Provide temporary dehumidification systems when required to reduce ambient and substrate moisture levels to level required to allow installation or application of finishes and their proper curing or drying.

F. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

G. Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service underground unless otherwise indicated.

H. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

3.4 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Maintain support facilities until Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Owner.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas within construction limits indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

C. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

D. Parking: Provide temporary parking areas for construction personnel.

E. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.

2. Remove snow and ice as required to minimize accumulations.

F. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.

2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.

a. Provide temporary, directional signs for construction personnel and visitors.

3. Maintain and touch up signs so they are legible at all times.

G. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.

J. Existing Elevator Use: Use of Owner's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.

2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

K. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

L. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

M. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

N. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

O. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

P. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."

Q. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to [erosion- and sedimentation-control Drawings] requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.

2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.

4. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

R. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

S. Tree and Plant Protection: Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."

T. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

U. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

V. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: As indicated on Drawings.

2. Maintain security by limiting number of keys and restricting distribution to authorized personnel.

W. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

X. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

Y. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

Z. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

AA. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program.

1. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.

2. Develop and supervise an overall fire-prevention and -protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.

3. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and replacing water-damaged Work.

2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.

3. Indicate methods to be used to avoid trapping water in finished work.

B. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.

2. Protect stored and installed material from flowing or standing water.

3. Keep porous and organic materials from coming into prolonged contact with concrete.

4. Remove standing water from decks.

5. Keep deck openings covered or dammed.

C. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.

2. Keep interior spaces reasonably clean and protected from water damage.

3. Periodically collect and remove waste containing cellulose or other organic matter.

4. Discard or replace water-damaged material.

5. Do not install material that is wet.

6. Discard and replace stored or installed material that begins to grow mold.

7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

D. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.

2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.

3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.

2. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures."

END OF SECTION

SECTION 01 56 39

TEMPORARY TREE AND PLANT PROTECTION

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.

1.2 RELATED REQUIREMENTS

A. Section 31 1000 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.

B. Section 31 2000 - Earthwork: Temporary and permanent grade changes for erosion control.

C. Section 32 1123 - Aggregate Base Courses: Temporary and permanent roadways.

1.3 DEFINITIONS

A. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.

B. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 96 inches unless otherwise indicated. Reference Demo and Tree Preservation Plan for tree protection fence locations.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.

C. Samples: For each type of the following:

1. Organic Mulch: Sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.

2. Protection-Zone Fencing: Assembled Samples.

3. Protection-Zone Signage: Full-size Samples.

D. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning of trees to remain that interfere with or are affected by construction.

1.6 INFORMATIONAL SUBMITTALS

A. Certification: From ISA Certified Arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.

B. Maintenance Recommendations: From ISA Certified Arborist, for care and protection of trees affected by construction during and after completing the Work.

C. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.

1.7 QUALITY ASSURANCE

A. Arborist Qualifications: Certified Arborist as certified by ISA, licensed arborist in jurisdiction where Project is located, current member of ASCA, or registered Consulting Arborist as designated by ASCA.

1.8 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.

2. Moving or parking vehicles or equipment.

3. Foot traffic.

4. Erection of sheds or structures.

5. Impoundment of water.

6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

B. Do not direct vehicle or equipment exhaust toward protection zones.

C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

PART 2 PRODUCTS

2.1 MATERIALS

A. Backfill Soil: Stockpiled soil mixed with planting soil of suitable moisture content and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth.

1. Mixture: Well-blended mix of two parts stockpiled soil to one part planting soil.

2. Planting Soil: Planting soil as specified in Section 329113 "Soil Preparation".

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood.

C. Protection-Zone Fencing: Fencing fixed in position and meeting one of the following requirements: Previously used materials may be used when approved by Engineer.

1. Chain-Link Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch- diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch- OD line posts, and 2-7/8-inch- OD corner and pull posts; with 1-5/8-inch- OD top rails and 0.177-inch- diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

a. Height: 48 inches

2. Plywood Protection-Zone Fencing: Plywood framed with four 2-by-4-inch rails, with 4-by-4-inch preservative-treated wood posts spaced not more than 96 inches apart.

a. Height: 48 inches.

3. Wood Protection-Zone Fencing: Constructed of two 2-by-4-inch (50-by-100-mm) horizontal rails, with 4-by-4-inch (100-by-100-mm) preservative-treated wood posts spaced not more than 96 inches (2400 mm) apart, and lower rail set halfway between top rail and ground.

a. Height: 48 inches.

4. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 2-inch (50-mm) maximum opening in pattern and supported by tubular or T-shape galvanized-steel posts spaced not more than 96 inches (2400 mm) apart. High-visibility orange color.

a. Height: 48 inches.

5. Gates: Swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones.

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering, stating "Notice: Tree Preservation Area DO NOT ENTER" or other verbiage as required by Urban Forester for the jurisdiction in which work will take place.

PART 3 EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Tree-Protection Area: An Arborist shall examine all trees to remain and assess the health and maintenance needed for each individual tree. A report shall be generated from the Arborist and submitted to the Contractor, Owner and Landscape Architect.

3.2 PREPARATION

A. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

B. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 4-inch uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 6 inches of tree trunks.

3.3 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones in a manner that will prevent people from easily entering protected areas except by entrance gates.

1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.

2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Landscape Architect.

3. Access Gates: Install where indicated.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect.

C. Maintain protection zones free of weeds and trash.

D. Maintain protection-zone fencing and signage in good condition as acceptable to Landscape Architect and remove when construction operations are complete, and equipment has been removed from the site.

3.4 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Section 312000 "Earth Moving" unless otherwise indicated.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.

C. Do not allow exposed roots to dry out before placing permanent backfill.

3.5 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as follows:

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.

2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.

3. Cover exposed roots with burlap or mulch and water regularly.

4. Backfill as soon as possible according to requirements in Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Expose roots by hand or using an air spade. Prune tree roots by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.6 CROWN PRUNING

A. Prune branches that are affected by temporary and permanent construction. Prune branches as directed by arborist.

1. Prune to remove only injured, broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.

2. Do not remove or reduce living branches to compensate for root loss caused by damaging or cutting root system.

3. Pruning Standards: Prune trees according to ANSI A300 and/or as indicated on Drawings.

B. Cut branches with sharp pruning instruments; do not break or chop.

C. Do not paint or apply sealants to wounds.

D. Chip removed branches and spread over areas identified by Engineer.

3.7 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

C. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with backfill soil approved by Landscape Architect. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.8 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

B. Reports: All trees disturbed or damaged within a tree protection area or easement are to be assessed and a report produced by an arborist. All trees to remain are to be evaluated individually in a report by an arborist. Report is to be reviewed and approved by the Landscape Architect. All associated cost of arborist and associated work recommended in reports are to be at the contractor’s expense. Including but not limited to pruning, dead wooding, tree removal and legal disposal of material offsite.

3.9 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by the Landscape Architect.

1. Perform repairs of damaged trunks, branches, and roots within 24 hours according to arborist's written instructions.

2. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.

B. Excess Mulch: Rake mulched area within protection zones, being careful not to injure roots. Rake to loosen and remove mulch that exceeds a 4-inch uniform thickness to remain.

3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION

SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

D. Performance bond.

E. Compensation of Owner for fines levied by authorities having jurisdiction due to non-compliance by Contractor.

1.2 RELATED REQUIREMENTS

A. Section 00 1003 – Stormwater Pollution Prevention Plan

B. Section 31 1000 - Site Clearing: Limits on clearing; disposition of vegetative clearing debris.

C. Section 31 2000 - Earthwork: Temporary and permanent grade changes for erosion control.

D. Section 32 1123 - Aggregate Base Courses: Temporary and permanent roadways.

1.3 PERFORMANCE REQUIREMENTS

A. Comply with all requirements of U.S. Environmental Protection Agency (EPA)and Arkansas Department of Environmental Quality (ADEQ) for erosion and sedimentation control.

1. Comply with requirements and recommendations of the EPA National Pollutant Discharge Elimination System (NPDES), Phases I and II, under requirements for the 2003 Construction General Permit (CGP)

2. Comply with requirements and recommendations of the ADEQ Construction Stormwater Discharge Permit ARR150000.

3. Comply with requirements and recommendation of the ADEQ Short Term Activity Authorization Permit, Specification Section 001001.

B. Comply with requirements of State of Arkansas, Erosion and Sedimentation Control Manual.

C. Comply with requirements of the City of Bentonville.

D. Develop and follow an Erosion and Sedimentation Prevention Plan and submit weekly inspection reports.

E. Do not begin clearing, grading, or other work involving disturbance of ground surface cover until applicable permits have been obtained; furnish all documentation required to obtain applicable permits.

1. Obtain and pay for permits and provide security required by authority having jurisdiction.

F. Provide to Owner a Performance Bond covering erosion and sedimentation preventive measures only, in an amount equal to 100 percent of the cost of erosion and sedimentation control work.

G. Timing: Put preventive measures in place prior to disturbance of surface cover and before precipitation occurs.

H. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.

1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.

2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

I. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.

1. Control movement of sediment and soil from temporary stockpiles of soil.

2. Prevent development of ruts due to equipment and vehicular traffic.

3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

J. Erosion Off Site: Prevent erosion of soil and deposition of sediment on other properties caused by water leaving the project site due to construction activities for this project.

1. Prevent windblown soil from leaving the project site.

2. Prevent tracking of mud onto public roads outside site.

3. Prevent mud and sediment from flowing onto sidewalks and pavements.

4. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

G. Sedimentation of Waterways Off Site: Prevent sedimentation of waterways off the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.

1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.

H. Open Water: Prevent standing water that could become stagnant.

I. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

J. All area left disturbed longer than 14 days shall be vegetated and/or stabilized.

1.4 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Erosion and Sedimentation Control Plan:

1. Submit within 2 weeks after Notice to Proceed.

2. Include:

a. Site plan identifying soils and vegetation, existing erosion problems, and areas vulnerable to erosion due to topography, soils, vegetation, or drainage.

b. Site plan showing grading; new improvements; temporary roads, traffic accesses, and other temporary construction; and proposed preventive measures.

c. Where extensive areas of soil will be disturbed, include storm water flow and volume calculations, soil loss predictions, and proposed preventive measures.

d. Schedule of temporary preventive measures, in relation to ground disturbing activities.

e. Other information required by law.

f. Format required by law is acceptable, provided any additional information specified is also included.

3. Obtain the approval of the Plan by authorities having jurisdiction.

4. Obtain the approval of the Plan by Owner.

C. Certificate: Mill certificate for silt fence fabric attesting that fabric and factory seams comply with specified requirements signed by legally authorized official of manufacturer; indicate actual minimum average roll values; identify fabric by roll identification numbers.

D. Inspection Reports: Submit report of each inspection; identify each preventive measure, indicate condition, and specify maintenance or repair required and accomplished.

E. Maintenance Instructions: Provide instructions covering inspection and maintenance for temporary measures that must remain after Substantial Completion.

PART 2 PRODUCTS

2.1 MATERIALS

A. Mulch: Use one of the following:

1. Straw or hay, certified weed seed free ‘clean’.

2. Erosion control matting or netting, bio- or photo-degradable straw, coconut, coir or jute.

3. 100% Wood Fiber Hydroseeding Mulch

B. Grass Seed for Temporary Cover: If same area will later be planted with permanent vegetation, do not use species known to be excessively competitive or prone to volunteer in subsequent seasons.

1. Summer Temporary Cover: May -September shall be Browntop Millet seeded at 100 lbs per acre and Plains Coreopsis seeded at 2 lbs per acre.

2. Winter Temporary Cover: September-May – shall be Cereal Rye -Secale cereale grain – 200 lbs/acre.

C. Silt Fence Fabric: Polypropylene geotextile resistant to common soil chemicals, mildew, and insects; non-biodegradable; in longest lengths possible; fabric including seams with the following minimum average roll lengths:

1. Average Opening Size: 30 U.S. Std. Sieve, maximum, when tested in accordance with ASTM D 4751.

2. Permittivity: 0.05 sec^-1, minimum, when tested in accordance with ASTM D 4491.

3. Ultraviolet Resistance: Retaining at least 70 percent of tensile strength, when tested in accordance with ASTM D 4355 after 500 hours exposure.

4. Tensile Strength: 100 lb-f, minimum, in cross-machine direction; 124 lb-f, minimum, in machine direction; when tested in accordance with ASTM D 4632.

5. Elongation: 15 to 30 percent, when tested in accordance with ASTM D 4632.

6. Tear Strength: 55 lb-f, minimum, when tested in accordance with ASTM D 4533.

7. Color: Manufacturer's standard, with embedment and fastener lines preprinted.

D. Silt Fence Posts: One of the following, minimum 5 feet long:

1. Steel U- or T-section, with minimum mass of 1.33 lb per linear foot.

E. Gravel: See Section 32 1123 for aggregate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.2 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.3 SCOPE OF PREVENTIVE MEASURES

A. In all cases, if permanent erosion resistant measures have been installed temporary preventive measures are not required.

B. Construction Entrances: Traffic-bearing aggregate surface.

1. Width: As required; 20 feet, minimum.

2. Length: 50 feet, minimum.

3. Provide at each construction entrance from public right-of-way.

4. Where necessary to prevent tracking of mud onto right-of-way, provide wheel washing area out of direct traffic lane, with drain into sediment trap or basin.

C. Linear Sediment Barriers: Made of silt fences.

1. Provide linear sediment barriers:

a. Along downhill perimeter edge of disturbed areas, including soil stockpiles.

b. Along the toe of cut slopes and fill slopes.

c. Perpendicular to flow across the bottom of existing and new drainage channels and swales that traverse disturbed areas or carry runoff from disturbed areas; space at maximum of 200 feet apart.

d. Across the entrances to culverts that receive runoff from disturbed areas.

2. Space sediment barriers with the following maximum slope length upslope from barrier:

a. Slope of Less Than 2 Percent: 100 feet..

b. Slope Between 2 and 5 Percent: 75 feet.

c. Slope Between 5 and 10 Percent: 50 feet.

d. Slope Between 10 and 20 Percent: 25 feet.

e. Slope Over 20 Percent: 15 feet.

D. Storm Drain Curb Inlet Sediment Trap: Protect each curb inlet using one of the following measures:

1. Filter fabric wrapped around hollow concrete blocks blocking entire inlet face area; use one piece of fabric wrapped at least 1-1/2 times around concrete blocks and secured to prevent dislodging; orient cores of blocks so runoff passes into inlet.

2. Straw bale row blocking entire inlet face area; anchor into pavement.

E. Storm Drain Drop Inlet Sediment Traps: As detailed on drawings.

F. Temporary Splash Pads: Stone aggregate over filter fabric; size to suit application; provide at downspout outlets and storm water outlets.

G. Soil Stockpiles: Protect using one of the following measures:

1. Cover with polyethylene film, secured by placing soil on outer edges.

2. Cover with mulch at least 4 inches thickness of pine needles, sawdust, bark, wood chips, or shredded leaves, or 6 inches of straw or hay.

H. Mulching: Use only for areas that may be subjected to erosion for less than 6 months.

I. Temporary Seeding: Use where temporary vegetated cover is required.

3.4 INSTALLATION

A. Traffic-Bearing Aggregate Surface:

1. Excavate minimum of 6 inches.

2. Place geotextile fabric full width and length, with minimum 12 inch overlap at joints.

3. Place and compact at least 6 inches of 1.5 to 3.5 inch diameter stone.

B. Silt Fences:

1. Store and handle fabric in accordance with ASTM D 4873.

2. Where slope gradient is less than 3:1 or barriers will be in place less than 6 months, use nominal 16 inch high barriers with minimum 36 inch long posts spaced at 6 feet maximum, with fabric embedded at least 4 inches in ground.

3. Where slope gradient is steeper than 3:1 or barriers will be in place over 6 months, use nominal 28 inch high barriers, minimum 48 inch long posts spaced at 6 feet maximum, with fabric embedded at least 6 inches in ground.

4. Where slope gradient is steeper than 3:1 and vertical height of slope between barriers is more than 20 feet, use nominal 32 inch high barriers with woven wire reinforcement and steel posts spaced at 4 feet maximum, with fabric embedded at least 6 inches in ground.

5. Install with top of fabric at nominal height and embedment as specified.

3.5 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Ecological Design Group, Inc.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

3.6 MAINTENANCE

A. Contractor shall maintain, repair, replace or add best management practices and structural erosion and sediment controls as necessary or required to maintain project compliance with all applicable local, state and federal requirements, including Project specific Permits.

3.7 WARRANTY

A. Contractor shall warrant the project for Permit compliance for the duration of all project work or project area surface disturbance and for one year after project completion, whichever is longer.

B. Contractor shall pay for any and all fines, fees or costs incurred by the Project or Owner for non-compliance with Permit requirements.

END OF SECTION

SECTION 01 60 00

MATERIAL AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Products.

B. Transportation and handling.

C. Storage and protection.

D. Product options.

E. Substitutions.

1.2 RELATED SECTIONS

A. Section 01 40 00 - Quality Control: Product quality monitoring.

1.3 PRODUCTS

A. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.

B. Provide interchangeable components of the same manufactures for components being replaced.

1.4 TRANSPORTATION AND HANDLING

A. Transport and handle Products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that Products comply with requirements, quantities are correct, and Products are undamaged.

C. Provide equipment and personnel to handle Products by methods to prevent soiling, disfigurement, or damage.

1.5 STORAGE AND PROTECTION

A. Store and protect Products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive Products in weather tight, climate controlled, enclosures in an environment favorable to Product.

D. For exterior storage of fabricated Products, place on sloped supports above ground.

E. Provide bonded or insured off-site storage and protection when site does not permit on-site storage or protection.

F. Cover Products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of Products.

G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store Products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of Products to permit access for inspection. Periodically inspect to verify Products are undamaged and are maintained in acceptable condition.

1.6 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any Product meeting those standards or description.

B. Products Specified by Naming One or More Manufacturers: Products of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.7 ALTERNATE SUBSTITUTIONS

A. In general, these Specifications identify the required materials and equipment by naming one or more manufacturer's brand, model, catalog number and/or other identification; the first-named manufacturer's product used as the basis for design; other named brands considered acceptable for the application by Architect. Alternate brand manufacturers named must furnish products consistent with the specifications for the first-named product, as determined by Architect. Base Proposal shall include only those brands named, except as hereinafter provided.
   1. Submit product data and specifications.
   2. Submit color samples if color selection is required or specified.
   3. Provide list, locations and contacts with telephone numbers of local installations.
   4. Provide qualifying comparison, comparing specifications of specified product to proposed substitution.

   If any of these items are not provided, proposed substitution will be rejected.

B. Where materials or equipment are described but not named, provide required first-quality items, adequate in every respect for the intended use; such items subject to Architect's approval prior to procurement.

C. Prior to receipt of proposals, should Contractor wish to incorporate in Base Proposal brands of products other than those named in Specifications, **he shall submit written request for substitution with required information to Architect not later than ten (10) days prior to date proposals are due.** Architect will consider requests and items. If proposed substitution is approved, it will be listed in an addendum issued to principal Proposers.

D. After execution of Owner-Contractor Agreement, alternate substitution of product brands for those named in Specifications will be considered, only if (1) request is received within thirty (30) calendar days after Contract date and request includes statement showing credit due Owner, if any; if substitution product is used, (2) Owner requests consideration be given to substitute brands, (3) Proposer provides qualifying comparison, comparing specifications of specified product to proposed alternate substitution. If this is not provided, proposed substitution will be rejected. The Architect/Engineer will notify Contractor in writing of decision to accept or reject request.

E. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents. Materials and equipment proposed for substitution shall be acceptable by Architect to that specified in regard to construction, efficiency, utility, aesthetic design, and color. The Architect's decision shall be final and without further recourse. Physical size of substitute brand shall not be larger than the space provided for it. Requests must be accompanied by full description and technical data, in two copies, including manufacturer's name, model, catalog number, photographs or cuts, physical dimensions, operating characteristics, and any other information necessary for comparison.

F. Substitutions may be considered when a Product becomes unavailable through no fault of the Contractor.

G. A request constitutes a representation that the Bidder: / Contractor:
   1. Has investigated proposed Product and determined that it meets or exceeds the quality level of the specified Product.
   2. Will provide the same warranty for the Substitution as for the specified Product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.
   5. Will reimburse Owner and Architect/Engineer for review or redesign services associated with re-approval by authorities if required.

H. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, specifications section states that no substitutions are allowed for a specific material or item, or when acceptance will require revision to the Contract Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Requirements and limitations for cutting and patching of Work.

1.2 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work: Work by Owner or by separate Contractors.

B. Section 01 35 16 - Alteration Project Procedures: Cutting and patching for alterations work.

C. Section 01 33 00 - Submittals.

D. Section 01 60 00 - Material and Equipment: Product options and substitutions.

E. Section 07 84 13 - Fire stopping.

F. Individual Product Specification Sections:
   1. Cutting and patching incidental to work of the section.
   2. Advance notification to other sections of openings required in work of those sections.
   3. Limitations on cutting structural members.

1.3 SUBMITTALS

A. Submit written request in advance of cutting or alteration which affects:
   1. Structural integrity of any element of Project.
   2. Integrity of weather exposed or moisture resistant element.
   3. Efficiency, maintenance, or safety of any operational element.
   4. Visual qualities of sight exposed elements.
   5. Work of Owner or separate Contractor.

B. Include in request:
   1. Identification of Project.
   2. Location and description of affected Work.
   3. Necessity for cutting or alteration.
   4. Description of proposed Work and Products to be used.
   5. Alternatives to cutting and patching.
   6. Effect on work of Owner or separate Contractor.
   7. Written permission of affected separate Contractor.
   8. Date and time work will be executed.

PART 2 PRODUCTS

2.1 MATERIALS

A. Primary Products: Those required for original installation.

B. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00.

PART 3 EXECUTIONS

3.1 EXAMINATION

A. Examine existing conditions prior to commencing Work, including elements subject to damage or movement during cutting and patching.

B. After uncovering existing Work, assess conditions affecting performance of work.

C. Beginning of cutting or patching means acceptance of existing conditions.

3.2 PREPARATION

A. Provide temporary supports to ensure structural integrity of the Work. Provide devices and methods to protect other portions of Project from damage.

B. Provide protection from elements for areas which may be exposed by uncovering work.

C. Maintain excavations free of water.

3.3 CUTTING

A. Execute cutting and fitting including excavation and fill if required, to complete the Work.

B. Remove and replace defective or nonconforming work.

C. Remove samples of installed work for testing when requested.

D. Provide openings in the Work for penetration of mechanical and electrical work.

E. Employ skilled and experienced installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

3.4 PATCHING

A. Execute patching to complement adjacent Work. Match with existing finish where exposed to view unless noted otherwise.

B. Fit Products together to integrate with other Work.

C. Execute work by methods to avoid damage to other Work, and which will provide appropriate surfaces to receive patching and finishing.

D. Employ skilled and experienced installer to perform patching for weather exposed and moisture resistant elements, and sight exposed surfaces.

E. Restore work with new Products in accordance with requirements of Contract Documents.

F. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

G. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire resistant material in accordance with Section 07 84 00 to full thickness of the penetrated element.

H. Refinish surfaces to match adjacent finish. For continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.

END OF SECTION

SECTION 01 75 00

STARTING OF SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Starting systems.

B. Demonstration and instructions.

C. Testing, adjusting, and balancing.

1.2 RELATED SECTIONS

A. Section 01 40 00 - Quality Control: Manufacturers field reports.

B. Section 01 77 00 - Contract Closeout: System operation and maintenance data and extra materials.

C. Division 23 – Heating, Ventilation, and Air Conditioning

1.3 STARTING SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify Architect/Engineer seven days prior to start-up of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions which may cause damage.

D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative or Contractors' personnel in accordance with manufacturers' instructions and requirements.

G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 01 33 00 that equipment or system has been properly installed and is functioning correctly.

1.4 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of Products to Owner's personnel two weeks prior to date of final inspection.

B. Demonstrate Project equipment and instruct owner’s representative by a qualified manufacturers' representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owners' personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start-up, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time, at equipment location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. The amount of time required for instruction on each item of equipment and system is that specified in individual sections.

H. Contractor to provide DVD recording of all training sessions with Owner personnel. A copy of the recorded training sessions are to be given to the Owner included in the closeout documents.

1.5 TESTING, ADJUSTING, AND BALANCING

A. The Contractor will employ services of an independent firm to perform testing, adjusting, and balancing. Contractor shall pay for services.

B. The independent firm will perform services specified in Division 23.

C. Reports will be submitted by the independent firm to the Architect/Engineer indicating observations and results of tests and indicating compliance or noncompliance with the requirements of the Contract Documents.

PART 2 PRODUCTS
Not Used.

PART 3 EXECUTIONS
Not Used.

END OF SECTION

SECTION 01 77 00

CONTRACT CLOSEOUT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.

B. Final cleaning.

C. Adjusting.

D. Project record documents.

E. Operation and maintenance data.

F. Spare parts and maintenance Products.

G. Warranties and Guarantees.

H. Maintenance service.

1.2 RELATED SECTIONS

A. Section 01 50 00 - Construction Facilities and Temporary Controls: Progress cleaning.

B. Section 01 75 00 - Starting of Systems: System start-up, testing, adjusting, and balancing.

1.3 CLOSEOUT PROCEDURES

A. Contractor shall notify Architect ten (10) days prior to the date on which the building will be ready for final inspection and prepare his own punch list of items to complete to meet contract documents. Such notice shall not be made until completion of all items is assured, and has submitted completed punch list items to Architect. Architect will not schedule inspection for punch list until Contractor's completed punch list is received and each item is initialed by contractor as complete.

B. Incomplete work found during the inspection shall be grounds for ceasing the inspection. Final inspection shall be resumed again only upon completion of work.

C. Minor adjustments and corrections to work shall not be considered cause for discontinuing final inspection.

D. Upon receipt of punch list prepared by Architect, the Contractor will immediately make necessary corrections to work as required for final completion of the project.

E. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Architect/Engineer's review.

F. Provide submittals to Architect / Engineer that are required by any governing or other authorities.

G. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and sum remaining due. The final application for payment will not be approved for payment by the Architect until the “COMPLETE CLOSEOUT” documents are provided to and reviewed by the Architect by the Contractor.

H. Owner will occupy all portions of the building as specified in Section 01 11 00.

1.4 FINISHING

A. Adjust windows, doors, drawers, hardware, appliances, motors, valves, controls, and other equipment for proper operation.

B. Seal exterior joints between materials to form a waterproofed and airtight enclosure.

C. Clean surface using appropriate materials and methods that will thoroughly clean but not damage materials and their finishes.

1.5 REPAIRS

A. Unless Architect grants permission to repair any defective work, remove from project any work not in accordance with Contract Documents. Permission to repair any such work shall not constitute a waiver of Architect’s right to require complete removal of defective work if repair operation does not restore quality and appearance of member of surface to Architect’s satisfaction. If permission is granted, repair according to Architect’s directions.

1.6 COMPLETED WORK

A. Completed work shall find materials structurally sound, free from scratches, abrasions, distortions, chips, breaks, blisters, holes, splits or other disfigurement considered as imperfections for the specific material.

B. Completed surfaces shall be thoroughly clean and free from foreign materials and stains.

C. Contractor is to install, connect, service and operate permanent systems at earliest practical dates, unless otherwise directed by Architect.

1.7 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.

B. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.

C. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.

D. Clean permanent filters or replace disposable filters of operating equipment.

E. Clean debris from roofs, gutters, downspouts, and drainage systems.

F. Clean site; sweep paved areas, rake clean landscaped surfaces.

G. Remove waste and surplus materials, rubbish, and construction facilities from the site.

1.8 ADJUSTING

A. Adjust operating products and equipment to ensure smooth and unhindered operation.

B. Adjust windows, doors, drawers, hardware, appliances, motors, valves, controls, and other equipment for proper operation.

1.9 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, Product Data, and Samples.
   6. Manufacturer's instruction for assembly, installation, and adjusting.

B. Ensure entries are complete and accurate, enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications. (Actual sections of addendum items may be pasted into specification in appropriate locations.)

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish floor datum.

2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent marker (i.e. new building, property line, etc.).
3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
4. Field changes of dimension and detail.
5. Details not on original Contract drawings.
6. Changes made by Addenda and modifications. (Actual sections of addendum items may be pasted onto drawings in appropriate locations.)

G. Submit to Architect in electronic media, **two (2) DVDs or Flash Drives,** containing **Record Documents as described in this section** and scanned **As-Built drawings in PDF format**, properly marked to show field modifications. **These shall include both Drawings and Specifications.** For videos asked for, provide videos on separate DVDs or Flash Drives

H. All paper copies of closeout items to be scanned and copied to the electronic media.

1.10 CLOSEOUT DOCUMENTS

A. Prepare DVD or Flash Drive titled "CLOSEOUT DOCUMENTS", title of project, and subject matter.

B. Submit two (2) complete Sets of closeouts and As-Built drawings in electronic format, within 10 days after final inspection.

C. Organize closeout contents, logically organized into sections as described below.

GENERAL (section tab)
Contents:

1. A Directory, listing names, addresses, and telephone numbers of Architect / Engineer, Contractor, Subcontractors, and major equipment suppliers.
2. Executed original of occupancy permit
3. Punch Lists showing items signed off as completed by Contractor.
4. Contractor's "Asbestos Free" certification letter stating that no materials have been placed in the building containing asbestos material.
5. Contractors "storm water pollution" certification letter stating that the work has been performed in compliance with the requirements of the Arkansas Water and Air Pollution Control Act and the Federal Clean Water Act.

LIEN WAIVERS (section tab)

Lien Waivers must demonstrate that the project is free of any debt or claim from any subcontractor, supplier or vendor and that the project is free and clear with the exception of monies owed the General Contractor. All subcontractors and suppliers must have been completely paid with the exception of the percentage of monies owed the General Contractor, or payment a bond posted for each sub-contractor and supplier for whom a balance is owed. For this project, the amount is not to exceed 5% of their contract. Lien waiver submitted from each subcontractor and supplier is to show amount they are still owed. **These requirements are mandatory condition to qualify for final payment.**

Contents:

1. AIA G706A - CONTRACTOR'S AFFIDAVIT OF RELEASE OF LIENS
2. AIA G706 - CONTRACTOR'S AFFIDAVIT OF PAYMENT OF DEBTS AND CLAIMS
3. AIA G707 - CONSENT OF SURETY TO FINAL PAYMENT
4. Final Lien Release from each subcontractor and supplier.

WARRANTIES / GUARANTEES / BONDS (section tab)

A. Provide notarized copies, one original and one photocopy. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers. Submit warranties prior to final Application for Payment. For items of Work delayed beyond date of Substantial Completion, provide updated submittal within 10 days after acceptance, listing date of acceptance as start of warranty period.

B. Provider manufacturer **warranties and guarantees** for each product and system provided under this contract. Provide installer and manufacturer warranty department phone numbers and contact person if available for each product and system. This is a general listing; your specific project may not contain some of the items listed.

   Contents:
   1. General Contractor's Statement of Warranty
   2. All manufacturer's warranties and guaranties stipulated or implied on equipment and products (i.e. carpet wear. prefinished metal finish, etc.)
   3. One-year warranty from each subcontractor
   4. Termite Protection Warranty (Five-Year)
   5. Polished concrete warranty: Ten-Year
   6. Below-Grade Waterproofing Membrane Warranty (Five-Year)
   7. Executed membrane Roofing Guarantee (Twenty-Year NDL), two-year installer's warranty
   8. FM 1-90 roof uplift compliance letter from roofer.
   9. Fluid-applied weather barrier (Five-Year)
   10. Wood interior door: Lifetime warranty
   11. Aluminum door construction: Lifetime warranty
   12. Coiling shutter door warranty: (Refer to specific Specification Section)
   13. Glazing warranty
   14. Continuous hinges warranty: (manufacturer's lifetime warranty)
   15. Lockset warranty: Cylindrical: 10-year
   16. Exit device: Three-years
   17. Door closers: 30-years
   18. Suspended ceilings: 30-year limited system performance Warranty
   19. Modular carpet warranty: (Refer to specific Specification Section)
   20. Fiber Reinforced Plastic (FRP): One-year warranty
   21. Acoustical Panels: manufacturer's 2-year product warranty
   22. Special coatings: 5 year warranty
   23. Toilet Partitions: Twenty-Five (25) year warranty
   24. Window Shades: 25-year standard manufacturer's warranty
   25. Hot Water Tank Warranty: (Refer to specific Specification Section and/or water heater schedule on drawings)

26. HVAC Manufacturers Warranties-(Contractor to fill out equipment warranty and registration cards and mail into manufacturer. Provide copy of each warranty in closeout manual.

1.11 OPERATION / MAINTENANCE DOCUMENTS

A. Submit data on DVD or Flash Drive.

B. Organize each individual section with printed title "OPERATION / MAINTENANCE DOCUMENTS", title of project, and subject matter.

C. Submit one set of volumes, within 10 days after final inspection.

D. Subdivide contents, logically organized into sections as described below; with tab titling each section. Prepare a Table of Contents for each system or material description identified as follows:

MECHANICAL (section tab)

Contents:

1. Directory, listing names, addresses, and telephone numbers of Subcontractors, and major equipment suppliers.
2. Operation and maintenance instructions, arranged by system. Identify the following:
   a. Significant design criteria.
   b. List of equipment.
   c. Parts list for each component.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.
   f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
   g. Video on flash drive or DVD of each equipment and system training session.
3. Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Air balance and test reports - see specifications.
   c. Certificates.
   d. Start up report on all major equipment items (See Division 23 of Specifications)
   e. Copies of registration and warranty cards on major equipment initiating warranty time dated the date of substantial completion and mailed by contractor as required.

ELECTRICAL (section tab)

Contents:

1. Directory, listing names, addresses, and telephone numbers of Subcontractors, and major equipment suppliers.
2. Operation and maintenance instructions, arranged by system. Identify the following:
   a. Significant design criteria.
   b. List of fixtures, equipment and switch gear.
   c. Parts list for each component.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.

f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
g. Video on flash drive or DVD of each equipment and system training session.

3. Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Electrical System Test Report - see specifications
   c. Certificates / Warranties.
   d. Start up report
   e. Copies of registration cards on major equipment initiating warranty time dated the date of substantial completion and mailed by contractor as required.

MISCELLANEOUS EQUIPMENT & MATERIALS (section tab)

Contents:

1. Directory, listing names, addresses, and telephone numbers of Subcontractors, and major equipment or materials suppliers.
2. Operation and maintenance instructions for equipment arranged by system and subdivided by specification section. Identify the following:
   a. Significant design criteria.
   b. List of equipment.
   c. Parts list for each component.
   d. Operating instructions.
   e. Maintenance instructions for equipment and systems.
   f. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
3. Finish material schedule including the following:
   a. Listing of all materials
   b. Manufacturer's of each material.
   c. Color or finish supplied on each material.
4. Project documents and certificates, including the following:
   a. Shop drawings and product data.
   b. Material Maintenance instructions and recommendations.
   c. Wear, finish or misc. guarantees

1.12 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Provide spare parts, maintenance, and extra products in quantities specified in individual specification sections.

B. Deliver to project site and place in location as directed by Owner; obtain receipt prior to final payment.

1.13 CLOSEOUT SUBMITTAL LIST

The following is a list of submittals required by this section. It includes but is not necessarily limited to the following:

- All warranties guarantees and bonds as listed above.
- Record Drawings and Shop Drawings - Provide one set of Shop Drawings, and two sets of Record Drawings.
- A Directory, listing names, addresses, and telephone numbers of Architect / Engineer, Contractor, Subcontractors, and major equipment suppliers.

- Executed original of occupancy permit
- Copy of Architect's and consultant's punch list(s) with the project manager's initials beside each item signifying that each item has been corrected.
- Contractor's "Asbestos Free" certification letter.
- Contractor's "storm water pollution" certification letter
- Contractor's "concrete placement" drawings identifying the area placed, the time and date of the placement and weather conditions.
- Letter or proof stating SWPPP has been terminated for this contract from state environmental office and responsibility transferred to Building Contractor.
- AIA G706A - CONTRACTOR'S AFFIDAVIT OF RELEASE OF LIENS
- AIA G706 - CONTRACTOR'S AFFIDAVIT OF PAYMENT OF DEBTS AND CLAIMS
- AIA G707 - CONSENT OF SURETY TO FINAL PAYMENT
- Final Lien Release from each subcontractor and supplier.
- General Contractor's Statement of Warrantee
- Inspection Report from Roofing Manufacturer's Representative.
- Third Party Special Inspection Reports
- Copy of HVAC Manufacturers Warranties and registration (Originals filled out and sent to manufacturer.)

- MECHANICAL, ELECTRICAL & MISCELLANEOUS EQUIPMENT

a. Directory, listing names, addresses, and telephone numbers of Subcontractors, and major equipment suppliers.
b. Design criteria.
c. List of equipment.
d. Parts lists
e. Operating instructions.
f. Maintenance instructions
g. Shop drawings and product data.
h. test reports.
i. Certificates.
j. Start up report

- Finish material schedule including the following:
  a. Listing of all materials
  b. Manufacturers of each material.
  c. Color or finish supplied on each material.
- Owner receipt of spare parts and maintenance products. Contractor will provide list, naming all spare material, items and parts as specified in individual sections or on drawings. Contractor will deliver spare material, items and parts to owner and ask him to sign list as proof that all items have been provided as listed.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

SECTION 02 26 23

ASBESTOS PRECAUTIONS AND PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contractors responsibilities concerning asbestos containing materials (ACM) in the existing building or systems where work is to occur.

B. Contractor's responsibilities concerning asbestos in materials, products, and equipment used in the construction project.

1.2 DISCOVERY OF ASBESTOS CONTAINING MATERIALS (ACM)

A. Unless indicated otherwise within the construction documents. ACM's are not known to be present in the existing building or system where work is to occur.

B. During the construction project, the contractor shall notify the Owner, the Architect and Arkansas Building Authority of any portion of the work which the Contractor knows or has reason to believe contains asbestos. The Contractor shall take necessary precautions to prevent damage and release of asbestos fibers to the air.

C. Any asbestos abatement procedures shall be performed by the Owner under a separate contract.

1.3 ASBESTOS CONTAINING MATERIALS AND PRODUCTS

A. All building construction materials, products, and equipment used in the project shall be asbestos free.

B. The Contractor shall be responsible for verifying with suppliers and manufacturers that construction materials, products, and equipment used in completion of the project are asbestos free.

C. The Contractor shall provide certification (typewritten, signed and dated) to the Owner indicating that asbestos free materials, products, and equipment were used in completion of the work.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

SECTION 02 32 00

GEOTECHNICAL SOILS REPORT

PART 1 GENERAL

1.1 SUMMARY

A. A soils investigation report has been prepared for the site of this work by GTS, Inc. Geotechnical & Testing Services, Fayetteville, AR, hereinafter referred to as the Soil Engineer.

B. Availability: The soils investigation report is bound in this specification for reference only.

C. Use of data:
   1. This report was obtained only for the Architect's use in design and is not a part of the Contract Documents. The report is available for bidders' information, but is not a warranty of subsurface conditions.
   2. Bidders should visit the site and acquaint themselves with all existing conditions. Prior to bidding, bidders may make their own subsurface investigations to satisfy themselves as to site and subsurface conditions, but all such investigations, shall be performed only under time schedules and arrangements approved in advance by the Architect.
   3. If a conflict should occur between soils report and Section 31 23 00, the information in Section 31 23 00 shall govern.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTIONS

3.1 SUMMARY

A. Contractor shall follow the design for this work indicated by the drawings. Include all labor, equipment, and materials including borrow and disposal of waste, to accomplish final grades shown on drawings and specified herein.

B. Adjustment of work: Re-adjust all work performed that does not meet technical or design requirements, but make no deviations from the Contract Documents without specific and written approval from the Architect.

END OF SECTION

Initial Geotechnical Engineering Report

Planned Bentonville Public Library Expansion

405 South Main Street
Bentonville, Arkansas
GTS Project No. 21-1-5-188

December 14, 2021

Prepared For:

Bentonville Public Library
405 South Main Street
Bentonville, Arkansas 72712

GTS, Inc.
Geotechnical & Testing Services
www.gtsconsulting.net

Geotechnical Engineering | Construction Materials Testing | Environmental Due Diligence

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GTS, Inc.
Geotechnical & Testing Services

www.gtsconsulting.net

December 14, 2021

Bentonville Public Library
405 South Main Street
Bentonville, Arkansas 72712

Attention: Ms. Hadi S. Dudley

RE: Initial Geotechnical Engineering Report
Planned Bentonville Public Library Expansion
405 South Main Street
Bentonville, Arkansas
GTS Project No. 21-1-5-188

Ms. Dudley:

This report provides the results of the subsurface exploration and geotechnical engineering analysis performed for the planned new expansion of the existing Bentonville Public Library (BPL) building in Bentonville, Arkansas. The property evaluated by this report has a real property address 405 South Main Street in Bentonville, Arkansas. A boundary outline of the evaluated property is shown on Page 6 within this report.

We appreciate the opportunity to be of assistance to you on this project. We encourage retaining GTS, Inc. (GTS) to be involved in any pre-bid and pre-construction meetings to allow GTS to discuss the following findings and recommendations. Please contact us if the assumptions stated in this report are incorrect and/or if further explanation is required for portions of the report.

Sincerely,

GTS, Inc.
Geotechnical & Testing Services

Certificate of Authorization No. 1251, expires 12/31/2021

STATE OF ARKANSAS
★★★
LICENSED PROFESSIONAL ENGINEER
★★★
No. 14967
ANDREW N. BEEKMAN
12/14/2021

Andrew N. Beekman, P.E.
Arkansas No. 14967

Travis Willis, P.E. 12-14-21
Senior Project Engineer

CERTIFICATE OF AUTHORIZATION
GTS, INC.
NO. 1251
ARKANSAS

ANB:TW

Copies to: Addressee (email-hdudley@bentonvillear.com)

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EXECUTIVE SUMMARY

The term “existing grade” used in this report refers to the ground surface elevations at the time of our field drilling and sampling. “Finished subgrade” is used in this report to describe the designed, top-of-soil elevations at the site upon completion of grading.

Development of the project site is understood to include a new library expansion that will be one-story in height and will have a footprint area of about 26,555 square feet. The expansion is anticipated to be constructed with structural steel framing, brick veneer and concrete slab-on-grade construction. We understand that preliminary maximum loading information includes column loads of 45 kips and wall loads of 2 kips per lineal foot. Maximum slab loading of 150 pounds per square foot were assumed by GTS for the structure. Specific grading plans are unknown to GTS; however, we anticipate that finished floor elevation for the new expansion will generally match the finished floor elevation of the existing library. Therefore, we anticipate maximum cut and fill depths of 3 feet, or less, will be required to reach finished subgrade elevations for the planned new structure.

Based on the in-situ soil and rock types as well as the in-place shear strength encountered at the 5 sample borings and based on our current understanding concerning site development plans, summary geotechnical engineering considerations for development of the project site are provided below. The below information should not be used separately from the more comprehensive discussion provided in the body of this report.

Narrative

Soil and Rock Types

Existing fill material was encountered beneath the surface organics at 3 of the 5 performed boring locations. The existing fill had varying composition and generally consisted of a combination of clayey sand, lean clay and clayey gravel soils with variable silt, sand, clay and gravel (chert) content. The existing fill, where encountered, extended to depths of about 3 ½ to 5 feet below existing grades and had low to moderate in-place shear strength during drilling and sampling.

Silt-based soils with varying amounts of sand were encountered below the surface organics at the 2 borings where existing fill material was not encountered. These soils extended to depths of about 1 to 1 ½ feet below existing grades and had very low to low shear strength during drilling and sampling.

A presumed native, combination of both lean clay and fat clay soils with variable plasticity, sand content and gravel content were encountered below the existing fill materials or silt-based soils at all boring locations. These soils had variable, very low to moderate, in-place shear strength at the time of drilling and sampling. These clays extended to depths of about 9 to 18 ½ feet below the existing ground surface.

Coarse-grained soils consisting of a combination of clayey sand, clayey gravel and sandy gravel soils were encountered beneath the clay soils at the majority of the boring locations. The coarse-grained soils extended to depths of about 16 ½ to 20 ½ feet below existing grades and had very low to high, yet generally moderate, in-place shear strength during drilling and sampling, where encountered.

The basal stratum at this site consisted of apparent limestone bedrock. The apparent limestone was encountered at all boring locations beginning at depths of about 16 ½ to 20 ½ feet below the ground surface. Auger refusal material was encountered in all borings within 6 inches of the top of the apparent limestone bedrock stratum.

Foundation Support Recommendations

The subsurface conditions at this project are consistent with a Site Class D per the International Building Code (IBC), 2012 Edition.

Based on soil and rock conditions encountered in the borings as well as the anticipated structural loads, we recommend the planned building structure be supported on a small-diameter, driven pile system. Driven piles should be designed as end-bearing piles, founded upon the underlying hard limestone stratum. Given the light loads of the structure, we recommend driving relatively small diameter, 3 ⅞-inch (OD), ductile iron piles (DIPs) to practical refusal, which we anticipate would result in an allowable pile capacity of about 40 kips in compression. The allowable capacity includes a factor of safety of 2.0. We estimate that the DIPs would achieve refusal between depths of about 16 to 21 feet below the existing ground surface. Preliminary pile recommendations for a DIP system are discussed within the body of this report.

As an alternative to the driven pile system, the library expansion can be supported on a cast-in-place, straight-shaft, drilled pier foundation system. The drilled piers should be designed to bear a minimum depth of 6 inches into the hard limestone bedrock. The drilled piers may be sized using a maximum net allowable end bearing pressure of 35,000 pounds per square foot (psf). Based on the results of the sample borings, apparent drilled pier depths of about 17 to 21 feet below existing grades are anticipated to be required. Due to the limited information concerning the competency of the limestone stratum, we recommend that probe holes be used at each drilled pier location to evaluate the competency of the underlying bedrock before construction of the drilled piers.

Floor Slab Support Recommendations

New floor slabs-on-grade should be supported on a minimum of 2 feet of newly placed and compacted, tested and approved, select fill material. Additional fill material is likely to be required to support new floor slabs if the on-site soils are weak and unstable at the time of mass grading and construction (similar to the conditions at the time of drilling and sampling).

PROJECT DESCRIPTION and INFORMATION

Project Site

The project site is located at the existing Bentonville Public Library (BPL), located at 405 South Main Street in Bentonville, Arkansas. The overall project site is relatively flat and is understood to be about 0.6 acres in footprint area. Based on a cursory review of historical satellite imagery, the project site consists of both developed and currently undeveloped areas.

The project site is occupied by an existing asphalt drive, gravel and grass with some trees present as well as a concrete drainage feature. A pre-existing residential structure is understood to have occupied the northwest portion of the project site and to have been razed and removed from the project site over 10 years ago. Additionally, a pre-existing metal building and concrete parking lot is understood to have occupied the western portion of the project site and to have been razed and removed from the project site in the past 18 months.

The general boundaries of the project site are outlined in yellow in Figure 1, below. The satellite image in Figure 1 is provided courtesy of Google.

Figure 1: General Boundaries of the Project Site

Planned Development

Based on a Request for Quote received from the Bentonville Public Library on October 14, 2021, development of the project site includes a new library expansion that will be one-story in height and that will have a footprint area of about 26,555 square feet. The expansion is understood to be located north of the northwest corner of the existing building footprint. The expansion is anticipated to be constructed utilizing structural steel framing, brick veneer and concrete slab-on-grade.

Preliminary structural loads were provided in a an email communication received from yourself on October 18, 2021, and we understand the information originated with the design team. Preliminary maximum column loads of 45 kips and preliminary maximum wall loads of 2 kips per lineal foot were provided for the new library expansion. GTS has assumed that maximum floor loads will be about 150 pounds per square foot (psf).

Existing Library Structure

A set of structural plans for the construction of the existing library were provided to GTS by the design team. The provided plans were titled “Coughlin Library” and were prepared by Ryan Engineering and dated July, 2005. We understand that the foundations of the existing library consist of straight-shaft, cast-in-place, concrete drilled piers. Based on information provided in the General Structural Notes, Sheet S0.1, we understand that the piers were designed using an allowable end bearing capacity of 35 kips per square foot. We also understand that the drilled piers were designed to bear a minimum of 6 inches into hard limestone. We further understand that pier probing was required to verify suitable bearing of these drilled pier foundations.

Based on information contained in the provided structural plans, we understand that the design of the drilled pier foundation system was based on a geotechnical engineering report prepared by Grubbs, Hoskyn, Barton, & Wyatt, Inc. It should be noted a specific report number or date was referenced in the provided plans as well as that GTS has not been provided any such geotechnical engineering report. However, we understand that precedence has been set at this project site concerning drilled pier foundation recommendations.

Planned Site Grading

GTS was not provided with a specific grading plan. However, we generally understand that the Finished Floor Elevation (FFE) of the expansion will match the FFE of the existing library. For the purposes of providing the recommendations in this report, we anticipate maximum cut and fill depths of about 3 feet, or less, will be required to reach finished subgrade elevations at the project site.

If our understanding of site grading plans is incorrect or when the final grading plans become available, please contact us to allow the recommendations in this report to be reviewed and, if necessary, revised.

Scope of Services

Our scope of services included evaluating the subsurface conditions at five (5) boring locations, identified as Borings B-1 through B-5. These borings were drilled to depths of approximately 17 to 20 ½ feet below existing grades in the planned building expansion footprint.

Our currently authorized scope of services is concluded with the issuance of this Geotechnical Engineering Report. It should be noted that GTS has issued a proposal for supplemental engineering as well as rock coring services at this project site and GTS anticipates that we will be authorized to perform a supplemental scope of work at this project site. If authorized, the results of the supplemental scope of work as well as the additional engineering analysis will be provided in an addendum letter.

SUMMARY of SUBSURFACE FINDINGS

Surface

The surface of the boring locations consisted of grass cover at the time of field sampling. The root mat associated with the surface organics was measured to be approximately 1 to 3 inches at the performed boring locations.

Photographs showing the general surface conditions at the time of drilling and sampling are provided below and on the following pages.

Photograph 1 – Looking Southwest with Boring B-3 in foreground and existing library in background, left

Photograph 2 – Looking Northeast towards Boring B-2

Photograph 3 – Looking West along existing drive towards Boring B-1

Photograph 4 – Looking East towards Boring B-4

Site Geology

Based on the results of our borings and available geologic maps, the project site is underlain by the Mississippian-aged Boone Formation. The Boone Formation consists of interbedded limestone and chert with chert nodules. Characteristics of the Boone Formation include a pinnacled bedrock surface, small solution cavities, and both horizontal and vertical weathering.

Residual soils resulting from weathering of the Boone Formation typically consist of lean clays, lean to fat clays, and fat clay soils with varying amounts of chert gravel. Deeper soils usually classify as clayey gravel soils due to the increased chert content of the soil with depth. Based on the subsurface conditions encountered at the boring locations, the subsurface conditions at the site are consistent with the Boone Formation[1].

[1] https://www.geology.arkansas.gov/geology/ozark-plateaus-region-mississippian-period.html, accessed December 10, 2021

Subsurface Soils and Rock

Existing Fill

Existing fill and possible fill materials were encountered beneath the surface organics at Borings B-1, B-3 and B-4. The existing fill had varying composition and generally consisted of a combination of clayey sand, lean clay and clayey gravel soils with variable silt, clay, sand and gravel (chert) content. The existing fill, where encountered, extended to depths of about 3 ½ to 5 feet below existing grades.

The existing fill had very low to moderate shear strength during drilling and sampling. Standard penetration test (SPT) N-values of 2 to 21 blows per foot (bpf) were recorded for the fill.

Stratum I – Silt-Based Soils

A combination of silt-based soils with varying sand content (i.e. topsoil) were encountered below the surface organics at Borings B-2 and B-5. These soils extended to depths of about 1 to 1 ½ feet below existing grades, where encountered, beneath the surface organics. The Stratum I soils had very low to low shear strength during drilling and sampling.

Stratum II – Clays

A combination of both lean clay and fat clay soils with variable plasticity, sand content and gravel content were encountered below the existing fill materials or Stratum I silt-based soils at all boring locations. Based on the results of the borings, it appears that intermittent seams, layers and/or boulders of hard chert may be present within the Stratum II soils. These soils extended to depths of about 9 to 18 ½ feet below existing grades.

The Stratum II soils had very low to moderate, yet generally low to moderate, in-place shear strength at the time of drilling and sampling. N-values of 1 to 17 bpf were recorded for the Stratum II soils.

Stratum III – Sands and Gravels

A combination of clayey sand with gravel, clayey gravel and sandy gravel soils was encountered beneath the clay soils at all boring locations, with the exception of Boring B-4. Based on the results of the borings, it appears that intermittent seams, layers and/or boulders of hard chert may be present within the Stratum III soils. The coarse-grained soils extended to depths of about 16 ½ to 20 ½ feet below existing grades, where encountered.

The Stratum III soils had very low to high, yet generally moderate, shear strength during drilling and sampling. SPT N-values of 0 to 52 bpf were recorded in the Stratum III soils. An N-value of “zero blows per foot” corresponds to the split-spoon sampler penetrating the sampled soils a

distance of 12 inches or more driven by the dead weight of the sampling equipment and with no corresponding blows of the 140-pound hammer.

Stratum IV – Limestone

The basal stratum at this site consisted of apparent limestone bedrock. The apparent limestone bedrock was encountered at all boring locations beginning at depths of about 16 ½ to 20 ½ feet below existing grades; the limestone extended to the terminal depth of each boring location.

The Stratum IV limestone had high in-place shear strength at the time of drilling and sampling. N-values of 50 blows per 1 inch of penetration were recorded for the Stratum IV limestone at each boring location.

Auger Refusal/Hard Drilling Conditions

Hard drilling conditions were encountered within very dense gravelly soils; on intermittent seams, layers and/or boulders of hard chert; or on deeper, hard limestone at depths ranging from about 13 ½ to 20 ½ feet below existing grades at the performed boring locations. Auger refusal material, presumably limestone bedrock, was also encountered beginning at depths of about 17 to 20 ½ feet below existing grades at the performed boring locations.

The depths to hard drilling and auger refusal at the performed boring locations are summarized in Table 1.

Table 1: Depths to Hard Drilling Conditions and Auger Refusal Material

Boring Number	Depths to Hard Drilling Conditions (feet below existing grades)	Depths to Auger Refusal Material (feet below existing grades)
B-1	20 ½	20 ½
B-2	16	17
B-3	17	17 ½
B-4	13 ½	17 ½
B-5	17	17

Water Measurements

Water observations were made by the drill crew during drilling and immediately after completion of drilling. Free water was observed at a depth of 19 feet below existing grades during drilling and at a depth of 17 feet below existing grades at completion of drilling at Boring B-1. Free water was also observed at a depth of 17 feet below existing grades during drilling at Boring B-3. Free groundwater was not observed in any other boring at these times. Furthermore, the

borings were generally backfilled upon completion of drilling due to safety concerns and no further groundwater observations were possible.

Cave-in depths noted on the boring logs represent a loss of soil shear strength in the sides of the borings. This may be associated with the presence of perched water and the cave-in depths may correlate to the surface of the perched water. Cave-ins were observed at all of the performed boring locations at depths of about 8 to 17 feet below the existing ground surface when the borings were checked for groundwater at completion of drilling.

The depths to water are intended as isolated measurements of groundwater levels at the time of drilling. The installation and periodic measurement of monitoring wells would be required to establish seasonal piezometric surfaces below this project site.

GEOTECHNICAL ENGINEERING ANALYSIS

Geotechnical Considerations

Existing Fill

Existing fill material was encountered to depths of about 3 ½ to 5 feet at the borings located in the central and western portions of the planned building footprint. The existing fill material had low shear strength below a depth of about 2 feet below the existing ground surface in Boring B-3 and had low shear strength throughout the entire depth at Boring B-4.

GTS has no information regarding the placement and compaction history of the existing fill. Compressible fill and/or deleterious and unsuitable materials might be buried within or by the existing fill. There is a potential risk of unpredictable settlement and performance by supporting foundations, slabs-on-grade and pavements above the existing fill. This risk cannot be eliminated unless the existing fill is removed and replaced full-depth with new fill. However, this risk can be reduced by only supporting slabs-on-grade and pavements on the fill after thorough testing and evaluation during construction, in conjunction with requiring all foundation loads to be transmitted through the existing fill. Recommendations are provided in this report to support all foundation loads on suitable native soils or rock, below the existing fill material.

Concrete floor slabs and pavements span weak zones much more effectively than concentrated foundation loading. Also, clients/owners typically have a higher tolerance for cracks developing in floor slab and pavement compared to building structures. Based on the results of our sample borings as well as our understanding of site grading, the existing fill material appears suitable for supporting typical floor slab and pavement loading throughout the project site, provided the subgrade soils are stable at the time of mass grading and construction and also provided the fill is generally free of deleterious material. However, the client/owner should understand that some premature surface distress and increased maintenance may occur in future floor slab and pavement sections supported above the existing fill.

Provided the recommendations in this report are followed, the risk associated with constructing floor slabs and pavements over the existing fill as discussed in this report should be low.

Low-Shear-Strength Soils

Low-shear-strength soils (SPT N-values of 6 or less) were encountered at varying depths at all of the 5 boring locations; the near-surface soils (within 5 feet of the existing ground surface) had low shear strength at the majority of the boring locations. The depths where low-strength soils were encountered at the boring locations are summarized in Table 2 on the following page.

Table 2: Low-Shear-Strength Soils

Boring Location	Depth of Low-Shear-Strength Soils (feet below existing grades)	SPT N-Values (bpf)
B-1	19 to 20 ½	0
B-2	0 to 4 ½, 13 ½ to 14 ½	4, 5
B-3	2 to 4 ½	2, 2, 5
B-4	0 to 5	5, 6, 5
B-5	0 to 4	1, 4

Shallow foundations sized using typical net allowable bearing pressures and supported within or immediately above the weak soils are likely to experience excessive settlement due to the consolidation of these weak soils. The variability of the strength of the soils throughout the project site would also result in excessive differential settlement of the new building structure. Supporting loading from foundations, floor slabs, pavements and new fills will likely require ground improvement.

Based on the understood site plan and FFE, we recommend that any unstable soils exposed in the planned building subgrade should be removed and replaced with select fill if the planned building will be supported above a shallow foundation system. GTS anticipates that extensive ground improvement would need to be performed to support shallow foundations at this project site. Based on the footprint size of the planned addition as well as the site constraints anticipated by GTS during construction, it is the opinion of GTS that supporting the addition on a shallow foundation system would not be cost-eefective. Recommendations are provided in this report to support deep foundations that will extend through the weak soils to bear in the underlying hard limestone.

Moisture-Sensitive Soils

The native silt-based soils and lean clay soils (Stratum I and portion of Stratum II) are susceptible to strength loss with increases in moisture content and/or when exposed to repetitive construction traffic. Ground improvement should be anticipated during wet periods of the year.

Expansive Soils

Moderate to high plasticity fat clay (portions of Stratum II) soils were encountered beginning at depths of about 8 ½ to 12 ½ feet below existing grades at 3 of the 5 performed boring locations. These soils are prone to volume changes with variations in moisture content. Because these soils have a high potential for shrink-swell movements, structures supported above these soils will shift and move during wet and dry periods of the year. This movement may lead to cracking of foundations and floor slabs and racking of door and window frames. However, based on our

understanding of site grading, site development plans and the results of our borings, these on-site expansive clays are anticipated to have a negligible impact on the planned development.

Foundation Recommendations

General Discussion

As discussed above, supporting the planned expansion above a shallow foundation system supported a few feet below existing grades would require a significant amount of removal and replacement of the on-site soils with imported fill material and/or extensive ground improvement (such as densifying the on-site soils through the installation of rammed-aggregate piers). Due to the size of the planned library expansion footprint and the site constraints, GTS anticipates that extensive earthwork at this project site would be time-consuming and relatively expensive. The extensive earthwork required for a viable shallow foundation system would be exacerbated by the requirements of shoring the on-site soils near the existing library structure and reducing distress to the existing library structure during construction. Lastly, the existing structure is supported on a deep foundation system and supporting the expansion above a similar foundation system will decrease the anticipated long-term differential settlement between the existing library structure and the expansion. Therefore, it is the opinion of GTS that the planned building expansion should be supported on a deep foundation system.

Based on the borings and anticipated structural loads, driven piles can be designed to bear in the hard limestone. It should be noted that, pre-mature refusal could be achieved within the dense gravels first encountered at a depth of 9 feet in Boring B-5 or within the seam of hard chert first encountered at a depth of about 13 ½ feet in Boring B-3. If this occurs, the piles may need to be pre-drilled in this area prior to the commencement of any additional pile driving.

The piles are anticipated to develop their capacity primarily from end bearing in the deeper hard limestone. Due to the relatively light loads for the expansion as well as the proximity of the existing library structure (and the consideration of decreasing vibration and noise), GTS is recommending that consideration be given to supporting the structure on a small-diameter Ductile Iron Pile (DIP) system as opposed to a conventional driven H-pile system.

As an alternative to driven pile foundations, the planned building structure may also be supported on a straight-shaft, cast-in-place, concrete drilled pier foundation system bearing in the underlying hard limestone bedrock. Due to the relatively light loading anticipated for this structure, all drilled shafts will inherently be considered “oversized” because their capacity derived from the minimum shaft diameter and the allowable bearing capacity of the underlying bedrock will be more than two times greater than necessary.

However, based on the results of our sample borings, it is the opinion of GTS that supporting the expansion above a drilled pier foundation system (similar to the existing library) would be relatively costly. The presence of uncontrolled existing fill material, weak soils, a perched groundwater table as well as the granular nature of portions of the on-site soils will likely require temporary casing be used during construction of the majority of the drilled pier foundations. The installation

of casing inherently requires that the drilled shafts be oversized (above the minimum). Therefore, GTS generally anticipates that the drilled piers will require more expensive methods as well as more materials to construct than would be necessary to adequately support the anticipated loads.

GTS would be pleased to discuss additional foundation support systems with the design team, upon request.

Driven Pile Foundation Design Recommendations

The planned structure may be supported on a driven pile foundation system. We recommend that consideration be given to supporting the structure on a Ductile Iron Pile (DIP) system. DIPs are small-diameter, low-vibration driven pile system that is used as a high-value alternative to micropipes or helical piles. The system uses modular, prefabricated, high-strength ductile iron pipes to develop working capacities ranging between 40 and 200 kips depending on soil conditions and loading demands. DIPs are installed using an excavator-mounted hydraulic hammer fitted with a special drive adapter that advances the 98 mm (3 ⅞-inch) to 170 mm (6 ⅝-inch) diameter pile into the ground using a combination of excavator crowd force and the percussive energy from the hammer. DIPs are prefabricated in lengths of 5 meters (16 ½ feet) per pile and employ a plug and drive connection system that allows for rapid pile connections in the field and variable pile lengths without additional equipment or splicing.

DIPs are designed to resist loads through either end-bearing on competent soils/rock or frictional resistance within a grouted bond zone, depending on the project geotechnical conditions. The design and installation of Ductile Iron Pile systems can be provided by most qualified geotechnical contractors.

Based on the subsurface conditions encountered at the boring locations, driven piles can be designed to bear in the underlying, native, hard limestone to support the planned library expansion. The pile recommendations provided below are meant to be preliminary. DIPs are a proprietary product and the final design should be performed by a certified, qualified geotechnical contractor. Given the design loads provided, we recommend driving 3 ⅞-inch (OD) DIPs driven to practical refusal using a hydraulic TB 325, 850-pound hammer or equivalent. Typically, refusal for a 3 ⅞-inch (OD) pile using the aforementioned equipment should be defined as less than 1-inch of penetration in 14-16 seconds. Given this refusal criteria, the allowable pile capacity would be expected to be on the order of 40 kips in compression. Based on the results of our sample borings, we estimate that the DIPs would achieve refusal between depths of 17 and 21 feet below the existing ground surface. Some variation in the pile lengths should be anticipated given the variable subsurface conditions encountered at our performed boring locations.

DIPs driven to the depths mentioned in the described soils/rock could support up to 3 kips of allowable lateral load on each pile. If more than one pile is needed per location, GTS should be contacted to provide minimum spacing requirements. If the piles are spaced less than 6D (pile diameters) apart some reduction in the allowable loads may be needed.

Based on the known subsurface conditions we anticipate that properly constructed DIP foundations supported in the very dense gravels and/or limestone and driven to refusal could experience maximum total and differential settlements of about ½ inch.

Driven Pile Foundation Construction Recommendations

Pile driving should be monitored by a qualified person to verify the piles sufficiently penetrate the recommended bearing strata and that satisfactory driving resistance is achieved for the design capacity.

Because of the high driving resistance anticipated in the subsurface materials, we recommend that the piles be equipped with driving tips that can endure high driving stresses.

All piles should be driven until satisfactory driving resistance is developed for the design capacity of the pile section. The required driving resistance and appropriate "refusal" criteria should be evaluated in accordance with an appropriate dynamic pile driving formula or wave equation analysis. Pile driving should cease if the "refusal" criteria is encountered to prevent undue tip distortion and damage to the bottom of the pile. Any pile that appears to be damaged or to deflect during driving should be substituted with another pile to replace the damaged one. A pile load test could also be considered to verify the design pile capacities.

Drilled Pier Foundation Design Recommendations

The planned building structure could alternatively be supported on a drilled pier foundation system consisting of cast-in-place, straight-shaft, concrete drilled piers. Based on how the existing structure is supported as described herein, the drilled piers should be designed to bear on a minimum penetration of 6 inches, into the hard limestone bedrock. Based on the results of the sample borings and this precedence, we anticipate that future drilled shaft lengths of about 17 to 21 feet should be anticipated to meet this recommended rock socket.

The piers may be designed using the geotechnical parameters shown in Table 3, on the following page. The design soil and rock parameters shown in Table 3 were calculated using a factor of safety of approximately 3 for end bearing and 2 for side friction. For design of straight-shaft drilled piers under uplift conditions, the computed skin friction values in both the native soils/existing fill should be multiplied by 0.7 and in the hard limestone by 1.0.

The depths to top of apparent limestone bedrock (approximately 16 ½ to 20 ½ below existing grades) generally correspond with the depths of auger refusal material, summarized in Table 1 on Page 13 of this report.

We recommend a minimum shaft diameter of 24 inches. Drilled piers should have a minimum (center-to-center) spacing of 3 pier diameters. Closer spacing may require a reduction in axial load capacity. Similarly, spacing closer 6 shaft diameters may require a reduction in lateral resistance of certain shafts within a shaft group.

Table 3: Drilled Pier Foundation Design Parameters

Depth Below Existing Ground Surface (ft.)	Soil/Rock Description	LPile Soil Type	Effective Unit Weight γ' (pcf)	Friction Angle φ	Cohesion c (psf)	Allowable Skin Friction (psf)	Horizontal Modulus of Soil Reaction K_f (pci)	Strain at 50% of Ultimate Compression ε_{50}	Net Allowable End Bearing Pressure q_{all} (psf)
0 to 3	Native Soils, Existing Fill	NA	110	The top 3 feet of soils should be ignored in design					
3 to Limestone (16 ½ to 20 ½ feet below existing grades)	Native Soils, Existing Fill	Stiff Clay without Free Water (Reese)	115	0°	750	200[E]	325	0.012	NR[A]
Limestone (16 ½ to 20 ½ feet below existing grades)	Hard Limestone	Weak Rock	88	0°	1,000[B]	3,500	100,000[C]	0.0005	35,000[D]

[A] NR = Not recommended

[B] Uniaxial Compressive Strength (psi)

[C] Mass modulus of weak rock (psi)

[D] The drilled piers should be embedded a minimum distance of 6 inches into the limestone bedrock and have a minimum L:D ratio of 3:1.

[E] Due to strain compatibility, skin friction in soils should only be used to resist uplift force, not axial compression loads.

We recommend that the drilled piers have a minimum length to diameter (L:D) ratio of 3:1.

Total long-term and differential settlement of drilled pier foundations, designed and constructed as recommended in this report and per the Mass Grading Recommendations section of this report, are estimated to be less than ½ inch (total and differential between isolated piers).

Drilled Pier Foundation Construction Recommendations

General Recommendations

Drilled pier installation should be performed as discussed in this report and in general accordance with the recommendations in the FHWA Publication No. FHWA-NHI-10-016, titled “Drilled Shaft: Construction Procedures and LRFD Design Methods”, dated May 2010.

All drilled pier excavations should be evaluated for suitable bearing material by GTS prior to placement of reinforcing bar and concrete. Additionally, the drilled pier excavations should be cleaned of loose soil/rock, debris and water prior to reinforcing bar and concrete placement.

Concrete should be placed as soon as possible after the foundation excavation is completed to reduce the potential disturbance of the bearing surface.

Based on the subsurface conditions encountered in the borings, temporary casing is anticipated to be required to prevent water infiltration and cave-in of the deep weak soils and granular soils encountered in the borings. However, because site conditions can change from those at the time of our field sampling, the contractor should determine if temporary casing is required based on subsurface conditions encountered during construction. Care should be taken so that the sides and bottom of the excavations are not disturbed during construction.

A heavy-duty drill rig equipped with a rock auger with rock teeth will likely be needed to penetrate the dense to very dense gravels and intermittent chert seams in the overburden soils (Strata II and III). A rock coring barrel will be needed to penetrate the hard limestone (Stratum IV) near and below the auger refusal depths encountered at the boring locations (Table 1).

A concrete slump of at least 6 inches is recommended to facilitate casing removal. While withdrawing casing, care should be exercised to maintain concrete inside the casing at a sufficient level to resist earth and hydrostatic pressures acting on the casing exterior. Arching of the concrete, loss of seal and other problems can occur during casing removal and result in contamination of the drilled shaft. These conditions should be considered during the design and construction phases. Placement of loose soil backfill should not be permitted around the casing prior to removal. If water cannot be removed in the excavations by pumping, the concrete should be tremied completely to the bottom of the excavation with a closed-end tremie.

GTS should observe all drilled pier excavations to evaluate the suitability of the bearing materials and to confirm that conditions in the drilled pier excavations are consistent with those encountered in the test borings. If unsuitable materials are encountered at planned depths, it may be necessary to deepen the excavations.

Evaluation of Bearing Material

At the time of writing this report, the competency of the apparent limestone bedrock immediately below auger refusal depths is unknown to GTS. It may be necessary to deepen the pier excavations if intensely weathered rock, voids or vugs are encountered within the hard limestone at the drilled pier locations. We recommend that the contractor advance a 1-inch diameter probe hole into the base of all piers to a depth of at least 5 feet or twice the pier diameter (2D), whichever is greater, below the base of the pier. If the probe holes indicate voids are present or if the rock is degraded below the base of the drilled pier excavation, it may be necessary to deepen the drilled pier to suitable bearing material.

GTS should observe all drilled pier excavations and probe holes to evaluate the suitability of the bearing materials and to confirm that the conditions in the drilled pier excavations are consistent with those encountered in the test borings. Again, if unsuitable materials are encountered at planned depths, it may be necessary to deepen the excavations.

Stress and Bearing Interactions with Existing Building Foundations

As previously discussed, structural plans have been provided to GTS regarding the existing building's foundation type and foundation bearing depth. We understand that the foundations of the existing library consist of straight-shaft, cast-in-place, concrete drilled piers. We also understand that the drilled piers were designed with an allowable bearing capacity of 35,000 psf and to bear a minimum of 6 inches into hard limestone as well as that pier probing was required to verify suitable bearing of these drilled pier foundations; however, the as-built foundation bearing depths are unknown to GTS.

Care should be taken during any excavation adjacent to existing floor slabs, so as not to disturb any existing foundation bearing materials. Excavations that extend below the level of the existing floor slabs should be backfilled the same day they are excavated. Where this is impractical, shoring or underpinning of existing floor slabs may be required.

The contractor is responsible for the means and methods of safe excavations, protection of existing structures and protection of all personnel entering the excavation. However, shoring and bracing should be expected to be required if large excavations are required near the existing building footprint.

Differential settlement between the new building addition and the existing buildings is expected to approach the magnitude of the total estimated settlement of the addition of approximately ½ inch. Expansion joints should be provided between the existing building and the proposed addition to accommodate differential settlement between the two structures. Underground piping between the two structures, if any, should be designed with flexible couplings and/or utility knockouts in foundation walls should be oversized, so minor deflections in alignment do not result in distress or breakage.

At-Grade Floor Slab-On-Grade Support Recommendations

New floor slabs-on-grade should be supported on a minimum of 2 feet of newly placed and compacted, tested and approved, select fill material. Additional fill material is likely to be required to support new floor slabs if the on-site soils are weak and unstable in the building footprint.

Risks associated with supporting floor slabs-on-grade above the existing fill are discussed in the beginning of the Geotechnical Engineering Analysis section of this report. Specific recommendations concerning construction of the floor slab subgrade, including the potential need for ground improvement to stabilize unstable subgrade soils, are provided in the Mass Grading Recommendations section of this report.

At-Grade Floor Slab-On-Grade Design

Concrete floor slabs constructed as slab-on-grade and supported on subgrade prepared as recommended in this report can be designed using a modulus of subgrade reaction (k) value of

125 pounds per square inch, per inch. We recommend that a minimum of 4 inches of free-draining gravel or sand be placed beneath the slab-on-grade to act as a capillary break. This layer is termed a "subbase" layer.

To be effective as a capillary break, the subbase should have a maximum of 5% by dry weight passing the No. 200 sieve. The modulus of subgrade reaction value applies to the top of the subbase layer. The top of the subbase should be compacted using a vibratory plate.

If rutting of the subbase layer is a concern for concrete placement, the subbase layer may be topped with an additional 2 to 4 inches of gravel or sand having sufficient fines to allow compaction. The optional topping layer is termed the "base" layer. The base layer, if used, should be compacted to a minimum of 95 percent Standard Proctor Value (ASTM D 698) at a workable moisture content that allows the density to be achieved. The base layer should have a percent passing the No. 100 sieve ranging from 10 to 30 percent by dry weight. ARDOT Class 7 Aggregate Base Course material is acceptable to use in the base layer.

A vapor barrier having a minimum thickness of 10 mil is recommended immediately below the concrete unless otherwise recommended by the finished flooring manufacturer or other members of the design team.

The general components of a floor slab, inclusive of the optional base course, are shown in Figure 2. The shown reinforcing steel location provides general guidance only. The location and composition of reinforcing steel should be determined by a structural engineer.

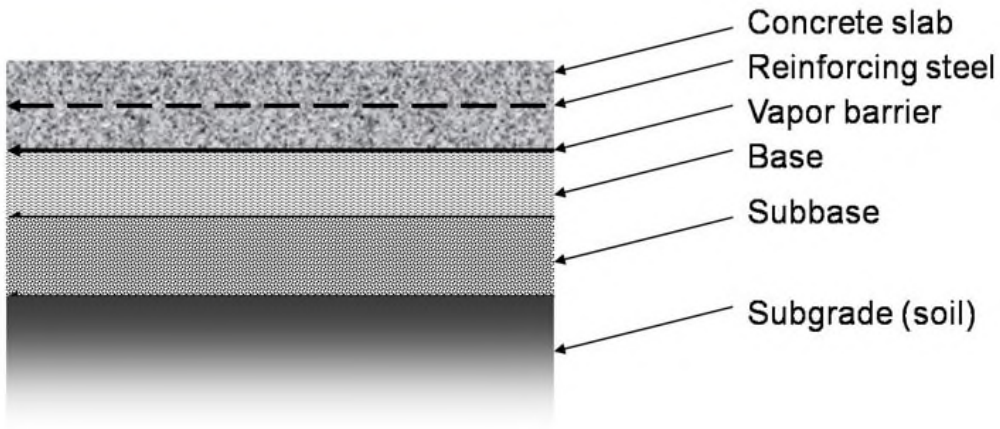


Figure 2: General Floor Slab-on-Grade Section Detail

IBC Site Classification

Based on the results of our sample borings, our knowledge of the regional geology and our current understanding of development plans at the project site, the subsurface conditions at this project site are consistent with a Site Class D per the International Building Code (IBC), 2012 Edition.

MASS GRADING RECOMMENDATIONS

Stripping of Surface Organics and Gravel

Mass grading should extend a minimum of 5 feet outside of the building addition footprint in all directions, where possible.

We understand that a portions of the existing building and pavements will be demolished and removed. It is our experience that properties with previously existing structures have a higher potential for encountering unknown conditions during mass grading and construction. These conditions include backfilled basements, trash pits, concrete foundations and underground utilities associated with the previous site use. Low-strength soils are expected adjacent and below the existing building when removed.

At a minimum, surface organics, pavement, curbs, trees and root bulbs, and any surface or subsurface structures should be removed from the areas of planned new construction. The topsoil material may be stockpiled and reused for landscaping, at the discretion of the design team. The asphalt, concrete and underlying gravel materials may be crushed, stockpiled and reused as fill material, at the discretion of the design team.

If a section of the existing building will need to be removed to construct the new addition, the floor slabs should be removed, and the resulting excavations should be backfilled with select fill as recommended in this report.

Also, any pre-existing subsurface structures at the project site in the vicinity of planned development should be removed full-depth. Buried utility lines should be relocated or abandoned, as necessary. Excavations to remove these structures should be backfilled as recommended in this report. Abandoned utility lines should be grouted and plugged.

Evaluation of Existing Fill

During mass grading and foundation excavation, existing fill material is anticipated to be exposed at some portions of the project site.

If the owner is allowing new pavements and floor slabs-on-grade to be constructed above the existing fill, exposed existing fill material should be evaluated for the presence of deleterious materials during mass grading and excavation. We recommend excavating test pits prior to or during mass grading to evaluate the extent and composition of the existing fill and provide additional recommendations during mass grading.

Portions of the existing fill material containing deleterious material should be removed full-depth from areas of new construction.

General Mass Grading

After removal of the surface organics and gravel, we recommend that additional undercuts be performed as necessary to reach a minimum depth of 2 feet below plan finished subgrade elevations.

After the recommended undercut depths are completed and before placement of new, approved fill material, the exposed soils should be evaluated for stability by GTS.

The exposed soils should be evaluated for stability by observing overlapping passes with a loaded tandem-axle dump truck (i.e., proofrolling) weighing at least 25 tons, if practical. Based on the subsurface conditions encountered during drilling and sampling, proofrolling might be impractical in portions of the project site. In this case, GTS should probe the soils to evaluate the extent of the low-strength soils, or test pits could be excavated at select locations.

If the exposed soils are stable, the exposed soils are anticipated to be suitable for directly supporting the placement and compaction of new fill material.

If the prepared subgrade should become saturated, desiccated or otherwise damaged prior to construction of the floor slab and pavement section, the affected subgrade material should be scarified, moisture conditioned and compacted prior to placing the base course. Final conditioning of the finished subgrade should be performed immediately prior to placement of the floor slab and pavement base course material.

We anticipate that portions of existing fill, and native silty and clay soils will be stable only during dry periods of the year. The potential for the on-site soils to become unstable, requiring additional undercutting or processing on-site, is considered in the Weather and Instability Considerations report section below.

Weather and Instability Related Considerations

Soil instability is directly related to the moisture within and below the exposed soils. If the on-site soils are moist to wet, or have undergone freeze-thaw cycles after mass grading and/or placement and compaction, we anticipate that the surface portion of the on-site soils may be unstable.

If the exposed soils are unstable, they may be scarified and allowed to dry to achieve stability if the construction timeframe and prevailing weather conditions allow. Alternatively, further undercuts may be performed to expose stable soils. For budgeting purposes, we anticipate that maximum average cut depths of 3 ½ feet below existing grades may be required to reach stable soils or to allow for placement of a bridging lift if the on-site soils are wet and unstable.

Bridging lifts may be considered to stabilize the soils if they remain unstable beginning at a 3 ½-foot undercut depth. We recommend that use of and construction of bridging lifts be overseen by GTS. The thickness of the bridging lift will depend on site conditions at the time of site grading

and should be evaluated and recommended by the GTS. We recommend that the top of all bridging lifts be a minimum of 18 inches below plan finished subgrade elevations.

Fill Placement

Lifts of fill material required to reach plan finished subgrade elevations should be composed of tested and approved fill material and placed per the specifications shown in this report. Fill should be placed in near-horizontal lifts beginning in areas requiring the deepest amount of fill. The fill should be benched into the native soils each lift. Fill should not be placed on frozen, saturated or unstable soils without the approval of GTS.

We recommend that fill material placed within the top 2 feet of planned building subgrade consist of select fill material. Additionally, approved granular select fill material may be used as bridging lift material. The requirements to meet for general fill, select fill, base course, and flowable fill are provided in the Geotechnical Report Requirements and Specifications section of this report.

Re-Use of On-Site Soils as Fill

The on-site concrete, asphalt and crushed gravel may be reused as fill material provided that all concrete, asphalt and gravel fragments are mechanically broken such that all fragments measure less than 3 inches in all dimensions.

The existing fill consists of a mixture of soils that will likely be suitable for use as general fill and/or select fill; however, other portions of the existing fill material are not anticipated to be suitable for reuse as fill material. The fill material should have further laboratory testing performed to verify the apparent classification of these soils and the fill material should also be relatively free of deleterious material before reuse.

Silt-based soils (Stratum I soils) may not be reused as fill below the planned building structure and pavements. These soils may be reused in planned landscaping areas at the discretion of the design team.

Fat clays should not be used as fill in the planned new development areas.

On-site lean clays, sands and gravels (portion of Stratum II and Stratum III) soils are anticipated to be suitable for reuse as general fill material. The on-site lean clays may require extensive drying before these soils will be suitable to be reused as general fill material.

Portions of the on-site sands and gravels (portions of Stratum III soils) are anticipated to be suitable for reuse as select fill for this development if it is not intermixed with the other on-site soils.

Soil classifications discussed in this report are based on approximately 2-inch diameter samples obtained during our field sampling. This type of sampling follows industry standards; however,

this type of sampling can under- or over-estimate the amount of gravel within a soil formation. Therefore, larger, bulk samples of the material should be obtained in the field during mass grading to confirm the apparent classifications of these soils prior to reuse.

The existing fill and native soils are likely to be intermixed during mass grading and construction. Larger, bulk samples of the on-site soils proposed for use as fill by the contractor should be observed for the presence of debris and unsuitable materials and sampled by GTS during mass grading and laboratory tested to confirm the classification of these soils prior to re-use. We recommend all on-site soils and material to be reused as fill or imported fill soils be thoroughly tested and evaluated by GTS before reuse.

Utility Trench Backfill

All trench excavations should be made with sufficient working space to permit construction including backfill placement and compaction. Utility trenches are a common source of water infiltration and migration. If utility trenches are backfilled with relatively clean granular material, they should be capped with at least 18 inches of cohesive fill to reduce the infiltration and conveyance of surface water through the trench backfill.

Rock Excavation Potential

Rock excavation means and methods are anticipated to be intermittently required to penetrate the very dense gravels and/or seams, layers and/or boulders of hard chert in isolated areas beginning at depths of about 13 ½ feet below existing grades. Rock excavation means and methods are also anticipated to be required to penetrate hard limestone beginning at depths of about 16 ½ to 20 ½ feet below existing grades. The depths where rock excavation techniques are anticipated to be required correspond with the top of hard drilling conditions and auger refusal material encountered at the boring locations and summarized in Table 1 of this report.

In general, track hoes and dozers with rock excavation attachments are expected to be required below the depths where we encountered hard drilling. The use of hydraulic or pneumatic hammers, rock breakers, rock saws and controlled blasting could be required near and below the depths where we encountered competent rock and auger refusal. Greater rock excavation effort is expected in limited access excavations, such as for foundations and utility trenches.

Earth Slopes and Excavations

Temporary earth slopes are anticipated to be constructed during development of the project site. The recommended maximum temporary slopes for overburden soils is 3.5H:1V (Horizontal:Vertical). Alternatively, local construction practices allow for benched excavations (4 feet vertical followed by 4 feet horizontal) with an effective slope of 1H:1V.

The contractor, by his contract, is usually responsible for designing and constructing stable, temporary excavations and should shore, slope or bench the sides of the excavations as required

to maintain stability of the excavation sides and bottom. All excavations should comply with applicable local, state and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards.

Grading and Drainage

During construction, grades should be developed to direct surface water flow away from or around the site. Exposed subgrades should be sloped to provide positive drainage so that saturation of the subgrade is avoided. Surface water should not be permitted to accumulate on the site to reduce the potential for strength loss of the subgrade soils.

Final grades should be sloped away from the building on all sides to promote effective drainage and prevent water from ponding. Downspouts should discharge water a minimum of 10 feet beyond the footprint of the building. This can be accomplished by using splash-blocks and downspout extensions. Also, the interface between the building and pavements or sidewalks should be effectively sealed to prevent water from infiltrating into the slab-on-grade subgrade.

Dispersive Soil, Soil Collapse, Liquefaction, Karst Formation Discussion

Based on our experience and the boring information, the on-site silt-based and lean clay soils are susceptible to dispersion and strength loss with increased moisture content. Portions of the on-site sands and gravels may be susceptible to dispersion (depending on local groundwater conditions and subsurface drainage) while other portions (sands and gravels) are not susceptible to dispersion. The soils and rock are not susceptible to wetting-induced collapse and liquefaction. The on-site fat clays are also not susceptible to dispersion or soil collapse. Based on the local geology, the possibility of sinkhole development and/or the presence of voids within the subsurface materials should be considered at this project site away from our performed boring locations.

More specifically, the site is predominantly underlain by a chert and limestone formation (Boone Formation) that is susceptible to dissolution along joints and bedding planes in the limestone. This results in voids and solution channels within the limestone stratum and a highly irregular bedrock surface (karst topography). The limestone was not sampled beyond auger refusal depths at any of the boring locations under our authorized scope of services. It is currently unknown to GTS if these conditions are present within the apparent limestone bedrock (Stratum IV) at this project site.

Any construction in areas with active karst features is accompanied by some degree of risk for future internal soil erosion and ground subsidence that could affect the stability of the proposed and existing structures. It is generally not economical to investigate nor to design to eliminate the described risk.

GEOTECHNICAL REPORT REQUIREMENTS and SPECIFICATIONS

Unless otherwise stated in this report, the recommendations contained in this report are based on the compaction specifications and material types noted in Table 4, Table 5 and the paragraphs on the following page.

Table 4: Recommended Soil Compaction

Type of Material	Moisture-Density Specification	Minimum Dry Density (percentage of proctor)	Range from Optimum Moisture Content (%)
Soil Fill Material	ASTM D-698 (Standard Proctor)	98 (building pad) 95 (other areas)	-3 to +3
Aggregate Base Course Material	ASTM D-1557 (Modified Proctor)	95	Sufficient to Achieve Compaction

Table 5: Soil Fill Material Requirements

Type of Soil Fill	Location/Use	Maximum LL	Maximum PI	USCS Classifications
Select	All Areas	40[A]	18[A]	GM, GC, GP, SP, SC, Chert
General	All Areas Excluding the Top 2 feet of building subgrade May not be used as bridging lift material	45[B]	20[B]	CL, SC, SM, SP, SW, GC, GM, GP, GW, Chert

[A] Plasticity requirements may be waived provided that the fill has a minimum of 65% retained on the No. 200 sieve.

[B] Plasticity requirements may be waived provided that the fill has a minimum of 50% retained on the No. 200 sieve.

Fill material should have a maximum particle size of 3 inches or less after placement and compaction.

With the exception of GTS-approved bridging lifts, fill needed for site grading should be placed in loose lifts not exceeding 9 inches in thickness (compacted lift thickness of approximately 6 to 7 inches). We recommend the fill be tested for density every lift during mass grading, with a minimum of one test every 2,500 square feet of building area.

The recommended moisture content and compaction of the fill should be maintained until fills are completed and floor slabs are constructed.

Design and construction plans should provide for rapid, positive drainage away from the building and pavement areas both during construction and at completion of the project, including any planned irrigation lines.

SUBSURFACE EXPLORATION and PROCEDURES

The current subsurface exploration consisted of evaluating and sampling 5 sample boring locations to planned depths of approximately 25 feet below existing grades or to auger refusal depths, whichever was least.

The boring locations were established in the field by GTS using a recreation-grade hand-held GPS unit. The approximate boring locations are shown on the attached Boring Location Diagram. The locations of the borings should be considered accurate only to the degree implied by the methods used to define them. The results of the borings are attached to this report.

The borings were drilled with a track-mounted Geoprobe 7720DT drill rig. Disturbed samples and estimates of the in-situ shear strength of the soil were obtained using an automatic-hammer-driven split barrel sampler, in general accordance with the Standard Penetration Resistance Test, at the performed boring locations. Rock samples were obtained using an NQ-sized double-barrel wireline coring assembly and a diamond-impregnated core bit.

The soil samples obtained in the field were sealed to reduce moisture loss and taken to the GTS soil laboratory for further examination, testing, and classification. The results of laboratory tests on select samples are shown on the boring logs and are attached to this report.

Field logs were prepared during the drilling and sampling of the borings. These logs report sampling methods, sampling intervals, soil and groundwater conditions, and notes regarding soil and drilling conditions observed between sample depths. The final boring logs, included in this report, have been prepared based on the field logs and have been modified, where appropriate, based on the results of the laboratory observation.

LABORATORY TESTING and PROCEDURES

The soil samples were examined in the field by an experienced geotechnical engineer and classified based on the soil's texture and plasticity, in accordance with the Unified Soil Classification System. The estimated Unified Soil Classification System group symbols are shown on the boring logs.

Hand penetrometer tests were performed on select intact cohesive samples. Unfactored hand penetrometer test values are shown on the boring logs as filled squares.

The laboratory testing was performed by GTS in general accordance with the American Society for Testing and Materials (ASTM) test designations shown in the table below:

Table 6: Laboratory Test Method Designations

Laboratory Test	Test Designation	Method (if applicable)
Moisture Content of Soil and Rock	ASTM D 2216-10	Method A
Visual Classification of Soil Types	ASTM D 2488	
Atterberg Limits	ASTM D 4318	Method A
Sieve Analysis	ASTM D 6913	Method A
USCS Classification	ASTM D 2487	

GEOTECHNICAL REPORT LIMITATIONS

The recommendations contained in this report are based on our interpretation of subsurface conditions encountered at the discrete boring locations. Variations between the subsurface conditions anticipated in this report and actual project site conditions may occur away from the boring locations.

If significant differences between the findings of the borings and site conditions are observed, GTS should be contacted to assess the variation and, if necessary, reevaluate the recommendations contained in this report.

ENVIRONMENTAL EXCLUSION

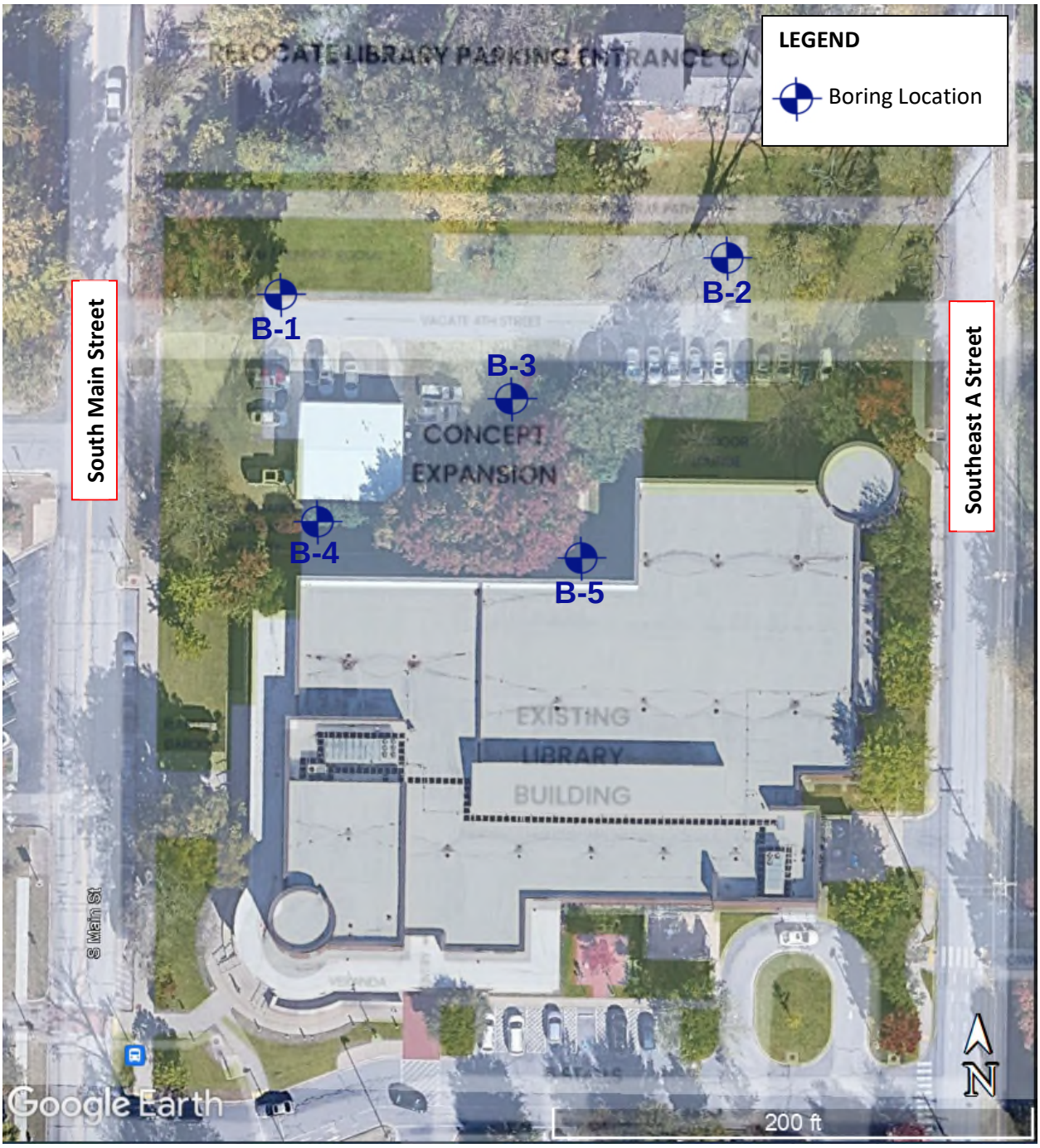
A Geotechnical Engineering report assesses the engineering properties of soil and rock. No environmental assessment of a project site is performed during a geotechnical exploration. If the owner is concerned about the potential for environmental hazards at the project site, additional studies should be performed by GTS.

APPENDIX A

Boring Location Diagram

Boring Logs

Bentonville Public Library
Planned Bentonville Public Library Expansion
405 South Main Street
Bentonville, Arkansas
GTS Project No. 21-1-5-188



Boring Location Diagram
with conceptual site plan overlay

GTS, Inc.
Geotechnical & Testing Services

LOG OF BORING NO.B-1

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● (PL — LL; 20, 40, 60, 80)	BLOWS PER FT
0				Surface Description = Grass Cover Rootmat - 3 inches				
		1	18	POSSIBLE FILL - predominantly silty clayey sand medium dense, orange, brown, gray and red, with chert fragments				21
2.5		2	11	- very stiff and predominantly dark brown and gray lean clay below 27 inches	FILL	97		14
		3	14			94		11
5		4	15	LEAN CLAY very stiff, gray and brown, dry	CL			17
7.5								
		5	16	LEAN CLAY, with sand medium stiff, red and brown	CL		■ 3.5	8
10				- cave-in at 11 feet upon completion of drilling				
12.5				SANDY LEAN CLAY, with gravel medium stiff, tan, orange and gray, with chert fragments				
		6	12		CL		■ 2.5	6
15								
17.5								

COMPLETION DEPTH: 20.58 ft.
DATE: 11/9/2021
RIG: 7720DT Geoprobe, Track Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: 19 ft
AT COMPLETION: 17 ft
AT 24 HOURS: Backfilled

LOG OF BORING NO.B-1

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
			7	6	CLAYEY SAND, with gravel very loose, brown and gray, with chert and limestone fragments	SC		●	0* (WOH)
20									
			8	1	LIMESTONE hard, gray AUGER REFUSAL AT 20½ FEET				50/1"
22.5									
25									
27.5									
30									
32.5									
35									

LOG OF BORING NO.B-2

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● (PL, LL; 20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover Rootmat - 2 inches				
			1	10	SILT, with sand very loose, dark brown, with rootlets and wood fragments	ML		●	4
2.5			2	14	LEAN CLAY medium stiff, red and orange	CL		● ■ 2.5	5
			3	14	- moist, orange and red, with fine sand pockets below 4 feet		87	● ■	8
5			4	13	SANDY LEAN CLAY very stiff, orange and red, with ferrous nodules, dry	CL		● ■ 4.0	12
7.5									
			5	15	SANDY FAT CLAY stiff, orange, yellow and red, with ferrous nodules and sand pockets - cave-in at 9 feet upon completion of drilling	CH		● ■	9
10									
12.5			6	3	SANDY GRAVEL variable very loose to medium dense, gray, orange and tan, with chert fragments, seams and possible voids	GP			11
15									
			7	1	LIMESTONE hard, gray				50/1"
17.5					AUGER REFUSAL AT 17 FEET				

COMPLETION DEPTH: 17 ft.
DATE: 11/9/2021
RIG: 7720DT Geoprobe, Track Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: Dry
AT COMPLETION: Dry
AT 24 HOURS: Backfilled

LOG OF BORING NO.B-3

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover Rootmat - 3 inches				
			1	18	FILL - predominantly clayey sand, with gravel medium dense, brown, gray and red, with chert fragments	FILL		●	15
2.5			2	6	POSSIBLE FILL - predominantly lean clay with gravel soft, brown and gray, with chert fragments, moist	FILL		●	2
			3	12	LEAN CLAY soft, brown, moist	CL		● ■	2
5			4	14	- medium stiff, red and brown, moist	CL		● ■	5
7.5						CL			
			5	15	SANDY LEAN CLAY medium stiff, orange, brown and red, moist	CL		● ■ 3.0 →	7
10						CL			
12.5					SANDY FAT CLAY, with gravel stiff, brown, orange and gray, with chert fragments and seams	CH		●	9
			6	10		CH		●	9
15						CH			
					SANDY GRAVEL medium dense to dense, orange, with chert fragments - cave-in at 17 feet upon completion of	GP			
17.5			7	1		GP			50/1"

COMPLETION DEPTH: 17.5 ft.
DATE: 11/9/2021
RIG: 7720DT Geoprobe, Track Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: 17 ft
AT COMPLETION: Dry
AT 24 HOURS: Backfilled

LOG OF BORING NO.B-3

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
					drilling				
					LIMESTONE				
					hard, gray				
					AUGER REFUSAL AT 17½ FEET				
20									
22.5									
25									
27.5									
30									
32.5									
35									

LOG OF BORING NO.B-4

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover Rootmat - 1 inch				
			1	18	FILL - predominantly sandy lean clay, with gravel medium stiff, orange, brown and red, with chert fragments				5
2.5			2	12		FILL			6
			3	10	- loose and predominantly dark brown, orange, brown and red clayey gravel, with sand and chert fragments below 3½ feet		43		5
5			4	11	LEAN CLAY, with sand medium stiff, brown, moist	CL			7
7.5									
			5	15	SANDY LEAN CLAY very stiff, orange, gray, olive and yellow	CL		3.75	12
10					- cave-in at 11 feet upon completion of drilling				
12.5					SANDY FAT CLAY, with gravel medium stiff, brown and gray, with chert fragments and seams as well as limestone fragments	CH			
					CHERT SEAM = 6"				
			6	12		CH			6
15									
					LIMESTONE hard, gray				
17.5			7	1					50/1"

COMPLETION DEPTH: 17.5 ft.
DATE: 11/10/2021
RIG: 7720DT Geoprobe, Track Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: Dry
AT COMPLETION: Dry
AT 24 HOURS: Backfilled

LOG OF BORING NO.B-4

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES / SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ 0.4 0.8 1.2 1.6 / WATER CONTENT, % ● PL LL 20 40 60 80	BLOWS PER FT
				AUGER REFUSAL AT 17½ FEET				
20								
22.5								
25								
27.5								
30								
32.5								
35								

LOG OF BORING NO.B-5

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● (PL — LL; 20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover Rootmat - 3 inches				
					SILT very loose, dark brown, with rootlets	ML			
			1	18	LEAN CLAY very soft, brown, moist	CL		■	1
2.5			2	12	LEAN CLAY, with sand soft, brown and red, moist	CL		2.5 ■	4
			3	13	SANDY LEAN CLAY medium stiff, orange and red, with ferrous nodules	CL		2.5 ■	6
5			4	14	- very stiff, with residual shale structure below 5 feet			3.25 ■	14
7.5					- cave-in at 8 feet upon completion of drilling				
			5	12	SANDY GRAVEL, with clay very stiff, brown, orange and gray, with chert fragments	GP			52
10									
12.5									
			6	9	CLAYEY GRAVEL loose, orange and brown, with chert fragments	GC			10
15									
			7	1	LIMESTONE hard, gray				50/1"
17.5					AUGER REFUSAL AT 17 FEET				

COMPLETION DEPTH: 17 ft.
DATE: 11/9/2021
RIG: 7720DT Geoprobe, Track Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: Dry
AT COMPLETION: Dry
AT 24 HOURS: Backfilled

APPENDIX B

Laboratory Data

GTS, Inc.
Geotechnical & Testing Services

1915 North Shiloh Drive
Fayetteville, Arkansas 72704

Office: (479) 521-7645

Office Locations

Little Rock, Arkansas
Fort Smith, Arkansas
Tulsa, Oklahoma
Dallas, Texas

PROJECT: Planned BPL Expansion

DATE: 11/23/2021

JOB NO: 21-1-5-188

BORING NO.	B - 1
SAMPLE NO.	S - 2
DEPTH (FT)	2.25' - 3.5'
PLASTIC LIMIT	19
LIQUID LIMIT	33
PLASTICITY INDEX	14

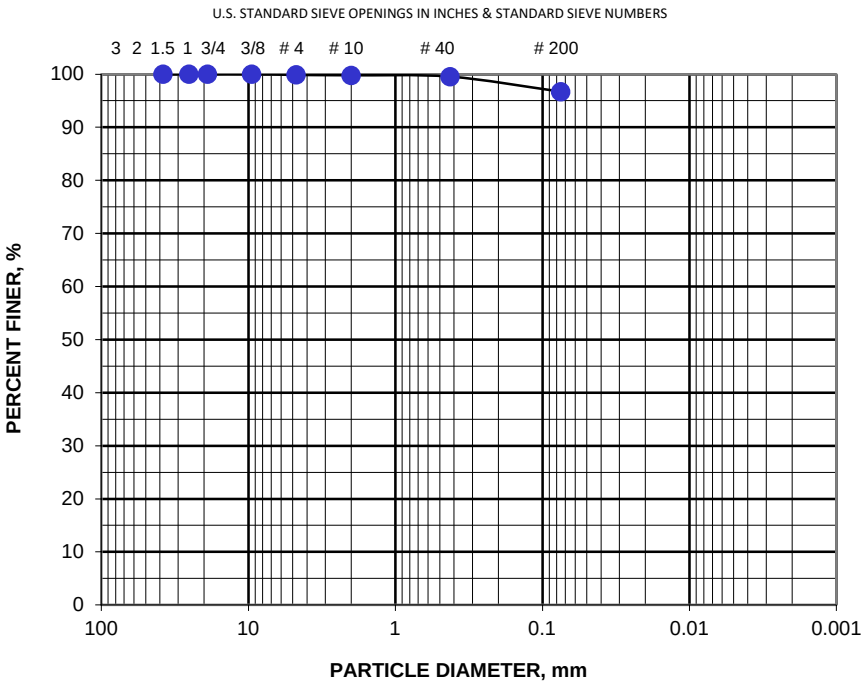
SIEVE SIZE	PERCENT PASSING
3.00"	100.0%
1.50"	100.0%
1.00"	100.0%
3/4"	100.0%
3/8"	100.0%
No. 4	99.9%
No. 10	99.8%
No. 40	99.5%
No. 200	96.7%

MOISTURE CONTENT (%) 16.0

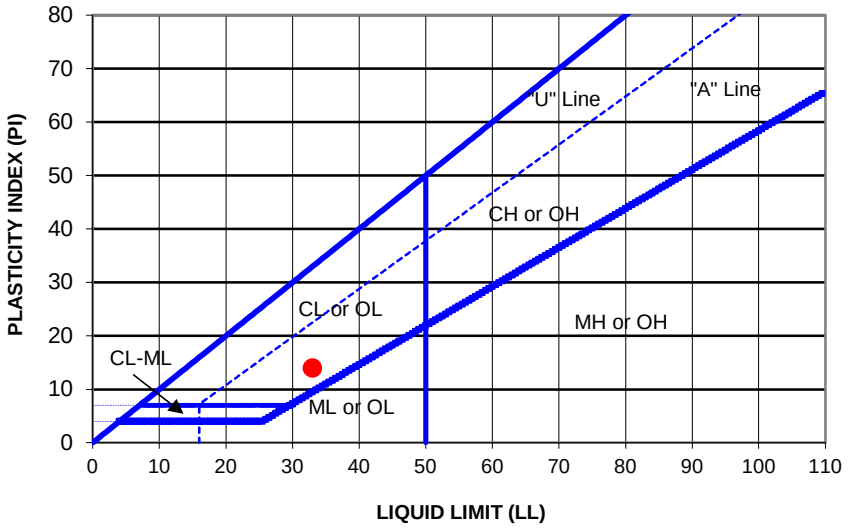
VISUAL DESCRIPTION	**POSSIBLE FILL** - dark brown and gray

ASTM DESCRIPTION	AASHTO CLASSIFICATION	AASHTO GI
Lean Clay, CL	**A-6**	**14**

GRAIN SIZE DISTRIBUTION CURVE



PLASTICITY CHART



GTS, Inc.
Geotechnical & Testing Services

1915 North Shiloh Drive
Fayetteville, Arkansas 72704

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Fort Smith, Arkansas
Tulsa, Oklahoma
Dallas, Texas

PROJECT: Planned BPL Expansion

DATE: 11/23/2021

JOB NO: 21-1-5-188

BORING NO.	B - 1
SAMPLE NO.	S - 3
DEPTH (FT)	3.5' - 5.0'
PLASTIC LIMIT	20
LIQUID LIMIT	35
PLASTICITY INDEX	15

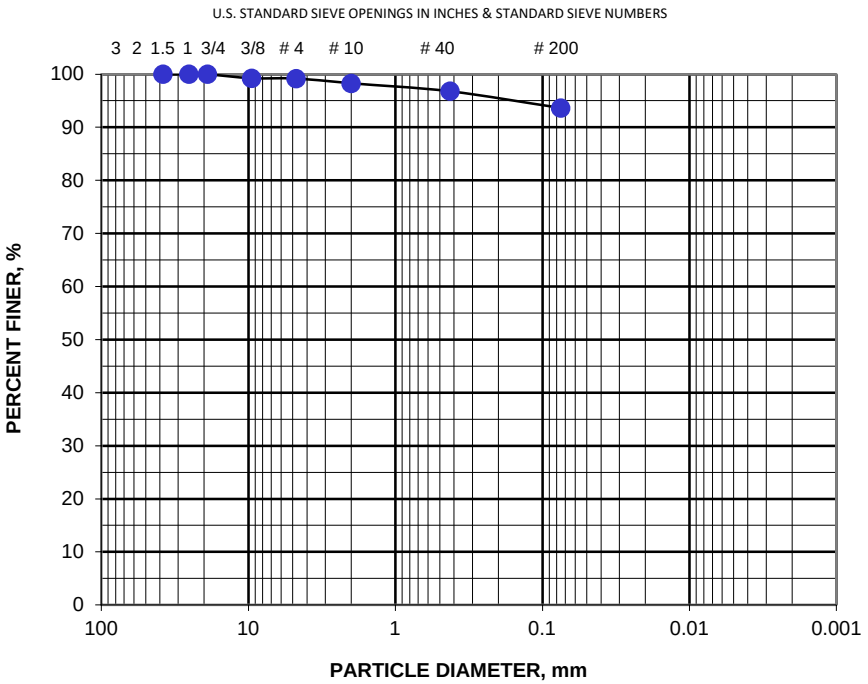
SIEVE SIZE	PERCENT PASSING
3.00"	100.0%
1.50"	100.0%
1.00"	100.0%
3/4"	100.0%
3/8"	99.2%
No. 4	99.2%
No. 10	98.3%
No. 40	96.8%
No. 200	93.7%

MOISTURE CONTENT (%) 17.3

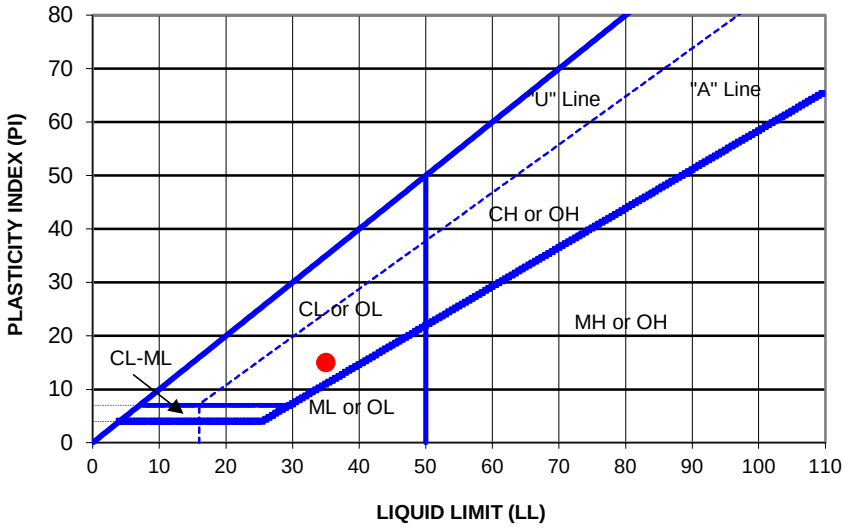
VISUAL DESCRIPTION	**POSSIBLE FILL** - dark brown and gray

ASTM DESCRIPTION	AASHTO CLASSIFICATION	AASHTO GI
Lean Clay, CL	**A-6**	**14**

GRAIN SIZE DISTRIBUTION CURVE



PLASTICITY CHART



GTS, Inc.
Geotechnical & Testing Services

1915 North Shiloh Drive
Fayetteville, Arkansas 72704

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Office Locations

Little Rock, Arkansas
Fort Smith, Arkansas
Tulsa, Oklahoma
Dallas, Texas

PROJECT: Planned BPL Expansion

DATE: 11/23/2021

JOB NO: 21-1-5-188

BORING NO.	B - 2
SAMPLE NO.	S - 3
DEPTH (FT)	4.0' - 5.0'
PLASTIC LIMIT	16
LIQUID LIMIT	29
PLASTICITY INDEX	13

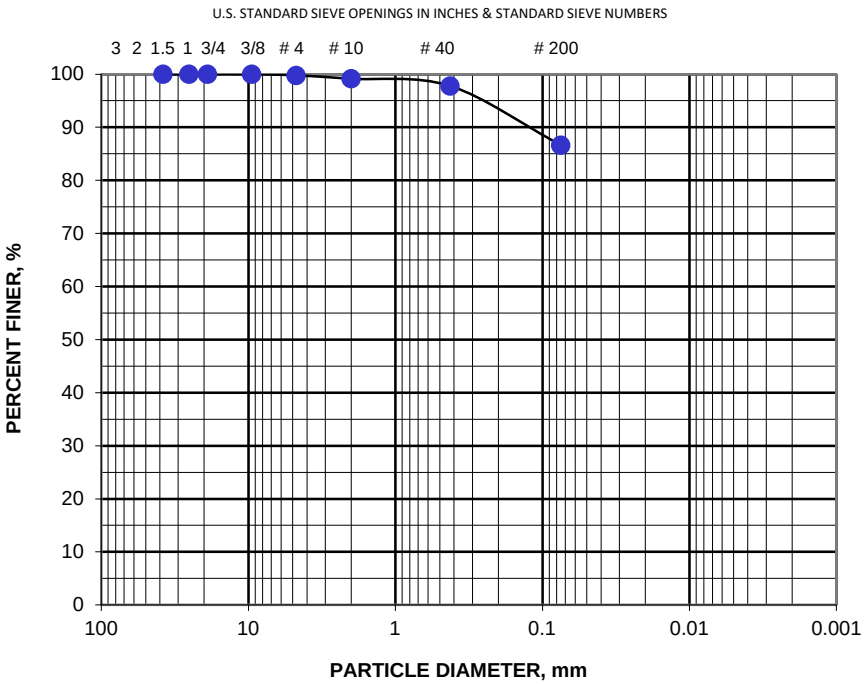
SIEVE SIZE	PERCENT PASSING
3.00"	100.0%
1.50"	100.0%
1.00"	100.0%
3/4"	100.0%
3/8"	100.0%
No. 4	99.8%
No. 10	99.1%
No. 40	97.8%
No. 200	86.7%

MOISTURE CONTENT (%) 19.3

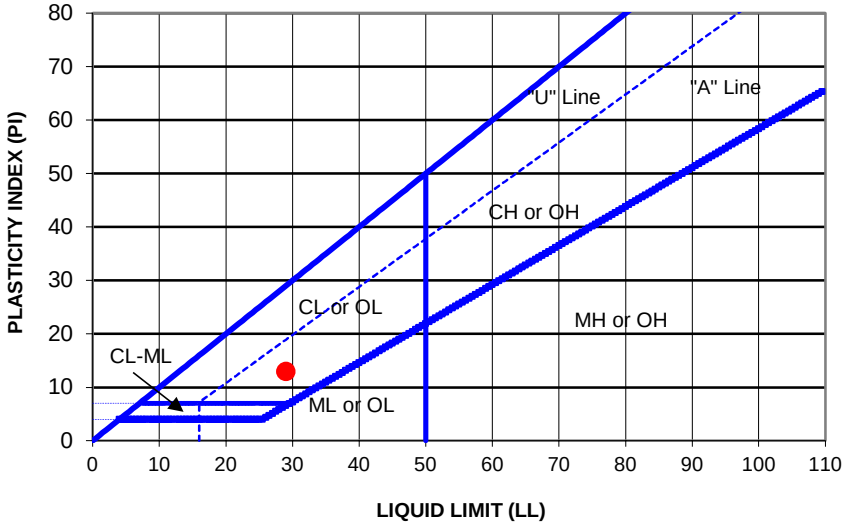
VISUAL DESCRIPTION	moist, orange and red, with fine sand pockets

ASTM DESCRIPTION	AASHTO CLASSIFICATION	AASHTO GI
Lean Clay, CL	**A-6**	**10**

GRAIN SIZE DISTRIBUTION CURVE



PLASTICITY CHART



GTS, Inc.
Geotechnical & Testing Services

1915 North Shiloh Drive
Fayetteville, Arkansas 72704

Office: (479) 521-7645

Office Locations

Little Rock, Arkansas
Fort Smith, Arkansas
Tulsa, Oklahoma
Dallas, Texas

PROJECT: Planned BPL Expansion

DATE: 11/23/2021

JOB NO: 21-1-5-188

BORING NO.	B - 4
SAMPLE NO.	S - 3
DEPTH (FT)	3.5' - 5.0'
PLASTIC LIMIT	17
LIQUID LIMIT	32
PLASTICITY INDEX	15

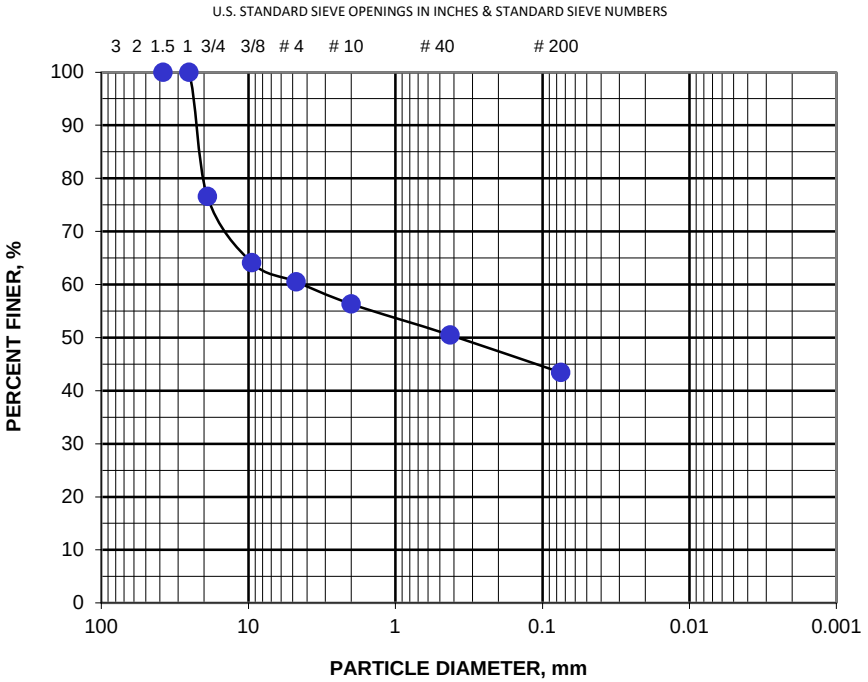
SIEVE SIZE	PERCENT PASSING
3.00"	100.0%
1.50"	100.0%
1.00"	100.0%
3/4"	76.6%
3/8"	64.2%
No. 4	60.5%
No. 10	56.3%
No. 40	50.5%
No. 200	43.4%

MOISTURE CONTENT (%) 16.4

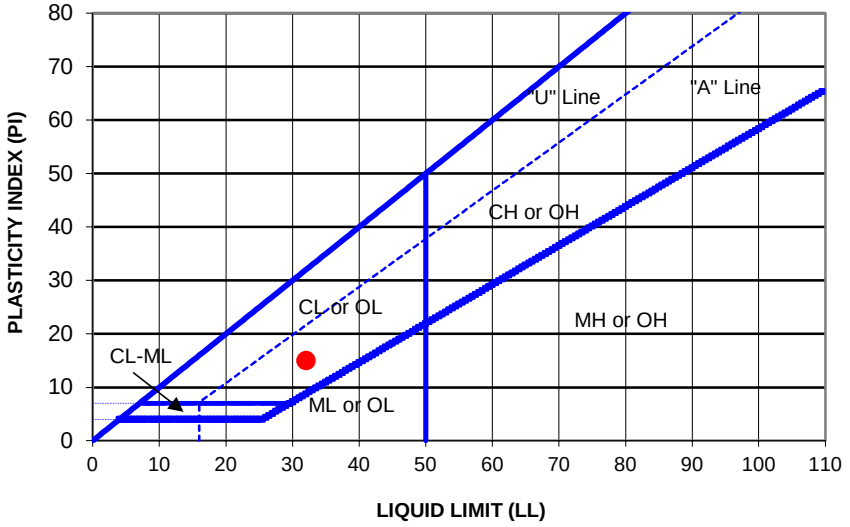
VISUAL DESCRIPTION	**FILL** - dark brown, orange, brown and red, with chert fragments

ASTM DESCRIPTION	AASHTO CLASSIFICATION	AASHTO GI
Clayey Gravel with Sand, GC	**A-6**	**3**

GRAIN SIZE DISTRIBUTION CURVE



PLASTICITY CHART



1915 North Shiloh Drive
Fayetteville, Arkansas 72704
Office: (479) 521-7645

Licensed:
Arkansas • Arizona • Kansas
Kentucky • Louisiana • Missouri
Oklahoma • Texas

GTS, Inc.
Geotechnical & Testing Services

www.gtsconsulting.net

January 5, 2022

Bentonville Public Library
405 South Main Street
Bentonville, Arkansas 72712

Attention: Ms. Hadi S. Dudley

RE: Geotechnical Engineering Report – Addendum No. 1
Planned Bentonville Public Library Expansion – Supplemental Evaluation
405 South Main Street
Bentonville, Arkansas
GTS Project No. 21-1-5-188

Ms. Dudley:

As requested, GTS, Inc. (GTS) is providing the results of our supplemental borings and subsequent evaluation of bedrock conditions underlying the project site. The geotechnical parameters and information provided in this addendum are meant to supplement those provided in our original report: reference "Initial Geotechnical Engineering Report", GTS Project No. 21-1-5-188, dated December 14, 2021 ("Geotech Report").

All geotechnical engineering recommendations and considerations described in our original report that are not specifically addressed in this addendum remain valid.

Supplemental Subsurface Exploration and Procedures

The supplemental subsurface exploration consisted of drilling and sampling at two supplemental boring locations within the planned building footprint. As proposed, the supplemental borings (identified as Borings SB-1 and SB-2) were advanced to auger refusal depths without sampling and the refusal material was sampled (i.e. cored) a distance of 5 feet beyond auger refusal depths.

The boring locations were established in the field by GTS using a recreation-grade, hand-held GPS unit. The approximate supplemental boring locations are shown on the attached boring location diagram and the results of the supplemental borings are attached to this letter.

The borings were drilled with a truck-mounted CME-75 drill rig. The auger refusal material was continuously sampled using an NQ-sized, double-barrel wireline coring assembly and a diamond-impregnated drill bit. The rock core samples were placed within waxed cardboard boxes in the field and transported to the GTS soil laboratory for further examination, testing and classification. The results of the laboratory tests on select rock core samples are provided

further in this letter and also shown on the boring logs attached to this letter. Photographs of the recovered rock cores are attached to the end of this letter.

Field logs were prepared during the drilling of the borings. These logs report sampling methods and soil, rock and groundwater conditions observed at the boring locations. The final boring logs, included in this letter, have been prepared based on the field logs and have been modified, where appropriate, based on the results of the laboratory observation/testing.

Subsurface Conditions

Stratum IV – Cherty Limestone

As discussed in the original Geotechnical Report referenced above, the basal stratum at this site consisted of cherty limestone bedrock. The cherty limestone bedrock was encountered beginning at depths of about 17 and 17 ½ feet below the ground surface at Borings SB-2 and SB-1, respectively. At the supplemental boring locations, the cherty limestone was generally hard and slightly weathered. At Boring SB-2, the cherty limestone was moderately fractured. The limestone extended to the terminal depth of the supplemental borings.

As previously discussed, the auger refusal (Stratum IV) materials were continuously sampled for about 5 feet at the supplemental boring locations. The rock cores had recoveries ranging from 80 to 90 percent. The Rock Quality Designation (RQD) of the rock cores ranged from 29 to 79 percent. Based on the recovered core samples, the quality of the cherty limestone bedrock was highly variable, poor to good quality, at the performed supplemental boring locations.

Laboratory compressive strength tests were performed on select intact rock core specimens obtained from the supplemental boring locations. Results of the compressive strength tests on select rock core samples are summarized in Table 1 below.

Table 1: Compressive Strength of Intact Rock Cores

Boring Number	Rock Core Sample Depth (feet below existing grade)	Laboratory Compressive Strength (psi)
SB-1	20	6,183
SB-2	21 ½	10,378

Geotechnical Considerations

Based on the results of our supplemental borings, the foundation recommendations provided in the Geotech Report remain valid.

Based on the results of our previously performed and supplemental borings, GTS anticipates that future drilled shafts or driven piles will extend to depths of approximately 17 to 21 feet below existing grades at this project site.

Due to the highly variable quality of the sampled cherty limestone, the moderate fracturing encountered in some of the recovered rock cores, as well as the past history of probes being performed for the original foundation construction, we do still recommend that all drilled pier foundations pass a probe hole verification test (as described in the Geotech Report).

Laboratory Testing and Procedures

The rock samples were examined in the laboratory by an experienced geotechnical engineer. The laboratory testing was performed by GTS in general accordance with the American Society for Testing and Materials (ASTM) test designations shown in Table 2.

Table 2: Laboratory Test Method Designations

Laboratory Test	Test Designation	Method (if applicable)
Compressive Strength of Rock Cores	ASTM D7012	Method C

Report Limitations

The recommendations and observations contained in this addendum letter are based on our evaluation of on-site soils and rock, our interpretation of subsurface conditions encountered within our explorations at the project site, and the project information provided to us. Soil and rock conditions away from the boring locations could be different than the subsurface conditions represented by the areas observed. If differing conditions are discovered during construction, GTS should be allowed to evaluate the new conditions and if necessary, amend our recommendations.

GTS, Inc.
Geotechnical & Testing Services

Closing

We appreciate the opportunity to provide engineering services for you on this project. Please contact us if the assumptions stated in this letter are incorrect and/or if further explanation is required for portions of the letter.

Sincerely,

GTS, Inc.
Geotechnical & Testing Services

STATE OF ARKANSAS
LICENSED PROFESSIONAL ENGINEER
No. 14967
ANDREW N. BEEKMAN
1/5/2022

Andrew N. Beekman, P.E.
Arkansas No. 14967

Travis Willis 1-5-22

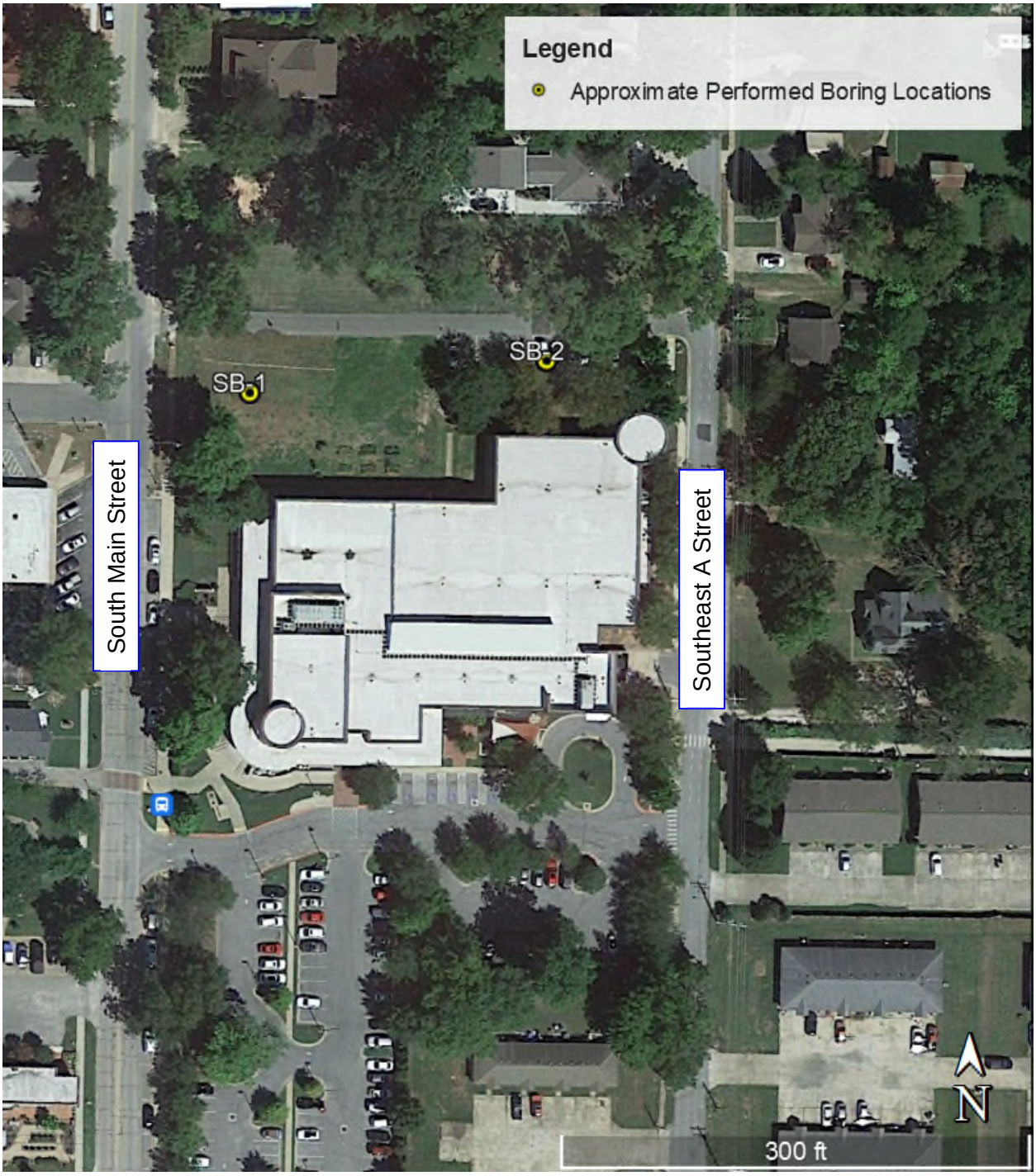
Travis Willis, P.E.
Senior Geotechnical Engineer

ANB:TW

Copies to: Addressee (email-hdudley@bentonvillear.com)

Attachments: Supplemental Boring Location Diagram, Supplemental Boring Logs, Rock Core Photographs

CERTIFICATE OF AUTHORIZATION
GTS, INC.
NO. 1251
ARKANSAS



Supplemental Boring Location Diagram

LOG OF BORING NO.SB-1

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover OVERBURDEN SOILS - not sampled				
2.5									
5									
7.5									
10									
12.5									
15					- cave-in at 15 feet upon completion of drilling				
17.5					CHERTY LIMESTONE				

COMPLETION DEPTH: 22.5 ft.
DATE: 12/22/2021
RIG: CME-75, Truck Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: Dry
AT COMPLETION: N/A
AT 24 HOURS: Backfilled

LOG OF BORING NO.SB-1

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
					hard, slightly weathered, gray and light gray				
					82% RECOVERY 51% RQD				
20					UCS = 6,183 psi @ 20 ft.				
					90% RECOVERY 79% RQD				
22.5					AUGER REFUSAL AT 17½ FEET BOTTOM OF BORING AT 22½ FEET				
25									
27.5									
30									
32.5									
35									

LOG OF BORING NO.SB-2

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
0					Surface Description = Grass Cover OVERBURDEN SOILS - not sampled				
2.5									
5									
7.5									
10					- cave-in at 10 feet upon completion of drilling				
12.5									
15									
17.5					CHERTY LIMESTONE hard, slightly weathered, gray and light				

COMPLETION DEPTH: 22 ft.
DATE: 12/22/2021
RIG: CME-75, Truck Mounted, Auto Hammer Assisted

DEPTH TO WATER: DURING DRILLING: Dry
AT COMPLETION: N/A
AT 24 HOURS: Backfilled

LOG OF BORING NO.SB-2

Planned Bentonville Public Library Expansion
405 South Main Street, Bentonville, Arkansas

GTS, Inc.
Geotechnical & Testing Services
Fayetteville, AR

Project No.: 21-1-5-188 Location: Shown On Attached Boring Location Diagram

DEPTH, FT	SYMBOL	SAMPLES	SAMPLE No.	RECOVERY (in.)	DESCRIPTION OF MATERIAL	USCS	%<#200	HAND PENETROMETER, TSF ■ / LAB. COHESION, TSF ▲ (0.4, 0.8, 1.2, 1.6) / WATER CONTENT, % ● PL — LL (20, 40, 60, 80)	BLOWS PER FT
					gray, moderately fractured				
					80% RECOVERY 29% RQD				
20									
					UCS = 10,378 psi @ 21½ feet				
22.5					AUGER REFUSAL AT 17 FEET BOTTOM OF BORING AT 22 FEET				
25									
27.5									
30									
32.5									
35									


21-1-5-188
SB-1
17.5' to 22.5'


21-1-5-188
SB-1
17' to 22'

SECTION 02 32 01

SITE AND SUBSURFACE INVESTIGATION BY CONTRACTOR

PART I GENERAL

1.1 SECTION INCLUDES

A. Surface reconnaissance and evaluation of existing site conditions.

B. Sub-surface evaluation by contractor's chosen method of investigation.

1.2 RELATED SECTIONS

A. Sections 00 72 00 - General Conditions.

B. Section 00 73 00 - Supplementary conditions.

PART 2 GENERAL

2.1 EXECUTION

A. The Contractor is responsible for having a thorough knowledge of all Drawings, Specifications, General and Supplementary Conditions, and other Contract Documents. Failure to acquaint himself with this knowledge does not relieve him of the responsibility for performing his work in a manner acceptable to the Owner. No additional compensation will be allowed because of conditions that occur due to failure by the Contractor to familiarize himself and all work with this knowledge.

B. The Contractor shall be responsible for determining the existing conditions of the site and shall thoroughly examine all factors reasonably available to him, including but not limited to the Drawings, Specifications, geotechnical report, site boundary and topography, site conditions, site history, local information, and seasonal weather conditions. Geotechnical report data is not considered all conclusive and it is the Contractor's responsibility to further investigate site conditions as he determines necessary. The Contractor shall be totally responsible for acceptance of the site and preparation of the site to the proper grade and compaction requirements as indicated by the Contract Documents including Construction Drawings and Specifications. Any construction performed by the Contractor on the project will constitute acceptance of the site.

END OF SECTION

SECTION 02 41 17

MINOR DEMOLITION FOR REMODELING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Removal of designated building equipment and fixtures.

B. Removal of designated construction.

C. Disposal of materials. Storage of removed materials.

D. Identification of utilities.

E. Refer to items as indicated on drawings.

1.2 RELATED SECTIONS

A. Section 01 11 00 - Summary of Work: Work sequence, Owner's continued occupancy.

B. Section 01 35 16 - Alteration Project Procedures: Re-installation of removed and stored products.

C. Section 01 50 00 - Construction Facilities and Temporary Controls: Temporary enclosures, dust control barricades, security at Owner occupied areas, and cleanup during construction.

D. Section 01 77 00 - Contract Closeout: Project record documents.

1.3 SUBMITTALS FOR CLOSEOUT

A. Section 01 77 00 - Contract Closeout: Procedures for submittals.

B. Project Record Documents: Accurately record actual locations of capped utilities, subsurface obstructions, and other items field verified as different from construction documents.

1.4 REGULATORY REQUIREMENTS

A. The Contractor shall obtain evidence in writing from the Owner prior to any work commencing that no asbestos-containing material exists in the area(s) where demolition or construction is to be performed. A copy of the Owner’s asbestos survey must be available on site during any renovation or demolition activity.

B. Conform to applicable code for demolition work, dust control, products requiring electrical disconnection and re-connection.

C. Obtain required permits from authorities.

D. Do not close or obstruct egress width to any building or site exit.

E. Do not disable or disrupt building fire or life safety systems without 2 days prior written notice to Owner.

F. Conform to procedures applicable when hazardous or contaminated materials are discovered.

1.5 SCHEDULING

A. Section 01 33 00 - Submittals, 01 32 36 Progress Schedules: Work schedule.

B. Schedule Work to coincide with new construction.

C. Describe demolition removal procedures and schedule.

D. Perform noisy work when the building is unoccupied.

1.6 PROJECT CONDITIONS

A. Conduct demolition to minimize interference with adjacent and occupied building areas.

B. Cease operations immediately if structure appears to be in danger and notify Architect/Engineer. Do not resume operations until directed.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 PREPARATION

A. After date of Notice to Proceed, Contractor to assume responsibility for structures and items to be demolished and removed until such work is completed to the satisfaction of the Owner's representative. After work is started on any building or structure, work shall continue without interruption until complete.

B. Provide, erect, and maintain temporary barriers and partitions at locations as required and indicated.

C. Erect and maintain weatherproof closures for exterior openings.

D. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Owner occupancy.

E. Protect existing materials and items which are not to be demolished.

F. Prevent movement of structure; provide bracing and shoring.

G. Notify affected utility companies before starting work and comply with their requirements.

H. Mark location and termination of utilities.

I. Provide appropriate temporary signage including signage for exit or building egress. Do not close or obstruct existing building fire exits.

3.2 DEMOLITION

A. Disconnect remove and / or cap designated utilities within demolition areas.

B. Demolish in an orderly and careful manner. Protect existing supporting structural members.

C. Remove demolished materials from site except where specifically noted otherwise. Do not burn or bury materials on site.

D. Remove materials as Work progresses. Upon completion of Work, leave areas in clean condition.

E. Remove temporary Work.

F. Wherever a cutting torch or other equipment that may cause a fire is used, provide and maintain fire extinguishers nearby ready for immediate use. All possible users shall be instructed in use of the extinguishers.

G. Hydrants shall be accessible at all times. No debris shall be permitted to accumulate.

3.3 CLEAN UP

A. On completion of work of this section and after removal of all debris, site shall be left in drainable, clean condition satisfactory to Owner's Representative. Clean-up shall include disposal of all items and materials not required to be salvaged as well as all debris and rubbish resulting from demolition operations.

3.4 SCHEDULES

A. Refer to drawings for items called for to be demolished.

END OF SECTION

SECTION 02 41 19

DEMOLITION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Selective demolition of built site elements.

B. Abandonment and removal of existing utilities and utility structures.

1.2 RELATED REQUIREMENTS

A. Section 312000 – Earthwork

1.3 REFERENCES

A. 29 CFR 1926 - U.S. Occupational Safety and Health Standards; current edition.

B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2004.

1.4 SUBMITTALS

A. Site Plan: Showing: Areas for temporary construction and field offices.

B. Demolition Plan: Submit demolition plan as specified by OSHA and local authorities.

1. Indicate extent of demolition, removal sequence, bracing and shoring, and location and construction of barricades and fences.

2. Identify demolition firm and submit qualifications.

3. Include a summary of safety procedures.

C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.5 QUALITY ASSURANCE

A. Demolition Firm: Company specializing in the type of work required.

1.6 PROJECT CONDITIONS

A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 SCOPE

A. Remove paving and curbs as required to accomplish new work.

B. Remove other items indicated, for salvage, relocation, and recycling.

C. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.2 GENERAL PROCEDURES AND PROJECT CONDITIONS

A. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

1. Obtain required permits.

2. Comply with applicable requirements of NFPA 241.

3. Use of explosives is not permitted.

4. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.

5. Provide, erect, and maintain temporary barriers and security devices.

6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.

7. Do not close or obstruct roadways or sidewalks without permit.

8. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.

9. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.

B. Do not begin removal until receipt of notification to proceed from the Owner.

C. Protect existing structures and other elements that are not to be removed.

1. Provide bracing and shoring.

2. Prevent movement or settlement of adjacent structures.

3. Stop work immediately if adjacent structures appear to be in danger.

D. Hazardous Materials: Comply with 29 CFR 1926 and state and local regulations.

E. Perform demolition in a manner that maximizes salvage and recycling of materials.

1. Dismantle existing construction and separate materials.

2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.

F. Partial Removal of Paving and Curbs: Neatly saw cut at right angle to surface.

3.3 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not disrupt public utilities without permit from authority having jurisdiction.

D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to the owner.

E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to the owner.

F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.

G. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

I. Coordinate re-location or modifications to all utilities affected by new access street tie ends to any public or private drives and or streets.

3.4 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.

1.Verify that construction and utility arrangements are as shown.

2. Report discrepancies to landscape architect before disturbing existing installation.

3. Beginning of demolition work constitutes acceptance of existing conditions.

B. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

C. Remove existing work as indicated and as required to accomplish new work.

1. Remove rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.

2. Remove items indicated on drawings.

D. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.

1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.

2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.

3. Verify that abandoned services serve only abandoned facilities before removal.

4. Remove abandoned pipe, ducts, conduits, and equipment; remove back to source of supply where possible, otherwise cap stub and tag with identification.

E. Protect existing work to remain.
1. Prevent movement of structure; provide shoring and bracing if necessary.

2. Perform cutting to accomplish removals neatly and as specified for cutting new work.

3. Repair adjacent construction and finishes damaged during removal work.

4. Patch as specified for patching new work.

3.5 DEBRIS AND WASTE REMOVAL

A. Remove debris, junk, and trash from site.

B. Remove from site all materials not to be reused on site.

C. Leave site in clean condition, ready for subsequent work.

D. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 03 11 00

CONCRETE FORM WORK

PART 1 GENERAL

1.1 SECTION INCLUDES

A. All concrete and related items required to complete the building, provide off-sets, bulkheads, recesses, openings, chases, etc., and install any inserts, sleeves, etc., required by other trades.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Concrete: Section 03 30 00

B. Concrete Reinforcement: Section 03 21 00

1.3 WORK INSTALLED BUT FURNISHED BY OTHER SECTIONS:

A. Built-in anchors, inserts and bolts for connection of other materials.

B. Built-in sleeves, thimbles, dovetail slots, and water-stops.

1.4 DEFINITIONS:

A. Architectural Concrete Surfaces: Formed surfaces where appearance is of major importance.

B. Non-Architectural Concrete Surfaces: Formed surfaces where appearance is not of major importance.

1.5 QUALITY ASSURANCE:

A. Design Criteria:
   1. General: Conform to ACI 347-Current Edition Chapter 1, Design.
   2. Plywood: Conform to tables for form design in APA Form V 345- Current Edition, including strength.

B. Requirements of Regulatory Agencies: Erect forms to meet requirements of the Local Building Code.

C. Allowable Tolerances:
   1. Non-Architectural Concrete: Conform to ACI 347- Current Edition.

D. Contractor shall assume full responsibility for earthwork or an existing structure used as a form and such form work must meet all requirements of this section.

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. On delivery to job site, place materials in area protected from weather.

B. Store materials above ground on framework or blocking and cover with protective waterproof covering providing for adequate air circulation or ventilation.

C. Handle materials to prevent damage.

PART 2 PRODUCTS

2.1 MATERIALS:

A. Conform to ACI 347- Current Edition, Chapter 3, Materials and Form Work.

2.2 LUMBER:

A. Softwood framing lumber: Kiln dried, PS 20-70.

B. Boards less than 1 1/2" thick, used for basic forms and form liners: Kiln dried.

C. Grade marked by grading rules agency approved by American Lumber Standards Committee.

D. Light framing or studs for plywood forms, 2 in. to 4 inches in width and thickness, construction grade.

2.3 PLYWOOD:

A. Exterior type softwood plywood, PS 1-66.

B. Each panel stamped or branded indicating veneer grades, species, type and identification.

C. Wood faced plywood for architectural concrete surfaces. Panel veneer grades: A-C. Mill-oiled sides and mill-sealed edges of panels.

2.4 CORNER FORMERS:

A. Profile type: chamfered face.

B. Material: Wood

2.5 TIES:

A. Material: Carbon Steel

B. Type: Snap ties

C. Depth of break back: 1 inch

D. Maximum diameter: 1/4 inch

2.6 FORM COATINGS:

A. Plywood and wood forms shall be sealed against absorption of moisture from the concrete with an approved non-staining form oil or sealer.

B. Form sealer, lacquer or any form of release agents containing wax, oil, or other materials that would interfere with adhesion shall not be used on form work for concrete which is to receive exposed aggregate coatings.

C. Provide dissipating polymerized solution for form release agent containing no oils, waxes, paraffin, or silicones for tilt-up precast concrete or cast-in-place concrete scheduled to receive interior or exterior finishes.

PART 3 EXECUTION:

3.1 GENERAL

A. The design, engineering, bracing and construction of form work shall be the responsibility of the Contractor.

B. Form work shall conform to shapes, lines and dimensions of members as shown on contract plans and shall be sufficient to prevent mortar leakage and to maintain position and shape during and after placing of concrete. Form work for exposed surfaces shall be constructed of undamaged materials that will result in an unblemished, flush surface when removed.

C. Shoring and bracing of form work shall be adequate to resist all construction loads, wet concrete, stored and lateral loads due to earthwork. Shoring and bracing of elevated slabs shall remain in place until the concrete has reached a minimum compressive strength of 3,500 psi. (75% of the specified 28-day design strength, f'c.)

D. Preparation of forms. Edges of exposed concrete work, exterior and interior shall be pointed up to present a good square appearance.

E. Provide temporary openings in framework for concrete placement.

F. Removal of forms is subject to weather conditions after concrete is poured. Remove formwork in manner to ensure complete safety of structure. Do not place building materials on slabs until they are strong enough to carry the imposed load. Contractor shall decide when to remove and accept full responsibility for their removal.

G. Do not run reinforcement, corner protection angles, or related fixed metal items, embedded in or bonded into concrete through expansion joints. Provide filler strips for expansion joints between slabs on grade and all joints between slabs on grade and vertical surfaces. Construct joints ½ inch wide and full depth of slab unless noted otherwise.

END OF SECTION

SECTION 03 20 00

REINFORCING STEEL

PART 1 GENERAL

1.1 DESCRIPTION

A. The Provide reinforcing steel and welded wire fabric.

B. Conform to "Placing Reinforcing Bars", Recommended Practices, Joint Effort of CRSI-WCRSI, prepared under the direction of the CRSI Committee on Engineering Practice.

C. Notify Engineer when reinforcing is ready for inspection and allow sufficient time for this inspection prior to casting concrete.

1.2 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete.

1.3 REFERENCES

A. American Concrete Institute, 22400 West Seven Mile Road, Detroit, Michigan 48219.

1. ACI-318-83 - Building Code Requirements for Reinforcing Concrete.

B. American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

1. ASTM A185 - Specification for Steel Welded Wire, Fabric, Plain, for Concrete Reinforcement.

2. ASTM A497 - Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement.

3. ASTM A615 - Specification for Deformed and Plain Billet-Steel for Concrete Reinforcement.

C. American Welding Society, 550 North West LeJeune Road, Miami, Florida 33126.

1. AWS D1.4-79 - Structural Welding Code; Reinforcing Steel.

D. Concrete Reinforcing Steel Institute, 933 North Plum Grove Road, Schamburg, Illinois 60195.

1. CRSI-MSP-1-86 - Manual of Standard Practice.

1.4 SUBMITTALS

A. Submit the following in accordance with Section 01001:

1. Bending lists.

2. Placing drawings.

3. Shop drawings.

B. Shop Drawings:

1. Bars for footings, including dowels, shall not be fabricated and shipped without prior review of Shop Drawings by the Engineer.

2. Otherwise, Shop and Placing Drawings shall include reinforcing placing plans and details indicating size, location, arrangement, placing sequence, etc., and shall conform to ACI 315.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Steel:

1. Deliver with suitable hauling and handling equipment.

2. Tag for easy identification.

3. Store to prevent contact with the ground.

B. Unloading, storing, and handling of bars shall conform to CRSI publication "Placing Reinforcing Bars".

PART 2 PRODUCTS

2.1 DEFORMED REINFORCING BARS

A. Deformed billet-steel bars conforming to ASTM A615, Grade 60.

2.2 WELDED WIRE FABRIC

A. Conform to ASTM A185 or A497.

2.3 ACCESSORIES:

A. Tie wire: 16-gage, black, soft-annealed wire.

B. Bar supports: proper type for intended use.

C. Bar supports in beams, columns, walls, and slabs exposed to view after stripping: Small rectangular concrete blocks of same color and strength of concrete that is being placed around them.

D. Concrete supports: for reinforcing concrete placed on grade.

E. Conform to requirements of "Placing Reinforcing Bars" published by CRSI.

PART 3 EXECUTION

3.1 REINFORCING STEEL

A. Clean metal reinforcement of loose mill scale, oil, earth and other contaminants.

B. Straightening and rebending reinforcing steel:

1. Do not straighten or rebend metal reinforcement.

2. Where construction access through reinforcing is a problem, use bundle or space bars instead of bending.

3. Submit details and obtain Engineer's review prior to placing.

C. Protection, spacing, and positioning of reinforcing steel: Conform to the current edition of the ACI Standard Building Code Requirements for Reinforced Concrete (ACI 318), reviewed placing drawings and design drawings.

D. Location Tolerance: Conform to the current edition of "Placing Reinforcing Bars" published by Concrete Reinforcing Steel Institute and to the Details and Notes on the Drawings.

E. Splicing:

1. Conform to Drawings and current edition of ACI Code 318.
2. Stagger splices in adjacent bars.

F. Tying deformed reinforcing bars: Conform to current edition of "Placing Reinforcing Bars" published by Concrete Reinforcing Steel Institute and to details and notes on Drawings.

G. Field Bending:

1. Field bending of reinforcing steel bars is not permitted when rebending will later be required to straighten bars.

2. Consult with Engineer prior to pouring if there is a need to work out a solution to prevent field bending.

3.2 REINFORCEMENT AROUND OPENINGS

A. Place an equivalent area of steel around pipe or opening and extend on each side sufficiently to develop bond in each bar.

B. See Drawings for bar extension length each side of opening.

C. Where welded wire fabric is used, provide extra reinforcement using fabric or deformed bars.

3.3 WELDING REINFORCEMENT

A. Welding shall not be permitted unless Contractor submits detailed Shop Drawings, qualifications, and radiographic nondestructive testing procedures for review by Engineer.

1. Obtain results of this review prior to proceeding.
2. Basis for submittals: Structural Welding Code, Reinforcing Steel, AWS D1.4-79, published by American Welding Society, and applicable portions of ACI 318, current edition.
3. Test 10 percent of welds using radiographic, nondestructive testing procedures in accordance to the above referenced codes.

3.4 PLACING WELDED WIRE FABRIC

A. Conform to ACI 318-77 and to current Manual of Standard Practice, Welded Wire Fabric, by Wire Reinforcement Institute regarding placement, bends, laps, and other requirements.

B. Placing:

1. Extend fabric to within 2 inches of edges of slab.

2. Lap splices at least 1-1/2 courses of fabric and a minimum of 6 inches.

3. Tie laps and splices securely at ends and at least every 24 inches with 16-gage black annealed steel wire.

4. Place welded wire fabric at the proper distance above bottom of slab.

END OF SECTION

SECTION 03 21 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.1 Section Includes:

A. All steel reinforcement, mesh, dowels, and related items to comply with drawings and specifications including materials, labor, and equipment to complete the building and work shown.

B. Observation and Required Special Inspections

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 01 40 00 – Quality Control: Required Special Inspections

B. Section 03 35 20 – Polished Concrete Finish System

C. Section 03 11 00 - Concrete Form Work: Section

D. Section 03 30 00 - Cast-In-Place Concrete

1.3 QUALITY ASSURANCE:

A. Acceptable Manufacturers: Regularly engaged in manufacture of steel bar and welded wire fabric reinforcing.

B. Installer Qualifications:
   1. Three years experience in installation of steel bar and welded wire fabric reinforcing.

C. Requirements of Regulatory Agencies: Conform to requirements of local Building Code.

D. Allowable Tolerances:
   1. Fabrication:
      a. Sheared length: + or - 1 inch
      b. Stirrups, ties and spirals: + or - 1/2 inch
      c. All other bends: + or - 1 inch
   2. Placement:
      a. Concrete cover to form surfaces: + or - 1/4 inch
      b. Minimum spacing between bars: + or - 1/4 inch
      c. Top bars in slabs and beams:
         (1) Members 8 inches deep or less: + or - 1/4 inch
         (2) Members more than 8 inches, but not over 2 feet deep:+ or - 1/2 inch
         (3) Members more than 2 ft. deep: + or - 1 inch
      d. Crosswise of members: Spaced evenly within 2 inches of stated separation.
      e. Lengthwise of members: + or - 2 inches.

3. Maximum bar movement to avoid interference with other reinforcing steel, conduits, or embedded items: 1 bar diameter.

1.4 SHOP DRAWINGS:

A. Comply with Section 01 33 00.

B. Show sizes and dimensions for fabrications and placing of reinforcing steel and bar supports.

C. Indicate bar schedule, stirrup spacing, and diagrams of bend bars.

D. All detailing, fabrication and erection of reinforcing bars shall comply with the A.C.I. Manual of Standard Practice for Detailing Reinforced Concrete Structures. (A.C.I. 315). ACI 315R- 18 is titled “Guide to Presenting Reinforcing Steel Design Details.”

E. Manufacturer's Literature: Manufacturer's specifications and installation instructions for splice devices.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Deliver reinforcement to project site in bundles marked with durable tags indicating bar size and length.

B. Handle and store materials to prevent contamination.

PART 2 PRODUCTS

2.1 MATERIALS

A. REINFORCING STEEL. Reinforcing steel for concrete shall be deformed, clean, free from rust and new. It shall conform to ASTM Standard A 615 and shall be Grade 60 for bars No. 4 and larger and Grade 40 for No. 3 bars and smaller.

B. SMOOTH STEEL DOWEL BARS. Plain steel dowel bars for reinforcing concrete slab joints shall meet the requirements of ASTM A 615, Grade 60. These plain round dowel bars shall be free from burrs or other deformations restricting slippage in the concrete.

1. Smooth Dowel bars shall be held in position parallel to the surface and centerline of the slab by a metal assembly of sufficient strength and anchorage to prevent displacement during the paving operations. Immediately prior to placement of concrete, each bar shall be field coated for a minimum distance of 2 inches greater than half the length of the bar with an approved lubricant. Lubricated ends of adjacent bars shall be on alternating sides of the slab joint.

C. WIRE FABRIC. Wire fabric shall be electrically-welded wire fabric of cold-drawn wire (70,000 psi yield point) of the diameter and spacing required and shall conform to ASTM Standard A 185. Welded wire fabric or mesh shall be of gauge and mesh shown on plans

and shall conform to "Standard Specifications for Welded Steel Wire Fabric for Concrete REINFORCEMENT: (ASTM A1064-Current Edition). Furnish mesh in flat sheets. ASTM A1064/A1064M – 17 is titled “Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.”

D. TIE WIRE: FS-QQ-W-461, annealed steel, black, 16 gauge minimum

E. BAR & WIRE MESH SUPPORTS: Conform to "Bar Support Specifications", CRSI Manual of Standard Practice. Metal bolsters required. No bricks or CMU allowed. Bars supports used over or against concrete surfaces which are exposed shall be plastic protected. The plastic shall have a thickness of 3/32" or greater at points of contact with the form work. The plastic shall extend upward on the wire to a point at least 1/2" above the form work. Provide following support types (CRSI Designation):
   1. Woven Wire Mesh: Type “SBU”, linear, longest length possible.
   2. Steel reinforcement bars: Type “SBU”, length as required to fit in trench and properly support bars.
   3. Note: “SBU” type supports to have two (2) bottom runners and one (1) top runner, all continuous.

F. DIAMOND PLATE DOWEL SYSTEM: Provide Diamond Dowel System manufactured by PNA construction technologies, “Speed Plate” System by Greenstreak Group, Inc. or approved alternate. Plates are manufactured from steel certified to meet ASTMA36 (1/4” and 3/8”) or ASTM A108 (3/4”)
   1. Install at all construction joints at building slabs-on-grade.
   2. Provide diamond plate thickness as follows, depending on slab thickness:
      a. 1/4” (6mm) – typically used in 4”- 6” slab depths
      b. 3/8” (10 mm) – typically used in 7”- 8” slab depths
      c. 3/4” (20 mm) – typically used in 9” plus slab depths

G. FIBER REINFORCEMENT Refer to Section 03 30 00.

PART 3 EXECUTION

3.1 FABRICATION

A. In accord with CRSI Manual of Standard Practice.

3.2 INSTALLATION:

A. Placements:
   1. Bar Supports: CRSI 65
   2. Reinforcing Bars: CRSI 63. Support footing reinforcement bars with SBU type supports. Space at no more than 4’-0” on center. Support reinforcement bars at each footing corner and intersection. **Rebar chairs will not be acceptable.** For large double layer reinforcement pad footing mats, provide doubling of the SBU supports. Concrete bricks may be used as an option at large double-matted footings, **but only upon Architect’s approval**.
   3. Details shall be in accordance with "Building Code Requirements for Structural Concrete" (ACI 318-Current Edition)

4. **Place supports for wire mesh concrete slab reinforcement no more than 3'-0" on center, or stagger at 2'-0" on center.** Do not extend supports through control joints.
5. Install #4 reinforcement hoops around slab penetrations 3" or larger in diameter. This would include, but not be limited to plumbing pipe, electrical conduit, floor drains, electrical floor boxes, etc.
6. Where groups of electrical conduits exceed 3" in diameter, install #4 reinforcement hoops around groups, or provide straight #4 bars around linear groups.

B. Steel Adjustment:
1. Move within allowable tolerances to avoid interference with other reinforcing steel, conduits, or embedded items.
2. Do not move bars beyond allowable tolerances without concurrence of Architect/Engineer.
3. Do not heat, bend, or cut bars without concurrence of Architect/Engineer.

C. Concrete covering over reinforcement shall be not less than the following:
1. Where concrete is deposited directly against earth: 3"
2. Where formed concrete surface will be exposed to weather or ground: 2"
3. Where formed concrete surface will not be exposed to weather or ground: for walls and slabs: 3/4"
4. For beams, girders and columns: 1-1/2"
5. All covering: Nominal bar diameter

D. Splices:
1. Lap splices: Tie securely with wire to prevent displacement of splices during placement of concrete.
2. Splice devices: Install in accordance with manufacturer's written instructions.
3. Welding: Do not weld reinforcement.
4. Do not splice bars except at locations shown on drawings without concurrence of Architect/Engineer.

E. Wire Fabric:
1. Install in longest practicable length.
2. Lap adjoining pieces one full mesh minimum, and lace splices with 16 gauge wire.
3. Do not make end laps midway between supporting beams, or directly over beams of continuous structures.
4. Offset end laps in adjacent widths to prevent continuous laps.
5. Do not continue wire fabric through control joints

F. Diamond Plate Dowel System:
1. Install Diamond Plate Dowell System, following manufacturer's instructions.
2. Provide diamond plate dowel spacing as follows, depending on slab thickness:
   a. 4" -6" slab thickness: ¼" thick at 18" O.C.
   b. 7" -8" slab thickness: 3/8" thick at 18" O.C.
   c. 9" -11" slab thickness: ¾" thick at 20" O.C.

3.3 CLEANING:

A. Remove dirt, grease, oil, loose mill scale, excessive rust, and foreign matter that will reduce bond with concrete.

3.4 . PROTECTION DURING CONCRETING:

A. Keep reinforcing steel in proper position during concrete placement.

3.5 OBSERVATION AND SPECIAL INSPECTIONS

A. Reinforcement and placement shall be observed by the Architect/Engineer prior to placing concrete. Inspection of reinforcement for conformance to the construction documents shall be completed by the designated third party Special Inspector.

3.6 INSTALLATION OF MISCELLANEOUS ITEMS:

A. Contractor shall coordinate and check that all work required to be embedded in concrete is in place prior to pouring. Placement of such work is to be done without disturbing reinforcing in place.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SCOPE:

A. This Contractor shall furnish all material and labor necessary to complete execution of all concrete portions of this project, including the following items and other items of concrete or cement work which may be essential to complete that portion of the work as shown on the contract drawings and as hereinafter specified.
   1. Footings, foundations and structural members as shown, including piers if required.
   2. Concrete finish floor slabs.
   3. All concrete steps, landings, walks, curbs, & etc.
   4. Interior trenching in existing concrete floors.
   5. Non-Shrink and Epoxy Grout
   6. Concrete Accessories
   7. Concrete Floor Densifier/Hardener
   8. Clear Sealer (Water and Oil Repellent)
   9. Micro-Fiber Concrete Admixture
   10. Concrete Minimum Finish Tolerances & Standards
   11. Concrete Slab Moisture Mitigation
   12. Observation and Required Special Inspections

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 01 40 00 – Quality Control: Required Special Inspections

B. Section 03 11 00 - Concrete Form Work

C. Section 03 21 00 - Concrete Reinforcement

D. Section 03 35 20 - Polished Concrete Finish System

E. Section 04 22 00 - Concrete Unit Masonry

F. Section 09 91 00 - Painting

G. Section 31 23 00 - Structural Excavation, Backfill and Compaction

H. Section 32 16 00 - Walks and Curbs

1.3 QUALITY ASSURANCE:

A. Standards: Provisions of American Concrete Institute "Building Code Requirements for Structural Concrete" (ACI 318-Current Edition). American Concrete Institute "Specifications for Structural Concrete" (ACI 301-Current Edition), Concrete Reinforcing Steel Institute "Manual of Standard Practice" (Current Edition), American

Concrete Institute "Guide to Presenting Reinforcing Steel Design Details" (ACI 315-Current Edition) and " Guide to Formwork for Concrete" (ACI 347-Current Edition) are adopted except that where additional or more stringent requirements are required by these specifications.

B. Tests: As listed in Standard Practice for Sampling Freshly Mixed Concrete ASTM C 172-Current Edition.

C. Control Joints and Expansion Joints: Follow Provisions of American Concrete Institute concerning maximum area for placement of expansion and control joints unless shown or noted otherwise on drawings and specifications. If contractor requests adjustments to control joint placement or additional control joints and/or expansion joints, consult Architect prior to concrete placement.

D. **Slabs must be replaced that have a crack(s) with a width of 0.05” or greater. In high visibility areas all cracks in slabs will be subject to replacement of slab sections at the discretion of the Architect.**

1.4 SUBMITTALS:

A. Test Reports: Reports of concrete compression, yield, and slump tests.

B. Certificates:
   1. Manufacturer's certification that materials meet specification requirements.
   2. Material content per cubic yard of each class of concrete furnished:
      a. Dry weights of cement.
      b. Saturated surface-dried weights of fine and coarse aggregate.
      c. Quantities, type and name of admixtures.
      d. Weight of water.
   3. Ready-mix delivery tickets, ASTM C 94-Current Edition.

1.5 PRODUCT AND ENGINEERING DATA:

A. Submit data for design mixes, proposed admixtures, etc. per Section 01 33 00.

B. The Contractor shall be responsible for checking quantities and dimensions in accordance with contract drawings and field conditions. Where discrepancies in dimensions are noted, the Contractor shall notify the Architect of such discrepancies and corrected dimensions noted on submittal drawings.

C. Contract drawings receive precedence over shop drawings unless authorized in writing.

D. Shop drawings furnished for reinforcing steel shall contain fabrication details as well as placement drawings which are to be used in conjunction with contract drawings.

E. Detailing and fabrication of reinforcing shall conform to " Guide to Presenting Reinforcing Steel Design Details", (ACI 315-Current Edition).

1.6 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Cement: Store in weather tight enclosures and protect against dampness, contamination, and warehouse set. Any cement damaged by moisture or which fails to meet any of the specified requirements shall be rejected and removed from the work.

B. Aggregates:
   1. Stock pile to prevent excessive segregation, or contamination with other materials or other sizes of aggregates.
   2. Use only one supply source for each aggregate stock pile.

C. Mixing: Ready-mixed concrete shall be mixed and delivered in accordance with Standard Specifications for Ready-Mixed Concrete" (ASTM C94-Current Edition).

1.7 ENVIRONMENTAL REQUIREMENTS:

A. Allowable Concrete Temperatures
   1. Cold Weather: Minimum 40 degrees. With temperatures lower than 40 degrees, approval by Architect shall be required.
   2. Hot Weather: Maximum 90 degrees F.

B. Do not place concrete during rain, sleet, or snow unless protection is provided which is approved by Architect.

1.8 CONCRETE SLAB MOISTURE MITIGATION:

A. It will be the responsibility of the Contractor to obtain moisture levels at or below required percentages as required for installation of all floor covering products by the time the products are ready to be installed. If moisture levels are not reached at the scheduled time to install floor coverings, the Contractor will pursue other means to meet floor covering moisture requirements at no additional cost to owner. This will not be a reason to delay project completion.

1.9 CERTIFICATION

A. Ready Mix concrete batch plant to be NRMCA (National Ready Mixed Concrete Association) certified. Submit proof of certification with submittals.

B. Concrete Flatwork Finishers to be ACI certified. Submit proof of certification to Architect for approval.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete:
   1. Portland Cement: Type 1 Portland, meeting "Standard Specifications for Portland Cement", (ASTM C150-Current Edition) shall be used.
   2. Aggregates: All aggregates shall be limestone, clean, hard strong and durable particles free of chemicals or foreign material that may affect the bonding of cement

paste and shall conform to "Specifications for Concrete Aggregates" (ASTM C33-Current Edition). Coarse aggregate gradation shall be within the limits of 1 inch to No. 4 standard sieve analysis. Alternate aggregate materials must be reviewed and approved by architect.

3. Mixing Water: Water shall be fresh, clean and potable.
4. Slump: 5 inch maximum: plus tolerance O inches, minus tolerance 2 inches.
5. Mix proportioning: To produce 28 day minimum compressive strength of moist cured laboratory samples. Provide the following minimum compressive strengths at listed locations unless noted otherwise in other specification sections or on drawings:
   a. 3000 psi for all footing and foundation stem walls.
   b. 3000 psi for all exterior sidewalk/stoop/patio locations.
   c. 3500 psi for all interior slabs-on-grade.
   d. 3000 psi for all other concrete items

B. Curing Material: Products and material as required to apply and maintain slab in moist condition during curing period per this specification. Constant water sprinkling or water curing covers kept wet are acceptable.
   1. Under no circumstances are chemical curing compounds to be used in slabs on grade unless prior approval is obtained from Architect.
   2. Do not use polyethylene vapor barrier or similar membrane for curing membranes when water curing in areas where exposed concrete finish is scheduled.
   3. At Polished Concrete Slab-on-Grade a full wet cure is required. No covers allowed. Refer to Specification 03 35 20 Polished Concrete Finish System.

C. Below-slab vapor barrier shall be as specified in Section 07 10 00, but no less than 15 mils thick.

D. Reinforcement: See Section 03 21 00

2.2 CONCRETE FLOOR DENSIFIER/HARDENER AND SEALER

A. Penetrating Hardener/Densifier: (Clear liquid reactive lithium-silicate based.)
   1. Retroplate 99 by Advanced Floor Products.
   2. Consolideck LS, by Prosoco.
   3. 3D HS, by Ameripolish
   4. Approved alternate by other manufacturer specified herein.

B. Clear Sealer: Refer to specification 09 91 00 Paint & Finishing

2.3 MIXES:

A. Proportions: Ready-mix concrete shall meet "Specifications for Ready-Mixed Concrete" (ASTM C94-94). Proportions of concrete shall produce the required strength and be workable to the extent that it can be worked into the corners and angles of forms and around reinforcement. Collection of excess free water on the surface will not be permitted nor a segregation of the materials in the mixture.

B. Free surface moisture on aggregates shall be included as part of the mixing water.

C. Water-cement ratios for project concrete mix shall be such that the relationship between the required strength and water-cement ratio of ingredients used has been previously established by reliable tests and data. Copies of previous test data, along with design mix data shall be submitted to the Architect by the Contractor for approval. Where such data is not available or is insufficient, water-cement ratios shall meet requirements of Table 4.2.2 of ACI 318-Current Edition. Cementitious content shall be the total weight of all Portland cement and fly ash in a given mix.

D. Micro Fiber Admixture: UltraFiber 500, manufactured by Solomon, 4050 Color Plant Road, Springfield IL 62702, 800-624-0261.
   1. Unless shown otherwise on structural drawings, provide micro fiber admixture for **all** interior slab-on-grade concrete for standard and polished concrete floors.
      a. Refer to structural drawings for slabs with additional means of reinforcement.
      b. Refer to Civil drawings for reinforcement at sidewalks and concrete paving.
   2. Micro fiber admixture will be added to concrete at batch plant. Adding admixture to mix at jobsite will not be permitted. Follow normal mixing, time and speed, as recommended by ASTM C94.
   3. Application Rate: 2.0 pounds per cubic yard of concrete.

E. Admixtures shall comply with the ASTM Specifications for Chemical Admixtures. (ASTM C494-Current Edition).
   1. Mid-Range Water Reducing Admixture: Mira 110, manufactured by Grace Concrete Products, 877-423-6491, Master Builders Polyheed 1720, manufactured by BASF or approved alternate product. Non-chloride, Non-corrosive. Admixture to meet ASTM C494 Type A & F requirements. **Required when using micro fiber admixture.** Comply with manufacturer's instructions for dosage. Admixture to be incorporated with mix at batch plant.
      a. Other admixtures may be used as a concrete mix component only with approval of the Architect.
      b. Use all admixtures in accordance with recommendations of the manufacturer.

   2. For concrete containing HRWR admixture (super- plasticizer) when approved by Architect: slump shall be 6"-8".

   3. In no case shall the use of the admixtures produce a compressive strength less than that specified in this section.

   4. Fly ash (Type C or F per ASTM C618) may be used as an admixture in concrete which is not exposed to view and does not require surface finish. Use of only one type of fly ash throughout the project shall be permitted. Such areas are limited to footings, below grade foundation walls, filled masonry voids, etc. The use of fly ash as an admixture **shall not be permitted** in concrete where surface finish is required. Such areas as floor slabs, exposed concrete walls, exposed concrete structure, etc., shall not be poured with concrete containing fly ash. Other admixtures may be used only with the approval of the Architect. Each delivery record shall indicate mix design. Concrete will be subject to rejection if mix design is not called out on invoice at time of delivery.

5. All concrete installed at exterior on a permanent basis shall be air entrained. Interior slabs shall not contain air entrainment. If admixture is desired, obtain approval through Architect.

6. Air-entraining admixture if used, shall meet "Specifications for Air-Entraining Admixtures" (ASTM C260-Current Edition) and shall produce air content by volume between 5 to 7%.

F. Use same Portland cement manufacturer throughout project for all interior concrete. Portland cement manufacturer may be different for exterior concrete, but must be the same Portland cement manufacturer for all exterior concrete.

2.4 NON-SHRINK AND EPOXY GROUT

A. Non-Shrink Grout, Non-Metallic Grout: Factory premixed grout conforming to CRD-C-621-80, “Corps of Engineers Specification for Non-Shrink Grout”.
   1. Acceptable Manufacturers:
      a. EUCO NS, the Euclid Chemical Company
      b. Sonogrout, Sonneborn-Contech
      c. Masterflow 713, Master Builders
      d. Duragrout, L & M Construction Chemical Co.

B. Epoxy Grout: Structural epoxy adhesive conforming to ASTM C881.
   1. Acceptable Manufacturers:
      a. Sikadur 32 Hi-Mod by Sika Corporation
      b. Sonneborn Epogel by Chemrex, Inc.
      c. Epcon C6 by ITW Ramset/Redhead
      d. Hilti HY-200

2.5 ACCESSORIES

A. Pre-cast Concrete Wheel Stops: Furnish and install as shown on the drawings a pre-cast concrete wheel stop at each designated parking space where no cast-in-place curb or turn-down sidewalk occurs. Anchor units as shown on drawings.

B. Water-stops: Pre-molded thermoplastic of types and styles shown on drawings, as manufactured by Sika., (800) 325-9504 or approved alternate.
   1. Provide Split-flange Dumbbell or Labyrinth waterstops where needed.
   2. Provide Sika “Hydrotite DSS” expandable waterstop wrapped around pipe or conduit where penetrating concrete wall or floor below grade or where shown on drawings. Also install Hydrotite DSS around the annulus where cored through or sleeved through concrete wall or floor prior to grouting opening. Where sleeve is set in place prior to concrete placement, install Hydrotite DSS around outside perimeter of sleeve Follow manufacturer’s instructions for each application.
   3. Waterstops are to be continuous. All splices are to be welded together to provide a watertight seal. Use manufacturer’s splicing irons, type as recommended for each type of waterstop.
   4. Continuous Waterstop Installation: Waterstops are to be set secure in place prior to concrete placement. “Wetstick” method of installation or installation after concrete

placement will not be allowed. Provide minimum 1 inch space between reinforcement and waterstop, so concrete can encapsulate both sides of the waterstop.

C. Bentonite Waterstops: Surface applied Bentonite waterstop to be Volclay RX Waterstop by American Colloid Company or approved alternate.

D. Furnish concrete splash block at each downspout approximately 12" wide x 24" long. Slope from back to front for proper drainage.

E. Safety Nosing
   1. Provide nosing inserts manufactured by Wooster Products, Inc., 1000 Spruce Street, PO Box 896, Wooster, OH 44691, Phone 1-800-321-4936, or approved alternate product.
      a. Type #1: “Spectra” WP24A profile, black infill. Embed into concrete steps.
      b. Type #2: “Spectra” WP2J profile, black infill. Embed into each tread and nose of landings at metal pan stairs.

PART 3 EXECUTION

3.1 OBSERVATIONS AND SPECIAL INSPECTIONS

A. All reinforced concrete construction shall be performed under the personal supervision of the Building Superintendent. This superintendent shall keep a record of all concrete poured on the job. The record shall show in detail the area placed, the time and date of the placement and weather conditions which existed at the time of the placement. Upon completion of the work, this record of Concrete Placement shall be included in the close out documents.

B. The Contractor shall plan his work so that adequate time is allowed for the Architect to properly observe all embedded work prior to actual placement of concrete. The Contractor shall notify the Architect of his intent to placement at least 24 hours prior to the time that he estimates the work will be ready for observation. The Contractor shall not place any reinforced concrete without the approval of the Architect.

C. Contractor shall plan work and coordinate with independent testing lab to be present on-site throughout concrete placement.

D. Inspection of concrete and concrete preparation for conformance to the construction documents and IBC shall be completed by the designated third party Special Inspector.

3.2 INSTALLATION:

A. Placing Concrete:
   1. Convey concrete from mixer to final position by method which will prevent separation or loss of material.

   2. Maximum time permitted before a placement of concrete after adding mixture water shall be as follows:
      a. Air temperature above 78 degrees F. - 60 minutes.

b. Air temperature below 78 degrees F. - 90 minutes.

3. Concrete shall not be placed until an observation by the Architect has been made and reinforcement placement, vapor barrier, perimeter insulation, etc., is approved.

4. Excavations for footing shall be free of debris, loose dirt, mud and water just prior to placing of concrete.

5. All forms shall be clean of debris and all embedded items shall be in place and secured prior to concrete placement.

6. Wood forms shall be sprinkled with water and wet when concrete is placed, but pooling of water in forms is to be prevented.

7. Maximum height of concrete free fall, 3 feet.

8. Regulate rate of placement so concrete remains plastic and flows into position.

9. Deposit concrete in continuous operation until panel or section is completed.

10. **Concrete Placement Tolerances & Standards**:
    a. Submit proposed slab pouring plan for review and approval by Architect prior to forming. For purposes of planning layout, approximately 5,000 to 7,000 sq.ft.is the maximum area allowed. Pending crew size and equipment larger square foot pour areas may be allowed by Architect. Provide diamond plate dowels at construction joints between placements. Refer to Section 03 21 00.
    b. **Control joints:** Saw cuts are to be performed within 12 hours after finishing. Use 1/8" thick blade, cutting no less than **1/3** of the slab thickness, unless noted otherwise.
    c. Place control joints for concrete slabs (slab–on-grade and elevated concrete slabs) no more than 8’-0” o.c. each way.
        i. For other concrete slab thicknesses, refer to structural drawings for control joint spacing.
    d. Note: Other placement methods may be considered only with approval of Architect.

11. Concrete Slab Levelness and Flatness:
    a. Levelness: FL=35 for polished slabs. FL=20 for non-polished slabs.
    b. Flatness: FF = 50 for polished slabs. FF = 25 for non-polished slabs
    c. In areas with floor drains, maintain finished floor level elevation at walls and slope surfaces uniformly to drains.

12. Place concrete in horizontal layers, 18 inches maximum thickness.

13. For concrete on grade or fill, sub-grades shall be properly prepared and maintained as specified previously. Where concrete is placed in direct contact with the earth, the subgrade material shall be wet but not muddy at time of placement.

14. Under all slabs, provide crushed stone choked off with fines per specification Section 31 23 00, meeting ASTM C33-Current Edition, which shall be leveled and compacted. A vapor barrier, as specified in Section 07 10 00 and shown on the drawings shall be placed under all interior slabs-on-grade.

15. Removal of forms. Do not remove forms until concrete has hardened sufficiently to support its own weight and imposed construction loads. Remove forms in such manner as to ensure the complete safety of the structure and to prevent spalling or chipping of concrete. When removing forms, conform to the following:
    a. Non-Weight Supporting Forms: Form work for columns, walls, sides of beams and other parts not supporting the weight of the concrete may be removed as soon as concrete has hardened sufficiently to resist damage from removal operations, but in no case sooner than 24 hours.
    b. Weight Supporting Forms: Do not remove form work for beam soffits, supported slabs or other parts which support the weight of concrete until concrete has reached 75% of its specified 28 day strength based on the lab cured concrete cylinder tests, but no sooner than 7 days.

16. Wall tie treatment. Wall ties shall be broken off after forms are removed, and sealed against water penetration.

17. Slope all concrete floors to trench, or floor drains from corners of room, or as shown on drawings. Provide total slope of 1/2", unless noted otherwise on drawings.

18. Follow procedures as listed below for placement and routing of pipes, sleeves, and electrical conduit:
    (If any of these items are not met, pouring of concrete will not be allowed until corrected.)
        a. **Do not** route groups of conduit, pipes or sleeves above footings, unless noted to do so. If conflict occurs, consult Architect/Engineer.
        b. **Do not** route conduit, pipes, and sleeves below bearing walls when running parallel with wall.
        c. Limit width of conduit, pipes and sleeves not to exceed 3’-0” in width as it passes under wall footing. As much as possible, align the items perpendicular to the footing as it passes below footing.
        d. Provide a minimum spacing of 2’-0” between conduit or pipe groups as items pass under footings.
        e. **Do not** route conduits, pipe or sleeves under or through column footings or pad footings unless prior approval is given by Architect/Engineer.
        f. At elevated slab work, conduits will not limit slab depth any less than one half of an inch of the total thickness. Conduits will not be within one inch of any reinforcing materials.
        g. The top of all conduit, sanitary drain pipe, water supply pipe, etc. shall be installed at or below bottom of concrete slab where slab is on grade.
        h. Where in-slab electrical floor boxes occur, the conduit shall slope down to below-slab elevation as soon as possible on exterior sides of floor box.

B. Consolidating Concrete at Steel Reinforcement:
    1. Use mechanical vibrating equipment for consolidation.

2. Vertically insert and remove hand-held vibrators having minimum 1” diameter at points 18 inches to 30 inches apart.
3. Do not use vibrators to transport concrete in forms.
4. Minimum vibrator speed, 3600 rpm.
5. Vibrate concrete minimum amount required for consolidation, 3 to 5 seconds maximum.

C. Construction Joints:
   1. Clean and roughen surface of concrete, and remove laitance.
   2. Wet concrete surface and flush with neat cement grout before placing additional concrete.
   3. Construction Joints for slabs on ground (floor joints) shall be plate dowel system. Plate dowel system sleeves shall be attached to 2 x wood members matching the depth of the slab for removal and reuse with steel stakes @ 2'-0" o.c. Form boards must have clean smooth top surface so finishing machines can pass over the top of the form.
   4. Construction Joints for elevated slabs shall be a straight edge pour stop. 2 x wood members matching the depth of the slab secured to the metal deck. Wire mesh is not to continue through the form board. Form boards must have clean smooth top surface so finishing machines can pass over the top of the form.

D. Plate Dowel System: Provide Diamond Dowel System manufactured by PNA construction technologies, “Speed Plate” System by Sika. or approved alternate. Refer to Section 03 21 00.
   1. Install at all slab on grade construction joints.

E. Expansion joints: Expansion joint filler, where indicated, shall meet "Specifications for pre-formed Expansion Joint Fillers for Concrete Paving and Structural Construction, Non-extruding and Resilient, Non-bituminous. (ASTM D1752-Type 1). Provide “Zip Strip” type filler so that top ½” can be provided for sealant installation.

F. Isolation Joint Material:
   1. Provide ½” thick closed cell foam material, separating steel or concrete columns from concrete slab at slabs-on-grade and at elevated slabs to prevent bonding and cracking of concrete from structure movement. Hold down from top of slab ½” and fill with sealant.
   2. At perimeter steel edge angles and other floor or wall penetrations where steel angles or framing exists, apply bituminous material on steel where concrete is to be placed to create bond breaker.

G. Column Block-Outs:
   1. Unless noted otherwise on drawings, provide round blockouts created by a “Sonotube form” section or other means. **Diamond shaped blockouts will not be accepted.**
   2. Provide same Portland Cement manufacturer and mix design for concrete fill in column block-outs as surrounding concrete slab.

H. Finishing:
   1. Floor Finish

a. Edge forms and intermediate screed strips shall be placed accurately to give the desired elevations and contours. Strike-off templates or straight edges shall be used to give all floor slabs an even surface. Screeds are to be of such type not to interfere with reinforcing.
b. Troweled finishes shall be applied to floors where concrete is the walking surface, or to have floor coverings. Troweling shall begin after all surface water has disappeared naturally and surface has wood floated to a plane smooth surface. Initial troweling shall be done after concrete has hardened sufficiently to prevent excess fines from working to surface, to produce a smooth surface free from defects and a final troweling shall be done after sufficient hardening to remove trowel marks and give a hard, dense smooth surface. Drying shall be natural. The use of "dryers" by dusting of cement or sand is not permitted.
c. Floors to receive tile or other bonded cementitious finishes shall, after wood floating to a smooth plane surface, be roughened with stiff brushes before final set.
d. All exterior concrete ramps, stairs, and landing slabs shall have a light broom finish of sufficient texture to prevent slipping.

2. Walks: See Section 32 16 00
3. Exposed Concrete Surfaces
   a. Areas not receiving special coatings shall be wetted and rubbed with carborundum bricks or other abrasive to give a smooth finish with a uniform color and texture. All edges shall be eased to give a good appearance.
   b. Areas receiving special coatings shall be free from imperfections such as voids and protrusions and shall be finished to a smooth and level surface.

I. Curing: Provisions shall be made for maintaining all concrete surfaces in a continuously moist condition immediately following finishing operations for a period of seven days by one of the following methods when exposed or immediately following removal of forms:
   1. Sprinkling
   2. Absorptive fabric, kept continuously wet.
   3. Maintain concrete within 40 degrees F. temperature range while curing for length of time shown below:
      a. Three (3) days for footings.
      b. Seven (7) days for flatwork.
   4. Chemical curing will be considered only when water curing is not practical such as threat of freezing weather conditions. Unless specified otherwise in this specification section, **Absolutely no chemical curing** is to occur on slab areas that are to receive carpet, resilient and synthetic floor coverings, or any other specified floor covering that prohibits chemical curing in their requirements.
   5. Polished Concrete at Slab-on-Grade is to be fully wet cured per specification section 03 35 20 Polished Concrete Finish System.

J. Patching: After removal of forms, all honeycomb areas, voids, air pockets, tie holes and surface cracks shall be immediately patched.

I. Application of Floor Densifier/Hardener:
   1. Apply to **polished and unpolished** interior concrete slabs and exterior porch or patio areas scheduled to be exposed to view.

2. Apply per manufacturer's instruction to all exposed trowelled concrete floor areas and other areas as called out on finish schedule. Product to be applied as soon after curing period as manufacturer's instructions allow. Application must be smooth and even. No excess application or puddling of the product will be allowed.
   a. Clean floors where densifier/hardener is applied with manufacturers cleaners.

3.3 TRENCHING OF EXISTING INTERIOR CONCRETE FLOORS
Unless noted otherwise, provide the following:

A. Sawcut concrete where trenching is required and remove all debris.

B. Fill trench with ½" or less clean washed gravel base and tamp tightly into place in no more than 8 inch lifts.

C. Place 15 mil vapor barrier per Section 07 10 00 over gravel base. Provide 12 inches long standard no.4 rebar, drilled and friction-set 4 inches into sides of existing cut concrete slab at maximum spacing of 24 inches o.c. **Place continuous strip of bentonite along each side of trench on top of vapor barrier.**

D. Place 6 x 6"-W1.4 x W1.4 WWF and pour minimum 4" thick, 3000 p.s.i. concrete. Finish as required for exposed finish of for floor finish scheduled to be installed.

E. Provide sawcut control joints at no more than 8'-0" o.c.

3.4 GRIND ONLY AT SEALED CONCRETE FLOORS

A. At sealed concrete floors
   1. Progressively polish slab surface with 200 grit resin-bonded, phenolic diamond heads. 1 pass.
   2. Seal with DNS-400 Sprayable Acrylic Sealer by Ameripolish.

3.5 ACCEPTANCE OF CONCRETE:

A. Concrete not meeting the strength requirements of these specifications shall be tested at critical locations designated by the Architect by a laboratory approved by the Architect. These tests shall be at the Contractor's expense. Such tests performed shall be in accordance with the Building Code Requirements for Structural Concrete: (ACI 318-Current Edition). If these tests still indicate below required strengths, or if inconclusive, then the Contractor shall proceed at his own expense as follows:

   Remove and replace or reconstruct all under strength concrete in an approved manner or perform load tests in accordance with the "Building Code Requirements for StructuralConcrete" (ACI 318-Current Edition). If load test results are not acceptable then Contractor shall remove and replace or reconstruct all designated under strength concrete to meet requirements of these specifications.

B. Concrete improperly placed, cured, reinforced, damaged or not meeting testing tolerances shall be considered potentially deficient and shall be tested and replaced if necessary in accordance with Paragraph a) above.

C. Concrete not meeting the tolerances of "Recommended Practice for Concrete Formwork: (ACI 347) and concrete not formed as shown on plans shall be considered as not acceptable and shall be removed and replaced by Contractor at his own expense unless Architect permits patching and repairing of such work. Finished repair work shall meet criteria mentioned above or shall be removed and replaced.

3.6 TESTING AND SAMPLING:

A. Slump Tests: A minimum of two (2) slump tests shall be made each day concrete is placed with one (1) test being made at the time test cylinders are made. Slump tests are to be made in accordance with " Standard Test Method for Slump of Hydraulic-Cement Concrete" (ASTM C-143-Current Edition). Where slump exceeds five inches (5") or the average 28 day strength of the three (3) test specimens falls below the strength specified for the class of concrete tested, or below proportional minimum seven (7) day strengths, (80 percent of specified 28 day strength) the proportions, water content or temperature conditions shall be changed to secure the required properties, and, at the discretion of the Architect, portions of the structure containing such concrete shall be removed and replaced, or reinforced as necessary. No concrete below 3" slump shall be accepted. Follow guidelines of ASTM C94 for water added to mix on site. Do not exceed design specifications.

B. Strength Tests. Compression strength test shall be performed in accordance with Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens" (ASTM C39-Current Edition). Samples for concrete cylinders shall be made in accordance with "Method of Sampling Fresh Concrete" (ASTM C172-Current Edition), and test cylinders shall be prepared and laboratory cured in accordance with "Method of Making and Curing Concrete Compression and Flexure Test in the Field" (ASTM C31-Current Edition).

C. Cylinders. Five (5) cylinders from the same batch shall be prepared by a certified technician for each 50 cubic yards or fraction thereof placed, but not less than four (4) cylinders for each day of concrete operations shall be made. **Location of batch as to placement on the subject and supplier mix ID# shall be noted on report, and cylinders so designated. Maximum and minimum initial curing temperatures as recorded per ASTM C31 shall be included in this report.** No tests shall be required for sidewalks. One (1) cylinder shall be tested at seven (7) days and three (3) at 28 days. **If cylinder break is lower than required, testing company to contact Contractor and Architect immediately for direction. Remaining cylinder shall be maintained in proper curing conditions until specified 28 day compressive strength has been affirmed.**

D. A minimum of nine (9) cylinders shall be tested for each class of concrete used on the project and the average of any three (3) consecutive strength tests at 28 days shall be equal to or greater than the specified strength with no test less than 500psi below the design strength.

E. Contractor shall bear expense of all testing by a Laboratory approved by the Architect prior to award of the contract. Testing results shall be sent directly to the Architect's

office, Contractor, and the Concrete Producer. Architect is to be notified of high slump concrete or low early strength (<75% of design at 7 days) immediately.

F. Floor Flatness and Floor Levelness test shall be performed in accordance with “Standard Test Method for determining FF Floor Flatness and FL Floor Levelness Numbers” (ASTM E1155- Current Edition) for entire interior slab on grade.

G. Floor Flatness test shall be performed in accordance with “Standard Test Method for determining FF Floor Flatness Numbers” (ASTM E1155- Current Edition) for entire elevated slab.

END OF SECTION

CONCRETE MIX DESIGN SUBMITTAL FORM

(Section 03 30 00 - Cast-in-Place Concrete)

Submitted Mix Design Date Submitted: _____

Location and Type (pump or chute) of Placement

Concrete Information

Supplier Mix Design #: _____

Design Strength (f'c), psi _____

Water/Cementitious Ratio _____

Total Air Content, % _____

(Entrapped or Entrained) _____

Density:

Wet, pcf _____

Dry, pcf _____

Slump:

Without WR, in. _____

With WE, in. _____

Admixture Information

		ASTM Designation	Product & Manufacturer	Dosage (oz/cy)
Water Reducing				
Accelerating				
Retarding				

Architect's Approval **Structural Engineer's Approval**

Mix Design Proportions Per Cubic Yard

	Identification (Type, size, source)	Weight (lbs)	Density (SSD)	Volume (cubic ft)	% Aggregate Absorption
Cement					
Fly Ash					
C.A. #1					
C.A. #2					
C.A. #3					
F.A. #1					
F.A. #2					
Water					
% Air					
	Totals				

Coarse and Fine Aggregate Gradation

Sieve Size	% Passing Each Sieve (All sieve sizes must be entered)					Combined% Passing	Combined % Retained	
	C.A. #1	C.A. #2	C.A. #3	F.A. #1	F.A. #2		Cumulative	Individual
1-1/2"								
1"								
3/4"								
1/2"								
3/8"								
#4								
#8								
#16								
#30								
#50								
#100								
#200								
% of Vol.								

Required Attachments and Supplemental Documentation

_____ Portland Cement mill test report/certification

_____ Fly ash mill test report/certification

_____ Separate aggregate gradation reports including all required sieve sizes

Note: * All gradation reports shall be dated within 60 days of submittal
* Separate gradation reports required for each coarse and fine aggregate material in the mix

_____ Product data for all admixtures including, but not limited to:

* WR
* Set retarder
* Set accelerator
* Air entrainer

_____ Concrete compressive strength data used for standard deviation calculations

Concrete Supplier Information

Supplier Name: _____

Technical Contact: _____ Cell # _____

Sales Contact: _____ Cell # _____

Primary Plant: _____

Location: _____

Miles from Site: _____

Travel Time to Site: _____

NRMCA Certified (Y/N): _____

AHTD Certified (Y/N): _____

Batch Mixing Typer (Dry/Central Mix): _____

_____

Secondary Plant: _____

Location: _____

Miles from Site: _____

Travel Time to Site: _____

NRMCA Certified (Y/N): _____

AHTD Certified (Y/N): _____

Batch Mixing Typer (Dry/Central Mix): _____

SECTION 03 35 20

POLISHED CONCRETE FINISH SYSTEM

PART 1 GENERAL

1.1 WORK TO INCLUDE:

A. Grinding and Polishing of interior concrete slab.

B. Application of reactive surface densifier.

C. Joint filler and installation

D. Application of stain guard surface treatment.

E. Progressive polishing of slab surface.

F. Protection of polished concrete floors.

1.2 RELATED WORK:

A. Section 03 21 00 – Concrete Reinforcement: Tapered plate dowel system

B. Section 03 30 00 - Cast-in-place Concrete

1.3 PROTECTION:

A. Finished system shall be protected against undue soilage and damage by other trades by the use of reasonable care and precaution during process of installation and after completion of installation, prior to substantial completion of project.

1.4 SUBMITTALS:

A. Color samples shall be submitted for consideration and selection in accordance with Section 01 33 00, Submittals.

B. Provide shop drawings showing pattern layout and locations of selected colors.

C. Letter of Certification: Provide Letter of Certification by the manufacturer that Contractor is a current qualified installer.

D. Product Data: Manufacturer’s technical literature for each product indicated, specified, or required. Include manufacturer's technical data, application instructions, and recommendations.

E. Installer Qualifications: Data for company, principal personnel, experience, and training specified in PART 1 “Quality Control” Article.

F. Maintenance Data: For inclusion in maintenance manual required by Division 01.
   1. Include instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
   2. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.5 JOB MOCK-UP:

A. Prior to installation of polished concrete finish system, contractor shall provide minimum 12' x 12' mock-up at the job site in area where the floor will always be visible such as a storage or mechanical room. Provide larger mock-up area if required to accommodate pattern and number of colors. Architect shall approve color and workmanship of the mock-up, then retain as a standard for judging completed work. This shall not become part of the finished work. Mock-up to be polished for approval. Also, include a 4'x4' mock-up of the topping slab at existing slabs referenced below.

1.6 QUALITY CONTROL

A. Installer Qualifications:
   1. Provide list of a minimum of 5 projects performed within last three years of similar type, size, and complexity. Submit project names, addresses, contacts, and phone numbers for each project. This is to be provided with data submittal.
   2. Company experienced in performing specified work similar in design, products, and extent to scope of this Project; with a five-year record of successful in-service performance; and with sufficient production capability, facilities, and personnel to produce specified work.
   3. Submit letter of certification from manufacturers of all products and equipment specified herein, stating that the applicator is a certified applicator of the system and is familiar with proper procedures and installation methods as required by the manufacturer. All certifications must accompany the bid.
   4. Polished concrete contractor has to have been regularly performing Polished Dyed Concrete work for at least 3 years prior to bid with manufacturer certifications or job history verifying this point. This is to be provided with data submittal.
   5. **INSTALLERS NOT MEETING THE AFORE-MENTIONED QUALIFICATION REQUIREMENTS WILL NOT BE APPROVED TO INSTALL POLISHED CONCRETE SYSTEM.**

B. All components of the polished concrete finish system shall be provided by one single system supplier / installer.

C. Do not apply polished concrete finish system when temperature is at or below 32 degrees Fahrenheit or temperatures are projected to go below freezing before dye can have time to cure.

D. Curing agents may only be used at elevated slabs where polished concrete system is to be installed. Test sample required per specification 03 30 00.

E. Power and water to be available prior to beginning of work.

1.8 PRE-INSTALLATION MEETING

A. The Contractor will schedule and conduct a pre-installation meeting **prior to pouring of concrete floors** where polished concrete is scheduled to be installed. Those attending are to include Contractor, Architect, Owner, Owner's floor maintenance representative, concrete finisher including supervisor, mason, concrete ready-mix plant representative, polished concrete installer and foreman, and other trades affected by the polished concrete system. Items to be discussed are as follows but are not limited to these:
   1. Schedule
   2. Concrete slab preparation and pouring.
   3. Required concrete mix design strength
   4. Initial grinding and polishing procedures
   5. Speed of operations for correct refinement of polished concrete
   6. Protection of floors and damage prevention during construction
   7. Project phasing and scheduling for each step of grinding, honing and polishing operations including, but not limited to:
      a. Quality of qualified personnel committed to project.
      b. Quality and size of grinders committed to project.
      c. Proper disposal of concrete slurry and/or concrete dust.
   8. Control joint cutting
   9. Control joint filler
   10. Maintenance
   11. Other items associated with polished concrete system.

1.9 WARRANTY

A. Furnish a written warranty covering both material and workmanship for period of ten (10) years from Date Of Substantial Completion.

1.10 MAINTENANCE

A. Provide owner and owners cleaning company with on site training. Instructional training video to also be provided.

B. Coordinate with owner a cleaning schedule.

C. Provide owner with a 2-month starter kit of cleaning products and pads. Cleaning products to be Amerpolish brand.

PART 2 PRODUCTS

CFIN-1

2.1 MATERIALS/MANUFACTURERS

A. Subject to compliance with project requirements, provide products and equipment by the following:
   1. Ameripolish (479) 725-0033 www.ameripolish.com
   2. Prosoco (800) 255-4255 www.prosoco.com

B. Penetrating Hardener/Densifier: (Clear liquid reactive lithium-silicate based.)
   1. 3D HSL, by Ameripolish

C. Protective Surface Treatment (Stain Guard):
   1. 3D SP, by Ameripolish

D. Joint Filler:
   1. 2-part polyurea, Spal-Pro RS 88 manufactured by Metzger/McGuire, 807 Route 3-A Bow, NH 03304, 1-800-223-6680
   2. 2-part polyurea, Versaflex SL/85, rapid curing, manufactured by Versaflex, Inc., 87 Shawnee Avenue, Kansas City, KS 66105 (913) 321-9000.
   3. 2-part polyurea, PE85, manufactured by Hi-Tech Systems, 1190 N. Del Rio Place, Onterio, CA 91764 (909)945-5530
   4. Approved alternate

E. Crack Filler:
   1. 2-part polyurea, HT Spall-TX3, manufactured by Hi-Tech Systems, 1190 N. Del Rio Place, Onterio, CA 91764 (909)945-5530
   2. Approved alternate

F. Concrete Topping Slab:
   1. Utilize CTS Rapid Set Tru PC Polished Concrete Topping prior to polishing of existing concrete slabs. Refer to finished floor plans for locations of topping.

2.2 EQUIPMENT

A. Contractor is to furnish minimum three grinding/polishing machines (HTC 800, HTC 950, Sase Products or similar) in full operating condition during the duration of work.
   1. Planetary, counter rotating variable speed floor grinder (4 head).
   2. Minimum 700 pounds of downward pressure.

B. Dust extraction system, pre-separator, and squeegee attachments with minimum flow rating of 322 cubic feet per minute.

C. Generators are required to provide required power. The Polished Concrete Contractor is to provide a minimum of two, each capable of running two classic (HTC 800 or similar) grinding machines concurrently to expedite work.

D. Allowable Grinding Heads:
   1. Metal Bonded Diamonds:
      a. Grit Size: 16, 30, 70, 100.
      b. Use of metal bonded diamonds shall be for removal of existing epoxy coating only, unless approved in writing prior to alternate use.
   2. Hybrid and Resin Bonded, Phenolic Diamonds
      a. Grit Size: 50, 100, 200, 400, 800, 1500
   3. Grinding/Polishing Pads:
      a. Grit Size: 60, 100, 120, 200, 400, 800, 1500, 3000.

E. Hand grinder with dust extraction attachment and pads.

F. High speed propane burnisher:
   1. Minimum 27 inch head generating pad speeds of 1,500 RPM or higher, as verified with tachometer

G. Diamond Impregnated Pads
   1. Twister Diamond Cleaning System Pads, by HTC.
   2. Diamond Polishing Pads, by Norton.
   3. SpinFlex Diamond Polishing Pads, by CPS.

H. Applicator pad:
   1. Professional Mighty Mop 077, by Quickie.
   2. 24" Microfiber Wet Room Pad, by Rubbermaid.

PART 3 EXECUTION

3.1 ADDITIONAL CONCRETE SLAB PROCEDURES FOR POLISHED CONCRETE

A. Refer to Specification 03 30 00 Cast-In-Place Concrete for concrete slab requirements

B. Additional Polished Concrete Floor Troweling Requirements:
   1. Final troweling shall be performed with finish blades.
   2. Finish blades shall be new or used steel finish blades that are in good shape.
   3. Finish blades may be steel reinforced plastic for the final pass only.
   4. Trowel as many times as possible.
   5. Lead finisher/foreman who finished the field sample shall be present for entire fresh concrete finishing process until final troweling is completed.

C. Additional Control Joint Requirements:
   1. After saw cutting, immediately vacuum up and clean residues.
   2. Employ sufficient number of saws and workers to complete cutting saw joints before shrinkage produces cracking.
   3. Saw cut to width of 1/8 inch, depth at least 1/3 thickness of the slab.
   4. Use saws, blades, skid plates, and accessories by Soff-Cut International, Inc. or approved alternate.
   5. Start cutting sawed joints as soon as concrete has hardened sufficiently to prevent raveling or dislodging of aggregates. This will typically be from 1 hour in hot weather to 4 hours in cold weather after completing finishing of slab in that joint location.
   6. Provide at least two “Soff-Cut” saws on site with blades capable of achieving the required depth of saw cut.
   7. Extend sawed joint to the slab boundaries and abutments, including columns, drains, and other penetrations in the path of a defined joint. Implement methods and timing of the saw cut beyond the limits of the Soff-Cut saw reach to provide a consistent depth of cut with minimal raveling of joint edges.
   8. Connect a dust collection system directly to each Soff-Cut saw being used.
   9. Remove all saw debris, either loose or compacted, from slab surface and joints prior to curing cover installation.

F. Additional Slab on Grade Concrete Curing Requirements
   1. Start curing as soon as concrete surface will not be damaged by curing operations.
   2. Continuously wet cure concrete for at least 7 consecutive days.
   3. During curing period, do not allow any part of the concrete to become dry.
   4. Do not use polyethylene sheets on exposed interior floors.
   5. Wet Cure Only:
      a. Use fine misting hoses to keep surfaces wet with a 1/8" nominal thickness film of water on concrete surface during entire curing period.
      b. Provide continuous observation for 24 hours per day for the duration of the curing period.
      c. Create a dam along the edge of pour to contain water on slab.
      d. Employ methods to remove excess water from around site. Do not allow any part of the concrete surface to dry before end of curing period.

3.2 EXAMINATION

A. Verify preparation conditions before beginning work.

B. After concrete curing period (14 days minimum and 3500 psi cylinder break) has elapsed, surface must be clean and dry, physically sound and free of contamination. Surfaces must be free of holes, voids, or defects. Cracks and abrupt changes in surface profile must be corrected or accepted as is. Fins and projections must be removed.

C. Contractor must report, in writing, surfaces left in improper condition by other trades. Application will constitute acceptance by the applicator.

3.3 PREPARATION

A. Close areas to traffic during and after floor finish application for time period recommended by product manufacturer(s).

B. Clean Substrate: Removal of surface contaminants to ensure penetration of reactive surface densifier. No hazardous, flammable, toxic or solvent based cleaning materials are permitted.
   1. Remove dust and loose material by brushing, sweeping, and vacuuming.
   2. Remove curing, sealing and coating agents, oil, breaking compound residue, wax, and grease by mechanically scraping off heavy deposits. Remove remaining residues using Wax and Curing Compound Remover.
   3. Remove deep-set oil and grease stains.
   4. Remove paint residue.
   5. Remove grease and general soiling with cleaner/degreaser diluted as recommended by manufacturer in an auto scrubber.
   6. Remove mildew by scrubbing with solution of trisodium phosphate and bleach. Rinse with clean water.
   7. Thoroughly rinse floor surface to remove soap residue and contaminants.
   8. Squeegee dry.

C. Repair all slab defects.

D. Ensure surfaces are clean, dry, and free of oil, grease, dirt, dust, and contaminants.

3.4 NEW CONSTRUCTION INSTALLATION PROCEDURE:

A. System to be installed by approved and licensed applicators from manufacturer. Comply with flooring system manufacturer's recommendations and instructions regarding preparation and mixing of materials and application of each component of floor system. Coordinate with contractor, scheduling for installation of the polished dyed concrete finish system. **Initial grinding of polished floor system to be performed prior to wall installation to assure proper polishing of entire room or area.**

B. For the initial grinding of the concrete slab, use coarse diamond segments bonded in a metallic matrix. These segments should be coarse enough to remove minor pits, blemishes, stains, or light coatings from the floor in preparation for final smoothing. A minimum of **4 passes** with 70 grit metal bonded diamond grinding heads is required. Depending on the condition of the concrete and the specified aggregate exposure additional passes and lower grit metal bonded heads may be required.

C. Protect surrounding and adjacent surfaces in accordance with floor finish manufacturer's written recommendations.

D. **Joint and/or crack filler to be installed in control joints, cracks, pitts, spalls and holes prior to final grinding and polishing.** Joint filler must bond to clean, exposed concrete for the full intended filler depth. Joints must be free of saw laitance, dirt, debris, coatings, sealers, etc. The only effective means of proper joint cleaning is the use of a dry cut saw, vacuum-equipped, with a diamond blade. The blade depth should extend to the intended filler depth. Run blade against each side wall on separate passes. After cleaning joints with saw, vacuum any remaining dust/debris from joint. Joint filler is designed to be placed to the full depth of the joint in saw-cut contraction/control or construction joints or at 2" minimum if joint depth exceeds 2". DO NOT USE COMPRESSIBLE BACKER ROD IN SAWCUT JOINTS. Follow all additional manufacturers installation instructions.

E. Grind slab surface with 150 grit metal-bonded OR 50 grit hybrid resin metal-bonded diamond grinding heads. **2 passes.**

F. Clean slab with wet auto scrubber with PH cleaner between **all** polishing passes.

G. Progressively polish slab surface with 100 and 200 grit resin-bonded, phenolic diamond heads. 2 passes each grit level minimum for a total of **4 passes**.

H. Apply reactive surface densifier per manufacturer's instructions to rejection.

I. Polish slab with 400 grit resin-bonded, phenolic diamond heads. 2 passes each grit level minimum for a total of **2 passes**.

J. Gloss and DOI readings are required to be taken prior to the application of surface treatment (stain guard)

M. Apply protective surface treatment (stain guard) per manufacturer's instructions. Draw out material to thin film with applicator pad.

N. A minimum of **12 passes** are required. Additional passes may need to be provided dependent on condition of concrete, specified aggregate exposure and operation of machinery. Slurry being produced should become slightly milky to clear.

O. Progressive edge grinding will be necessary along all vertical abutments.

P. At installer's option, water polishing can be implemented to aid in achieving specified reflective and finished requirements

3.5 EXISTING CONSTRUCTION INSTALLATION PROCEDURE:

A. **Joint and/or crack filler to be installed in control joints, cracks, pitts, spalls and holes prior to final grinding and polishing.** Joint filler must bond to clean, exposed concrete for the full intended filler depth. Joints must be free of saw laitance, dirt, debris, coatings, sealers, etc. The only effective means of proper joint cleaning is the use of a dry cut saw, vacuum-equipped, with a diamond blade. The blade depth should extend to the intended filler depth. Run blade against each side wall on separate passes. After cleaning joints with saw, vacuum any remaining dust/debris from joint. Joint filler is designed to be placed to the full depth of the joint in saw-cut contraction/control or construction joints or at 2" minimum if joint depth exceeds 2". DO NOT USE COMPRESSIBLE BACKER ROD IN SAWCUT JOINTS. Follow all additional manufacturers installation instructions.

B. Grind slab surface with 60 and 70 grit metal-bonded diamond grinding heads. 2 passes each grit level minimum for a total of **4 passes**.

C. Clean slab with wet auto scrubber with PH cleaner between **all** polishing passes.

D. Progressively polish slab surface with 100 and 200 grit resin-bonded, phenolic diamond. 2 passes each grit level minimum for a total of **4 passes.**

E. Apply reactive surface densifier per manufacturer's instructions to rejection.

F. Polish slab with 400 grit resin-bonded, phenolic diamond heads. 2 passes each grit level minimum for a total of **2 passes.**

G. Gloss and DOI readings are required to be taken prior to the application of surface treatment (stain guard)

H. Apply protective surface treatment per manufacturer's instructions. Draw out material to thin film with applicator pad.

I. A minimum of **10 passes** are required. Additional passes may need to be provided dependent on condition of concrete, specified aggregate exposure and operation of machinery. Slurry being produced should become slightly milky to clear.

J. Progressive edge grinding will be necessary along all vertical abutments.

K. At installer's option, water polishing can be implemented to aid in achieving specified reflective and finished requirements

3.6 GRIND ONLY AT SEALED CONCRETE FLOORS

A. At sealed concrete floors
   1. Progressively polish slab surface with 200 grit resin-bonded, phenolic diamond heads. 1 pass.
   2. Seal with DNS-400 Sprayable Acrylic Sealer by Ameripolish.

3.6 FINISH REQUIREMENTS:

A. Aggregate Exposure:
   Class B – Fine Aggregate: Fine aggregate exposure with little or no medium aggregate at random locations. Approximate surface cut of 1/16"

B. Gloss Level: All gloss levels are to be measured using a Rhopoint IQ Gloss & DOI reader. Reader must be factory calibrated yearly.
   Level 2: Honed Polished. A low-sheen finish.

C. DOI Value: All DOI (distinctness of image) values are to be measured using a Rhopoint IQ Gloss & DOI reader. Reader must be factory calibrated yearly.
   DOI, Image Clarity Values should range from 70 to 85 prior to surface treatment (stain guard)

D. Slip Resistance: Measured dynamic coefficient of friction (DCOF) shall be 0.42 or greater as measured in accordance with ANSI A137.1. Testing apparatus shall be the BOT 3000E

E. Leave work complete and ready for final inspection by Architect.

3.7 PROTECTION:

A. Contractors shall be advised that the concrete slab ***is*** the finished floor. Do not allow marking of the floor (even with pencil). Do not apply chemicals of any kind. No chemical process or cleaning system is known that will remove petroleum stains and certain other chemicals from concrete surfaces.

B. Polished floor areas are to be protected by the general contractor/construction manager with taped hardboard or ram board for duration of project until time of final cleaning. Periodically inspect protection board for damage and keep it free from debris.

C. Perform final cleaning of polished floor area after protection is removed.

D. Coordinate with Contractor to protect exposed edges of construction joints immediately following form removal.

E. Coordinate with Contractor to assure smooth, clean sawing of control joints to prevent chipping or aggregate pullout during sawing process.

F. DO NOT allow trades to park vehicles on the slab without protection, such as plastic or non absorbent drop clothes, under the vehicles.

G. ALWAYS DIAPER any hydraulic equipment used on the floor during the construction process. No exceptions.

H. NO PIPE FITTING/cutting will take place on the floor slab.

I. DO NOT place steel on the slab without protection beneath.

J. Protect wet cured surfaces as follows:
   1. Barricade concrete surfaces immediately after finishing
   2. Do not allow light traffic, except for curing purposes, on concrete surfaces until concrete has obtained 1800 psi (approx 3 days).
   3. Do not allow heavy traffic on concrete surface until concrete has obtained, by test, its design strength, but not sooner than 9 days after placement.
   4. Permit concrete to dry minimum of 2 additional days after curing is completed before removing barricades.

K. Provide access ramps of compacted earth or other means along exposed concrete edges of floor slabs to prevent equipment and machinery from impacting edges. Barricade all other exposed edges to vehicular traffic which may damage edges. Broken or chipped edges along construction joints will not be tolerated.

L. When traffic is allowed on the slab tires must be WHITE. Tires shall be inspected to insure no foreign objects are embedded in tires such as rocks, screws, nails, etc., which could damage polished floor finish.

M. DO NOT ALLOW BLACK TIRES on polished concrete slabs. If black tire equipment must access the slab the tires must be fitted with protective tire socks.

N. Do not allow clay gravel, etc. to be tracked onto bare unpolished or polished concrete slab.

O. Do not allow work resulting in oils dripping onto concrete slabs to occur without floor protection.

3.8 TESTING

A. Using a Rhopoint IQ Gloss & DOI reader randomly test the floor with architect and contractor present. Floor polisher to provide instrument and show calibration. Equipment to be calibrated yearly by manufacturer. The minimum number of tests distributed across the polished surface should be three test for areas up to 1000 sf and one additional test for each 1000 sf or fraction thereof. This applies to both Gloss and DOI.

B. Gloss readings at 60 degrees shall average a minimum of 55 with no area measuring less than 45 prior to stain guard application.

C. Gloss readings at 60 degrees shall average a minimum of 70 with no area measuring less than 60 after stain guard application.

D. Minimum DOI reading to be 70 or higher prior to stain guard application

E. Minimum DOI reading to be 85 or higher after stain guard application

F. Slip Resistance: Measured dynamic coefficient of friction (DCOF) shall be 0.42 or greater as measured in accordance with ANSI A137.1. Testing apparatus shall be the BOT 3000E

3.9 CLOSEOUT ACTIVITIES

A. Maintenance Training: Polish concrete company shall train Owner's designated personnel in proper procedures for maintaining polished concrete floor. Training must include hands on demonstrations of all cleaning steps. Contractor must provide 2 months of care and maintenance products to the owner.

END OF SECTION

SECTION 03 62 00

NON-SHRINK GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. Provide non shrink, rapid setting, high strength repair mortar for horizontal structural patch and repair of existing concrete substrate.

B. Provide high strength, non-metallic, Portland cement based non shrink grout.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation for each material and product used. Include manufacturer's Material Safety Data Sheets.

1.3 REFERENCES

A. ASTM C 109: Compressive Strength of Hydraulic Mortars

B. ASTM C 191: Setting time of Hydraulic Cement

C. ASTM C 882: Slant Shear Bond Strength

D. ASTM C 928: Rapid Hardening Cementitious Materials for Concrete Repairs

E. ASTM C 939: Flow of Grout

F. ASTM C 1107: Hydraulic Cement Grout (Non Shrink)

G. Region III Test Method IV: Freeze/Thaw Testing

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: The manufacturer shall be a company with at least fifteen years experience in the manufacturer and marketing of pre-packaged cementitious repair materials.

B. Installer's Qualifications: The contractor shall be qualified to perform the work specified by reason of experience.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver products in original packaging, labeled with product identification, manufacturer, batch number and shelf life.

B. Store products in a dry area. Protect from direct sunlight.

C. Handle products in accordance with manufacturer's printed recommendations.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Non Shrink rapid setting high strength, hydraulic cement based repair mortar and Non Shrink Grouts for horizontal applications. Comply with the following:
   1. Manufacturer: Fastset™ Non Shrink Grout (#1585-09) as manufactured by the QUIKRETE® Companies, One Securities Centre, 3490 Piedmont Road, NE, Suite 1300, Atlanta, GA 30305; telephone (404) 634-9100.
      a. Substitutions: Comply with Section 01 11 00.
   2. Performance and Physical Properties at 73 degrees F and 50 percent relative humidity:
      a. Compliance: ASTM C 928 R-3 specifications ASTM C 1107 CRD 621
      b. Working Time, ASTM C 1107: 15-20 minutes.
      c. Final Set Time, ASTM C 191: 20-45 minutes.
      d. Compressive Strength, ASTM C 109 Modified:

         Fluid: 2000 psi (13.8 MPa) @ 3 hours, 4000 psi (27.6 MPa) @ 24 hours, 5000 psi (34.5 MPa) @ 7 days and 6500 psi (44.8 MPa) @ 28 days.

         Flowable: 2500 psi (19.2 MPa) @ 3 hours, 4500 psi, 4500 psi (31 MPa) @ 24 hours, 5500 psi (37.9 MPA) @ 7 days and 7500 psi (51.7 MPa) @ 28 days.

         Plastic: 3000 psi (20.7 MPa) @ 3 hours, 5000 psi (34.5 MPa) @ 24 hours, 6000 psi (41.3 MPs) @ 7 days and 8000 psi (55.1 MPs) @ 28 days.

      e. Slant Shear Bond Strength, ASTM C 928: 1000 psi (6.9 MPa) @ 24 hours, 1500 psi (10.3 MPa) @ 7 days and 2500 psi (17.2 MPa) @ 28 days.
      f. Height Change, ASTM C 1090: 0-0.2%.
      g. Flow at Fluid Consistency, ASTM C 939: 20-30 seconds.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions under which materials will be installed. Do not proceed with installation until unsatisfactory conditions are corrected.

B. Coordinate installation with adjacent work to ensure proper sequence of construction. Protect adjacent areas landscaping from contact due to mixing and handling of materials.

3.2 SURFACE PREPARATION:

Comply with manufacturer's printed instructions and the following:

A. Remove all spalled and unsound concrete from area to be repaired. If rusty reinforcing steel is present; it must be abrasive blasted to remove rust.

B. Remove enough material to completely expose reinforcing steel.

C. Large vertical or overhead patches deeper than 2" (50 mm) should contain reinforcing steel. Additional steel should be inserted using appropriate techniques, if none is present.

D. Clean surface to be repaired of all materials including dust, oil, dirt and grease.

E. Dampen with clean water before patching and remove standing water.

3.3 MIXING:

Comply with manufacturer's printed instructions and the following:

A. Material should be mechanically mixed for a minimum of three (3) minutes using a five (5) gallon (19L) bucket with a ½″ (12mm) drill and paddle mixer. For large grouting applications a standard mortar mixer should be used.

B. Add 1 ¼ gallon (4.7L) of clean water for each 60lb (27.2 kg) bag to achieve a plastic consistency. (Flowable: 1½ gallon (5.7L), fluid 1¾ gal. (6.6L)).
Add the powder to the water and mix to achieve required placing consistency.
Add water sparingly to reach the desired consistency.
Do not mix more material than can be placed in 15 minutes.

C. For repair deeper than 2" (50 mm), up to 30 lbs (13.6kg) of clean, high quality ½″ (12mm) gravel may be added to the mix at the plastic consistency. The water required will be reduced to 1 gallon (3.8 L) per 60-pound (27.2 kg) bag.

D. Do not re-temper with additional water.

3.4 APPLICATION:

Comply with manufacturer's printed instructions and the following:

A. Instructions for use as a Grout
1. The area to be grouted should be thoroughly flushed and soaked with clean water prior to grouting. Leave no standing water.
2. Place the grout quickly and continuously use light rodding or strapping is permitted to eliminate air bubbles.
3. Grout temperature should be maintained from 50°F to 90°F (10°C - 32°C) to achieve specified results. Use cold water in hot weather or hot water in cold weather to achieve desired grout temperature. Do not use if temperature is expected to go below 32°F (0°C) within a 12 hour period.

B. Instructions for use as a Repair Mortar
1. Remove all areas of spalled and unsound concrete from surface to be repaired.
2. Repair areas that are subject to heavy traffic should have a vertical edge of ½"

(12 mm) or more, formed by use of a pneumatic jackhammer or sawing.
3. Dampen surface with clean water before patching. Remove standing water.
4. The repaired areas should be filled by placing material full depth, from one end to the other to eliminate partial depth lifts between batches.
5. Consolidate the material by hand tamping or chopping with a shovel or trowel. This is particularly important around the edges.
6. Screed and finish to create a surface that matches the surrounding finish.
7. Repair Mortar temperature should be maintained from 50°F to 90°F (10°C - 32°C) to achieve specified results. Use cold water in hot weather or hot water in cold weather to achieve desired grout temperature. Do not use if temperature is expected to go below 32°F (0°C) within a 12 hour period.

3.5 CURING

A. Grouting applications must be damp cured for at least one day. No special curing procedures are required for repair applications but sealing surface with QUIKRETE® Acrylic Concrete Sealer (No. 8800) after concrete has hardened will ensure proper curing and help prevent shrinkage cracking.

3.6 CLEANING

A. Remove excess material before material cures. If material has cured, remove using mechanical methods that will not damage substrate.

END OF SECTION

SECTION 04 05 13

MORTAR

PART 1 GENERAL

1.1 SUMMARY

A. Examine all Drawings, General Conditions, Supplementary Conditions, and General Requirements which are part of this Contract. Furnish all labor, materials, and equipment necessary for masonry mortar.

1.2 RELATED SECTIONS

A. Section 04 21 13: Brick Masonry

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM-most recent issue)
   1. ASTM C94, Specification for Ready-Mixed Concrete
   2. ASTM C109 Specification for Compressive Strength of Hydraulic Cement Mortars.
   3. ASTM C143, Test Method for Slump of Hydraulic Cement Concrete
   4. ASTM C144, Specification for Aggregate for Masonry Mortar
   5. ASTM C150, Specification for Portland Cement
   6. ASTM C207, Specification for Hydrated Lime for Masonry Purposes
   7. ASTM C270, Specification for Mortar for Unit Masonry
   8. ASTM C404, Specification for Aggregates for Masonry Grout
   9. ASTM C476, Specification for Grout for Masonry
   10. ASTM C1019, Specification for Method of Sampling and Testing Grout
   11. ASTM C1329, Specification for Mortar Cement

B. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.

C. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specifications for Hot Weather Masonry Construction.

1.4 SUBMITTALS

A. Comply with Section 01 33 00.

B. Submit Certification of mortar components and type for pre-blended masonry mortars such as “Spec Mix” or other approved manufacturers, dated within 12 months of contract date.

1.5 GENERAL REQUIREMENTS

A. Deliver materials in unbroken bags or containers, plainly marked and labeled with Manufacturer's name, brand and mortar type.

B. Storage of Materials
   1. Cement and hydrated lime: Stored in a manner to afford ready access for inspection and in suitable building to protect material from dampness. Insure protection against inclusion of foreign materials in cements and limes. MASONRY CEMENT WILL NOT BE ALLOWED IN MORTAR.
   2. Aggregates - use only clean, dry materials. Use no frozen materials.

C. Build in all sheet metal work, anchors, anchor bolts, hangers, sleeves, thimbles, frames, structural members, etc. as shown and as required for other trades.

D. Environmental Requirements: See Section 04 21 13 for temperature and laying restrictions.
   1. Cold Weather Requirements
      a. Comply with IMIAC - Recommended Practices and Guide Specifications for Cold Weather Masonry Construction.
      b. When the ambient air temperature is below 40 degrees F, heat mixing water to maintain mortar temperature between 40 degrees F and 120 degrees F until placed. When the ambient air temperature is below 32 degrees F and holding, dropping, or predicted to drop below 32 degrees, no mortar is to be mixed.
   2. Hot Weather Requirements
      a. Comply with IMIAC - Recommended Practices and Guide Specifications for Hot Weather Masonry Construction.

E. Remove any materials that have partially hardened or set. DO NOT USE.

F. Build in door and window frames and their anchors. Slush steel door frame jambs and heads full of mortar. Slush cells full or mortar where excessive cutting for conduit or other devices has weakened masonry.

PART 2 PRODUCTS

2.1 MATERIALS

A. The mortar for all masonry, block, and brick shall meet the minimum requirements of the International Building Code.

B. Mortar shall conform to the minimum proportion requirements given in Table II of ASTM C270, based on 28 day laboratory testing ONLY. Select mortar type based on the criteria below:
   1. Type “S”: For walls in contact with earth or below grade, and load-bearing interior and exterior walls.
   2. Type “S”: For load-bearing interior and exterior walls above grade.
   3. Type “N”: For non load-bearing walls no higher than 20’-0”.
   4. Use Type “S” for non load-bearing walls higher than 20’-0”.
   5. Use Type ‘N’ only for masonry veneer.

D. Pigment should NOT exceed 10 percent of the weight of Portland cement. Limit carbon black, if used, to 2 percent of the total allowed color additive.

E. The mortar for all masonry shall be chosen from manufacturer's standard colors.

F. Provide only pre-mixed mortar of types specified manufactured by "Spec-Mix" or approved alternate substitution. **Mixing of any mortar on-site will not be allowed.**

G. Use same manufacturer's products throughout project.

H. Use of anti-freeze compound or other additives are not to be used without written approval of the Architect.

2.2 MORTAR MATERIALS

A. Portland Cement: ASTM C150, normal. Type I or III; gray color. Fly ash, slag, and pozzolans are NOT permitted as substitutes for Portland Cement.
   1. For pigmented mortars, use premixed, colored cements of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 5 percent of cement by weight for mineral oxides nor 1 percent for carbon black.

B. Hydrated Lime: ASTM C 207, Type S, and UBC 21-13 hydrated lime for masonry purposes.
   1. Manufactured by Chemstar of approved equal.

   2. For pigmented mortars, use colored Portland cement-lime mix of formulation required to produce color indicated, or if not indicated, as selected from manufacturer's standard formulations. Pigments shall not exceed 10 percent of Portland cement by weight for mineral oxides nor 2 percent for carbon black.

C. Aggregate for Mortar: ASTM C 144; except for joints less than 1/4 inch (6.5 mm), use aggregate graded with 100 percent passing the No. 16 (1.18 mm) sieve.
   1. Colored-Mortar Aggregates: Natural-colored sand or ground marble, granite, or other sound stone, as required to match Architect's sample.

D. Aggregate for Grout: ASTM C404 with 100 percent passing the 3/8" (9.5mm) sieve.

E. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortars.

F. Admixtures: NOT permitted unless approved by the Structural Engineer of Record, prior to construction.
   1. Calcium Chloride is NOT permitted in mortar. Admixtures and other chemicals containing Thyocyanates, Calcium Chloride or more than 0.1 percent chloride ions are NOT permitted.

G. Water: Potable

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine conditions with installer present, for compliance with requirements for installation tolerances and other specific conditions, and miscellaneous conditions affecting performance of unit masonry.

B. Examine rough-in and built-in construction to verify actual locations of piping and other penetrations prior to installation.

3.2 INSTALLATION

A. Maintain an ambient temperature of the materials in contact with the mortar, of NOT less than 40 degrees F, unless otherwise recommended by the International Masonry All-Weather Council (IMIAC). Maintain this temperature limitation at every area and elevation of weather enclosures, when used.

B. Lay solid brick-sized masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. DO NOT slush head joints.

C. In existing construction, maintain joint widths shown, to match existing coursing, except for minor variations required to maintain bond alignment. If not shown, lay walls to match existing or 3/8" joints.

D. Cut joints flush for masonry walls that are to be concealed or to be covered by other materials, unless otherwise indicated.

E. Remove masonry units disturbed after lying; clean and reset in fresh mortar. DO NOT pound corners or jambs to shift adjacent stretcher units that have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

3.3 MIXING OF MORTAR

A. Machine mix in an approved type of mixer in which quantity can be accurately and uniformly controlled. Only small batches of mortar may be mixed at one time. Mixing time is not less than five (5) minutes and not less than three (3) minutes after water has been added. If hydrated lime is used, use dry-mixed method (optional) of first consistently mixing hydrated lime into putty.

B. Dry Blended in Silos: Mixing shall be done using continuous, self-cleaning mixer mounted at the apex of the silo. The water flow valve shall be set to provide desired workability.

C. Keep all mixers and equipment clean. Do not deposit mortar on ground.

3.4 WORKMANSHIP

A. Mortar having stood for more than one hour shall not be used or re-tempered.

B. Lay no masonry when danger of freezing conditions exists before mortar sets.

END OF SECTION

SECTION 04 21 13

BRICK MASONRY

PART 1 GENERAL

1.1 SCOPE:

A. Examine all Drawings, Specifications, General Conditions, Supplementary General Conditions, and General Requirements which are part of this Contract. Furnish all labor, material, tools, equipment, scaffolding, and other items necessary to complete all masonry work, with all inclusions, inserts and provisions for inclusion, connection or passage by other Trades.

1.2. RELATED SECTIONS

A. Section 04 05 13: Mortar

B. Section 05 50 00: Metal Fabrications-Loose lintels, anchor bolts, and steel bearing plates where anchored to, or bear on masonry:

C. Section 07 10 00: Waterproofing and Damp Proofing Through-wall flashing system

D. Section 07 62 00: Flashings and Sheet Metal

E. Section 07 19 00: Water Repellent Coatings

F. Section 07 92 00: Sealants

G. Section 08 11 13: Hollow Metal Doors & Frames

1.3 REFERENCES

A. ASTM A153 – Zinc Coating (Hot Dip)

B. ASTM C67 – Test Methods of Sampling and testing Brick and Structural Clay Tile.

C. ASTM E 835 / E835M – Guide for Dimensional Coordination of Structural Clay Units, Concrete Masonry Units, and Clay Flue Linings.

1.4 MOCK-UP SAMPLE PANEL

A. Before commencing any work, Contractor shall erect a mockup panel of face brick in all patterns with correct mortar and joint sealant color. Refer to drawing on A201 for details on panel layout. Lay brick in pattern to simulate wall pattern. Panel is NOT PART OF BUILDING and is to remain in place until removal is authorized by the Architect. Contractor shall have sufficient brick on site to erect two panels if necessary.

B. Panel face shall show mortar, bond, widths and tooling of joints.

C. Approval of Architect is required before proceeding with any part of the building.

D. Panel is to remain in place until completion of the work.

E. Construct mock-up panel in "cut-away" view, exposing all wall assembly components. Refer to Section 01 40 00 Quality Control-Mock-Ups.

PART 2 PRODUCTS

2.1 MATERIALS

BRK-1

A. Brick to be ASTM C652, or ASTM C216 grade SW, Type FBX (ASTM C216 & ASTM C652).

B. Face Brick: All face brick shall be of Norman type (3-5/8" x 2-1/4" x 11-5/8") and approved by the Architect.

C. Face brick to be Acme, Dove Gray, PEP030, smooth, sourced by Acme Brick, Dan Olenberg, 479-530-0388, dolenberg@brick.com.

D. All face brick shall be laid in accordance with the standards of Brick Institute of America.

E. Common brick for back-up shall be of sound #1 common brick.

F. Refer to Drawings for special brick shape profiles and locations.

G. **Brick Anchoring System to Stud Wall:**
2X-Hook 3/16" diameter clip hook ties (above structural deflection joints, utilize Mighty-Lok™ Hook Heavy Duty 1/4" Ø Compressed Leg Pintle), HB-213-2X S.I.S. with HB-213 washer, 14 gage adjustable anchor manufactured by Hohmann & Barnard, Inc., or approved equal. Screw to studs with corrosion resistant screws approved by manufacturer. Screws to be minimum #10 self-tapping, copolymer coated, and weld clip to steel structure. Secure to back-up walls at 16" o.c. vertically and 16" o.c. horizontally or 12" o.c. vertically and 16" o.c. horizontally at soldier stack bond. Finish to be hot dipped galvanized, 1.50 oz. per sq., ft. Provide "Pencil Rod", 9 gage, continuous reinforcement at brick with Seismiclip Interlock System attached to each wall tie. Install at 16" max o.c. vertically and 12" at soldier stack bond.

H. All ties to be installed per TMS 402 and placed so as not to exceed 16" vertically and 16" horizontally, unless noted otherwise.

I. **TWF-1** Cavity Wall Flashing System: See Section 07 10 00.

J. Provide solid brick at all rowlock sills, in areas where brick voids will be exposed to view, and where shown on plans. Color must match stretcher course brick.

K. Weep Vents:

a. Manufactured by Mortar Net, ½" thick, size as required to match brick head dimension (except at soldier course, refer to drawings). Refer to Section 07 10 00.
b. Install at 24" o.c. horizontally.
c. Provide ventilation vents at top of wall in same location and centering as weep vents. Where shelf angles are installed, provide ventilation vents just below angle and offset one course so that vents not align with weeps above.

PART 3 EXECUTIONS

3.1 GENERAL REQUIREMENTS

A. Deliver and store on the site, face brick, sufficient in quantity for the entire job, and secure approval of Architect before placing any of same in the work.

B. Lay no units having a film of water or frost on their surfaces.

C. Lay no masonry when temperature is below 40 degrees F. without Architect's permission. Such permission shall not relieve the Contractor from responsibility for the work, however. If permitted to work below 40 degrees F., but above 32 degrees F., make provisions to heat and dry materials and protect work from freezing during the installation and curing period. No masonry is to be laid when temperatures are holding, dropping on are predicted to go below 32 degrees F. unless heated protection is provided during installation and curing period and has been approved by Architect.

D. Build in bolts, ties, other metal anchors, sleeves, miscellaneous metals, and wood nailing strips as necessary to secure masonry together or to other materials. Use no continuous wood nailing strips.

E. Build in steel lintels, bearing plates and flashings in contact with masonry. Bed flashings in mortar.

F. Close up any recesses after pipes, ducts, conduits and other items are in and have been inspected by Architect and/or other proper authorities and do all patching after other trades have completed their work.

G. Cut exposed masonry with masonry saw to produce clean-cut edges.

H. At end of each work day or shut down period cover walls with strong waterproof membrane overlapping walls 12" minimum on each side and securely anchor in place.

I. Use a full height story pole at all corners. Level first and frequent courses with instrument.

J. Carefully ship and stack upon delivery to avoid chipping. Do not stack directly on ground.

K. Cutting and Patching: Consult other trades in advance and make provisions for installation of their work to avoid unnecessary cutting and patching. Do all cutting with a power saw designed for the purpose.

L. Fully butter head and bed joints prior to laying.

3.2 WORKMANSHIP

A. Lay all masonry in full bed of mortar, plumb and true to line with accurately spaced course and reveals. Keep bond plumb throughout, with head points of alternate courses in straight vertical lines.

B. Provide tooled, concave joints where brick will be left exposed as a finished product, unless specifically called out to be otherwise. Verify and match existing joint strike if brick is adjoining existing brick.

C. Where fresh masonry adjoins previously set masonry, clean, roughen, and lightly wet the set masonry before joining with the new.

D. Where stop-offs are necessary in horizontal runs, rake back the unfinished work for joining the new work. Toothing is not permitted unless approved by the Architect.

E. Initial rate of absorption (IRA) of the units is determined by the laboratory method described in Section 9 of Test Methods C67. IRA in the field depends on the moisture content of the masonry unit and is determined in accordance with Section 14 of Test Methods C67. Units having average field IRA exceeding 30 g/min -30 sq. in. (30 g/min-194 cm squared) should have their IRA reduced below 30 g/min-30 sq.in. prior to laying. It is preferable to wet masonry units thoroughly 3 to 24 hrs prior to their use so as to allow time for moisture to become distributed throughout the unit except when in judgment of Architect the temperature is too low. No freshly wetted masonry units or those having film of water or frost on surface shall be laid.

F. Horizontal & Vertical Face Joints: Use tooled joints, approximately 1/4" deep and 3/8" wide.

G. Expansion Joints: Expansion joints shall be spaced as shown on the drawings, but space no more than 24’-0” o.c. and no more than 12’-0’ from corners. Provide backer rod and caulk joints in accordance with Section 07 92 00.

H. Bond Pattern: Refer to drawings for locations. Face Brick to be laid in stack bond (corbel, horizontal, and soldier stack) pattern.

I. If brick sills are to be installed, slope minimum 15 percent unless shown otherwise.

J. Where masonry is installed, all vertical and horizontal joints to align according to bond types. Where differing masonry types are installed in same wall, joints are to align between each masonry unit type unless noted otherwise.

3.3 MASONRY WEEPS & CAVITY-WALL FLASHING MEMBRANE TERMINATION

A. It will be the responsibility of the Contractor and the Mason to coordinate installation elevation of all weeps and cavity wall flashing membrane termination in masonry walls at

specified locations. Adjust as needed to terminate above concrete walks. Where masonry cavity walls occur at slab-on grade conditions, locate weeps one brick course below finished floor elevation unless items such as a sidewalk, etc, interferes, in which case the weeps would be located at finished floor elevation. If finish grade elevation extends beyond 16 inches below finished floor elevation, locate weeps approximately 2-4" above finish grade unless noted otherwise. Continue through-wall flashing between weep elevation changes, keeping waterproofing integrity. Finish grade to be a minimum 2" below weeps. **WEEPS ARE TO REMAIN EXPOSED. DO NOT COVER WEEPS WITH SOIL, FLASHING, CONCRETE, OR ROOFING MATERIAL.**

3.4 CLEANING

A. Remove excess materials, mortar droppings. Remove mortar droppings on connecting or adjoining work before its final set.

B. Exposed Masonry: At completion of work, point holes in joints of exposed exterior masonry surfaces, completely fill with mortar, tool properly. After pointing has set, hardened, wet exposed masonry surfaces. Clean soiled surfaces with a solution which will not harm masonry or adjacent materials equal to Sure Klean 600 manufactured by ProSoCo, Inc. Cleaner must be approved by brick manufacturer. Apply with stiff fiber brush, leave masonry clean, free of mortar daubs, with tight mortar joints throughout. Immediately after cleaning, rinse masonry surfaces with clear water. DO NOT USE PRESSURE SPRAY WASHER TO CLEAN OR RINSE OFF MASONRY.

C. Protect all other trade's work and other items set into wall.

D. Remove, replace defective materials, correct defective workmanship, and leave masonry clean.

E. Replace defective mortar. Match adjacent work.

F. Remove excess mortar and smears.

G. Use non-metallic tools in cleaning operations.

3.5 WATER REPELLANT COATING:

A. At completion of cleaning, apply water repellent coating. Refer to Section 07 19 00, Water Repellent Coating.

B. Application is to be done only with approval of the Architect and may be delayed for an extended period due to time of year or weather conditions.

3.6 REMOVAL OF DAMAGED EXISTING BRICK:

A. On areas where new construction adjoins existing, removal and/or replacement of damaged brick may be necessary. Should such conditions be present, work shall be accomplished by chiseling out, and replacement of the damaged unit.

B. After removal of the damaged unit(s), placement of new brick to match existing units shall be accomplished using wedges of wet wood, positioned so as to allow sufficient mortar to match existing mortar on all sides of the unit, and of sufficient depth to provide 1 1/2" minimum of mortar over the face of the wood wedges.

C. Replacement units shall be properly aligned with mortar joints matching the depth, width, and profile of the surrounding units.

D. After placement and proper pointing, the repaired area shall be scrubbed clean with a brush and water to remove any excess mortar.

END OF SECTION

SECTION 05 12 23

STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

A. This section shall cover the furnishing, fabrication, erection and connection of all structural steel complete.

1.2 WORK INCLUDED & FURNISHED

A. All labor, tools, materials, scaffolding, bracing, cranes, hoist, and other construction equipment required for the completion of the structure.

B. Preparation of shop drawings.

C. Furnishing and fabrication of all structural steel and miscellaneous metal work including beams, columns base plates, cap plates, bearing plates, angles, struts, bracing, girts, girders, connection material, fasteners, anchor bolts, shims, loose lintels, stiffeners, hangers, brackets, rods, and welding material.

D. Shop and field painting.

E. Shop and field connections including temporary bracing.

F. Section 01 40 00 – Quality Control: Required Special Inspections

1.3 QUALITY ASSURANCE

A. Fabricator's Qualifications: **A qualified fabricator that is AISC Certified for conventional steel building structures. If fabricator is not an AISC certified plant, then the fabricator must meet the protocol for special inspection requirements of IBC, Section 1704, paragraphs 1704.2.5 and 1704.2.5.1.** Documentation that one of the above requirements is met must be submitted to the Architect before starting shop drawings.

1.4 RELATED SECTIONS

A. Section01 40 00 – Required Special Inspections

B. Section 03 30 00- Cast-in-Place Concrete

C. Section 05 50 00 - Metal Fabrications

1.5 FURNISHED BUT INSTALLED ELSEWHERE

A. Anchor Bolts, Loose Bearing Plates: Refer to Sections 2 and 7d of AISC Code of Standard Practice.

B. Loose Lintels: Refer to Section 7f of AISC Code of Standard Practice.

1.6 STANDARDS

A. Structural Steel fabrication, connections, detailing and erection shall be in accordance with the specifications for the "Design Fabrication and Erection of the AISC Manual of Steel Construction, unless indicated otherwise in these specifications or on plans.

B. All structural steel shall conform to standard specifications for structural steel, ASTM A36, except:
   1. Wide Flanges and WT Tees - ASTM A992, Fy=50 ksi
   2. Structural steel tubing - ASTM A500, Fy=46 ksi.
   3. Structural Steel Pipe - ASTM A501, Fy=35 ksi.
   4. Anchor Rods – ASTM F1554, Grade 36
   5. Headed Stud Anchors - ASTM A108, Fy=50 ksi.
   6. High Strength Bolts – ASTM A325

1.7 SHOP DRAWINGS

A. Comply with Section 01 33 00. When corrections are required, reproducibles will be returned noting such. Drawings will then be corrected and resubmitted until final approval is received. Items not noted as requiring corrections may be fabricated after return of a previous submittal even though drawings shall be such that corrections noted on one sheet that affect another drawing will be transmitted and made on all sheets and also resubmitted.

B. The Contractor will be responsible for checking quantities and dimensions in accordance with contract drawings. Where discrepancies in dimensions are noted, the Contractor shall notify the Architect of such discrepancies and corrected dimensions then will be furnished by the Architect. Contractor shall coordinate any dimension changes or additions with fabricator.

C. Contract drawings receive precedence over shop drawings unless authorized in writing. Approval of shop drawings does not grant authorization of change to contract.

D. Standard AWS symbols shall be used and shown for all welded connection details for both shop and field welds. Joint reference numbers as noted in part 4 of 7th Edition of AISC "Manual of Steel Construction" shall be shown where full strength welds are required.

E. All splices and connections, both shop and field, shall be detailed on shop drawings.

1.8 PRODUCT HANDLING

A. Delivery of materials to be installed under other sections:

1. Anchor bolts and other anchorage devices which are embedded in cast-in-place concrete or masonry construction shall be delivered to the project site in time to be installed before the start of cast-in- place concrete operations or masonry work.
2. Provide setting drawings, templates, and directions for the installation of the anchor bolts.

B. Storage of Materials
1. Structural steel members which are stored at the project site shall be above ground on platforms, skids or other supports.
2. Steel shall be protected from corrosion.
3. Other materials shall be stored in a weather-tight and dry place, until ready for use in the work.
4. Packaged materials shall be stored in their original unbroken package or container.

1.9 COOPERATION WITH OTHER WORK

A. Fabricator shall punch all necessary holes and provide the connection material required for the attachment of miscellaneous items, such as nailers, hangers and mechanical equipment framing. Contractor shall coordinate such work with all plans.

1.10 WORKMANSHIP

A. All welding, both shop and field welding, shall be made by welders qualified by tests as prescribed in the "Code for Welding in Building Construction" (AWS D1.1-Current Edition).

B. All fabrication and erection work shall be performed by skilled workmen, working under experienced supervision.

1.11 UNIT PRICES

A. Provide allowance of $10,000 per ton for three (3) tons of miscellaneous beams, channels, and angles in addition to the steel framing shown on the plans and details. Contractor shall include additional allowance cost for fabrication, design, installation and erection cost for the additional framing. Construction Manager is to record use and credit back unused cost to Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. All structural steel shall meet the specifications for "Structural Steel" (ASTM A36). Except wide flanges and tees shall conform to ASTM A992, Fy=50 ksi, steel tubes shall conform to ASTM A500, Grade B, Fy-46 KSI, and steel pipe shall conform to ASTM A501.

B. Filler Metal for Welding shall conform to one of the following:
1. Manual Shielded Metal Arc Welding - E70 Series of the "Specifications for Mild Steel covered Welding Electrodes" (AWS A51-Current Edition).

2. Submerged Arc Welding - F70 AWS-flux Series of the "Specifications for Bare Mild Steel Electrodes and Fluxes for Submerged Arc Welding" AWS 5.17-96.

C. Bolts
1. High Strength Bolts shall be A325 bolts meeting the requirements of "Specification for Structural Joints Using ASTM A325 or A490 Bolts", including suitable nuts and plain hardened washers.
2. Other bolts shall conform to "Specification for Low-Carbon Steel Externally and Internally Threaded Standard Fasteners" (ASTM A307).

2.2 CONNECTIONS

A. Type
1. Unless indicated and detailed otherwise on plans, all connections shall be detailed and designed by the fabricator as unrestrained flexible connections described as Type 2 construction in Section A2.2 of the most current edition of the AISC manual of Steel Construction, but provisions must be made for excessive eccentric connections. All connections shall be in accordance with Part 4 and Part 5 of the above cited AISC Manual.

2. Bolted Connections
a. All bolted connections, unless noted otherwise, shall be A325 high strength steel bolts, nuts and harden washers, conforming to the "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
b. All bolted connections, unless noted otherwise, shall be of bearing type with threads included in the shear planes. These bolts shall be snug tightened. The snug-tight condition is defined as the tightness attained by a few impacts of an impact wrench or the full effort of a man using an ordinary spud wrench.
c. Bolts, nuts and washers shall conform to Tables 1 and 5 of Specifications and Commentary for "Structural Joints, Using ASTM A325 or A490 Bolts" of Current Edition of AISC Manual of Steel Construction.
d. Bolted parts shall be fitted tightly together before bolt installation.
e. All bolts shall have one nut and a hardened washer under the turning element.
f. When surface of bolted part in contact with nut or bolt head exceeds a slope of 1:20 with respect to a plane normal to the bolt axis, smooth beveled washers shall be used.
g. Bolt assembly and contact surfaces shall be free from scale, burrs, dirt and other foreign matter which might prevent solid seating.
h. Minimum bolt size, unless noted otherwise, shall be 5/8" in diameter. Adequate "stick through" for bolts must be provided in accordance with section C2 and Table 6, pages 5-201 and 5-202 of reference cited in part c) of the section.
i. All bolts at the column cap plates shall be installed with the bolt on top and the nut below the cap plate.

3. Welded
a. Minimum size of fillet weld permitted shall be 3/16", unless noted otherwise.
b. All surfaces to be welded shall be free from loose scale, slag, rust, grease, paint and other foreign materials.

c. All welding shall be in accordance with AWS "Structural Welding Code" (AWS D1.1-Current Edition) and as illustrates and described in "Welded Joints" in Part 4 of the 7th edition of the AISC Manual of Steel Construction.
d. Shop welding and field welding shall be performed by a certified welder in accordance with AWS D1.1-2000, licensed in the State of Arkansas.

PART 3 EXECUTIONS

3.1 FABRICATION

A. Connections and Splices
1. Shop connections and splices may be bolted or welded.
2. All holes for bolts shall be punched or drilled without ragged or torn edges. Finished holes for bolts shall be 1/16 inch larger than nominal diameter of the bolt.

B. Metal Preparation
1. All metal shall be properly prepared before shop connections are made in accordance with welding and bolting requirements of these specifications, AISC and AWS standards.
2. All completed members shall be straight, without kinks, twists, bulges, bends and open joints.
3. Shearing, punching and cutting of materials shall be without torn or ragged edges.
4. Holes too small to meet above requirements shall be enlarged without distortion to the metal by reaming.
5. Bolted parts, when assembled, shall be fabricated so that the bolts will enter without distortion.
6. Compression members shall have milled or sawed shop ends and joints.
7. Open holes necessary for connection of other work shall be provided at time of fabrication. Contractor shall coordinate work with that of other trades.
8. Grind all factory or field welds where exposed to achieve smooth consistent surface. Field-apply primer (or galvanized paint if metal is galvanized) immediately following grinding.

C. Painting
1. All steel work except that encased in concrete or otherwise noted, shall receive one shop coat of a rust inhibitive paint meeting Federal Specification TT-P-636 with a minimum dry paint film thickness of 2.0 mils.
2. All metal shall be free of dirt, grease, rust, mill scale, oil and other foreign material, and shall be wire brushed before painting.

D. Tolerances
1. Fabrication tolerances shall be in accordance with AISC Manual of Steel Construction- Current Edition.

3.2 ERECTION

A. Precautions

1. The Contractor shall take necessary precautions to secure all steel against movement during erection and that bracing as noted in the remainder of this section of the specifications is installed.

B. Base Connections
   1. Anchor rods shall be placed and accurately located in footings, piers, and walls in advance of column erection.
   2. Column bases shall be set level, using steel shims on four corners and grouted solid to ensure full bearing contact on foundation or support material.
      a. Grout shall be a minimum of 1 1/2" thick, high strength, non-metallic, non-shrink, damp packed consistency construction grout.
   3. Column bases are designed as unrestrained and all columns require temporary bracing until all framing and erection work is secure and in place.

C. Field Connections
   1. Field connections may be either welded or bolted.
   2. As erection work progresses, all steel work shall be secured and fastened with either temporary or permanent connections.
   3. Bolts exposed to weathering or to earth shall be dipped in a rust inhibitive paint prior to installation.
   4. Gas cutting: Field correcting of fabrication by gas cutting shall not be permitted on any major member in the structural framing without prior approval of the Architect.
   5. All beams with or without bearing plates shall be set in 1 to 1 mix of sand and Portland cement so as to ensure full contact bearing.

D. Bracing - All structural steel shall be braced, guyed and stayed to prevent lateral or vertical movement against construction loads, dead loads, wind forces and erection forces. Such bracing shall remain in place until secured and all exterior walls are in place.

E. Field Painting
   1. Damage of shop paint or exposed rusted metal spots shall be cleaned and painted before erection. Paint shall be same as applied by fabricator.
   2. After erection, all steel exposed to earth or weather shall be painted with a 2nd coat of rust inhibitive paint.
   3. After erection, all abrasions or damaged paint marks, including bolts, nuts and welds, shall be touched up with shop paint by the erector.
   4. See Section 09 91 00 for finish coats required.

F. Tolerances - Erection tolerances shall conform to part b) of section 7 of AISC "Code of Standard Practice for Steel Buildings and Bridges", as stated in the 7th Edition of AISC Manual of Steel Construction or most current edition.

3.3 IMPROPER FIT OF STEEL WORK

A. All framing or connections that do not properly fit, or are not located according to plans, shall be modified or replaced at contractor’s expense. Contractor shall submit to the Architect drawings and proposals for modifications and replacement, for approval. No work shall proceed until approval is received, but temporary shoring and bracing shall be placed until approved corrections are made.

3.4 SPECIAL INSPECTIONS

A. Inspection of Steel structure placement and connections for conformance to the construction documents and the IBC shall be completed by the designated third-party Special Inspector.

END OF SECTION

SECTION 05 31 23

METAL DECKING - ROOF

PART 1 GENERAL

1.1 SCOPE

A. This section shall cover all furnishing, fabrication, connection and erection of steel roof deck complete.

1.2 WORK INCLUDED AND FURNISHED

A. All labor, tools, materials, scaffolding, bracing hoists and other construction equipment required for the complete erection and installation of roof deck.

B. Shop drawings showing complete erection details shall be submitted in quadruplicate to the Architect for approval before fabrication is begun.

C. Furnishing of steel deck, accessories and clips necessary for the completed deck, including rubber type and closures.

D. Shop and field painting.

1.3 RELATED SECTIONS

A. Section 01 40 00 – Quality Control: Required Special Inspections

B. Section 05 12 23: Structural Steel

C. Section 05 21 00: Open Web Steel Joists

D. Section 05 50 00: Metal Fabrications

1.4 STANDARDS

A. Design properties shall be computed in strict accordance with the latest edition of "Specifications for the Design of Light Gage Structural Members" of the AISI. Steel decking shall meet SDI Specifications and Certification.

PART 2 PRODUCTS

2.1 MATERIALS

A. Roof deck shall be manufactured from steel conforming to A-1008 having a minimum yield value of 33,000 P.S.I.

B. In no case shall properties of the deck be less than that indicated on plans or herein these specifications.

C. Deck shall be steel sheets with a shop coat of primer.

D. Steel Deck Types
   1. **1 ½" Steel Form Deck:** Deck shall have continuous integral ribs 1 1/2" deep, spaced no more than 6 1/4" on center. Ribs at bearing points shall be commonly referred to as "wide rib". Gauge of material shall be as noted on contract plans, but in no case shall be less than 22 gauge, `B' deck.

   2. **3" Steel Deck:** Deck shall have continuous integral ribs 3" deep, spaced no more than 8" on center. Ribs at bearing points shall be commonly referred to as "wide rib". Gauge of material shall be as noted on contract plans, but in no case shall be less than 20 gauge, Vulcraft `N' deck or approved alternate.

PART 3 EXECUTION

3.1 INSTALLATION

A. General: Install roof deck units and accessories in accordance with manufacturer's recommendations and shop drawings.

B. Placing Roof Deck Units.
   1. Position roof deck units on supporting steel framework and adjust to final position with ends bearing on supporting members and accurately aligned end to end before being permanently fastened.
   2. Lap ends not less than 2 1/2 inches. Laps shall occur at a support.
   3. Do not stretch or compress the side lap interlocks.
   4. Place deck units flat and square, and secure to adjacent framing without warp or deflection.

C. Fastening Deck Units
   1. Secure roof deck units to supporting members with 5/8" diameter puddle welds at spacing as noted in structural notes on structural drawings.
   2. Welding to conform to AWS D1.1-Current Edition.
   3. Side laps shall as noted between each support according to structural notes on structural drawing.

D. Cutting and Fitting
   1. Cut and fit roof deck units and accessories around projections through roof decking.
   2. Make cuts neat, square, and trim.
   3. Cut openings in roof deck true to dimensions using metal saws, drills or cutting torches.
   4. Do not use cutting torches where a finished appearance is required.

E. Closure Strips: Install closure strips at all open uncovered ends and edges of roof decking, and in voids between decking and other construction.

F. All erection work shall be coordinated with other trades to provide the necessary vents, hangers, openings, etc. required.

G. After installation, deck shall be a continuous, clean, dry surface ready for roofing materials.

H Architect and structural engineer shall observe the finished roof deck prior to placing of covering materials.

3.2 JOINT SEALING

A. Remove dust, dirt, and moisture from joint surfaces.

B. Apply sealant in accordance with manufacturer's instructions.

3.3 TOUCH-UP PAINTING

A. Wire brush, clean and paint scarred areas, welds, and rust spots on top and bottom surfaces of decking units and supporting steel members.

B. Touch-up shop painted surfaces with same paint used in shop, and apply as recommended by manufacturer.

C. Touch-up paint shall match existing paint in exposed areas.

3.4 SPECIAL INSPECTIONS

A. Inspection of steel deck placement and connections for conformance to the construction documents and the IBC shall be completed by the designated third-party Special Inspector.

END OF SECTION

SECTION 05 40 00

COLD-FORMED METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY

A. Furnish labor and materials for installation of all load bearing metal stud walls, metal floor joist, and metal roof joist framing as indicated on drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE:

A. Quality Control - Section 01 40 00: Required Special Inspections

B. Submittals: Section 01 33 00

C. Insulation: Section 07 21 00

D. Clips and Bracing: Structural Drawings

E. Metal Studs: Section 09 22 16

F. Drywall: Section 09 29 00

1.3 REFERENCES

A. AISI - Standard for Cold-Formed Steel Framing General Provisions.

B. AISI - North American Specification (NASPEC) for the Design of Cold-Formed Steel Structural Members – Current Edition.

C. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

D. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

E. ASTM A 1003 - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

F. ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

G. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

H. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

I. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

J. ASTM E 413 - Classification for Rating Sound Insulation.

K. GA-600 - Fire Resistance Design Manual.

1.4 DESIGN REQUIREMENTS

A. Design steel in accordance with American Iron and Steel Institute Publication "Specification for the Design of Cold-Formed Steel Structural Members" or the North American Specification for the Design of Cold-Formed Steel Structural members, except as otherwise shown or specified.

B. Design loads: As indicated on the Architectural and Structural drawings.

C. Design framing system to accommodate deflection of primary building structure and construction tolerances.

D. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provides materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing laboratory, and by UL 263. Products used in the assembly shall carry a classification label from the testing laboratory.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submit manufacturer's product literature and data sheets for specified products.

C. Manufacturer's certification of product compliance with codes and standards.

1.6 QUALITY ASSURANCE

A. Contractor shall provide effective, full time quality control over all fabrication and erection complying with the pertinent codes and regulations of government agencies having jurisdiction.

B. Contractor to conduct pre-installation meeting to verify project requirements, substrate conditions, and manufacturer's installation instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installing.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Store materials protected from exposure to rain, snow or other harmful weather conditions, at temperature and humidity conditions per the recommendations of ASTM C754 section 8.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. ClarkDietrich Building Systems, 9100 Pointe Drive, Suite 210, West Chester, OH. Phone: 513-870-1100. www.clarkdietrich.com, info@clarckdietritrich.com.
   2. Other manufacturers as referenced in this section for specific products.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

C. All products to be manufactured by current members of the Steel Stud Manufacturers Association (SSMA), Steel Framing Industry Associates (SFIA), or the Certified Steel Stud Association (CSSA).

D. All studs and/or joists and accessories shall be of the type, size, gauge and spacing shown on the drawings. Exterior studs and load bearing studs shall have a 1-5/8" flange with 1/2" return lip.

E. All framing members shall be formed from steel, corresponding to the requirements of ASTM A653, with minimum yield strength of 33 ksi. All studs shall be galvanized.

F. Flexible Track: Flex-C Trac manufactured by Flex-Ability Concepts, P.O. Box 7145, Edmond, OK 73083, (405) 302-0645, www.flexc.com, or approved alternate.
   1. Subject to compliance with requirements provide ClarkDietrich™ Building Systems; Framing Contour Track (CNTB).
   2. Gauge to match stud gauge.
      a. Depth as indicated on Drawings.
   3. Provide in depths as required to meet stud depth.
   4. Cut, Slice, and install track per manufacturer's instructions.

G. Where fire blocking is required or called for on drawings, provide blocking equal to prefabricated fire blocking manufactured by Metal-Lite, Inc., Placentia, CA (800) 886-6824. Provide blocking same width as metal stud.
   1. Provide where stud frame bypasses floors and where studs bypass roof.
   2. For draft-stopping with mineral wool refer to specification section 07 84 00.

2.2 MATERIALS

A. Steel: Galvanized Steel meeting or exceeding the requirements of ASTM A 1003.
   1. Coating: Galvanized G60 (Z180) coating minimum, complying with ASTM A1003.

B. Fasteners: Self-drilling, self-tapping screws; complying with ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

C. Touch-Up Paint: Complying with ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

2.3. FRAMING ACCESORIES: Provide accessories as required in this project.

A. Flat Strapping for Backing Strip.

B. Flat Strapping and bridging for lateral bracing.

C. L-Angles.

D. SwiftClip Fixed Connection Angles.

E. Deflection Slip Connectors: “Verticlip” Series, manufactured by Steel Network, Inc, or approved alternate. Provide clip as required for each situation to compensate for deflection of structure.

F. Additional accessories as indicated on Drawings.

PART 3 EXECUTIONS

3.1 FABRICATION

A. Prior to fabrication of framing, the contractor shall submit fabrication and erection drawings to the Architect to obtain approval.

B. Method of construction may be either piece by piece (stick built), or by fabrication into panels either on or off the site.

C. Prefabricated panels shall be square, with components attached in a manner as to prevent racking and to minimize distortion while lifting.

D. All framing components shall be cut squarely for attachment to perpendicular members, or, as required, for an angular fit against abutting members.

E. Axially loaded studs shall be installed in a manner which will assure that their ends are positioned against abutting members.

F. Fastening of components shall be with welding or with minimum 1 #8 screw both sides of flange. Welds shall conform to the requirements of AWS D.1.1, AWS D.1.3 and AISI Manual Section 4.2. All welds shall be touched up using zinc-rich paint. Wire tying will not be permitted.

G. Cutting of steel framing members may be accomplished with a saw or shear. Torch cutting of load bearing studs will not be permitted.

H. Install headers in all openings in axially loaded walls that are larger than the stud spacing in the wall. Form headers as shown on drawings.

I. Unless shown otherwise on drawings, brace top of metal stud walls to structure above at max. 4’-0” O.C. with minimum 20 gauge stud bracing.

J. Insulation equal to that specified elsewhere shall be provided in all double jamb studs and doubled headers not accessible to insulation contractors.

K. Care should be taken to allow for additional studs at intersections, corners, doors, windows, steel joists, diagonal bracing and as called for in the shop drawings.

3.2 ERECTION (AXIAL LOAD-BEARING).

A. Runners shall be securely anchored to the supporting structure as shown on the drawings.

B. Complete, uniform and level bearing support shall be provided for the bottom runner.

C. Abutting lengths of runner shall be butt-welded or spliced.

D. Studs shall be plumbed, aligned and securely attached to flanges of both upper and lower runners.

E. Framing of wall openings shall include headers and supporting studs as shown on the drawings.

F. Temporary bracing, where required, shall be provided until erection is completed.

G. Resistance to bending and rotation about the minor axis shall be provided by gypsum board and gypsum sheathing as per manufacturer's recommendations. If diaphragm rated materials is used, it must be installed prior to loading the wall. At load-bearing walls, channel bridging shall be provided at 4’-0” for the full height of the wall. Bridging shall be screwed to each stud.

H. Diagonally braced stud walls, as indicated on the structural drawings shall be provided at locations designated as "shear walls" for frame stability and lateral load resistance. Additional studs, when necessary, shall be positioned as indicated on drawings to resist the vertical components. 16-gauge top runner track shall also be provided at diagonally braced stud walls.

I. Splices in studs shall not be permitted.

J. See Structural Drawings for the locations of the “Verticlip SLB Series” slide clip as manufactured by Steel Network or approved alternate. Coordinate with stud size.

K. See Structural Drawings for the locations of the “Stiff Clip LB Series” stationary clip as manufactured by Steel Network or approved alternate. Coordinate with stud size.

L. Coordinate stud wall bracing placement to work with installation of ductwork, piping, etc.

3.3 SPECIAL INSPECTIONS

A. Inspection of cold formed steel for conformance to the construction documents and the IBC shall be completed by the designated third-party Special Inspector.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Furnish labor and materials for installation of miscellaneous metal products as indicated on plans and/or specified herein.

1.2 INTEGRATION WITH OTHER TRADES

A. Each Trade shall provide all items necessary to be built into masonry, concrete, tile, etc., prior to when needed. Construction Manager is to be responsible for coordination and scheduling of such items.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Section 01 40 00: Quality Control: Required Special Inspections

B. Section 03 30 00: Cast-in-Place Concrete:

C. Section 09 91 00: Painting and Finishing

1.4 QUALITY

A. Welders: Use only certified welders in accordance with AWS D1.1-Current Edition., licensed in the State of Arkansas.

B. Codes and Standards
   1. "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings", A.I.S.C.
   2. "Code for Welding in Building Construction", American Welding Society.
   3. Applicable codes and ordinances.

1.5 SHOP DRAWINGS

A. Comply with requirements of Section 01 33 00.

PART 2 PRODUCTS

2.1 METALS

A. Metals shall conform to applicable ASTM specifications, including but not limited to:
   1. Steel wide flanges and tees ASTM A992 with 50 KSI yield strength
   2. Standard steel pipe ASTM A501
   3. Steel tubing ASTM A500, Grade B
   4. Steel plate ASTM A36

5. Other Structural Steel ASTM A36
6. Bolts ASTM A307
7. Anchor Rods – ASTM F1554, Grade 36
8. Exterior steel angle lintels and exposed steel plates and bent plates – Galvanized finish, hot dipped, ASTM 385/385M-15, grade 65.

2.2 PAINT

A. Primer paint: Manufacturer's standard, compatible with finish coat paint specified in Section 09 91 00.

B. Dissimilar metals shall be protected from galvanic action by coating with one coat of zinc chromate primer prior to assembly.

2.3 MISCELLANEOUS ANCHORS:

A. Furnish anchor rods and miscellaneous anchors as required except where such items are specified in other sections of these specifications, or where customarily furnished with the items to be attached.

2.4 MISCELLANEOUS ITEMS

A. Furnish and install where shown in accordance with drawings and details other items of miscellaneous metals except where same are specified in other sections of these specifications. These items to include, but not be limited to:
   1. Slip angles, stiffener channels, equipment frames, legs, supports, etc.
   2. All other materials, not specifically described, but required for a complete and proper installation.

2.5 ROOF CROSSOVER STAIRS

A. Elevated walkway systems as manufactured by PHP Systems/Design or approved alternate.
   1. Support Spacing: As needed, verify in field.
   2. Bases High Density Polypropylene plastics with additives for UV protection
   3. Substructure: 12-gauge back-to-back strut G-1012A, or approved equal supported directly from the bases.
   4. Grating: Mill-galvanized carbon steel in accordance with ASTM A525:
      a. Gauge 14-ga. steel.
      b. Section Width: 12 inches (305 mm) (standard),
      c. Channel Height: 2 inches (51 mm) (standard).
      d. Surface Condition: MG-traction grip
   5. Handrail: 12 gauge, 1-5/8 inch (41 mm) strut G-5812, or approved equal.
   6. All substructures and handrails shall be galvanized steel. Spring nuts and bolts for spring nuts will be electro-plated.
   7. Provide a factory-trained representative of the manufacturer to visit the site while the work is in progress to assure that the installation conforms to the design requirements and the manufacturer's installation requirements.

PART 3 EXECUTION

3.1 QUALITY CONTROL

A. All material shall be new, of the best quality, and subject to the approval of the Architect.

B. Weld or rivet permanent connections; do not use screws or bolts where they can be avoided.

C. Fastenings shall be concealed where practical, and heads countersunk where required. Use lock washers to prevent loosening.

D. Provide holes and connections for the work of other trades.

E. Welds in flat surfaces, where exposed in finished rooms, or where noted shall be ground smooth and exposed corners or edges shall be rounded where practicable.

F. All items shall be properly located, set level, plumb, square and in alignment, and shall be securely attached.

G. Grind all factory or field welds where exposed to achieve smooth consistent surface. Field-apply primer (or galvanized paint if metal is galvanized) immediately following grinding. Paint all exposed steel per section 09 91 00.

H. Provide galvanized finish on exterior, exposed angle lintels, exposed steel plates and steel bent plates unless noted otherwise, provide galvanized finish on other items where specified and called for.

3.2 TOUCH-UP PAINTING

A. Wire brush, clean and paint scarred areas, welds, and rust spots on top and bottom surfaces of decking units and supporting steel members.

B. Touch-up shop painted surfaces with same paint used in shop, and apply as recommended by manufacturer.

C. Touch-up galvanized welded areas with Galvilite By ZRC Products Company, or approved equal.

3.3 SPECIAL INSPECTIONS

A. Inspection of miscellaneous metal placement and connections for conformance to the construction documents and the IBC shall be completed by the designated third-party Special Inspector.

3.4 WALKWAY, CROSSOVER & EQUIPMENT PLATFORM ACCESS

A. Install substructures at spacing indicated, but not greater than 5 feet (1.5 m) on center.

B. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all structures.

C. Accurately locate and align bases.

a. Consult manufacturer of existing or new roofing system as to the type of isolation pads required between the roof and base.
b. Set isolation pads in adhesive if required by manufacturer's instructions.
c. Place bases on isolation pads.
d. Adhere or mechanically attach if required by code.
e. Where applicable, replace gravel around bases.

D. Set legs of substructures into bases as indicated.

E. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.

F. Layout and fasten planking to substructures.

G. Where handrails are required, install as follows:

a. Install intermediate rails without tightening.
b. Make minor adjustments as needed, such as spacing of substructures to accommodate intermediate handrails, and install hold-downs.
c. Secure intermediate handrails and install top handrails.

END OF SECTION

SECTION 06 10 00

ROUGH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install all wood framing members, stripping, blocking, grounds, pressure treated wood, fire treated wood, equipment curbs and cants, and other miscellaneous.

1.2 PRODUCT HANDLING

A. Protection:
   1. Store all materials in such a manner as to ensure proper ventilation and drainage, and to protect against damage and the weather. Store in a well-ventilated building where not exposed to extreme changes of temperature and humidity.
   2. Keep all materials clearly identified with all grade marks legible. Keep all damaged material clearly identified as damages, and store separately to prevent its inadvertent use.
   3. Do not allow installation of damaged or otherwise non- complying material.
   4. Use all means necessary to protect the installed work and materials of all other trades.
   5. Protect all metal products with adequate waterproof outer wrappings.
   6. Use extreme care in off-loading of lumber to prevent damage, splitting, and breaking of materials.

1.3 ECOLOGICAL PRESERVATION

A. Contractor will not use old growth Western Red Cedar, Sitka Spruce, Western Hemlock, Pacific Fir, or Coastal Redwood unless it is recycled. Only upon written request, under unusual circumstances, will use of any of these species be considered by Architect.

PART 2 PRODUCTS

2.1 MATERIALS

A. All materials herein specified: The best of their respective grades, conforming to grading rules of lumber association under which they are produced, thoroughly seasoned or kiln dried. Protect and cover in shipment and on job site.

B. Framing lumber and miscellaneous blocking - No. 2 Grade Douglas Fir, or Southern Pine, S4S in conformance with ASTM 245- 69 grading, or as otherwise specified on plans.

C. Pressure treated wood:
   1. Use arsenic-free pressure treated lumber, Copper Azole Type-B (CA-B), Alkaline Copper Quat (ACQ), or approved equivalent product conforming to American Wood Preservers Association standards for use above ground in all places where lumber is used in contact with masonry work and concrete. Where used with roofing, at roof curbs, parapet caps, roof edge member or roof cant strips, whether noted on plans or not, type MCA treatment is acceptable.

2. Use minimum 0.40 Lbs./Cu. Ft. retention for ground contact lumber, and 0.25 for above ground applications.
3. Pressure treated wood shall leave no apparent odor or stain in the completed work.
4. Fasteners shall be stainless steel or hot-dipped, galvanized conforming to ASTM A-153.

D. Fire treated wood: All concealed lumber, wood products and wood materials used in construction that are to remain as part of the finished work, shall be fire retardant treated, Pyro-Guard manufactured by Hoover Treated Wood Products, PO Box 7807, Pine Bluff, AR 71611 (501)247-3511, or approved alternate. Flameproof treatment shall be tested to produce a flame spread of 25 or less as determined by Underwriters Laboratories in the extended 30 minute duration of ASTM E-84, "Standard Test Method for Surface Burning Characteristics of Building Materials.". Provide with 20 year manufacturer's warranty.
   1. For IBC type I and type II construction, concealed lumber used for blocking in attachment of handrails, toilet accessories, markerboards, etc. is not required to be fire treated.
   2. Isolate metal materials coming in contact with Fire treated wood with 30# felt.

E. Plywood and Lumber:
   1. Plywood to meet performance standards for its type as described in Product Standard PS 1 for Douglas Fir plywood. Provide exterior type plywood for permanently exposed plywood in outdoor applications.
   2. Provide lumber for structural carpentry using the following species provided grade for each is not lower than minimum shown:
      Fir, Douglas – WCLIB, Standard
      Pine, Southern Yellow - SPIB Rules, No. 2 Common
   3. Pressure treat concealed wood including lumber, grounds, nailers, blocking, backing, rough framing, and lumber in contact with the ground, in contact with concrete or masonry within 24" of the ground, installed on or above roof deck, and as required, complying with published standards or the American Wood Preserver's Association.
   4. Plywood not otherwise specified or not on the drawings: Douglas Fir or Southern Yellow Pine panels, C-D grade for concealed applications and A-C grade for exposed applications, meeting US product standard PS1. Furnish plywood for underlayment using underlayment grade with exterior glue.
   5. **SHTG-2** Exterior Plywood: APA CDX, exposure 2 with exterior glue thickness as called for. Butt joint and tongue & groove. See drawings.
   6. Interior Plywood: Thickness & type indicated on drawings;
      APA A-A INT, where exposed two sides and painted finished is called for.
      APA N-N INT, where exposed two sides and stained or natural finish is called for.
      APA A-D INT, where exposed one side (ie. shelving, panel boards, etc.)

F. Plywood Floor Decking: 1 1/8" thick "Plytanium Plywood Sturd-I-Floor", Tongue and Groove 4'-8' plywood panels, southern pine,, manufactured by Georgia Pacific.
   a. Exposure 1, fire classification III or C, Fire Spread Rating-76-200, smoke developed index of 450.
   b. Warranty: 2 year limited warranty.

G. Backer Board: Provide at roof side of all metal stud roof parapet walls (refer to drawings for locations and thickness).
   1. Backer board thickness: Coordinate with drawing details.

2. Roofing installer is responsible for providing any required priming for adhesion of roofing membrane.
3. Protect the backer board from moisture and weather per manufacturer's recommendations.
4. Acceptable products:
   a. Den Deck Roof Board by Georgia Pacific
   b. Securock Gypsum –Fiber Roof Board by USG

H. Exterior Sheathing Board: Refer to Section 09 29 00 Drywall.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. Framing: Frame, fit closely, set framing according to required lines, levels and secure rigidly in place.

B. Grounds and Blocking: Provide wood grounds and blocking of size and shape required to secure other work or equipment in place. **NO METAL STRAPPING WILL BE ACCEPTED AS A SUBSTITUTE FOR WOOD BLOCKING.** Set grounds true to line, level or plumb and well secured in place. Wood blocking or nailer on steel framing shall be bolted thereto. Provide solid grounds blocking in walls for wall hung or attached items and equipment (i.e. cabinets, countertop brackets and supports, wall mounted hardware, coat hooks, toilet accessories, etc.) Also provide wood blocking in walls and/or ceilings for all owner-provided items. Verify and coordinate with owner actual locations.

C. Nails, spikes, screws and other anchoring items shall be of the approved size and type to secure the member in place if not called out on drawings.

D. If approved by Architect, fir dimensional lumber and fir plywood may be used in lieu of pressure treated wood in concealed areas unless pressure treated wood is required by code. If pressure treated wood is used, secure with 304 or 316 stainless steel fasteners or other corrosive-resistant fasteners approved for use with pressure treated wood and approved by manufacturer. Install 30# felt paper over metal substrates or coat with bituminous material prior to installation of pressure treated wood products.

E. Metal products in contact with pressure-treated wood must be corrosion resistant. Examples include flashing, termite shields, fasteners (e.g. nails, screws, and bolts), and all connecting hardware (e.g. joist hangers, straps, hinges, post anchors, and truss plates). Provide non corrosive separation material between such as felt paper, bituminous material, etc.

F. Defective materials shall be removed from the job site and replaced with acceptable materials at no additional cost to the Owner.

3.2 PROTECTION OF INSTALLED PRODUCT

A. Any exposed exterior or interior plywood sheathing to be covered with temporary or permanent weather barrier within 24 hours following sheathing installation to prevent exposure to moisture or sunlight. Gypsum sheathing to be covered with temporary or permanent weather barrier within minimum time allowed by sheathing manufacturer.

B. No plywood roof decking will be left exposed to moisture and sunlight. Weather barriers are to be installed immediately following installation of roof deck.

C. Schedule work so that wood framing for roof and exterior walls are covered with decking or sheathing as soon as possible to prevent weathering and warpage of framing materials.

3.3 GRADE STAMPS

A. Framing lumber: Identify all framing lumber by the grade stamp of the Southern Pine Inspection Bureau.

B. Plywood: Identify all plywood as to species, grade, and glue type by the stamp of the American Plywood Association.

C. Other: Identify all other materials of this Section by the appropriate stamp of the agency listed in the reference standards.

3.4 CLEAN UP

A. Keep the premises in a neat, safe, and orderly condition at all times during execution of this portion of the work. Clean up and remove from site the debris, cut ends, and sawdust.

END OF SECTION

SECTION 06 20 23

FINISH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install items of finish carpentry and miscellaneous millwork, including all finish trim; fitting and installing all wood doors and frames; installing all finish hardware, and construction of job-built shelving.

B. Furnish and install medium density fiberboard (MDF) and associated items.

C. Hardwood Veneer Plywood

1.2 RELATED WORK

A. Section 06 10 00 - Rough Carpentry

B. Section 08 14 16 - Wood Doors

C. Section 08 71 00 - Finish Hardware

D. Section 08 81 00 - Glass and Glazing

E. Section 09 91 00 – Finishes

1.3 SHOP DRAWINGS

A. Submit complete shop drawings for Architect's approval prior to fabrication of any millwork or trim.

1.4 REFERENCES

A. Comply with State of Arkansas Adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

1.5 FIELD DIMENSIONS & COORDINATION

A. The millwork manufacturer is responsible for details and dimensions set in accordance with field measurements. The Contractor and the Millwork Supplier shall coordinate and correct any discrepancies prior to fabrication or placement of any work.

B. Coordinate clearances of door hardware items with lites and lite frames.

1.6 PRODUCT HANDLING AND DELIVERY

A. Contractor and Millwork Supplier are to coordinate all phases of the work provided in under this section to ensure timely delivery and setting after building is sufficiently dry and climate controlled to protect the work.

PART 2 PRODUCTS

2.1 FINISH WOOD MATERIALS:

A. All interior trim and railings which are to be stained shall be ash unless otherwise shown on drawings.

B. When painted, material shall be close grained, smooth surface, suitable for painting. Species to be ash or other similar closed grain species with Architect's approval.

C. All materials shall be of select material, with no splits, knots, or other defects.

D. **WD-1** White Ash, Clear Coat:
   a. ANSI Grade B, quarter cut white ash veneer, reverse slip match.
   b. Face to be stained clear with clear, water-based sealer.

2.2 **WD-4** MEDIUM DENSITY FIBERBOARD (MDF)

A. Interior, industrial grade, manufactured with a core density that is 88 percent of board average density. Board will meet requirements of ANSI A208.2-1994, product class MD.

B. All surfaces to be painted PT-3B and as called for on drawings.

C. Refer to drawings for thickness and face dimension.

2.3 **WD-2** HARDWOOD VENEER PLYWOOD

A. ANSI Grade A/A, rotary cut white ash veneer, 4’ x 8’ x 3/4” 7 ply, cabinet grade.

B. Face to be stained clear.

2.4 **WD-3** WOOD TO MATCH EXISTING

A. White maple solid trim and veneer plywood to match existing. Clear, waterbased sealer, result to match existing.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. Frame, fit closely, and set accurately to required lines, levels, and secure rigidly in place.

B. All interior trim is to be sanded smooth at job so that no sand marks, scratches, blemishes, etc., are noticeable after finish is applied.

C. All interior trim against concrete or masonry or solid backings is to have hollow backs.

D. Joints are to be mitered or angled to conceal shrinkage. Butt joints are not acceptable.

E. Trim and moldings are to be set with finish nails, screws or glue, where required. All fastening devices are to be set and holes filled with similar material not noticeable after finish.

3.2 FINISH HARDWARE: See Section 08 71 00.

A. Installation only by this section. Cut, fit, and install without marring or injuring work. Examine hardware at completion of work; test, oil, grease, adjust, and perform all necessary work to insure correct operation.

B. Doorknobs, pulls, kick plates, push plates, etc., are to be fitted and installed before finishing, then removed and re- installed after finish work is completed.

3.3 WOOD DOORS: See Section 08 14 16

A. Installation only under this section. Fit, hang, trim as required.

B. Provide the following clearances:

Sides	1/16"
Top	1/16"
Base (with threshold)	3/16"
Base (without threshold)	3/8 "

C. Install hardware as specified. Locksets and latches to have centers at 38" above finish floor unless otherwise stated. Coordinate location of locks with approved Hardware Schedule.

END OF SECTION

SECTION 06 22 00

FLEXIBLE WOOD TAMBOUR PANELS

PART 1 - GENERAL

1.1 SUMMARY

A. Provide flexible wood tambour panels of the following types:

1. Solid wood tambours.
2. Veneer tambours.

B. Related Sections: Coordinate with the following as applicable:

1. Section 09 29 00 - Gypsum Board Assemblies for substrate.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's literature including product characteristics and accessories.

B. Shop Drawings: Submit diagram showing layout of pattern and configuration, including details of perimeter conditions and mounting.

C. Verification Samples: Submit samples of materials selected for use to verify profile, color, and finish.

1.3 QUALITY ASSURANCE

A. Manufacturer: Minimum of 5 years experience manufacturing similar products.

B. Installer: Minimum of 2 years experience installing similar products.

C. Field Measurements: To the greatest extent practical, take field measurements prior to fabrication.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and products in unopened factory labeled packages. Store and handle in strict compliance with manufacturer's instructions and recommendations.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Basis-of-Design Manufacturer: Surfacing Solution, 2480 Chaska Blvd., Chaska, MN 55318. Tel 800-964-6727. Direct 952-448-6556. www.SurfacingSolution.com.

B. Submit requests for alternates in accordance with Section 01 60 00.

2.2 **WDPNL-1** SOLID WOOD TAMBOUR PANELS

A. Basis of Design: Solid Wood Tambour by Surfacing Solution.
1. Species: Ash.
2. Sheet Lengths: Refer to drawings.
3. Sheet Widths: Refer to drawings
4. Profiles: T493: Slat width of 1 inch (25 mm) and height of 1/2 inches (13 mm).
5. Field Finish: Clear.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install products in strict accordance with manufacturer's instructions, approved submittals and in proper relationship to adjacent construction.

1. Clean substrate of dirt and bond breaking substances prior to beginning installation.
2. Acclimatize panels at the installation site for a minimum of 48 hours prior to installation.
3. Roll tambour panels in accordance with manufacturer's instructions to properly space slats.
4. Follow manufacturer's recommendations for adhesives and mounting devices.
5. Replace damaged or defaced products prior to Substantial Completion.

3.3 CLEANING

A. Clean surfaces to remove soiling, stains, dust, and dirt using materials acceptable to manufacturer.

B. Leave installation area clean and free of residue and debris resulting from work of this Section.

END OF SECTION

SECTION 06 41 13

CABINET WORK AND SHELVING

PART 1 GENERAL

1.1 SUMMARY

A. Furnish labor and materials for fabrication and installation of wood cabinet work indicated and specified, including cabinet hardware.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough-in Carpentry - Blocking

B. Section 09 65 00 - Resilient Flooring - Rubber Base

1.3. QUALITY ASSURANCE

A. All cabinets and millwork to conform to the **Architectural Woodwork Institute (AWI)** quality standards, **Custom Grade** in addition to requirements as specified in this section.

B. Manufactured casework is approved, but must meet requirements as shown on drawings and as specified in this section.

C. Subcontractor / supplier providing work under this section will install work specified in this section with their company's own installers, employed by the company. **Subcontracting of installation will not be allowed.**

D. Manufacturers, suppliers and fabricators to have minimum 5 years in the manufacturing and installation of cabinets and millwork.

E. ADA-Americans with Disabilities Act requirements: The special requirements of ADA shall be a requirement of this section and where specifically indicated on drawings in detail or notation. Comply with Federal Register Volume 56, No. 144, rules and regulations.

F. Provide balanced construction for all plastic laminated panels.

1.4 WARRANTY

A. Provide manufacturer's warranty against defects in materials, fabrication and installation, excluding damages caused by physical or chemical abuse or excessive heat. Warranty shall provide for replacement or repair of material and labor for a period of ten (10) years, beginning at Date of Substantial Completion.

B. Maintain surfaces in accordance with manufacturer's care and maintenance instructions.

C. Fabrications shall not have been moved from original place of installation.

D. Warranty shall be transferable to subsequent owner.

1.5 SHOP DRAWINGS

A. Submit accurately detailed shop drawings to Architect for approval prior to fabrication. Comply with section 01 33 00 for submittal.

B. Submit two copies or shop drawings and one reproducible set to Architect.

C. Samples: Submit PVC edging, full color ranges for Architect's selection.

1.6 COORDINATION & FIELD VERIFICATION

A. Cabinet/millwork contractor to be responsible for coordination of installed equipment and fixtures specified in other sections and shown on drawings. Contractor is to provide required specifications to cabinet/millwork contractor so he may make provisions for installation and attachment of equipment and fixtures which are to be installed in cabinets. Contractor is responsible for field verifying accurate field measurements prior to fabrication and placement.

1.7 PRODUCT HANDLING & DELIVERY

A. No delivery or installation shall be allowed until building is sufficiently dry; and climate controlled to receive such materials without risk or damage to same.

PART 2 PRODUCTS

2.1 CUSTOM OR JOB CONSTRUCTED CABINETS & OPEN SHELVING:

A. Cabinet Construction: Fabricate from sound, kiln-dried lumber with exposed frames rails, stiles, and intermediate members, not less than 3/4" thick ash and of sufficient width to ensure sturdy, rigid construction. (See details on plans).

B. **WD-2** All exposed lumber shall be ash and plywood ash veneer for panels unless otherwise called for on plans. All lumber exposed on interior of the cabinets shall be ash solid core plywood Grade A-A where both sides are exposed and Grade A-B where only one side is exposed.

C. Tops, bottoms, and sides of interior partitions and shelves: 3/4" fir plywood. Exposed bottoms of wall cabinets to have same material and color as door faces.

D. Back and Ends: Fir A-B plywood unless exposed, then use veneer to match face frame's wood species.

E. Concealed Shelves: Shelves 3/4" thick, ash plywood veneer

F. All plywood exposed edges shall have sealed ash nosing materials as detailed on plans, unless specifically called out otherwise on plans.

G. Interior surfaces (behind doors), unexposed end panels: Fabricated from 3/4" thick 47 lb. density particle board with thermally fused melamine laminate. Backs to be min. 1/2" thick 47 lb. density particle board with thermally fused melamine laminate or ash plywood veneer where called for.

H. Counter Tops: Refer to drawings for counter material.

I. Bases: 3/4" thick x 4" wide exterior pine or fir plywood with 3/4" thick x 4" wide supports at 32" o.c. minimum. 4" coved Rubber base to be installed. Refer to section 09 65 00 Resilient Flooring.

J. Drawer Body: Sides and back - (Provide AWI premium grade construction as minimum requirement)
   1. Drawer body: Sides, fronts and backs shall be ½" thermally fused melamine laminate both sides (1/2" hardwood solid core plywood finger jointed or Dovetail jointed on all four corners, glued and cross pinned will be considered equal construction). (Dovetail joint will be considered equal construction)
   2. Drawer bottom: Minimum1/4" plywood or hardboard, grooved in on all four sides, or ½" 47 lb. density particle board with thermally fused melamine laminate. Provide minimum ½" plywood with hardwood veneer for drawers 30 inches or wider.
   3. Drawer slides:
      a. Standard: Accuride #7432 or approved alternate
      b. Heavy duty (equipment shelves and drawers over 30 "wide and 8" in height): Accuride #3832 or approved alternate.
   4. Index followers: (file drawers) K.V. #476F.
   5. Additional support to be provided for drawers 30" wide or more.

K. All exposed edges of melamine to have edge banding of 3mm PVC as selected by Architect.

2.2 HARDWARE
   1. **MWA-1** Pulls: IKEA Begripa Handle, Half Round Cabinet Pull, or equivalent pull. 5-1/8" x 2-9/16"x7/8", White.
   2. Concealed Hinges: Salice Hinge Part #C2R9A99, Plate #B2V3 H09/15. Blum or H'A'FELE are approved alternates. Hinges to be self-closing.
   3. Locks: (When called for) If required, locks can be keyed different and master keyed. Otherwise, key each group of locks together. Verify with owner prior to cabinet fabrication.
      a. Drawers and single leaf doors: CompX National #C8053 series, cylinder type, 5 disk tumbler mechanism.
      b. Double leaf locking:
         Lock - CompX National #C8053 series, cylinder type, 5 disk tumbler mechanism.
         Latch: CompX Timberline DL series double door latching system with the DL-200 and DL300 activator and catch. Provide black color. Provide 1 latch system (bottom) for doors up to 48" in height and two latch systems (top & bottom) for doors over 48" in height.
      c. Provide Chain-type door stop installed on inside of cabinet where unit butts up against sidewall to prevent door from opening into wall or possible other device mounted on wall.

4. **MWA-2** Countertop Bracket: Hafele Centerline Brackets Series, 10" – 14" D, 2-1/2" W, 3/8" T, Front mounting countertop bracket, hand crafted premium steel, powder coated white, surface mounted in vertical plate at stud location.

2.3. Miscellaneous Hardware Items:

1. **MWA-5** Wheel Casters: Richelieu Industrial Grey Thermoplastic Rubber Caster, 5" wheel diameter with mounting plate, swivel without break, capacity up to 298 lbs each.
2. **MWA-6** Cord Grommets: Oval grommets in countertops, Doug Mockett, Model Desk Grommet King Kong, 6-1/2" x 3" x 3/8", 5-7/8" oval cutout, Color: Desert Sand (93D).
3. **MWA-3** Trash Bin: Rubbermaid Office Trash Can – 10 gallon, Model S-13527BE, Finish: Beige, 15" x 11" x 20".
4. **MWA-4** Lazy Susan: Rockler Lazy Susan, Extra Large, Aluminum swivel with ball-bearing construction, 23-5/8" x 7/8", capacity up to 660 lbs.
5. **MWA-7** Trim Angle: Fry Reglet Millwork Reveal L Angle, MWRL100, White, 1"x1".
6. **MWA-8** Wire Manager: Doug Mockett J-shape under desk wire cable manager w/ flange, WM22, Black.
7. **MWA-9** Cabinet Pull: Doug Mockett Round Top Pull, DP128, 6-11/16", Stainless Steel.

2.4 OPEN SHELVING

A. All open wood shelving to be 3/4" ash plywood with matching hardwood nosing on exposed edges.

B. At Contractor's option: All cabinets and open shelving may be preassembled provided the details shown on the plans are followed.

2.5 SHELF HARDWARE:

A. Adjustable shelves: Provide holes @ 32 mm o.c. vertical, provide minimum 4 polymer twin pin-locking shelf clips per shelf capable of receiving ¾" or 1" thick shelving. Clips to withstand 500 lb. Static load per shelf.

B. Fixed shelves: Dowels and glue, AWI premium grade construction.

2.6 MELAMINE BOARD (THERMALLY FUSED LAMINATE PANELS):

A. Architect to select from all available colors as manufactured by Wilsonart Coordinated Surfaces, Pluswood/Panolam/Domtar Melamine Laminate colors, or approved equal.

2.7 **TZ-1** PRECAST TERAZZO

A. Naxco Agglo Mafi, Slab 120" x 49" x 3/4", Profile Edge: Bullnose, Finish: Honed, Refer to millwork drawings for locations and exact dimensions.

2.8 UPHOLSTERY

A. **UPH-1:** Carnegie Xorel Snap Knit, 6019-4, 55" width, 100% IFR Xorel, Backing: X-Protect Sit.

B. **UPH-2:** Maharam Compound, Color: 002 Mirage, 100% Polyester.

2.9 CABINET FINISH:

A. For other than plastic laminate covered cabinet work. Surfaces shall be thoroughly sanded and prepared before finish is applied. No misfits, hammer marks, splinters, bruises, etc., set and fill all nail holes. Cabinets to be stained inside and out unless called out otherwise on plans. See section 09 91 0.

B. Architect may select an assortment of up to three different plastic laminate colors for each cabinet in addition to melamine color.

2.10 SEALANTS

A. Sealant Applications

1. Plastic laminate to plastic laminate (i.e. counter top to backsplash)
   a. "Color Matched Acrylic Latex (Match countertop color)

2. Solid surface to solid surface (i.e. counter top to backsplash)
   a. Color Matched Acrylic Latex (Match countertop color)

2. Epoxy resin to epoxy resin-Black (i.e. counter top to backsplash)
   a. 100% Silicone, Black

3. Stainless steel to walls (i.e. counter top to wall at concession areas)
   a. 100% Silicone, Clear

4. Casework to walls
   a. Acrylic Latex, clear, tinted with paint provided by the painters to create a color match sealant to match wall color.

2.11 CONSTRUCTION

A. As a minimum requirement, conform to construction standards of AWI, premium grade and as specified this section.

B. Millwork fabricator/supplier is responsible for proper construction of each item of millwork, including support of each unit and countertops. If fabricator/supplier finds conditions on millwork drawings that might affect proper operation or require additional support from that shown, notify Architect and provide recommendation so that proper operation or support is provided.

C. ADA- Americans with Disabilities Act Requirements: The following special requirements shall be met, where specifically indicated on architectural plans as "ADA", or by General

Note. To be in compliance with Federal Register Volume 56, No. 144, Rules and Regulations:

1. Countertop height: with or without cabinet below, not exceed a height of 34 inches A.F.F., (Above Finished Floor), at a surface depth of 25 inches unless noted otherwise.
2. Knee space clearance: to be minimum 27 inches A.F.F., and 30 inches clear span width.
3. 12 inch deep shelving, adjustable or fixed: not to exceed a range from 9 inches A.F.F. to 54 inches A.F.F. unless noted otherwise.
4. Wardrobe cabinets: to be furnished with rod/shelf adjustable to 48 inches A.F.F. at a maximum 21inch shelf depth.
5. Sink cabinet clearances: Upper knee space frontal depth to be no less than 8 inches, and lower toe frontal depth to be no less than 8 inches, and lower toe frontal depth to be no lower than 11 inches, at a point 9 inches A.F.F., and as further described in Volume 56. Section 4.19 unless noted otherwise.
   a. Catches to have a maximum resistance of 5 pounds.

D. Countertops
   1. Underside to be properly balanced with backing sheet. Furnish counter tops with edge treatment and profile as shown on the shop drawings. Whenever possible, provide continuous lengths. Provide field joints as required using adhesive and tite-joint fasteners. No joints within 24" of a sink cut-out.
   2. Provide proper support for all types of countertops at no more than 3'-0" on center unless noted otherwise.

E. Workmanship
   1. Laminate surface/balancing liner to core under controlled conditions, by approved and regulated lamination. Natural-setting hybrid P.V.A. Type III water resistant adhesives that cure through chemical reaction, containing no health or environmentally hazardous ingredients, are required. Methods requiring heat are not allowed.
   2. Cabinet parts shall be accurately machined and bored for premium grade quality joinery construction utilizing automatic machinery to insure consistent sizing of modular components. End panels shall be doweled to receive bottom and top.
   3. Back panels shall be fully housed into, and recessed 7/8 inch from the back of cabinet sides, top, and bottom to insure rigidity and a fully closed cabinet. Cabinet back shall be shimmed from rear of body for tight interior fit.
   4. ¾ inch thick hang rails shall be mechanically fastened to end panels of wall, base, and tall cabinets for extra rigidity and to facilitate installation.
   5. All cases shall be square, plumb, and true.
   6. Provide removable back panels and closure panels for plumbing access where shown on drawings and required by code. Coordinate with plumbing, mechanical, and electrical trades.
   7. Cutouts for plumbing piping in concealed rear, sides or bottom cabinet panels shall be no larger than ¼" larger than the pipe diameter. Install sealant around all penetrations.

PART 3 EXECUTION

3.1 COORDINATION

A. Coordinate work of this section with related work of other sections and drawings as necessary to obtain proper installation of all items.

B. Field verify site dimensions of cabinet locations in building prior to fabrication.

C. Coordinate all plumbing/mechanical item locations and openings with plumbing/mechanical contractor where items are related to millwork prior to routing and installation of plumbing/mechanical items.

D. Coordinate all owner furnished items, which are to be installed in or adjacent to millwork.

E. Coordinate locations of wood grounds and blocking concealed in walls with cabinet anchoring requirements prior to installation of wall covering.

3.2 INSTALLATION

A. Storage and Protection: Cabinets and millwork shall be protected in transit. Store under cover in a ventilated building not exposed to extreme temperature and humidity changes. Do not store or install cabinets in building until concrete, masonry, and drywall/plaster work and painting is dry and building temperature and humidity are stabilized. Exterior doors, windows and glass shall be installed prior to millwork storage and installation in building. If project calls for polished concrete floors, final polishing of floor shall be complete in areas where millwork is being installed.

B. Workmen: Install under the supervision of manufacturer's or supplier's representative if manufactured casework is provided, factory-trained mechanics certified by manufacturer will be required.

C. Workmanship:
   1. Erect cabinets and millwork straight, level and plumb and securely anchor in place. Scribe and closely fit adjacent work. Cut and fit work around pipes, ducts, etc.
   2. Install all items complete and adjust all moving parts to operate properly.
   3. Leave surface clean and free from defects at time of final acceptance.

D. Maximum width of any filler to be 3" inches wide. Filler width dimension to be balanced on each side of cabinet length.

E. Coordinate equipment and plumbing fixture locations, scheduled to be installed in cabinets.

F. Install sealant between countertop and backsplash, and between backsplash and wall, and other locations where cabinet buts to walls or ceilings.

H. Install grommets in countertops where shown on drawings and for each computer station where computer stations are shown on drawings. Coordinate and provide access to electrical receptacles below tops and in panels below countertops.

I. Anchors for cabinets to be countersunk and plugged with vinyl inserts to match back panel colors. Arrange anchors in uniform manner, anchoring to wood ground and/or masonry wall.

3.3 CABINET FINISH

A. For other than thermally fused melamine laminate or high pressure laminate cabinet work, surfaces shall be thoroughly sanded and prepared before finish is applied. No misfits, hammer marks, splinters, bruises, etc., set forth all nail holes. Cabinets to be stained inside and out shall be called out on plans. See section 09 91 00.

B. Architect may select an assortment of up to three different plastic laminate colors for each cabinet.

3.4 CLEANUP

A. Remove all cartons, debris, sawdust, scrapes, etc. Leave cabinet surfaces and spaces clean, ready for owner's use.

END OF SECTION

SECTION 06 61 19

QUARTZ SURFACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Fabrication and installation of quartz surfacing components including accessories indicated, specified, and required for installation.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough-in Carpentry - Blocking
B. Section 06 41 16 – Cabinet Work and Shelving

1.3. QUALITY ASSURANCE

A. Fabricator Qualifications:

1. Experienced with successful fabrication of specified work similar to scope of this Project, and product by Manufacturer.
2. Record of successful in-service performance.
3. Sufficient production capability, facilities, and personnel to produce required work.

B. Installer Qualifications:

1. Experienced in installation of specified work similar to scope of this Project.
2. Record of successful in-service performance.
3. Sufficient installation capability, facilities, and personnel to produce required work.

1.4 SHOP DRAWINGS

A. Product Data: Manufacturer’s technical literature for each product indicated, specified, or required. Include manufacturer’s written fabrication and installation instructions.

B. Shop Drawings: Dimensioned and detailed plans, elevations, and large-scale details.

1. Show locations of each component.
2. Show materials, finishes, edge and splash profiles, and methods of joining.
3. Show locations and sizes of cutouts and holes for plumbing fixtures, accessories and other items installed in countertops.
4. Show attachment devices and other components to be incorporated into work.

C. Samples for Verification: 4-inch square sample of selected material, in specified gloss, cut into 2 pieces and then joined together to represent an inconspicuous seam; indicate full range of color and pattern.

D. Maintenance Data:

1. For inclusion in maintenance manual close-out documents
2. Include manufacturer's instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use.
3. Include precautions against cleaning products and methods which may be detrimental to finishes and performance.

1.5 COORDINATION & FIELD VERIFICATION

A. Field Measurements:

1. Where components are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
2. Locate concealed framing, blocking, and reinforcements that support components by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.6 PRODUCT HANDLING & DELIVERY

A. Delivery: Do not deliver components until painting and similar activities have been completed in installation areas.

B. Storage: Prior to installation, store in areas in which material will be installed.

C. Handling: Handle components to prevent damage to finished surfaces.

1.7 WARRANTY

A. Manufacturer's Warranty: Provide manufacturer's warranty against defects in materials. Warranty shall provide material and labor to repair or replace defective materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Specification and color selection are based on Cosentino Quartz. Alternates will be reviewed by Architect for compliance with the selected product as specified.

2.2 QUARTZ SURFACING MATERIAL

SSF-1

A. Sheet Material:

1. Basis of Design Selection:
   a. Manufacturer: Cosentino Silestone
   b. Color Name: Faro White
   c. Finish: Suede
   d. Thickness: 2 cm

e. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

2.3 ACCESSORIES

A. Mounting Adhesive:
1. Provide structural grade '50 year' silicone or epoxy adhesive.

B. Quartz Surface Adhesive:
1. Provide epoxy or polyester adhesive of a type recommended by manufacturer for application and conditions of use.
2. Acceptable manufacturers:
a. Cambria Two Part Acrylic Adhesive.
b. Akemi North America.
c. Bonstone Material Corporation.
d. Tenax USA.
3. Adhesive which will be visible in finished work shall be tinted to match quartz Surface.

C. Joint Sealant:
1. Clear sealant of type recommended by manufacturer for application and use.

D. Solvent: Denatured alcohol for cleaning quartz surfacing to assure adhesion of adhesives and sealants.

E. Cleaning Agents: Mild soap and water.

2.4 FABRICATION

A. Shop Assembly:

1. Fabricate shapes in sizes and profiles indicated according to approved shop drawings and manufacturer's instructions.
2. Where necessary for fitting at Project, provide ample allowance for scribing, trimming, and fitting.

B. Seams:

1. Form inconspicuous joints between components.
2. Reinforce on concealed side with strip of solid surfacing material not less than 1 inch on either side of joint by same thickness as components being joined.
3. Locate more than 3 inches from cutouts.
4. Layout surface to minimize joints and avoid L-shaped pieces of quartz surfacing. Layout and fabricate with 'hairline' joints.

C. Cutouts:

1. Use router to make openings according to templates and finish with clean and smooth edges. Cutouts shall have a minimum of 3/8 inch (10mm) radius.
2. Provide not less than 1/8-inch clearance between cutout edges and appliance or plumbing fixture.
3. Remove nicks and scratches.
4. Where edges of cutouts will be exposed in finished work, polish edges.

D. Overhangs: Support overhangs that are more than 6 inches.

E. Countertop Configuration:

1. General Provisions:
   a. Fabricate with loose backsplashes for field assembly.
   b. Accurately cut holes and drill countertop panels to receive plumbing, fixtures, soap dispensers and other accessories.
2. Countertop and Splashes Thickness: Not less than 1/2 inch.
3. Front Edge: Bullnose
4. Splashes: Straight, slightly eased at corner.

F. Inspect materials for defects prior to fabrication.

G. Tools: Cut and polish with water cooled power tools.

PART 3 EXECUTION

3.1 EXAMINATION

A. Acceptance of Surfaces and Conditions:

1. Examine substrates to which quartz surfacing components will be applied for compliance with requirements and other conditions affecting performance.
2. Proceed only when unsatisfactory conditions have been corrected in a manner complying with Contract Documents.
3. Starting work within a particular area will be construed as acceptance of surface conditions.
4. Verify dimensions by field measurements prior to installation.
5. Verify that substrates supporting quartz surfaces are plumb, level, and flat to within 1/8 inch in 10 feet and that all necessary supports and blocking are in place.
6. Base Cabinets shall be secured to adjoining units and back wall.

3.2 INSTALLATION

A. Install materials in accordance with manufacturer's instructions and approved shop drawings.

B. Preliminary Installation:
   1. Position materials to verify the correct size.
   2. If size adjustments, or additional fabrication is necessary, use water cooled tools. Protect jobsite and surface from dust and water. Perform work away from installation site if possible.
   3. Allow gaps for expansion of not less than 1/8 inch(1.5mm) per ten feet when installed between walls or other fixed structure.

C. Permanent Installation:
   1. After verification of fit and finish, clean substrate; remove loose and foreign matter which may interfere with adhesion. Clean quartz surface backside & joints with denatured alcohol.
   2. Horizontal surface: Apply continuous bead of mounting adhesive around perimeter of structural substrate and supports.

3. Vertical surface: Apply continuous bead of mounting adhesive around perimeter. In addition, apply ¼ inch mounting adhesive bead every 8 inches on vertical center.
4. Install quartz surfacing plumb, level, square and flat to within 1/8 inch in ten Feet, non-cumulative.
5. Align adjacent pieces in same plane.

D. Joints:

1. Joints Between Adjacent Pieces of Quartz Surfacing:
   a. Joints shall be flush, tight fitting, level and neat.
   b. Securely join adjacent pieces with Cambria Two Part Acrylic Adhesive.
   c. Fill joints level to polished surface.
   d. Secure adjacent quartz surfaces with vacuum clamps until adhesive hardens.
2. Joints Between Quartz Surface and back splash:
   a. Seal joints with ’50’ year silicone sealant.

3.3 CLEANING

A. Remove masking, excessive adhesive and sealants. Clean exposed surfaces according to manufacturer’s published maintenance instructions.

3.4 PROTECTION

A. Protect installed fabrications from damage during remainder of construction period.

3.5 REPAIR

A. If permissible to Architect, minor surface marring for quartz surfacing components may be repaired according to manufacturer’s published installation instructions.

B. Remove and replace quartz surfacing components that are damaged and cannot be satisfactorily repaired.

END OF SECTION

SECTION 07 01 50

ROOF PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes
   1. Patching of TPO roofing system.

1.2 RELATED SECTIONS

A. Section 01 11 00: Summary of Work

B. Section 01 73 29: Cutting and Patching

C. Section 01 35 16: Alteration Project Procedures

D. Section 02 41 19: Minor Demolition

E. Section 07 62 00: Sheet Metal Flashing & Trim

1.3 QUALITY ASSURANCE

A. Roofing Installer: Company specializing in membrane roof application approved by the roofing materials manufacturer specified and who has been installing roofs for at least 5 years.

1.4 PROJECT/SITE CONDITIONS

A. Environmental Requirements;
   1. Do not apply roofing membrane during inclement weather or when air temperature may fall below 40 degrees F.
   2. Do not apply roofing membrane to damp or frozen deck surface.
   3. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weather-proofed during same day.

B. Coordinate the work with affected mechanical and electrical work associated with roof penetrations.

1.5 MANUFACTURER'S GUARANTEE

A. Roofing installer will perform patching of roof system in a manner approved by the existing roofing manufacturer so that patching will not void warranty of existing roof system.

B. Submit proof to Architect's office prior to beginning work that current roof warranty will continue and applicator is certified by roof system manufacturer.

C. Provide two year warranty covering all materials and workmanship for a period of two years for the areas of repair and/or modification. See sample guarantee form at end of this specification.

PART 2 PRODUCTS

2.1 ROOF MEMBRANE

A. If not specified or noted on the plans, the roofing installer is to determine existing roofing membrane and match type and finish.

B. Use only the flexible membrane flashing materials that are recommended by the roofing manufacturer. Written documentation required before acceptance.

2.2 METAL ROOFING

A. Metal roofing installer to match existing panel type, profile, gauge, finish type and color.
   1. At new openings for roof mounted mechanical equipment, provide prefabricated curbs as manufactured by Thycurb or Pate, matching existing panel profile, where more than one roof panel is involved. Curbs must have built-in diverter on the up-slope side.

2.3 INSULATION AND RECOVERY BOARD

A. Where rigid roof insulation board is to be replaced or patched, provide faced isocyanurate insulation board of thickness as required to match existing insulation thickness. Mechanically fasten to existing roof deck. Provide tapered where shown or as required.

B. Where recovery board is to be replaced, provide minimum 1/2” high pressure fiberboard. Mechanically attach to existing roof deck.

C. Insulation board and recovery board to be approved by roofing membrane manufacturer and be compatible with roofing system.

2.4 ACCESSORIES

A. Roofing Fasteners: Galvanized or non-ferrous type, size, and style as required to suit application.

B. Mechanical Fasteners for Insulation: Appropriate to purpose intended and approved by Factory Mutual; length required for thickness of material; with metal washers. Type as required to fastening into existing roof deck.

C. Bituminous Materials
   1. Asphalt Bitumen: ASTM D312, Type III.
   2. Plastic Cement: No. 885, (ASTM D2822) by Tamko

2.5 Architect will approve all patching materials prior to installation.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify existing roof surface in areas to be patched or repaired is clean and smooth, free of depressions, waves, or projections.

B. Verify roof openings, curbs, pipes, sleeves, ducts, or vents through roof are solidly set, cant strips, nailing strips, and reglets are in place.

C. Verify deck is in satisfactory condition, is supported and tightly secured.

D. Verify existing roof surfaces are dry and free of snow or ice. Confirm dry surface by moisture meter with 12 percent moisture maximum. Provide documentation of moisture test.

3.2 PREPARATION

A. Protect building surfaces against damage from roofing work.

B. Temporary Protection: Sheet polyethylene, fiber reinforced. Provide weights to retain sheeting in position.

C. Remove flashings, roofing gravel, membrane and insulation if needed in preparation for new protected membrane roof patching system.

D. Repair any damaged or rotting deck in area of patch or repair prior to patching.

3.3 INSTALLATION

A. Roofing membrane system, insulation, and recovery board to be installed per manufacturer's instruction and be compatible with existing roofing. Install flashings as shown on drawings and per manufacturer's instructions.

B. Prefinished metal roofing system, curbs, flashings, and sealant to be installed per manufacturer's instructions.

3.4 WEATHERTIGHTNESS

A. All patching work on existing roof systems to be performed to provide weathertight seal in patched areas.

3.5 ROOF SPLICES

A. All splices shall be made with materials supplied for this purpose by the manufacturer.

3.6 CLEANING

A. Remove bituminous markings from finished surfaces. In areas where finished surfaces are soiled by asphalt or any other source of soiling caused by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their instruction.

B. Replace defaced or disfigured finishes caused by Work of this Section.

3.8 SCHEDULE

A. Patch all areas disturbed during re-flashing, mechanical or electrical work, or other areas needing repair as shown on drawings. Match surface conditions (ie: gravel or smooth surface). Architect to inspect and approve all work and entire roof surface prior to acceptance.

END OF SECTION

COMPANY LETTERHEAD

CERTIFICATE OF GUARANTEE FROM INSTALLER

We, _____
(Name of Company or Contractor)
agree to maintain the roofing and flashing on the below mentioned building for the period indicated. This agreement is to render the roof and the flashing waterproof subject to the conditions outlined below.

OWNER OF BUILDING _____

Location of Building _____

City_____Roof Area_____ square feet_____

This Guarantee effective this_____ day of _____, 20_____, for the term of two (2) years from this date, provided any defects result from defective material or workmanship and are not caused by other mechanics, fire, accidents, or by nature over which we have no control.

It is understood and agreed that we will not be responsible for leaks in the roofing or flashing due to excessive winds, distortion of the foundation on which the roofing rests, excessive hail storms, or any other conditions over which we have no control.

Signed _____
Name of Company

By _____

Position _____

Company is a _____
Corp./Partnership/Individual

NOTARY PUBLIC _____

Registered in the State of _____

SEAL

NOTE: Standard Fifteen (15) year unlimited dollar coverage warranty from the manufacturer is to be submitted in addition to the guarantee from the installer found on this form. Manufacturer's Warranty is mandatory - **NO EXCEPTIONS.**

SECTION 07 10 00

WATERPROOFING AND DAMPPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Furnish labor and materials to complete waterproofing and dampproofing shown and specified.

B. Section Includes:
   1. Horizontal joint waterproofing
   2. Expansion joint fillers
   3. Cavity wall flashing system
   4. Below-slab vapor barrier
   5. Below-Grade Waterproofing membrane
   6. Above-grade waterproofing membrane

1.2 RELATED SECTIONS

A. Section 03 30 00 – Cast-In-Place Concrete

B. Section 04 22 00 – Concrete Unit Masonry

C. Section 05 40 00 – Cold Formed Metal Framing

D. Section 07 62 00 – Flashing and Sheet Metal

E. Section 09 29 00 – Drywall-Sheathing

1.3 SUBMITTALS

A. Comply with Section 01 33 00.

1.4 WARRANTY

A. The Contractor must guarantee all materials and workmanship for a minimum period of two (2) years from the date of Substantial Completion of the building unless longer warranty periods are specified for individual specified products.

B. The Contractor will, at any time within the two (2) year period, remedy all leaks of any nature in any part of the building due to the use of faulty materials and/or workmanship, without additional cost to the Owner. The Contractor shall further reimburse the Owner for any damage occasioned by such leaks.

C. The Contractor is cautioned to supplement the work, described in this section of the specifications, by any means necessary to permit the above guarantee, which he will be called upon to make as an obligation of the Contract.

D. Below-Grade Waterproofing warranty is to be free of defects for a period of five years.

1.5 PRE-INSTALLATION MEETING

A. The Contractor will schedule and conduct a pre-installation meeting for the following items:
   1. Cavity wall flashing system
   2. Heavy duty moisture barrier
   3. Below-Grade Waterproofing

B. The following shall be in attendance:
   1. Contractor
   2. Architect
   3. Product supplier and or manufacturer's representative
   4. Installer

PART 2 PRODUCTS

2.1 MATERIALS:

A. Horizontal expansion joint waterproofing of exterior slabs or slabs on grade: Tremco Vulkem #45 SSL Sealant as manufactured by Tremco, W.R. Meadows, Inc., or approved alternate. Color to be coordinated with Architect.

B. Horizontal expansion Joint Filler: Asphalt impregnated expansion joint material. Provide "Zip Strip" type filler so that top ½" can be removed for sealant installation.

C. Vertical Expansion Joint Filler: 'Colorseal' (width as required), manufactured by Emseal Joint Systems, LTD (800) 526-8365. No substitutions will be accepted. Architect to select color from standard and special color selections.

D. Cavity wall flashing system:
   1. Alternate manufacturers with equal or better product may submit product data to Architect for approval, following requirements of Section 01 60 00.
      a. York 304 SA w/ Drip and transition membrane.
   2. Individual Components
      a. **TWF-1** Through-Wall Flashing: 2 mil. Stainless steel sheet on self-adhering butyl backing, York 304SA. Provide with all available preformed shapes (i.e. corners, level changes, end dams, stop ends, etc.) as needed to fit job conditions. Apply Primer-SA by HB where installed on exterior sheathing.
      b. Drainage & Vents: Mortar Net Drainage & Vent System or Mortar Trap & Weep Vent by HB.
      c. Termination Bar: Provide continuous aluminum or stainless-steel termination bar where membrane terminates on wall sheathing or substrate. Secure to substrate with screws meeting manufacturer detailing.
      d. Drip Edge: Stainless steel drip edge always required, trim flashing short of f.o. brick and extend only drip edge beyond.
      e. Sealant: Provide sealant at termination bar and where thru wall flashing ends overlap, inside and outside corners and any other type of soft joints. Verify compatibility of

sealant with any adjacent materials. HB Sealant, Dow Corning 790 & 791 with 1200 prime coat. Silaflex-1A with #260-205 primer or Sonolastic NPI with #733 primer.

E. Weep and VentilationVents:
   1. QV- Quadro Vent by HB, or Weepvent by Mortar Net, ½" thick, size as required to match brick or CMU veneer head dimension.
   2. Install at 24" o.c. horizontally for brick veneer, 32 o.c. horizontally for CMU veneer.
   3. Provide ventilation vents at top of wall in same location and centering as weep vents.
   4. Confirm Color with Architect for each masonry color used.

F. Mortar Collection Material:
   1. Mortar Trap by HB, or MortarNet by Mortar Net, or approved alternate.
   2. Thickness as required to fill cavity. Install just above thru-wall flashing in cavity at bottom of walls and above window and door openings per manufacturer's instructions.

G. **VB-1** Underslab Moisture Barrier: 15 mil thick virgin polyethylene, Approved Products and Manufacturers:
   - Yellow Guard 15 mil vapor barrier, Manufactured by Husky
   - "Perminator" under-slab vapor mat manufactured by W.R. Meadows, 15 mil thick
   - "Stego Wrap Class A", manufactured by Stego Industries, Inc., 15 mil thick
   - "EXTREME" manufactured by Textrude, Class A",
   - W.R. Meadows (Perminator), Vaporblock
   - VB15, manufactured by Raven Industries,
   - Viper "Vaporcheck II" 15 mil class A vapor barrier, manufactured by Insulation Solutions, Inc., or approved alternate.

   1. Use High Density Polyethylene Tape with pressure sensitive adhesive. Minimum width 4 inches. Sealing tape shall be coated with a high tack natural rubber adhesive.
   2. Waterproofing adhesive or mastic equal to Stego Mastic shall be a high quality, long lasting, asphalt-based material and shall be applied in accordance with its manufacturer's specification. Waterproofing adhesive shall be compatible for use with the vapor barrier and shall meet the applicable standards for the intended use. The installation contractor shall submit the product specification for Architect's review and approval prior to using the product.
   3. References
      a. ASTM E 1745-09 Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs.
      b. ASTM E 154-99 (2005) Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
      c. ASTM E 96-05 Standard Test Methods for Water Vapor Transmission of Materials.
      d. ASTM F 1249-06 Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
      e. ASTM E 1643-09 Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs.
   4. American Concrete Institute (ACI):
      a. ACI 302.2R-06 Guide for Concrete Slabs that Receive Moisture-Sensitive Flooring Materials.
   5. Vapor barrier must have all of the following qualities:

a. Permeance of less than 0.01 Perms [grains/(ft^2 · hr · inHg)] as tested in accordance with ASTM E 1745 Section 7.
b. Other performance criteria:
i. Strength: ASTM E 1745 Class A.
ii. Thickness: 15 mils minimum

6. Quality control/assurance (Submit the following for Architect's approval):
a. Summary of test results as per paragraph 8.3 of ASTM E 1745.
b. Manufacturer's samples, literature.
c. Manufacturer's installation instructions for placement, seaming and penetration repair instructions.

H. **WP-1** Below-Grade Waterproofing Membrane: Bituthene 3000 waterproofing membrane with **DMAT-1** hydroduct drainage composite as manufactured by W.R. Grace & Company, Mel Rol by W.R. Meadows, Carlisle MiraDRI 860/861, or approved alternate.

I. Transition Membrane Flashing: **MBF-1** York 304 SA.

J. Above-Grade Wall Waterproofing Membrane: Refer to section 07 27 26.

K. Refer to Section 07 19 00 for brick damp-proofing.

L. Refer to Section 03 30 00 for water-stops.

PART 3 EXECUTION

3.1 WORKMANSHIP:

A. Horizontal expansion joint waterproofing:
1. All horizontal expansion joints shall be 1/2 inch asphalt impregnated expansion joint material with "zip-strip" feature. Insulation-type material will not be acceptable. Install to provide 1/2"depth below finish surface and apply sealant as called for above.

B. Expansion joint Filler:
1. All vertical expansion joints shall be 1/2 inch asphalt impregnated expansion joint material. Not Insulation. The top 1/2 inch of material shall be omitted and joint filled with caulking as specified in Section 07 92 00. All caulking shall be installed flush with wall surface.

C. Below-Grade Waterproofing:
1. Install waterproofing membrane system where shown on drawings and on walls where finished grade or subgrade elevation is above finished floor elevation.

2. Apply Bituthene Membrane vertically in strips of 8 feet in length or less. Edge seams must be overlapped at least 2-1/2". On higher walls apply in two or more sections with the upper overlapping the lower by at least 2-1/2". Press all membrane on vertical surfaces with heavy hand pressure during application or roll with a wall or counter top roller.

3. Bituthene membrane should be applied over the edge of the slab or over the top of the foundation or parapet wall. If the membrane is terminated on the vertical surface, a reglet or counter flashing may be used or the membrane may be terminated on the concrete by pressing very firmly to the wall. Press edges with a metal or hard-wood tool such as a hammer or knife handle. Failure to use heavy pressure at terminations can result in a poor seal. At the base of the foundation wall Bituthene Membrane must be drawn down the base of the wall over the edge of the footing on to the footing face and rolled or pressed firmly. Apply a troweled bead of Bituthene EM-3000 to all vertical and horizontal terminations. Liquid Membrane LM-3000 can be used as an alternate. Create a formed footing face to allow membrane to be applied over face of footing.

4. Seal all daily terminations with a thin troweled bead of EM-3000.

5. Patch tears and inadequately lapped seams with Bituthene Membrane. Slit fishmouths and repair with a patch extending 6" in all directions from the slit and seal edges of the patch with EM-3000. Inspect membrane thoroughly before covering and make any corrections immediately.

6. Protection of membrane: Bituthene should be protected to avoid damage from other trades, construction materials, or backfill. The Bituthene Protection System should be used on foundation walls and horizontal surfaces with light traffic. Provide "Hydroduct" drainage composite system. Install hydroduct drainage composite per manufacturer's instructions over membrane. Protect horizontal decks exposed to heavy construction traffic with 1/8" asphalt hardboard. The Bituthene Protection System should be installed the same day the membrane is applied or immediately after 24 hours flood testing. No waiting before backfilling or applying topping slabs is necessary.

D. **DMAT -1:** Cavity Wall Flashing System:
1. The installer shall be knowledgeable of system installation. Contractor to have product representative on site when installation begins to verify correct installation procedures are being performed.
2. Contractor to inspect each installed section of flashing system and approve before covering with veneer.
3. Install Flashing/Drainage System in accordance with manufacturer's installation instructions.
4. Install cavity wall flashing system at base of exterior masonry cavity walls and above doors and window openings where located in exterior masonry cavity walls and where shown on drawings. Extend flashing flush with outside face of masonry veneer.
5. Prior to installation of wall flashing, prime substrate where wall flashings are to be installed with product approved by manufacturer.
6. Where installed at stud walls, secure to sheathing with continuous galvanized metal or stainless steel termination bar and set in adhesive.
7. Where installed at CMU walls, secure with continuous galvanized metal or stainless steel termination bar and set in adhesive.
8. Install preformed shapes at corners, changes in elevation, etc. provide end dams and end stops where required per manufacturer's instruction. Provide preformed transitions where transitioning from grade to top of walk or drive.
9. Replace any damaged membrane prior to installation of masonry veneer.
10. Coordinate installation in veneer with weeps and drainage material.

11. At brick veneer cavity walls, grout solid below grade, turn out at bed joint at least one brick course below finished floor, or 4" (1/2 course) below finished floor for CMU veneer unless shown otherwise on drawings. Install above all window and door openings at masonry cavity walls and where shown on drawings.
12. Just prior to laying of masonry veneer, install mortar collection material.
13. Install weep joints at brick head joints, 24" o.c. (horizontally), at CMU head joints at 32" o.c. (horizontally).
14. If masonry is to receive paint, stain, or special coating, weep vents and drainage vents are not to be coated. Protect as required during coating process.

E. Below-Slab Vapor Barrier (15 mil below-slab):
   1. Prepare surfaces in accordance with manufacturers instructions.
   2. Installation shall be in accordance with manufacturer's instructions and ASTM E 1643. All lap joints and areas to be sealed shall be free from dirt, dust, and moisture. Sealing tape shall be applied in temperatures ranging from 41°F to 122 °F or according to its manufacturer specification. Where inconsistencies occur between the project plans and specification and ASTM E1643, the project plans and specification shall govern.
   3. Unroll vapor barrier with the longest dimension parallel with the direction of the pour.
   4. Lap vapor barrier over footings and seal to foundation walls or top of footings with manufacturer approved sealant.
   5. Overlap joints 6 inches and seal with manufacturer's tape.
   6. Seal all penetrations (including pipes) with manufacturer's pipe boot and sealant.
   7. No penetration of the vapor barrier is allowed except for reinforcing steel and permanent utilities.
   8. Repair damaged areas by cutting patches of vapor barrier, overlapping damaged area 6 inches and taping all four sides with tape.
   9. Pipe/Conduit Boots and Penetration Sealing:
      a) Cut a piece of vapor barrier. Width: minimum 12 inches Length: one and one-half times the pipe circumference
      b) With scissors, cut slits half the width of the vapor barrier.
      c) Wrap boot around pipe and tape onto pipe, completely taping the base to vapor barrier using the polyethylene tape.
      d) Install mastic around and through groups of conduit, grade stakes or piping, which cannot be sealed by taping. Seal to vapor barrier. As an allowable alternate method of penetration sealing in lieu of taping, mastic may be used to seal around single penetrations such as pipe, conduit, floor drains, etc. Confirm that the material mastic is installed at is compatible with the mastic prior to application.
   10. Seal vapor barrier to top of footings with mastic where vapor barrier terminates at perimeter or interior footings. When vapor barrier terminates at concrete or CMU walls, seal with mastic. Do not apply mastic above top of finished slab elevation.

F. Vertical Expansion Joint Filler: Protect from adjacent finish application. Prep substrate and install per Emseal instruction for application in which it is being installed.

END OF SECTION

SECTION 07 19 00

WATER REPELLENT COATING

PART I GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Water repellent coating to exterior concrete and masonry surfaces.

B. Related Sections:
   1. Section 03 30 00 - Cast-In-Place Concrete
   2. Section 04 21 13 - Brick Masonry

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 QUALITY ASSURANCE

A. Applicator: Acceptable to coating manufacturer.

B. Field Sample: Apply coating to field sample described for material water repellent is to be applied to.

1.4 ENVIRONMENTAL REQUIREMENTS

A. Follow manufacturer's recommendations for temperature range in which coating may be applied.

B. Comply with National Volatile Organic Compound Emission Standards for Architectural coatings, Rule 40 CFR, Part 59, established by Environmental Protection Agency for VOC limits unless stricter local regulations are required.

1.5 GUARANTEE/WARRANTY:

A. Provide 10-year warranty for water repellent coating on brick, precast, stone, and 5 year warranty for CMU guaranteeing the installation waterproof and watertight, except for structural cracks or opening caused by settling, expansion or contraction.

B. Warranty Period: 10 years from date of Substantial Completion. Non-prorated labor and materials.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURER/PRODUCT

A. **SLR-1** Brick application:
   1. Siloxane WB Concentrate by ProSoCo.
   2. Prime-a-Pell 200. Manufacturer: Chemprobe Corporation.

2.2 SUBSTITUTIONS

A. Refer to Specification Section 01 60 00 for product substitution requests.

B. No substitution will be accepted 10 days prior to bid date.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify joint sealants are installed and cured.

B. Beginning of installation means acceptance of substrate.

3.2 PREPARATION

A. Remove loose particles and foreign matter.

B. Remove oil or foreign substance with a cleaning agent which will not affect coating.

C. Scrub and rinse surfaces with water and let dry.

D. Protect adjacent surfaces not scheduled to receive coating.

E. If applied on unscheduled surfaces, remove immediately, by approved method.

F. Protect landscaping, property, and vehicles from over spray and drift.

3.3 APPLICATION

A. Delay work until masonry mortar is cured for seven days and weather forecast calls for hot, dry conditions. Follow manufacturer's directions for masonry cure periods before applying water repellent.

B. Apply coating **(minimum 2 coats)** in accordance with manufacturer's instructions, using appropriate method and coverage rate.

C. Application:
   1. Surface must be clean and dry.
   2. Air temperature must be 50° F or higher during application.
   3. Re-pointing shall be allowed to dry for 72 hrs. minimum before application.
   4. All caulking and sealant work must be done prior to application and have a minimum of 12 hours of curing time or until set.
   5. All alkali or efflorescence to be cleaned and/or treated prior to application.
   6. Material to be applied with a 12" rundown.

7. Mask off other finish materials, aluminum storefronts, windows, glass, etc. that are not scheduled to receive water repellent coating.
8. Coverage must meet or exceed normal coverage rates stated by the manufacturer.
9. Application may be low pressure sprayer (less than 200 psi or lower as recommended by manufacturer.,

END OF SECTION

SECTION 07 21 00

INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, material, equipment, and services necessary for and reasonably incidental to complete insulation as called for below.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 QUALITY CONTROL

A. All packages and containers of foam plastic and foam plastic ingredients shall bear the label of an approved agency showing either the flame spread rating and smoke developed rating of the product at the thickness tested or the use for which the product has been listed.

B. All foam plastics or foam plastic cores in manufactured assemblies used in building construction shall have a flame spread rating of not more than 75 and shall have a smoke developed rating of not more than 450 when tested in the maximum thickness intended for use in accordance with ASTM E84.

C. The potential heat of foam plastic in any portion of the wall or panel shall not exceed 6000 BTU/sq.ft. of projected area as described by tests conducted in accordance with NFPA 259.

D. Foam plastic insulation, exterior coatings and facings tested separately shall have a flame spread rating of 25 or less and a smoke developed rating of 450 or less as determined in accordance with ASTM E 84.

E. Results of diversified or full scale fire tests reflecting an end use configuration shall be submitted to the Building Official demonstrating the assembly in its final form does not propagate flame over the surface or through the core when exposed on the exterior face to a fire source.

F. The edge or face of each piece of foam plastic insulation shall bear the label of an approved agency. The label shall contain the manufacturer's or distributor's identification, model number, serial number of definitive information describing the product or materials performance characteristics and approved agency's identification.

G. Insulating materials, concealed as installed shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 450. Insulating materials exposed as installed shall have a flame spread rating of not more than 25 and a smoke developed rating of not more than 450.

PART 2 PRODUCTS

2.1 MATERIALS:

A. Fiberglass batt type as manufactured by Owens Corning, Certainteed, Johns Manville or approved equal of thickness or R-value as shown on drawings, un-faced, meeting smoke and flame spread rating as specified this section. All concealed and exposed insulation to meet minimum flame spread and smoke development ratings per this specification and governing code requirements.

B. **INSUL-2:** Perimeter slab and below grade wall insulation - rigid expanded polystyrene (EPS), Type IX, of thickness as shown on drawings and equal to that manufactured by Dow, or approved equal.

C. Rigid Fiberglass Insulation Board
   1. Type 703 (3.0 PCF) and type 705 (6.0 PCF) manufactured by Owens Corning, or approved alternate. Refer to drawings for insulation thickness and density locations.

D. **INSUL-1:** Sound Attenuation Batts: thickness varies, un-faced fiberglass "Sonobatts", manufactured by Owens Corning, or approved alternate.
   1. Provide sound attenuation batts in stud walls as shown on the drawings.
   2. Refer to drawings and finish schedule notes for other areas where sound attenuation batts are called for.

E. **INSUL-2:** Rigid Cavity Wall Insulation – Expanded polystyrene (EPS), ASTM C578, Type IX; (R4.2 per inch min.) by Dow, Atlas, or approved alternate.

F. **INSUL-3:** Rigid Roof Insulation: Refer to individual roofing sections for description or insulation.

G. **INSUL-4:** Mineral Wool Blanket – At exterior wall parapets, refer to drawings for exact locations.

H. **INSUL-5:** Foil-faced mineral wool board – ASTM C612, Type IVB, R4.3 per inch min. by Rockwool or approved alternate.

I. **INSUL-6:** Low-expanding Foam Sealant: Refer to drawings for sealant location.

PART 3 EXECUTION

3.1 WORKMANSHIP

A. Batt Insulation between metal studs
Friction-fit insulation between studs after cover material has been installed on one side of the cavity. When unfaced insulation is used, and in applications without a cover material or where the stud depth is larger than the insulation thickness, use wire or metal straps to hold insulation in place, maximum spacing 2'-0" o.c. When faced insulation is

used, the attachment flanges may be taped to the face of metal stud prior to applying the interior finish.

1. Provide supplementary support to hold the product in place until finish surface is applied when insulation is installed in heights over 8 feet.
2. Coordinate to assure electrical conduits and water piping are held to the interior face side of the wall.
3. Unless other types of insulation is called for, install minimum 6" thick batt insulation (additional thickness as called for on drawings) above ceilings where attic space exists, and at roof where no attic space exists. Provide complete thermal seal between exterior and conditioned space.
4. Unless noted otherwise and in addition to locations called for on drawings and in specifications, batt insulation shall be installed in exterior wall studs and interior walls separating conditioned space from non-conditioned spaces (i.e. offices from warehouse). Provide the following minimum R values:
   a. R-19 at nominal 6" stud walls.
   b. R-11 at nominal 4" stud walls.

B. Fiberglass wall insulation and sound attenuation batts shall be friction fit, with electrical conduits and water piping held to the interior face side of the wall. When unfaced insulation is used, and in applications without a cover material or where the stud depth is larger than the insulation thickness, use wire or metal straps to hold insulation in place, maximum spacing 2'-0" o.c.
   1. Install tight to sides of studs.

C. Rigid Cavity Wall Insulation
   1. Install tight to substrate. Panels are secured in place with wall tie system. Refer to Sections 04 21 13 and/or 04 22 00 for masonry wall tie product information.
   2. Joints to be butted tight to each other at ends and sides.

D. Rigid Fiberglass Insulation Board
   1. Install and adjust panels to lines and levels to provide accurate alignment and reveal widths as detailed.
   2. Provide an adhesive compatible with panel and substrate behind. Install panels using adhesive applied continuously across the back of the panel according to the manufacturer's recommendation. Core shall make continuous contact with substrate after installation.

E. Hold perimeter insulation at foundation walls tight to walls. Turn down and out under slab as shown on drawings. Install on gravel base, free of voids below insulation. Butt joints tight to each other.

END OF SECTION

SECTION 07 27 26

FLUID-APPLIED WEATHER BARRIER SYSTEM

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. The General Conditions, Supplementary Conditions, Instructions to Bidders, and Division 01- General Requirements shall be read in conjunction with and govern this section.

B. The Specification shall be read as a whole by all parties concerned. Each Section may contain more or less than the complete Work of any trade. The Contractor is solely responsible to make clear to the installing Subcontractor the extent of their Work.

1.2 SUMMARY

A. This Section includes requirements for supplying labor, materials, tools, and equipment to complete the Work as shown on the Drawings Architectural Division as specified herein including, but not limited to, the following:
   1. Adhesive/Primer
   2. Fluid Applied Air and Vapor Barrier
   3. Air Barrier/Thru-wall Flashing
   4. Sealant

1.3 RELATED REQUIREMENTS

1. 03 30 00 - Cast in Place Concrete
2. 04 22 00 - Concrete Unit Masonry
3. 07 62 00 - Sheet Metal flashing
4. 07 92 00 - Joint Sealants
5. 08 11 13 - Hollow Metal Doors & Frames
6. 08 43 13 - Alum Storefronts, Curtain walls, and Fixed Units
7. 09 29 00 – Drywall: Exterior Sheathing

1.4 ALTERNATES

A. Submit requests for alternates in accordance with Section 01 60 00.

B. Alternate submission format to include:
   1. Evidence that alternate materials meet or exceed performance characteristics of product requirements and documentation from an approved independent testing laboratory certifying that the performance of the system including auxiliary components exceed the requirements of the local building code.

2. References clearly indicating that the Air Barrier Manufacturer has successfully completed projects of similar scope and nature on an annual basis for a minimum of ten (10) years.
3. Air Barrier Manufacturer's guide specification.
4. Air Barrier Manufacturer's complete set of technical data sheets for assembly.
5. Air Barrier Manufacturer's complete set of details for assembly.
6. Product certification confirming assembly components are supplied and warranted by a single source Air Barrier Manufacturer.
7. LEED HPD declaration
8. Air Barrier Manufacturer statement that anticipated wall assembly compliance with NFPA 285.
9. Sample warranty as specified.

C. Submit requests for alternates to this specification a minimum of ten (10) working days prior to bid date. Include a list of twenty-five (25) projects executed over the past five (5) years.

D. Acceptable alternates will be confirmed by addendum. Substitute materials not approved in writing prior to tender closing shall not be permitted for use on this project.

1.5 REFERENCES

A. American Architectural Manufacturers Association (AAMA):
1. AAMA 711-13 - Voluntary Specification for Self-Adhering Flashing Used for Installation of Exterior Wall Fenestration Products
2. AAMA 2400-02 - Standard Practice for Installation of Windows with a Mounting Flange in Stud Frame Construction

B. American Society for Testing and Materials (ASTM):
1. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting
2. ASTM D903 - Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
4. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials
5. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
6. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights, and Curtain Walls by Uniform Static Air Pressure Difference
7. ASTM E2178 - Standard Test Method for Air Permeance of Building Materials
8. ASTM E2357 - Standard Test Method for Determining Air Leakage of Air

Barrier Assemblies

C. National Fire and Protection Agency (NFPA):
   1. NFPA 285 - Standard Fire Test Method for Evaluation Of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

D. US Green Building Council (USGBC), Leadership in Energy and Environmental Design (LEED)

1.6 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation meetings:
   1. When required, and with prior notice, an Air Barrier Manufacturer representative will meet with the necessary parties at the jobsite to review and discuss project conditions as it relates to the integrity of the assembly.

1.7 SUBMITTALS

A. Provide the following requested information in accordance with Section 01 33 00 Submittal Procedures.

B. Action Submittals:
   1. Product Data:
      a. Air Barrier Manufacturer’s guide specification.
      b. Air Barrier Manufacturer’s complete set of technical data sheets for assembly.
      c. Air Barrier Manufacturer’s complete set of guide details for assembly.
   2. Certificates:
      a. Product certification confirming assembly components are supplied and warranted by a single source Air Barrier Manufacturer.
   3. Tests and Evaluation Reports:
      a. NFPA 285 wall assembly compliance:
         1. Air Barrier Manufacturer statement that anticipated wall assembly complies with NFPA 285.
   4. Warranty:
      a. Sample warranty as specified.

1.8 QUALITY ASSURANCE

A. Single Source Responsibility:
   1. Obtain air barrier and auxiliary materials including adhesive/primer, air barrier, flashings, and sealants from a single Air Barrier Manufacturer regularly engaged in the manufacturing and supply of the specified products.
   2. Contactor to verify product compliance with federal, state, and local regulations controlling use of Volatile Organic Compounds (VOC).

B. Manufacturer Qualifications:
   1. Air Barrier Manufacturer shall demonstrate qualifications to supply materials of this section by certifying the following:
      a. Air Barrier Manufacturer must not issue warranties for terms longer than they have been manufacturing and supplying specified products for similar scope of Work.

C. Installer Qualifications:
   1. Perform Work in accordance with the Air Barrier Manufacturer's published literature and as specified in this section.
   2. Maintain one (1) copy of the Air Barrier Manufacturer's installation instructions on site.
   3. At all times during the execution of the Work allow access to site by the Air Barrier Manufacturer representative.
   4. If meeting with the Air Barrier Manufacturer during project construction, contact the Air Barrier Manufacturer a minimum of two weeks prior to schedule meeting.

1.9 MOCK-UPS

A. Mock-ups: Construct mock-ups to verify selections made under submittals and to set quality standards for materials and execution for mock-ups.

B. Review and acceptance of mock-ups does not constitute approval of deviations from the Contract Documents contained in mock-ups unless architect specifically notes such deviations in writing.

C. Refer to mock-up drawing on A201for detailed layout of panel.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery of Materials:
   1. Materials shall be delivered to the jobsite in undamaged and clearly marked containers indicating the name of the Air Barrier Manufacturer and product.

B. Storage of Materials:
   1. Store materials as recommended by the Air Barrier Manufacturer and conforming to applicable safety regulatory agencies. Refer to all applicable data including, but not limited to, SDS information, Product Data sheets, product labels, and specific instructions for personal protection.
   2. Keep solvents away from open flame or excessive heat.
   3. Store materials in original packaging.
   4. Protect rolls from direct sunlight until ready for use.
   5. Refer to Air Barrier Manufacturer's published literature.

C. Handling:
   1. Refer to Air Barrier Manufacturer's published literature.

1.11 SITE CONDITIONS

A. Environmental Requirements:
   1. No Work shall be performed during rain or inclement weather.
   2. No Work shall be performed on frost covered or wet surfaces.

B. Protection:
   1. It is the responsibility of the installing Subcontractor to protect all surfaces not included in scope of Work from overspray including, but not limited to, windows, doors, adjacent areas, and vehicles.
   2. Cap and protect exposed back-up walls against wet weather conditions during and after application of membrane.

C. Ensure all preparation Work is completed prior to installing air barrier.

D. All equipment shall be grounded during operations.

1.12 WARRANTY

A. Manufacturer's Single Source Warranty; choose from the following:
   1. Product Warranty:
      a. Manufacturer must warrant the material against product defect for a period of one (1) year from date of purchase.
   2. Assembly Warranty:
      a. Manufacturer must warrant the assembly against product defect for a period of ten (10) years from the date of substantial completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Air Barrier and auxiliary materials must be obtained as a single-source from the Air Barrier Manufacturer to ensure total system compatibility and integrity.

B. Acceptable Manufacturers:
   1. Henry® Company
      999 N. Sepulveda Blvd. Suite 800
      El Segundo, CA 90245
      (800) 486-1278
      www.henry.com

C. Substitutions: Comply with Section 01 60 00.

2.2 MATERIALS

A. **WAVB-1:** Primary Fluid-Applied, Air and Vapor Barrier (Basis of Design):

1. Fluid-applied vapor impermeable air and water barrier consisting of a single component water-based elastomeric formulation that cures to a tough monolithic rubber-like membrane; having the following typical physical properties:
    a. Basis of Design: Henry® Air-Bloc® 16MR Air and Vapor Barrier
    b. Color: Gray
    c. Water Vapor Permeance (ASTM E96 Method A): 0.03 perms
    d. Air Leakage of Air Barrier Assemblies (ASTM E2357): Pass
    e. Air Permeance (ASTM E2178): Pass
    f. Elongation (ASTM D412): 270%
    g. Tensile Strength (ASTM D412): 100 psi (689 kPa)
    h. Surface Burning Characteristics (ASTM E84):
        1. Flame Spread: Class A
        2. Smoke Development: Class A
    i. Minimum Application Temperature: 20 degrees F (-6 degrees C)
    j. Water Penetration Resistance Around Nails (ASTM D1970): Pass
    k. Maximum VOC: 68 g/l

B. Assembly Auxiliary Materials:

1. Adhesives/Primers:
    a. Standard VOC adhesive:
        1. Synthetic rubber based quick setting adhesive; having the following typical physical properties:
            a. Basis of design: Henry® Blueskin® Adhesive
            b. Color: Blue
            c. Maximum VOC: 450 g/L
            d. Drying time (initial set): 30 minutes
            e. Low Application Temperature: 10 degrees ºF (-12 degrees ºC)
    b. Low VOC adhesive:
        1. Synthetic rubber based quick setting adhesive with low VOC content; having the following typical physical properties:
            a. Basis of design: Henry® Blueskin® LVC Adhesive
            b. Color: Blue
            c. Maximum VOC: <240 g/L
            d. Drying time (initial set): 30 minutes
            e. Low Application Temperature: 10 degrees F (-12 degrees C)
    c. Quick setting primers:
        1. Synthetic rubber based quick setting adhesive with low VOC content; having the following typical physical properties:
            a. Basis of design: Henry® Blueskin® LVC Spray Primer
            b. Color: Blue
            c. Maximum VOC: 250 g/L
            d. Dry time: 1-3 minutes
            e. Low Application Temperature: 40 degrees F (4.4 degrees C)
        2. Polymer emulsion water based quick setting adhesive with low VOC content; having the following typical physical properties:

a. Basis of design: Henry® Aquatac™ Primer
b. Color: Aqua
c. Maximum VOC: 50 g/L
d. Drying time (initial set): 30 minutes
e. Low Application Temperature: 25 degrees F (-4 degrees C)

2. Liquid-Applied Flashing:
   a. Moisture-curing single component elastomeric liquid-applied flashing using a highly advanced Silyl-Terminated Polyether (STPE) polymer curing to a monolithic membrane; having the following typical physical properties:
      1. Basis of design: Henry® Air-Bloc® LF Liquid-Applied Flashing
      2. Color: Blue
      3. Air Permeance (ASTM E2178): Pass
      4. Water Vapor Permeance (ASTM E96): 21.8 perms @ 25 mils
      5. Air Leakage of Air Barrier Assemblies (ASTM E2357): Pass
      6. Water Resistance (AC212/ASTM D2247): Pass
      7. Nail Sealability (AAMA 711): Pass
      8. Surface Burning Characteristics (ASTM E84):
         a. Flame Spread: Class A
         b. Smoke Development: Class A
      9. Elongation (D412): 264%
      10. Low Application Temperature: 20 degrees F (-7 degrees C)
3. Self-Adhered Flashing:
   a. Non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of a synthetic butyl compound integrally laminated to a white engineered polypropylene film surface; having the following typical physical properties:
      1. Basis of design: Henry® Blueskin® Butyl Flash
      2. Color: White
      3. Thickness: 14 mils (0.36 mm)
      4. Water Vapor Permeance (ASTM E96): 0.14 perms
      5. Nail Sealability (ASTM D1970): Pass
      6. Elongation (ASTM D412): 825% minimum
      7. Low Application Temperature: 25 degrees F (-4 degrees C)
   b. Non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of an SBS rubberized asphalt compound integrally laminated to a high strength polyethylene with surface layer of metallic aluminum film; having the following typical physical properties:
      1. Basis of design: Henry® Metal Clad® Self-Adhered Water Resistive Air Barrier
      2. Color: Metallic Aluminum
      3. Thickness: 45 mils (1.14 mm)
      4. Water Vapor Permeance (ASTM E96): 0.014 perms
      5. Nail Sealability (ASTM D1970): Pass
      6. Elongation (ASTM D412): 85%
      7. Low Application Temperature: 20 degrees F (-7 degrees C)

c. Non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of an SBS rubberized asphalt compound integrally laminated to a blue engineered thermoplastic film surface; having the following typical physical properties:
    1. Basis of design: Henry® Blueskin® SA Self-Adhered Water Resistive Air Barrier
    2. Color: Blue
    3. Thickness: 40 mils (1 mm)
    4. Water Vapor Permeance (ASTM E96): 0.86 perms
    5. Nail Sealability (ASTM D1970): Pass
    6. Elongation (ASTM D412-modified): 200% minimum
    7. Low Application Temperature: 41 degrees F (5 degrees C)
d. Low temperature non-vapor permeable, self-adhered water resistive air and vapor barrier consisting of an SBS rubberized asphalt compound integrally laminated to a blue engineered thermoplastic film surface; having the following typical physical properties:
    1. Basis of Design: Henry® Blueskin® SA LT Low Temp Self-Adhered Water Resistive Air Barrier
    2. Color: Blue
    3. Thickness: 40 mils (1 mm)
    4. Water Vapor Permeance (ASTM E96): 0.86 perms
    5. Nail Sealability (ASTM D1970): Pass
    6. Elongation (ASTM D412-modified): 200% minimum
    7. Low Application Temperature: 10 degrees F (-12 degrees C)

4. Sealants:
    a. Building Envelope Sealant:
        1. Moisture cure, medium modulus polymer modified sealing compound; having the following typical physical properties:
            a. Basis of design: Henry® 925 BES Sealant
            b. Color: Varies
            c. Elongation: 450 – 550%.
    b. Termination Sealant:
        1. Sealing compound; having the following typical physical properties:
            a. Basis of Design: Henry® Polybitume® 570-05
            b. Color: Black
5. Joint Treatment Mesh:
    a. Open weave glass fabric yarn saturated with synthetic resins, having the following typical physical properties:
        1. Basis of Design: Henry® 183 Repair Fabric Yellow Fiberglass

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:

1. Verify substrates to receive Work and surrounding adjacent surfaces are in accordance with Air Barrier Manufacturer published literature prior to installation of self-adhered air barrier assembly.
2. Existing substrate must be continuous and secured prior to application of air barrier.
3. Sheathing panels must be securely fastened and installed flush to ensure a continuous substrate in accordance with Air Barrier Manufacturer published literature.
4. Fastener penetrations must be set flush with sheathing and fastened into solid backing.
5. Strike masonry joints flush.
6. Concrete surfaces shall be smooth and without large voids, spalled areas or sharp protrusions.
7. New concrete should be cured for a minimum of sixteen (16) hours days after forms are removed.
8. Curing compounds or release agents used in concrete construction must be resin based without oil, wax or pigments.
9. Do not install air barrier over saturated substrates.

B. Notify Contractor in writing of any conditions that are not acceptable.

C. The installing contractor shall examine and determine that surfaces and conditions are ready to accept the Work of this section in accordance with published literature. Commencement of Work or any parts thereof shall mean installer's acceptance of the substrate.

D. Do not apply air barrier until substrate and environmental conditions are in accordance with Air Barrier Manufacturer's published literature.

3.2 PREPARATION

A. All surfaces must be sound, dry, clean, and free of oil, grease, dirt, excess mortar, frost, laitance, loose and flaking particles, or other contaminants.

B. Protect adjacent surfaces not included in scope of Work to prevent spillage and overspray.

C. Cap and protect exposed back-up walls against wet weather conditions during and after application of membrane.

D. Hot weather or direct-sun applications over porous substrates, such as concrete, promote rapid surface drying and can form blisters in the fluid applied membrane air barrier during curing. To aid in blister prevention prepare substrate in accordance with one of the following optional procedures:
1. Prime coat:
    a. Apply a thin prime coat of air barrier to substrate.
    b. Allow air barrier to fully cure prior to subsequent application.

c. Install air barrier to Air Barrier Manufacturer minimum recommended mil thickness.

2. Two coat:
   a. Apply air barrier to achieve one-half (1/2) of Air Barrier Manufacturer minimum recommended mil thickness.
   b. Allow air barrier to fully cure prior to subsequent application.
   c. Apply air barrier to achieve one-half (1/2) of Air Barrier Manufacturer minimum recommended mil thickness.
   d. Overall dry mil thickness shall be in accordance with Air Barrier Air Barrier Manufacturer published literature.

3.3 INSTALLATION

A. Ensure substrate is ready to receive air barrier in accordance with Air Barrier Manufacturer's published literature.

B. Temperature limitation:
1. Primary air barrier:
   a. Substrate temperature must be above 20 degrees F (-6 degrees C) and rising.
2. Auxiliary products:
   a. Temperature limitations may vary. Refer to Air Barrier Manufacturer published literature.

B. Application of flashing:
1. Self-adhered flashing:
   a. Where required install adhesive/primer recommended by Air Barrier Manufacturer continuously at rate recommended ensuring complete substrate coverage of anticipated flashing installation area.
      1. Allow adhesive/primer to cure to a tacky film prior to application of flashing.
      2. Only apply adhesive/primer to surfaces which will be covered during the same working day. Primed areas not covered by end of day must be re-primed prior to installation of flashing.
   b. Measure and cut self-adhered flashing to ensure adequate length to achieve continuous coverage of desired installation.
   c. Peel protective film from leading edge of self-adhered flashing and align top of membrane verifying proper positioning prior to complete film removal and flashing placement.
   d. Press self-adhered flashing firmly into place by applying hand pressure to the middle of the membrane and working the pressure to the edges eliminating wrinkles and air bubbles.
   e. Install self-adhered flashings in shingle fashion to eliminate reverse laps.

f. Where required, prime laps at rate recommended by air barrier manufacture to ensure complete coverage of anticipated lap installation.
g. Lap adjoining edges a minimum of two (2) inches.
h. Roll flashing and laps with countertop roller to obtain thorough adhesion.
i. Seal end of day exposed leading edges of self-adhered flashing with building envelope sealant.

2. Liquid-applied flashing:
a. Apply a uniform film of aerosol spray adhesive to raw edges of gypsum sheathing at rate recommended by air barrier manufacturer to completely encapsulate cut edge of gypsum sheathing.
b. Allow adhesive to cure to a tacky film prior to application of liquid-applied flashing.
c. Apply flashing in accordance with and at rate recommended by air barrier manufacturer.
d. Spread flashing to achieve a monolithic membrane over substrate requiring flashing.
e. Allow flashing to cure prior to subsequent installations.

C. Detailing/Flashing:
1. Complete detailing and flashing installations per Air Barrier Manufacturer's published literature.
2. Refer to Air Barrier Manufacturer guide details for further clarification and installation procedures including, but not limited to, the following:
a. Inside corners
b. Outside corners
c. Pipe penetrations
d. Shelf angles
e. Wall to foundation transitions
f. Rough openings:
1. Install rough opening details per Window Manufacturer's published literature and in accordance with ASTM E2112.
2. Wall assemblies containing a vapor retarder on the interior wall assembly:
a. Extend flashing into rough opening to ensure sufficient membrane for connection with vapor retarder and provide a continuous air barrier assembly.

3. Reverse laps:
a. Seal permanently exposed leading edges with sealant:
1. Building envelope sealant
2. Termination sealant
3. Liquid flashing

4. Moving Joints:
a. Contact Air Barrier Manufacturer.

5. Transitions:

a. Contact Air Barrier Manufacturer to coordinate transition of self-adhered air barrier to adjacent areas including, but not limited to, the following:
    1. Roof to air barrier
    2. Air barrier to waterproofing
    3. Fastener penetrations

D. Thru-Wall Flashing:
1. Coordinate with Section 07 62 00.

E. Application of Primary Fluid-Applied, Air and Vapor Barrier:
1. Apply air barrier in continuous, monolithic application without sags, runs, or voids, transitioning onto flashing membrane and overlapping one (1) inch, to create uniform drainage plane and air barrier.
2. Install air barrier so that subsequent membrane installation laps one (1) inch onto flashing ensuring an air and air barrier assembly.
3. Allow air barrier to fully cure prior to placement of insulation.
4. Total dry film thickness (DFT):
    a. Coverage rates may vary due to surface texture or porosity. Refer to Air Barrier Manufacturer Technical Data Sheet for recommended coverage rates.

F. Fastener Penetrations Through Primary Air Barrier:
1. It is the responsibility of the installer penetrating the air barrier assembly to properly install fasteners and components in accordance with the Air Barrier Manufacturer's published literature.
2. Installation requirements:
    a. Drill fasteners and components with sufficient compression to maintain continuity in the air barrier assembly.
    b. Refer to "Self-tapping fasteners" and/or "Pre-drilled fasteners".
3. Supplemental sealant:
    a. Penetrations that do not meet installation requirements require the addition of sealant at point of insertion through the air barrier membrane to maintain continuity in the air barrier assembly.
4. Self-tapping fasteners:
    a. Fastener head must be larger in diameter than the shank.
    b. Drill fasteners perpendicular to the substrate until flush with the air barrier.
    c. Drill fasteners to provide a continuous compression firmly against the air barrier membrane creating a gasketing seal without damaging the membrane.
    d. Do not install fasteners through air barrier over unsupported areas of the substrate such as sheathing joints.
    e. Overdriven fasteners, improperly installed fasteners, defective/broken fasteners, or fasteners not properly fastened into the building structure beyond the air barrier membrane should be removed and the vacated hole sealed with sealant prior to the installation of the cladding or veneer system.

5. Pre-drilled fastening assemblies:
    a. Fastening head or assembly component must be larger in diameter than predrilled hole.
    b. Fastening head or assembly component must be mounted flush with the air barrier.
    c. Fastening head or assembly component must provide a continuous compression firmly against the air barrier creating a gasketing seal without damaging the integrity of the air barrier.
    d. Do not install fastening components through air barrier over unsupported areas of the substrate such as sheathing joints.
    e. Seal improperly drilled and/or vacated holes with sealant prior to the installation of the cladding or veneer system.

3.4 FIELD QUALITY CONTROL

A. Damage to surface by other trades shall not be the responsibility of the installing Subcontractor.

B. Final Observation and Verification:
    1. Final inspection of air barrier assembly shall be carried out by the Owner's representative, the contractor, or Air Barrier Manufacturer as required by warranty.
    2. Contact Air Barrier Manufacturer for warranty issuance requirements.

C. Air barrier assembly is not designed for permanent UV exposure. Refer to Air Barrier Manufacturer published literature for product limitations.

3.5 CLEANING

A. Promptly as the Work proceeds, and upon completion, clean up and remove from the premises all rubbish and surplus materials resulting from the foregoing Work.

B. Clean soiled surfaces, spatters, and damage caused by Work of this Section.

C. Check area to ensure cleanliness and remove debris, equipment, and excess material from the site.

END OF SECTION

SECTION 07 54 23

THERMOPLASTIC OLEFIN MEMBRANE ROOFING SYSTEM (TPO)

PART 1 GENERAL

1.1 SUMMARY

A. Furnish and install fully adhered elastomeric sheet roofing system over metal deck, including:
   1. Roofing manufacturer's requirements for the specified warranty.
   2. Preparation of roofing substrates.
   3. Insulation.
   4. Elastomeric membrane roofing.
   5. Metal roof edging and copings.
   6. Flashings.
   7. Walkway pads.
   8. Roof drains
   9. Other roofing-related items specified or indicated on the drawings or otherwise necessary to provide a complete weatherproof roofing system.

B. Disposal of construction waste is the responsibility of Contractor. Perform disposal in manner complying with all applicable federal, state, and local regulations.

C. Comply with the published recommendations and instructions of the roofing membrane manufacturer, at http://manual.fsbp.com.

E. Commencement of work by the Contractor shall constitute acknowledgement by the Contractor that this specification can be satisfactorily executed, under the project conditions and with all necessary prerequisites for warranty acceptance by roofing membrane manufacturer. No modification of the Contract Sum will be made for failure to adequately examine the Contract Documents or the project conditions.

1.2 REFERENCES

A. Referenced Standards: These standards form part of this specification only to the extent they are referenced as specification requirements.

B. ASTM C 1289 - Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board; 2004.

C. ASTM C 1549 - Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer; 2004.

D. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics; 2003.

E. ASTM D 1004 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting; 2003.

F. ASTM D 1079 - Standard Terminology Relating to Roofing, Waterproofing, and Bituminous Materials; 2005a.

G. ASTM D 6878 - Standard Specification for Thermoplastic Polyolefin Based Sheet Roofing; 2003.

H. CAN-ULC-S770 - Standard Test Method Determination of L-Term Thermal Resistance

Of Closed-Cell Thermal Insulating Foams; 2003.

I. FM 1-28 - Design Wind Loads; Factory Mutual System; 2002.

J. FM 1-29 - Roof Deck Securement and Above Deck Roof Components; Factory Mutual System; 2005.

K. PS 1 - Construction and Industrial Plywood; 1995.

L. PS 20 - American Softwood Lumber Standard; 2005.

M. SPRI ES-1 - Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems; 2003. (ANSI/SPRI ES-1).

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 for definition of terms related to roofing work not otherwise defined in the section.

B. LTTR: Long Term Thermal Resistance, as defined by CAN-ULC S770.

1.4 SUBMITTALS

A. Product Data:
   1. Provide membrane manufacturer's printed data sufficient to show that all components of roofing system, including insulation and fasteners, comply with the specified requirements and with the membrane manufacturer's requirements and recommendations for the system type specified; include data for each product used in conjunction with roofing membrane.
   2. Where UL or FM requirements are specified, provide documentation that shows that the roofing system to be installed is UL-Classified or FM-approved, as applicable; include data itemizing the components of the classified or approved system.
   3. Installation Instructions: Provide manufacturer's instructions to installer, marked up to show exactly how all components will be installed; where instructions allow installation options, clearly indicate which option will be used.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.

   1. Flashings and membrane terminations.
   2. Insulation fastening patterns.
   3. Sheet layout with perimeter and corner defined.

C. Samples for Verification: For the following products:

   1. Thermoplastic (TPO) Membrane
   2. Insulation Board

D. Samples: Submit samples of each product to be used.

E. Specimen Warranty: Submit prior to starting work.

F. Installer Qualifications: Letter from manufacturer attesting that the roofing installer meets the specified qualifications.

G. Pre-Installation Notice: Copy to show that manufacturer's required Pre-Installation Notice (PIN) has been accepted and approved by the manufacturer.

H. Executed Warranty.

I. Membrane must be Energy Star rated.

1.5 QUALITY ASSURANCE

A. No private label products or products manufactured by second party are allowed.
   1. All roofing membrane products must be manufactured by Roofing Manufacturer.

B. Applicator Qualifications: Roofing installer shall have the following:
   1. Current Firestone Red Shield Licensed Contractor status.
   2. At least five years experience in installing specified roofing system.
   3. Capability to provide payment and performance bond to building owner.

C. Contractor providing work under this section will install work specified in this section with their company's own installers, employed by the company. Subcontracting of installation will not be allowed.

D. Pre-Installation Conference: Before start of roofing work, Contractor shall hold a meeting to discuss the proper installation of materials and requirements to achieve the warranty.
   1. Require attendance with all parties directly influencing the quality of roofing work or affected by the performance of roofing work.
   2. Notify Architect well in advance of meeting.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver products in manufacturer's original containers, dry and undamaged, with seals and labels intact and legible.

B. Store materials clear of ground and moisture with weather protective covering.

C. Keep combustible materials away from ignition sources.

1.7 PROJECT/SITE CONDITIONS

A. Environmental Requirements:
   1. Do not apply roofing membrane during inclement weather or when air temperature may fall below 40 degrees F.
   2. Do not apply roofing membrane to damp or frozen deck surface.
   3. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weather-proofed during same day.

1.8 ROOFING CONTRACTOR'S QUALIFICATIONS

A. Contractor shall submit written statement authorized by the roofing system manufacturer to be certified to install the specified manufacturer's materials and has been certified for two consecutive years.

B. The contractor shall use adequate amounts of such qualified workmen who are thoroughly trained in the crafts and techniques required to properly install the type of roofing system proposed for use and other work required to complete the work specified and within the specified time.

C. The contractor shall have a superintendent having five (5) years experience installing the roof system specified, who is familiar with the requirements of this project, on the job at all times when roofing system work is in progress.

1.9 ROOFING MANUFACTURER INSPECTION

A. Final inspection by roofing manufacturer's representative is mandatory prior to substantial completion. **Architect to be notified a minimum of 24 hours prior to manufacturer's inspection and be performed in his presence.**

B. Written proof of final inspection by roofing manufacturer's representative is to be included in closeout documents.

C. **It will be mandatory** that the final roof inspection report containing items to be corrected be sent to Architect for his records.

D. Upon date of Substantial Completion, a **No Dollar Limit Warranty** will be issued and begin for a Twenty (20) year period for the total system warranty. **No exceptions**.

1.10 PRE-ROOFING MEETING AGENDA

A. Verifying roof type and insulation thickness with roofing sub.

B. Warranty: 2 year-installer/ 20 year NDL-manufacturer

C. Manufacturer's scheduled inspection for warranty-Notification of Architect
   1. Warranty period does not start until date of Substantial Completion
   2. Distribution of inspection review to Architect

D. Areas of concern:
   1. Covering over top of parapet walls with roofing membrane
   2. Temporary sealing of roofing membrane against walls until parapet wall membrane flashing or reglets are installed
   3. Installation of welded sub-flashing pieces at parapet corners
   4. Installation of crickets at equipment curbs
   5. Turning up and over of roofing membrane on top of equipment curbs.
   6. Sealing of roof penetrations at membrane
   7. Keeping roof clean after roofing is installed (trash, screws, nails, etc.)
   8. Positive slope all areas

E. Schedule of installation for each area of building.

1.11 WARRANTY

A. Comply with all warranty procedures required by manufacturer, including notifications,

scheduling, and inspections.

B. Warranty: Firestone 20 year Red Shield Limited Warranty covering membrane, roof insulation, and membrane materials and accessories.
   1. Limit of Liability: No dollar limitation.
   2. Scope of Coverage: Repair leaks in the roofing system caused by:
      a. Ordinary wear and tear of the elements.
      b. Manufacturing defect in Firestone brand materials.
      c. Defective workmanship used to install these materials.
      d. Damage due to winds up to 55 mph (88 km/h).

C. Roof flashings and metal work shall be covered under installer's two (2) year warranty.

D. In addition to Mfg's Warranty, a Company 2-year Guarantee from the installer (included in this specification) shall be delivered to the Owner as a condition of Acceptance.

E. Roofer will provide a letter stating the roof system meets or exceeds 1-90 uplift design requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Roofing System: Firestone Building Products Co., Carmel, IN. www.firestonebpco.com.
   1. Roofing systems manufactured by others are acceptable provided the roofing system is completely equivalent in materials and warranty conditions and the manufacturer meets the following qualifications:
      a. Specializing in manufacturing the roofing system to be provided.
      b. Minimum ten years of experience manufacturing the roofing system to be provided.
      c. Able to provide a no dollar limit, single source roof system warranty that is backed by corporate assets in excess of one billion dollars.
      d. ISO 9002 certified.
      e. Able to provide isocyanurate insulation that is produced in own facilities.
      f. Roofing systems manufactured by the companies listed below are acceptable provided they are completely equivalent in materials and warranty conditions:
      g. Able to provide membrane that is produced in own facilities.

B. Manufacturer of Insulation and Cover Boards: Same manufacturer as roof membrane.

C. Manufacturer of Metal Roof Edging:
   1. Metal roof edging products by manufacturers other than roofing manufacturer are acceptable, but must be approved by roofing manufacturer.
   2. Field- or shop-fabricated metal roof edgings are acceptable, but must be covered under the scope of the roofing membrane system no dollar limit warranty.

D. Acceptable alternate manufacturers (Must meet guideline requirements as specified this section)
   1. Johns Manville JM TPO, 717 17th Street, Denver, CO 80202 (800) 922-5922

2. Carlisle Syntec Sure-Weld TPO, PO Box 7000, Carlisle, PA 17013, 800-479-6832
3. GAF Commercial Roofing Systems, 60-mil EverGuard TPO, 1361 Alps Rd, Wayne, NJ 07470, 973-628-3000

E. Substitution Procedures: See Instructions to Bidders.
1. Submit evidence that the proposed substitution complies with the specified requirements. Comply with Section 01 60 00.

2.2 ROOFING SYSTEM DESCRIPTION

A. Roofing System:
1. Membrane: Thermoplastic olefin (TPO).
2. Thickness: 60 mil
3. Membrane Attachment: Fully Adhered.
4. Slope: 1/4 inch per foot by means of sloped roof deck and tapered insulation, refer to drawings.
5. Comply with applicable local building code requirements.
6. Provide assembly having Underwriters Laboratories, Inc. (UL) Class A Fire Hazard Classification.
7. Provide assembly complying with Factory Mutual Corporation (FM) Roof Assembly Classification, FM DS 1-28 and 1-29, and meeting minimum requirements of FM 1-90 wind uplift rating.

B. Insulation:
1. Total R Value: 28.5 minimum.
2. Tapered: Slope as indicated; provide minimum R-value at thinnest point (outer edge of tapered sumps); place tapered layer on top. Provide tapered sumps, ½" per 1'-0" slope, 4'x4', thickness at drains 1" less than minimum required for R-value.
3. Base Layers: Polyisocyanurate foam board, non-composite.
a. Attachment: Mechanically fastened.
4. Top Layer: Where shown and required: 1/4"/foot tapered Polyisocyanurate foam board, non-composite.
a. Attachment: Fully adhered.

2.3 TPO MEMBRANE MATERIALS

RFMB-1

A. Membrane: Flexible, heat weldable sheet composed of thermoplastic polyolefin polymer and ethylene propylene rubber; complying with ASTM D 6878, with polyester weft inserted reinforcement and the following additional characteristics:
1. Thickness: 0.060 inch (1.52 mm) plus/minus 10 percent, with coating thickness over reinforcement of 0.024 inch (0.61 mm) plus/minus 10 percent.
2. Sheet Width: Provide sheets of width necessary to accommodate batten spacing required by manufacturer for project conditions.
3. Puncture Resistance: 265 lbf (1174 N), minimum, when tested in accordance FTM 101C Method 2031.
4. Solar Reflectance: 0.79, minimum, when tested in accordance with ASTM C 1549.
5. Color: White.
6. Acceptable Product: ULTRAPLY TPO by Firestone.

B. Formable Flashing: Non-reinforced, flexible, heat weldable sheet, composed of

thermoplastic polyolefin polymer and ethylene propylene rubber.

1. Thickness: 0.060 inch (1.52 mm) plus/minus 10 percent.
2. Tensile Strength: 1550 psi (10.7 MPa), minimum, when tested in accordance with ASTM D 638 after heat aging.
3. Elongation at Break: 650 percent, minimum, when tested in accordance with ASTM D 638 after heat aging.
4. Tearing Strength: 12 lbf (53 N), minimum, when tested in accordance with ASTM D 1004 after heat aging.
5. Color: White.
6. Acceptable Product: ULTRAPLY TPO Flashing by Firestone.

C. Tape Flashing: 5-1/2 inch (140 mm) nominal wide TPO membrane laminated to cured rubber polymer seaming tape, overall thickness 0.065 inch (1.6 mm) nominal; TPO QuickSeam Flashing by Firestone.

D. Pourable Sealer: Two-part polyurethane, two-color for reliable mixing; Pourable Sealer by Firestone.

E. Bonding Adhesive: Neoprene and SBR rubber blend, formulated for compatibility with the membrane other substrate materials, including masonry, wood, and insulation facings; ULTRAPLY Bonding Adhesive by Firestone.

F. Seam Plates: Steel with barbs and Galvalume coating; corrosion-resistance complying with FM 4470.

G. Termination Bars: Aluminum bars with integral caulk ledge; 1.3 inches (33 mm) wide by 0.10 inch (2.5 mm) thick; Firestone Termination Bar by Firestone.

H. Cut Edge Sealant: Synthetic rubber-based, for use where membrane reinforcement is exposed; UltraPly TPO Cut Edge Sealant by Firestone.

I. General Purpose Sealant: EPDM-based, one part, white general purpose sealant; UltraPly TPO General Purpose Sealant by Firestone.

J. Molded Flashing Accessories: Unreinforced TPO membrane pre-molded to suit a variety of flashing details, including pipe boots, inside corners, outside corners, etc.; UltraPly TPO Small and Large Pipe Flashing by Firestone.

K. Roof Walkway Pads: Non-reinforced TPO walkway pads, 0.130 inch (3 mm) by 30 inches (760 mm) by 50 feet (15.24 m) long with patterned traffic bearing surface; UltraPly TPO Walkway Pads by Firestone.

RFMB-2

L. Vapor Barrier Membrane: Firestone V-Force Vapor Barrier Membrane. SBS modified bitumen adhesive, factory-laminated to a tri-laminate woven, high-density polyethylene top surface. A polymeric release liner protects the adhesive.

2.4 ROOF INSULATION AND COVER BOARDS

A. **INSUL-3** Polyisocyanurate Board Insulation: Closed cell polyisocyanurate foam with black glass reinforced mat laminated to faces, complying with ASTM C 1289 Type II Class 1, with the following additional characteristics:

1. Thickness: 5” minimum + 1/4” per foot tapered iso where shown on drawings.

a. Insulation Joints must be staggered.

2. Size: 48 inches (1220 mm) by 96 inches (2440 mm), nominal.
   a. Exception: Insulation to be attached using adhesive or asphalt may be no larger than 48 inches (1220 mm) by 48 inches (1220 mm), nominal.
3. R-Value (LTTR):
   a. 5" Thickness: (R28.5 minimum) 2.5" + 2.5"
      2.0" = 11.4 LTTR
      2.3" = 13.2 LTTR
      2.5" = 14.4 LTTR
      2.8" = 16.2 LTTR
      3.0" = 17.4 LTTR
4. Compressive Strength: 20 psi (138 kPa) when tested in accordance with ASTM C 1289.
5. Ozone Depletion Potential: Zero; made without CFC or HCFC blowing agents.
6. Recycled Content: 19 percent post-consumer and 15 percent post-industrial, average.
7. Acceptable Product: ISO 95+ GL Polyisocyanurate Insulation by Firestone.

B. Insulation Fasteners: Type and size as required by roof membrane manufacturer for roofing system and warranty to be provided; use only fasteners furnished by roof membrane manufacturer.

C. **RFBD-1:** High Density Polyiso coverboard, C1289, Type II, Class 4, Grade 1, 80 PSI, min. compressive strength, R-Value: 2.5 total, coated glass facer, thickness: ½".

2.5 METAL ACCESSORIES

A. **SMF-1:** Aluminum sheet metal flashing and trim; Prefinished formed aluminum flashing, .040" thickness, finish: Fluropon Pure by Sherwin Williams, Coil-Coated, Color: Black; Verify and match ALSF-2/ALSF-3.

B. **SMF-3:** TPO-Coated sheet metal flashing and trim; TPO-coated formed galvanized steel sheet metal flashing per TPO manufacturer, G-90 hot-dipped galvanized steel; 0.023" thickness, Color: white.

2.6 ACCESSORY MATERIALS

A. Wood Nailers: PS 20 dimension lumber, Structural Grade No. 2 or better Southern Pine, Douglas Fir; or PS 1, APA Exterior Grade plywood; pressure preservative treated.
   1. Width: 3-1/2 inches (90 mm), nominal minimum, or as wide as the nailing flange of the roof accessory to be attached to it.
   2. Thickness: Same as thickness of roof insulation.

2.7 MISCELLANEOUS ACCESSORIES

A. Roofing Fasteners: Galvanized or non-ferrous type, size, and style as required to suit application.

B. Mechanical Fasteners for Insulation: Appropriate to purpose intended and approved by Factory Mutual; length required for thickness of material; with metal washers. Type as required to fastening into metal, concrete, plywood deck.

PART 3 EXECUTION

3.1 GENERAL

A. Install roofing, insulation, flashings, and accessories in accordance with roofing manufacturer's published instructions and recommendations for the specified roofing system. Where manufacturer provides no instructions or recommendations, follow good roofing practices and industry standards. Comply with federal, state, and local regulations.

B. Obtain all relevant instructions and maintain copies at project site for duration of installation period.

C. Do not start work until Pre-Installation Notice has been submitted to manufacturer as notification that this project requires a manufacturer's warranty.

D. Perform work using competent and properly equipped personnel.

E. Temporary closures, which ensure that moisture does not damage any completed section of the new roofing system, are the responsibility of the applicator. Completion of flashings, terminations, and temporary closures shall be completed as required to provide a watertight condition.

F. Install roofing membrane only when surfaces are clean, dry, smooth and free of snow or ice; do not apply roofing membrane during inclement weather or when ambient conditions will not allow proper application; consult manufacturer for recommended procedures during cold weather. Do not work with sealants and adhesives when material temperature is outside the range of 60 to 80 degrees F (15 to 25 degrees C).

G. Protect adjacent construction, property, vehicles, and persons from damage related to roofing work; repair or restore damage caused by roofing work.
   1. Protect from spills and overspray from bitumen, adhesives, sealants and coatings.
   2. Particularly protect metal, glass, plastic, and painted surfaces from bitumen, adhesives, and sealants within the range of wind-borne overspray.
   3. Protect finished areas of the roofing system from roofing related work traffic and traffic by other trades.

H. Until ready for use, keep materials in their original containers as labeled by the manufacturer.

I. Consult membrane manufacturer's instructions, container labels, and Material Safety Data Sheets (MSDS) for specific safety instructions. Keep all adhesives, sealants, primers and cleaning materials away from all sources of ignition.

3.2 EXAMINATION

A. Examine roof deck to determine that it is sufficiently rigid to support installers and their mechanical equipment and that deflection will not strain or rupture roof components or deform deck. Observe and verify deck is not damaged prior to insulation installation.

B. Verify that surfaces and site conditions are ready to receive work. Correct defects in the substrate before commencing with roofing work.

C. Examine roof substrate to verify that it is properly sloped to drains.

D. Verify that the specifications and drawing details are workable and not in conflict with the roofing manufacturer's recommendations and instructions; start of work constitutes acceptable of project conditions and requirements.

3.3 PREPARATION

A. Take appropriate measures to ensure that fumes from adhesive solvents are not drawn into the building through air intakes.

B. Prior to proceeding, prepare roof surface so that it is clean, dry, and smooth, and free of sharp edges, fins, roughened surfaces, loose or foreign materials, oil, grease and other materials that may damage the membrane.

C. Fill all surface voids in the immediate substrate that are greater than 1/4 inch (6 mm) wide with fill material acceptable insulation to membrane manufacturer.

D. Seal, grout, or tape deck joints, where needed, to prevent bitumen seepage into building.

E. The total extent of preparation shall include the above and comply with the membrane manufacturer's recommendations.

3.4 INSULATION AND COVER BOARD INSTALLATION

A. Install insulation in configuration and with attachment method(s) specified in PART 2, under Roofing System.

B. Install only as much insulation as can be covered with the completed roofing system before the end of the day's work or before the onset of inclement weather.

C. Lay roof insulation in courses parallel to roof edges.

D. Neatly and tightly fit insulation to all penetrations, projections, and nailers, with gaps not greater than 1/4 inch (6 mm). Fill gaps greater than 1/4 inch (6 mm) with acceptable insulation. Do not leave the roofing membrane unsupported over a space greater than 1/4 inch (6 mm).

E. Mechanical Fastening (Base layer only): Using specified fasteners and insulation plates engage fasteners through insulation into deck to depth and in pattern required by Factory Mutual for FM Class specified in PART 2 and membrane manufacturer, whichever is more stringent.

3.5 ELASTOMERIC MEMBRANE INSTALLATION

A. Beginning at low point of roof, place membrane without stretching over substrate and allow to relax at least 30 minutes before attachment or splicing; in colder weather allow for longer relax time.

B. Lay out the membrane pieces so that field and flashing splices are installed to shed water.

C. Install membrane without wrinkles and without gaps or fishmouths in seams; bond and test seams and laps in accordance with membrane manufacturer's instructions and details.

D. Install membrane adhered to the substrate, with edge securement as specified.

E. Adhered Membrane: Bond membrane sheet to substrate using membrane manufacturer's recommended bonding material, application rate, and procedures.

F. Edge Securement: Secure membrane at all locations where membrane terminates or goes through an angle change greater than 2 in 12 inches (1:6) using mechanically fastened reinforced perimeter fastening strips, plates, or metal edging as indicated or as

recommended by roofing manufacturer.

1. Exceptions: Round pipe penetrations less than 18 inches (460 mm) in diameter and square penetrations less than 4 inches (200 mm) square.
2. Metal edging is not merely decorative; ensure anchorage of membrane as intended by roofing manufacturer.

3.6 FLASHING AND ACCESSORIES INSTALLATION

A. Install flashings, including laps, splices, joints, bonding, adhesion, and attachment, as required by membrane manufacturer's recommendations and details.

B. Metal Accessories: Install metal edgings, gravel stops, and copings in locations indicated on the drawings, with horizontal leg of edge member over membrane and flashing over metal onto membrane.
   1. Follow roofing manufacturer's instructions.
   2. Remove protective plastic surface film immediately before installation.
   3. Install water block sealant under the membrane anchorage leg.
   4. Flash with manufacturer's recommended flashing sheet unless otherwise indicated.
   5. Where single application of flashing will not completely cover the metal flange, install additional piece of flashing to cover the metal edge.
   6. If the roof edge includes a gravel stop and sealant is not applied between the laps in the metal edging, install an additional piece of self-adhesive flashing membrane over the metal lap to the top of the gravel stop; apply seam edge treatment at the intersections of the two flashing sections.
   7. When the roof slope is greater than 1:12, apply seam edge treatment along the back edge of the flashing.

C. Flashing at Walls, Curbs, and Other Vertical and Sloped Surfaces: Install weathertight flashing at all walls, curbs, parapets, curbs, skylights, and other vertical and sloped surfaces that the roofing membrane abuts to; extend flashing at least 8 inches (200 mm) high above membrane surface.
   1. Use the longest practical flashing pieces.
   2. Evaluate the substrate and overlay and adjust installation procedure in accordance with membrane manufacturer's recommendations.
   3. Complete the splice between flashing and the main roof sheet with specified splice adhesive before adhering flashing to the vertical surface.
   4. Provide termination directly to the vertical substrate as shown on roof drawings.

D. Roof Drains:
   1. Utilize pre-fabricated tapered insulation sumps around drain to provide smooth transition from roof surface to drain.
   2. Position membrane, then cut a hole for roof drain to allow 1/2 to 3/4 inch (12 to 19 mm) of membrane to extend inside clamping ring past drain bolts.
   3. Make round holes in membrane to align with clamping bolts; do not cut membrane back to bolt holes.
   4. Apply sealant on top of drain bowl where clamping ring seats below the membrane
   5. Install roof drain clamping ring and clamping bolts; tighten clamping bolts to achieve constant compression.

E. Flashing at Penetrations: Flash all penetrations passing through the membrane; make flashing seals directly to the penetration.
   1. Pipes, Round Supports, and Similar Items: Flash with specified pre-molded pipe

flashings wherever practical; otherwise use specified self-curing elastomeric flashing.

2. Pipe Clusters and Unusual Shaped Penetrations: Provide penetration pocket at least 2 inches (50 mm) deep, with at least 1 inch (25 mm) clearance from penetration, sloped to shed water.
3. Structural Steel Tubing: If corner radii are greater than 1/4 inch (6 mm) and longest side of tube does not exceed 12 inches (305 mm), flash as for pipes; otherwise, provide a standard curb with flashing.
4. Flexible and Moving Penetrations: Provide weathertight gooseneck set in sealant and secured to deck, flashed as recommended by manufacturer.
5. High Temperature Surfaces: Where the in-service temperature is, or is expected to be, in excess of 180 degrees F (82 degrees C), protect the elastomeric components from direct contact with the hot surfaces using an intermediate insulated sleeve as flashing substrate as recommended by membrane manufacturer.

F. After constructing pitch pans for conduit and piping penetrating roof system, fill pitch pans with pourable sealer to completely waterproof penetrations.

3.7 FINISHING AND WALKWAY INSTALLATION

A. Install walkways at access points to the roof, around rooftop equipment that may require maintenance, and where indicated on the drawings.

B. Walkway Pads: Adhere to the roofing membrane, spacing each pad at minimum of 1.0 inch (25 mm) and maximum of 3.0 inches (75 mm) from each other to allow for drainage.

1. If installation of walkway pads over field fabricated splices or within 6 inches (150 mm) of a splice edge cannot be avoided, adhere another layer of flashing over the splice and extending beyond the walkway pad a minimum of 6 inches (150 mm) on either side.
2. Prime the membrane, remove the release paper on the pad, press in place, and walk on pad to ensure proper adhesion.

3.8 FIELD QUALITY CONTROL

A. Inspection by Manufacturer: Provide final inspection of the roofing system by a Technical Representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes (i.e. not a sales person).

B. Perform all corrections necessary for issuance of warranty.

C. **NEW ROOFING SYSTEM SHALL NOT ALLOW PONDING WATER.** Architectural details are graphic in nature and do not show actual scale installation of roofing layers or flashing. Taper roofing insulation at perimeter of roof drains to allow proper drainage of surrounding roof, free of ponding.

3.9 CLEANING

A. Clean all contaminants generated by roofing work from building, roof membrane, flashing, and surrounding areas, including bitumen, adhesives, sealants, clay, dirt and coatings.

B. Repair or replace building components and finished surfaces damaged or defaced due to the work of this section; comply with recommendations of manufacturers of components and surfaces.

C. Remove leftover materials, trash, debris, equipment from project site and surrounding areas.

3.10 PROTECTION

A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition.

END OF SECTION

COMPANY LETTERHEAD

CERTIFICATE OF GUARANTEE FROM INSTALLER

We, _____
(Name of Company or Contractor) agree to maintain the roofing and flashing on the below mentioned building for the period indicated. This agreement is to render the roof and the flashing waterproof subject to the conditions outlined below.

OWNER OF BUILDING _____

Location of Building _____

City _____ Roof Area _____square feet_____

This Guarantee effective this _____day of _____ , 20_____, for the term of two (2) years from this date, provided any defects result from defective material or workmanship and are not caused by other mechanics, fire, accidents, or by nature over which we have no control.

It is understood and agreed that the Contractor will not be responsible for leaks or failure in the roofing system or flashing due to sustained winds in excess of speeds stated in manufacturer's warranty, distortion of the foundation on which the roofing rests, excessive hail storms, or any other conditions over which we have no control as stated in manufacturer's exclusions.

Signed _____
Name of Company

By _____

Position _____

Company is a _____
Corp./Partnership/Individual

NOTARY PUBLIC

Registered in the State of _____

SEAL

NOTE: Roof system manufacturer's NDL Twenty (20) year warranty from the manufacturer is to be submitted in addition to the guarantee from the installer found on this form. Manufacturer's Warranty is mandatory - **NO EXCEPTIONS**.

COMPANY LETTERHEAD

CERTIFICATE OF GUARANTEE FROM INSTALLER

We, _____
(Name of Company or Contractor) agree to maintain the roofing and flashing on the below mentioned building for the period indicated. This agreement is to render the roof and the flashing waterproof subject to the conditions outlined below.

OWNER OF BUILDING _____

Location of Building _____

City _____ Roof Area _____square feet_____

This Guarantee effective this _____day of _____ , 20_____, for the term of two (2) years from this date, provided any defects result from defective material or workmanship and are not caused by other mechanics, fire, accidents, or by nature over which we have no control.

It is understood and agreed that the Contractor will not be responsible for leaks or failure in the roofing system or flashing due to sustained winds in excess of speeds stated in manufacturer's warranty, distortion of the foundation on which the roofing rests, excessive hail storms, or any other conditions over which we have no control as stated in manufacturer's exclusions.

Signed _____
Name of Company

By _____

Position _____

Company is a _____
Corp./Partnership/Individual

NOTARY PUBLIC

Registered in the State of _____

SEAL

NOTE: Roof system manufacturer's NDL Twenty (20) year warranty from the manufacturer is to be submitted in addition to the guarantee from the installer found on this form. Manufacturer's Warranty is mandatory - **NO EXCEPTIONS**.

SECTION 07 62 00

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SCOPE:

A. The work required under this specification includes all labor, materials, equipment and services necessary for and reasonably incidental to the completion of all metal flashing and counterflashings, wall flashings, parapet cap flashing, joint covers, crickets, and other metal work required to complete the job.

1.2 RELATED SECTIONS

A. Section 07 54 23: Thermoplastic Membrane Roofing

B. Section 07 92 00: Sealants

1.3 WORKMANSHIP

A. All workmanship shall be in accordance with plans, with the various sections uniform, and sections accurately fitted and rigidly secured. All exposed edges shall be seamed, and all work shall be neatly fitted to the framework, with necessary ribs or stiffeners and other reinforcements required to make all sections rigid and substantial. This section to comply with SMACNA Standards.

B. Proper allowance shall be made in all cases for expansion and contraction, with the vertical joints not secured directly but constructed weather and watertight to allow members to slide freely. Joint covers shall be installed over all joints.

PART 2 PRODUCTS

2.1 MATERIALS

A. Refer to drawings for metal types and locations. All flashing shall not be less than 24 gauge, and shall be compatible to other materials they may be in contact with. No dissimilar metals will be used together.
SMF-1: Aluminum Sheet Metal Flashing and Trim, Color Black
SMF-2: Stainless Steel Sheet Metal Flashing and Trim, Color Black
SMF-3: TPO-Coated Sheet Metal Flashing and Trim, Color White

B. Fasteners shall be non-rusting materials which are not subject to galvanic action. Fasteners shall be of proper length and spacing to assure secure attachment, fit and alignment. Furnish and install continuous clip at cap flashing. Provide pre-finished fasteners, matching pre-finished flashing color.

C. In general, all exposed flashing is pre-finished material, but where exposed galvanized iron flashings occur, paint grip materials shall be used.

D. Where flashing shown must be fabricated into watertight multi-sided slopes, use paint grip material with soldered joints.
   1. Solder: Half and half solder made from virgin lead and tin shall conform to the Standard Specifications of the ASTM, E-32, latest edition.
   2. Flux: All galvanized sheet metal shall have non- corrosive acid used as a flux.
   3. All exposed paint grip galvanized material shall be painted color as selected by Architect.

E. Pre-finished flashing to be shop formed sections out of material supplied by the metal roofing manufacturer with same color selection available.

F. Flashing and Trim: Cap Flashing and Counterflashing - 24 gauge prefinished steel. Pitchpocket - two (2") inches deep, 24 galvanized iron. All flashing and trim located in areas which are visually exposed shall be prefinished unless noted otherwise.

G. Provide cap and parapet flashing in minimum lengths of 10 feet or more between joints.

2.2 FINISH:

A. Color: To be selected by Architect. See schedule above.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install work watertight, without waves, warps, buckles, fastening stresses or distortion, allowing for expansion or contraction.

3.2 FLASHING:

A. Flash walls, etc., as detailed. Flashing shall be of material and gauge as specified on plans. All walls flashing, crickets, counterflashings, etc., shall be installed in accordance with SMACNA standards and in conformance with details shown or implied on plans.

B. Counterflashing generally shall be in 10'-0" lengths. Counterflashing shall be free from longitudinal joints. End joints in counterflashing generally shall not be soldered. Flashing to be installed with masonry, no saw cut installations will be allowed.

C. On counterflashings, the ends of one (1) length shall fit into a pocket on the adjacent length which has been formed by soldering a skirter lining on the back of the adjoining member. Counterflashings must be bent to the required shape before being placed.

D. Provide splices for cap flashing as shown on drawings.

E. Provide flexible flashing with stainless steel band clamp for pipe roof penetrations.

F. Secure all cap flashings with continuous cleats on both sides of parapets. Lap cleat sections minimum 2 inches. Secure to wood nailers with screws at minimum 16 inches on center.

3.3 WORKMANSHIP

A. Fasteners shall be concealed anchors of compatible materials.

B. Metal surfaces shall be formed and applied in strict accordance with SMACNA sheet metal working standards.

C. No perforations of metal surfaces shall be made except as shown on details for flashing, closures, trim, etc.

D. All exposed edges shall be seamed and all work shall be neatly fitted to the framework, with necessary ribs or stiffeners and other reinforcement required to make all sections rigid and substantial.

E. Install work watertight, without waves, warps, buckles, fastening stresses or distortion, allowing for expansion and contraction.

END OF SECTION

SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification Section, apply to work specified in this section.

1.2 DEFINITIONS

A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in, or construction joints between, fire rated wall and floor assemblies.

1.3 GENERAL DESCRIPTION OF THE WORK OF THIS SECTION

Only tested firestop systems shall be used in specific locations as follows:

A. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electrical busways and raceways through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.

B. Safing slot gaps between edge of floor slabs and curtain walls.

C. Openings between structurally separate sections of wall or floors.

D. Gaps between the top of walls and ceilings or roof assemblies.

E. Expansion joints in walls and floors.

F. Openings and penetrations in fire-rated partitions or walls containing fire doors.

G. Openings around structural members which penetrate floors or walls.

1.4 RELATED WORK OF OTHER SECTIONS

A. Coordinate work of this section with work of other sections as required to properly execute the work and as necessary to maintain satisfactory progress of the work of other sections, including:
   1. Section 03 30 00 - Cast-In-Place Concrete
   2. Section 07 92 00 - Joint Sealers
   3. Section 09 29 00 - Gypsum Drywall Systems
   4. Section 21 13 01 - Fire Suppression Sprinkler Systems
   5. Section 22 01 00 - Plumbing
   6. Section 23 01 00 - Basic Mechanical Materials and Methods
   7. Section 23 07 13 - Mechanical Insulation

8. Section 26 00 10 - Basic Electrical Materials and Methods

1.5 REFERENCES

A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"

B. Test Requirements: UL 1479, “Fire Tests of Through-Penetration Firestops”

C. Test Requirements: UL 2079, “Tests for Fire Resistance of Building Joint Systems”

D. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
   1. UL Fire Resistance Directory:
      a. Firestop Devices (XHJI)
      b. Fire Resistance Ratings (BXRH)
      c. Through-Penetration Firestop Systems (XHEZ)
      d. Fill, Voids, or Cavity Material (XHHW)
      e. Forming Materials (XHKU)
      f. Joint Systems (XHBN)
      g. Perimeter Fire Containment Systems (XHDG)

   2. Alternate Systems: “Omega Point Laboratories Directory” (updated annually).

E. Test Requirements: ASTM E 1966, “Standard Test Method for Fire Resistive Joint Systems”

F. Test Requirements: ASTM E 2307, “Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-story Test Apparatus”

G. Inspection Requirements: ASTM E 2174, “Standard Practice for On-site Inspection of Installed Fire Stops”

H. ASTM E 84, “Standard Test Method for Surface Burning Characteristics of Building Materials”

I. ASTM G 21, “Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi”

J. International Firestop Council Guidelines for Evaluating Firestop Systems Engineering Judgments

K. All major building codes: IBC

L. NFPA 101 - Life Safety Code

M. NFPA 70 - National Electric Code

1.6 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide through-penetration fire stop systems and fire resistive joint systems that comply with specified requirements of tested systems.

B. Firestop System installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no qualified tested system is available through a manufacturer, an engineering judgment derived from similar qualified tested system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment documents must follow requirements set forth by the International Firestop Council.

F. Source Limitations: Obtain firestop products and systems from a single manufacturer.

1.7 SUBMITTALS

A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of qualified tested firestop systems to be used and manufacturer's installation instructions to comply with Section 01 33 00.

B. Manufacturer's engineering judgment identification number and document details when no qualified tested system is available for an application. Engineering judgment must include both project name and contractor’s name who will install firestop system as described in document.

C. Submit material safety data sheets and certificates of compliance provided with product delivered to job-site.

1.8 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A supplier’s willingness to sell its firestopping products to the contractor or to an Installer engaged by the contractor does not in itself confer qualification on the buyer.

B. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in project to a single firestop specialty contractor.

C. The work is to be installed by a contractor with at least one of the following qualifications:
Hilti Accredited Firestop Specialty Contractor
UL Approved Contractor
FM 4991 Approved Contractor

D. Firm with not less than 3 years experience with firestop installation.

E. Successfully completed not less that 3 comparable scale projects using similar systems.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements, including temperature restrictions.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.

E. Do not use damaged or expired materials.

1.10 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet. For non-water resistant firestop materials, protect from exposure to water -- firestop materials that are water resistant shall be protected until fully cured.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 PRODUCTS

FS-1

2.1 FIRESTOPPING, GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that are needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

C. Firestopping Materials are either "cast-in-place" (integral with concrete placement) or "post installed." Provide cast-in-place firestop devices prior to concrete placement.

D. Firestopping will also act as a weather barrier at roof parapet cavities, refer to drawings for further details.

2.2 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ), joint systems (XHBN), and perimeter firestop systems (XHDG) listed in Volume 2 of the UL Fire Resistance Directory; provide products of the following manufacturers as identified below:
   1. Hilti, Inc., Tulsa, Oklahoma
      800-879-8000/www.us.hilti.com
   2. 3M, Inc.
   3. STI
   4. Provide products from the above acceptable manufacturers; *Refer to Section 01 60 00 for Product or Manufacturer Substitutions.*

B. Source all firestop products from a single-source manufacturer.

2.3 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E 814 or UL 2079, ASTM E 1966, ASTM E 2307 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.

B. Pre-installed firestop devices for use with noncombustible and/or combustible pipes (closed and open systems), conduit, and/or cable bundles penetrating concrete floors, the following products are acceptable:
   1. Hilti CP 680P or CP 680M Cast-In Place Firestop Devices:
      a. Add Aerator adapter when used in conjunction with an Aerator (Sovent system)
      b. Add metal deck adapter kit if utilizing CP 680P or M on corrugated metal deck.
      c. Add height extension if utilizing CP 680P or M in concrete slabs thicker then 8".
      d. Add Hilti Water Module (2" up to 6") to achieve UL W-Rating
      e. Add Hilti TOP SEAL (1/2" up to 2") to achieve UL W-Rating
   2. Hilti CP 681 Tub Box Kit for use with bath tub installations.

3. Hilti Toilet Flange for use with floor outlet water closets.
4. Hilti coupling sleeve for use with floor, shower or general purposes drains
5. Hilti CFS-DID Drop-in devise for use with cored holes.

C. Pre-installed firestop devices containing built-in self-sealing intumescent inserts for use with data and communication cabling which allow for cable adds or changes without the need to remove or replace any firestop materials, the following product is acceptable:
   1. Hilti CP 653 Speed Sleeve
   2. Hilti CFS-CC Cable Collar for us in renovation work with existing cables.

D. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
   1. Hilti FS-ONE Intumescent Firestop Sealant
   2. Hilti CFS-SIL SL: Self Leveling Silicone
   3. Hilti CP 620 Fire Foam
   4. Hilti CP 606 Flexible Firestop Sealant
   5. Hilti CFS-SIL GG: Gun Grade Silicone

E. Sealants or caulking materials for use with sheet metal ducts, the following products are acceptable:
   1. Hilti CFS-SIL GG: Gun Grade Silicone
   2. Hilti CP 606 Flexible Firestop Sealant
   3. Hilti FS-ONE Intumescent Firestop Sealant

F. Sealants, caulking or spray materials for use with fire-rated construction joints and other gaps, the following products are acceptable:
   1. Hilti CFS-SP WB Firestop Spray
   2. Hilti CFS-SIL GG: Gun Grade Silicone
   3. Hilti CP 606 Flexible Firestop Sealant
   4. Hilti CFS-SIL SL: Self Leveling Silicone

G. Pre-formed mineral wool designed to fit flutes of metal profile deck and gap between top of wall and metal profile deck as a backer for spray material, the following products are acceptable:
   1. Hilti CP 777 Speed Plugs
   2. Hilti CP 767 Speed Strips

H. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:
   1. Hilti FS-ONE Intumescent Firestop Sealant
   2. Hilti CFS-PL Firestop Plug

I. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
   1. Hilti FS-ONE Intumescent Firestop Sealant
   2. Hilti CP 620 Fire Foam
   3. Hilti CFS-SIL GG: Gun Grade Silicone

4. Hilti CP 606 Flexible Firestop Sealant

J. Non-curing, re-penetrable intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
   1. Hilti CP 618 Firestop Putty Stick
   2. Hilti-PL Firestop Plug

K. Wall opening protective materials for use with UL listed metallic and specified nonmetallic outlet boxes, the following products are acceptable:
   1. Hilti CFS-P PA Firestop Putty Pad
   2. Hilti Firestop Box Insert
   3. Hilti CFS-BL Firestop Block

L. Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:
   1. Hilti CP 643 N Firestop Collar
   2. Hilti CP 644 Firestop Collar
   3. Hilti CP 648E Endless Wrap Strips
   4. Hilti CP 648S Single Wrap Strips

M. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
   1. Hilti CP 637 Firestop Mortar
   2. Hilti CFS-BL Firestop Block
   3. Hilti CP 620 Fire Foam
   4. Hilti CP 675T Firestop Board

N. Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
   1. Hilti CFS-BL Firestop Block
   2. Hilti CP 675T Firestop Board

O. Sealants or caulking materials used for openings between structurally separate sections of wall and floors, the following products are acceptable:
   1. Hilti CFS-SP WB Firestop Spray
   2. Hilti CFS-SIL GG: Gun Grade Silicone
   3. Hilti CP 606 Flexible Firestop Sealant
   4. Hilti CFS-SIL SL: Self Leveling Silicone

P. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
   1. Hilti CFS-BL Firestop Block
   2. Hilti CFS-PL Firestop Plug

Q. Draftstopping at floor or roof bypass studs:
   1. 4” or 6” (fill depth of stud) thick mineral wool safing cut oversize to friction fit into place between studs at slab and roof edge, including where wall framing bypasses roof

decking to act as air barrier separation with parapet cavity above. Refer to drawings for continuity of air barrier between framing of back of sheathing.

R. Provide a firestop system with a "F" Rating as determined by UL 1479 or ASTM E814 which is equal to the time rating of construction being penetrated.

S. Provide a firestop system with an Assembly Rating as determined by UL 2079 or ASTM E 1966 which is equal to the time rating of construction joint assembly.

PART 3 EXECUTION

3.1 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
   1. Verify penetrations are properly sized and in suitable condition for application of materials.
   2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
   3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.
   4. Comply with firestop manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.
   5. Do not proceed until unsatisfactory conditions have been corrected.

3.2 COORDINATION

A. Coordinate construction of openings, penetrations and construction joints to ensure that the firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration fire stop systems. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

C. Coordinate firestopping with other trades so that obstructions are not placed in the way prior to installation of the firestop systems.

D. Do not cover up through-penetration and joint firestop system installations that will become concealed behind other construction until each installation has been examined by the building inspector, per requirements of Section 110, IBC 2012.

3.3 INSTALLATION

A. Regulatory Requirements: Install firestop materials in accordance with UL or Intertek approved systems.

B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration and construction joint materials.
   1. Seal all holes or voids made by penetrations to ensure an air and water-resistant seal.
   2. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.
   3. Protect materials from damage on surfaces subjected to traffic.

3.4 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Inspection of through-penetration firestopping shall be performed in accordance with ASTM E 2174, “Standard Practice for On-Site Inspection of Installed Fire Stops” or other recognized standard.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

E. Manufacturer’s Field Services: During initial installation, firestop manufacturer should be present to assure proper installation/application.

3.5 IDENTIFICATION & DOCUMENTATION

A. The firestop contractor is to supply documentation in the form of the Hilti CFS-DM Documentation Manager
   The FTP is to include:
   1. Architectural details
   2. Firestop affidavit
   3. Firestop system snapshot
   4. Installation log
   5. Firestop systems
   6. IFC guidelines for Engineering Judgments
   7. Product Information of utilized products
   8. All other relevant documentation
   9. Building code excerpts

B. Copies (electronic) of the FTP are to be provided to the general contractor, architect, inspector & owner at the completion of the project.

C. Identify through-penetration firestop systems with self-adhesive, preprinted labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
   1. Installer/Contractor's name, address, and phone number.
   2. Date of installation.

3. Through-Penetration firestop system and manufacturer's name.

3.6 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION

SECTION 07 92 00

JOINT SEALANTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing sealant substrate surfaces.
   2. Concrete slab control joint filler
   3. Sealant and backings
   4. Acoustical Sealants and Sound Dampening Compounds
   5. Special expansion and control joint fillers
   6. Sill Sealer (Sealant between bottom of exterior stud track and substrate.)

1.2 RELATED SECTIONS

A. Section 03 30 00: Cast-In-Place Concrete

B. Section 04 21 13: Brick Masonry

C. Section 06 41 16: Cabinetwork & Shelving

D. Section 07 84 00: Firestopping

E. Section 08 11 13: Hollow Metal Doors & Frames

F. Section 08 43 13: Aluminum Storefront, Doors, and Exterior Fixed Units

G. Section 08 81 00: Glass & Glazing

H. Section 09 29 00: Drywall

I. Section 32 16 00: Walks and Curbs

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.4 REFERENCES

A. American Society for Testing and Materials (ASTM):
   1. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
   2. ASTM C1087 - Sealant Compatibility with Glazing Materials and Accessories.
   3. ASTM D1565 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Open Cell Foam).
   4. ASTM C920 - Elastomeric Joint Sealants.

B. Sealing and Waterproofer Institute (SWI):
   1. SWI - Sealant and Caulking Guide Specifications.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not install solvent curing sealants in enclosed building spaces.

B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate work of this Section with all Sections referencing this Section.

1.7 WARRANTY

A. The Contractor must guarantee weathertightness for a period of two (2) years from the date of Substantial Completion of the building.

B. The Contractor will, at any time within the two (2) year period, remedy all leaks of any nature in any part of the building due to the use of faulty materials and/or workmanship under this section, without additional cost to the Owner. The Contractor shall further reimburse the Owner for any damage occasioned by such leaks.

C. The Contractor is cautioned to supplement the work, described in this section of the specifications, by any means necessary to permit the above guarantee, which he will be called upon to make as an obligation of the Contract.

D. Provide **Silicone sealant #4** manufacturer's twenty (20) year warranty. All other sealants to have manufacturer's minimum ten (10) year warranty provided.

E. Butyl Rubber Sill Sealer: Provide subcontractor and manufacturers One (1) year warranty from date of substantial completion.

PART 2 PRODUCTS

2.1 SEALANT MATERIALS

A. Polymer or Polyurethane Sealants:
   1. **Polyurethane Sealant #1**: ASTM C920, Type M, Grade NS, Class 25.
   2. ASTM C719, ASTM D412, ASTM C661, ASTM C679 and ASTM C510
   3. Polyurethane Sealant approved manufacturers:
      a. MasterSeal NP-150 by BASF.
      b. Note: A two-part sealant with custom color availability are to be provided where sealants are installed in exterior walls and interior walls with painted finishes so that color matches each finish color. Architect to approve color all sealant color matches.
   2. **Polymer or Polyurethane Sealant #2**: ASTM C920, Type S, Grade P, Class 25.
      a. Titebond "Weathermaster" , self leveling, manufactured by Franklin International.
      b. MasterSeal SL1 or SL2 by BASF.
      c. Sikaflex 1c SL or 2c SL by Sika
      d. Approved alternate
      e. Provide standard color selections. **Architect to approve color.**

B. Silicone Sealant:
   1. **Silicone Sealant #1**: Dow Corning No. 790 Silicone building sealant or approved equal.
   2. **Silicone Sealant #2**: ASTM C920, Type S, Grade NS,Class 25, mildew resistant.
      a. Sanitary 1702 by General Electric Silicone Products Division.
      b. 786 by Dow Corning Corporation.
   3. **Silicone Sealant #3**: Dow Corning No. 795 Silicone building sealant or approved alternate.
   4. **Silicone Sealant #4**: Dow Corning No. 756 Silicone building sealant, Dow Corning Corporation, P.O. Box 994, Midland, MI 48686-0994; (800) 248-2481; www.dowcorning.com/construction.
      a. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant, ASTM C 920, Type S, Grade NS, Class 50, for Use NT; SWRI validation.
      b. Type: One-component, ultra-low modulus, neutral-cure silicone rubber sealant; *Dow Corning*® 756 Silicone Building Sealant, as manufactured by Dow Corning Corporation.
   5. **Note: Silicone sealants #1, #3 and #4 to have custom color availability, matching adjacent material where installed. Architect to approve color match.**
   6. Acceptable Alternate Silicone Sealant Manufacturers: GE Sealants

C. Concrete Slab Control Joint Filler:
   1. 2-part polyurea, Versaflex SL/85, rapid curing, manufactured by Versaflex, Inc., 87 Shawnee Avenue, Kansas City, KS 66105 (913) 321-9000.
   2. 2-part polyurea, PE85, manufactured by Hi-Tech Systems, 1190 N. Del Rio Place, Onterio, CA 91764 (909)945-5530
   3. Approved alternate

D. Sill Sealer:
   1. Butyl rubber, continuous under bottom track of exterior stud walls.

E. Sound Sealant:
   1. At all interior sound wall applications (to comply with ASTM C334-76).
   2. Approved manufacturers:
      a. SC-177 Sound Sealant by OSI
      b. BA 98 by Pecora
      c. Synthetic Rubber Acoustical Sealant by Trimco

F. Provide fire rated sealant, where installed in fire rated walls. Refer to section 07 84 00.

2.2 ACCESSORIES

A. Primer: Non-staining, clear type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Filler: Polyethylene foam rod, oversized 30% to 50%

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

E. Backer Seal: “Greyflex” backer seal, manufactured by Emseal Joint Systems, LTD (800) 526-8365. No substitutions will be accepted.

2.3 SPECIAL EXPANSION / CONTROL JOINT FILLERS

A. 1/2” – 7/8” wide joints: Provide ‘BACKERSEAL’ secondary joint filler by Emseal Joint Systems, Ltd, 800-526-8365, or approved alternate. This is to be provided in addition to backer rod and sealant.

B. Install joint fillers per manufacturer’s instructions.

2.4 SEALANT COLORS

A. Colors to be selected from manufacturer’s standard color selection for each type of sealant specified with exception of two-part polyurethane sealants and silicone sealants, which are to match finishes as stated in 2.1 A & B. Architect to approve color matches.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that surfaces and joint openings are ready to receive work and field measurements are as shown on Drawings and recommended by the manufacturer.

B. Beginning of installation means installer accepts existing substrates

3.2 PREPARATION

A. Clean and prime joints in accordance with manufacturer's instructions.

B. Remove loose materials and foreign matter which might impair adhesion of sealant.

C. Verify that joint backing and release tapes are compatible with sealant.

D. Protect elements surrounding work of this Section from damage or disfiguration.

3.3 INSTALLATION

A. Install sealant in accordance with manufacturer's instructions.

B. Measure joint dimensions and size materials to achieve required width/depth ratios.

C. Install joint backing rods to achieve neck dimension no greater than 1/3 the joint width. For joints ½” to 7/8”, install backer seal prior to installing backer rod material install backer seal and backer rods as required to keep a uniform depth along entire joint.

D. Install bond breaker where joint backing is not used.

E. Apply sealant within recommended temperature ranges. Consult manufacturer when sealant cannot be applied within recommended temperature ranges. In no case, allow the depth of sealant be less than ½".

F. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

G. Tool joints concave.

H. Where sound walls are indicated on drawings, install sound sealant around all penetrations, each side, under stud base plate, at intersection of wall, roof deck, and around all windows and hollow metal frames.

I. Interior sealants are not to be installed until building is tempered by HVAC system and temperature will remain constant. **DO NOT PAINT POLYURETHANE AND SILICONE SEALANTS**. Do not install sealants in walls or floors where paint, stain, etc is scheduled to be applied until after finishes are applied unless sealants are masked off during coating process.

J. Concrete slab control joint filler:
   1. Use only at concrete floors which **do not** receive any floor coverings or polished concrete finish.
   2. Prior to final seal coat, install joint filler flush with top of slab. Remove any excess filler.

3.4 SCHEDULE

A. General Exterior Construction (Non-stone or masonry construction):
   1. Polyurethane Sealant #1

B. Horizontal Exterior Locations:
   1. Polyurethane Sealant #2

C. Masonry Exterior Locations:
   1. Silicone Sealant #3

D. General Interior Construction:
   1. Polyurethane Sealant #1 (All wall control joints.)

E. Plumbing Fixtures:
   1. Silicone Sealant #2.

F. Horizontal Interior Locations:
   1. Polyurethane Sealant #2.

G. Aluminum Storefront and Curtainwall Systems, Aluminum Windows:
   1. Silicone Sealant #1

H. Concrete Slab Control Joint Filler

1. All control joints for slab-on-grade and elevated slabs where no finish or floor coverings are scheduled.

I. Butyl Rubber
   1. Continuous bead below bottom track of exterior stud walls and below metal thresholds.

END OF SECTION

SECTION 08 11 13

HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish labor and materials to complete Hollow Metal Doors, Hollow metal frames, and related items as shown and specified.

1.2 RELATED SECTIONS

A. Section 04 22 00 - Concrete Unit Masonry

B. Section 08 14 16 - Wood Doors.

C. Section 08 71 00 – Finish Hardware

D. Section 08 43 13 - Aluminum Storefront, Doors, and Exterior Fixed Units.

E. Section 08 81 00 – Glass and Glazing

F. Section 09 29 00 – Drywall

G. Division 26 - Electrical Requirements.

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

B. Shop Drawings: Submit prior to fabrication for approval of Architect detailed shop drawings, showing all doors, frames, other miscellaneous materials. Shop drawings to show all locations of reinforcement for door hardware in doors and frames.

1.4 REFERENCES

A. Comply with State of Arkansas Adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

PART 2 PRODUCTS

2.1 MATERIALS

A. Hollow Metal Frames -
   1. Manufactured by Steelcraft, Ceco, Curries or Amweld, or approved alternate, constructed of cold rolled steel, commercial quality, annealed and temper passed. All frames, interior, exterior: 16 gauge all openings 3'-6" or less, and 14 gauge for all openings over 3'-6".

2. Exterior Frames: **Fleming** or approved alternate, special galvanized, paintable. Field paint all doors and frames.
3. Frames:
    a. All frames shall be a one piece unit type with head and jambs completely mitered and face joints continuously welded in their entirety and ground smooth. Inside corners to be caulked prior to painting. The use of tenons or bent tabs is not acceptable. Where transoms and sidelights are required, frames: shop assembled for a proper fit, then shipped in largest size units permitted by shipping restriction. Mullions: assembled by sliding two sections together with continuous welded interior guides. Screwed on mullion covers and visible seams, not acceptable. All seams ground smooth. All exposed welding tabs ground smooth.
    b. No KD type frames shall be permitted.
4. Provide concealed reinforcements, drilled and tapped, to receive hardware. Hinge reinforcements: 10 gauge with top hinge high frequency usage hinge reinforcement, 10 gauge angle stiffener welded to both sides of the frame and hinge reinforcement. Lock reinforcement: spring type stabilizer to hold lock in place. Lock and surface applied hardware reinforcement 10 gauge. Clip angles: spot welded to bottom of each frame for anchoring to floor. Mortar 14 gauge anchors, one per each 2' of height, per jamb of a type to suit conditions and requirements. All other reinforcement for hardware to be minimum 10 gauge.
5. Frames where Underwriter Labeled doors are used: carry Underwriter Label frame.
6. Provide three (3) rubber silencers on strike side of all frames.
7. All exposed screws to be countersunk using flathead screws, flush with surface.

B. Hollow Metal Doors:
1. Non-label and label steel doors: to be completely flush design with lights, louvers, etc., as required on schedule doors as manufactured by Ceco, Amweld, Steelcraft, Curries, Mesker, Dittco, Truscon, or approved equal. Provide **type "A" series** doors with flush door light frames where lights are called for on drawings.
2. Exterior Doors: Fleming or approved alternate, 'D' Series, special galvanized, flush design, paintable. Field paint.
3. Construction: Doors shall be constructed of 18 gauge sheets for interior applications, and 16 gauge for exterior applications. Leveled steel formed and rigidly connected and reinforced inside with continuous vertical interlocking 24-gauge stiffeners. All doors shall be continuously arc welded vertically where the two outer sheets are joined on edges and dressed smooth.
4. All exterior doors shall be insulated and sound deadened with super-core expanded foam or approved alternate.
5. Provide and properly locate required reinforcement in door for all door mounted hardware.
6. For door leaf 3'-6" to 4'-0" or wider, provide preparation for 2 pairs butt hinges or continuous hinge as specified.

C. Doors and frames shall be prepared to receive hardware as specified in section 08 71 00 and glass of type, size, and shape as shown on drawings. Use reinforcing plates welded to inner face of frames for all hardware.

D. All exterior doors to receive aluminum thresholds. Supply with added aluminum spacer on exterior side if required. Threshold to be type and style to match details if shown on plans, but

in no case on plans, no more than 1/2" in height with transition slope not to exceed 1:2 to meet Arkansas Architectural Barriers Law and Americans with Disabilities Act Guidelines.

E. Coordinate frame throat sizes with wall thicknesses where frames are installed in stud and drywall partitions.

F. Provide three (3) rubber door silencers for each single leaf door frame, and two (2) door silencers for each double leaf door frame.

PART 3 EXECUTION

3.1 COORDINATION

A. Coordinate location and installation of reinforcement for all scheduled door hardware items attached to hollow metal doors and frames.

3.2 FRAME ANCHORING

A. Provide proper anchors for wall type frames are to be installed in.

B. Hollow metal door frame jambs and heads are to be slushed full of mortar. Refer to Section 04 22 00 Concrete Masonry Units.

3.3 FINISHES

A. All surfaces to be job finished shall be thoroughly cleaned, removing all rust, scales, grease, etc.

B. All exterior hollow metal doors and frames: Given shop coat of rust resistant prime paint oven baked.

3.4 STORAGE AND ERECTION

A. Carefully store frames in an upright position, not on ground, protected from moisture and weather. Frames and doors that are dented or sprung, before, during, or after installation will not be accepted.

END OF SECTION

SECTION 08 14 16

WOOD DOORS

PART 1 GENERAL

1.1 SCOPE:

A. Furnish and install wood doors as shown and as specified herein. Doors are to be of type, size, and design shown and scheduled on drawings.

1.2 RELATED WORK:

A. Section 08 71 00 - Hardware

B. Section 08 81 00 - Glass & Glazing

C. Section 09 91 00 - Finishes

1.3 QUALITY REQUIREMENT:

A. All wood doors shall meet N.W.W.D.A. Industry Standard 1-A and Architectural Woodwork Institute Section 1300-G-3, Type FPC-7.

1.4 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

B. Submit shop drawings in accordance with General Requirements. Include full size molding section detail for light and louver installation. Show glazing material, louver type and thickness, and face veneer grade and species.

1.5 REFERENCES

A. Comply with State of Arkansas Adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

1.6 DELIVERY

A. Package in heavy Kraft paper or polyethylene bags. Deliver and store in areas of Temperature and humidity such as will not adversely affect doors.

B. Doors shall be packaged in individual cartons.

1.7 PROTECTION

A. Protect work from damage until final acceptance.

1.8 WARRANTY

A. Manufacturer to provide lifetime warranty for interior duration, and two (2) year warranty for exterior duration.

B. Door warp tolerance shall not exceed 1/4" in any section of the door.

C. Stile, rail and core "telegraphing" shall not exceed 1/100" in any 3" span.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Masonite

B. Oshkosh Architectural Door Company.

C. VT Industries

2.2 MATERIALS

A. Doors shall be 1 3/4" thick, 5 or 7 ply, solid core, stain grade, maple. Paint grade may be used where called for on finish schedule. Top and bottom rails to be 1 1/8" min. width, stiles 1 3/8" min. Width prior to field fitting. Core shall be wood particle core meeting ANSI A208.1, Grade 1-LD-1, or 1-LD-2 with a 28-32 lb density, and type II adhesive. Veneer shall be provided on side edges and shall match species of face veneer. Where a pair of doors are called for, face veneer shall be book-matched grain. Provide mineral composition core when fire rating is required.

B. Provide factory-prefinished doors from manufacturer. Architect to select stain color from manufacturer’s standard colors.

2.3 FABRICATION

A. Fabricate premium type doors in accordance with requirements of WDMA Quality Standards (SCLC-5 or 7) unless specifically indicated otherwise.

B. Fabricate fire rated doors in accordance with requirements of Underwriter’s Laboratories (UL).

C. Provide doors with edge strips, of wood species to match face veneers.

D. Make cutouts and provide stops for glass.

E. Pairs of doors shall be products of a manufacturer who can furnish such doors without astragals and meet the UL requirements.

F. Pre-fit doors at factory with 1/8 inch tolerance on each vertical face, 1/8 inch tolerance at top, and ½ inch at bottom, except where undercuts are scheduled.

G. Machine doors for hardware as required by Hardware Schedule listed in Section 08 71 00, which will be supplied together with all necessary templates for hardware requiring door preparation.

H. Steel frame shop drawings will be furnished showing location and size of hardware preparation.

I. Bevel strike edge of single acting doors 1/8 inch in 2 inches. Radius strike edge of double acting swing doors, 2-1/8 inches.

J. All fire rated doors shall be factory prepped to receive hardware and glazing.

K. Pre-finish doors at factory with clear WDMA System #6 finish.

PART 3 EXECUTION

3.1 INSTALLATION AND WORKMANSHIP:

A. Install doors plumb and true to operate without bind or drag with 1/8" clearance top and sides. Provide 3/4" undercut at bottom unless indicated otherwise.

B. Doors damaged before or after hanging will be replaced.

C. All edge and end surfaces will be sealed with two (2) coats of door manufacturer's standard sealer before final hanging. **This includes top and bottom ends**.

D. All necessary refitting or adjustment shall be the Contractor's responsibility during the guarantee period.

E. Provide moldings and glass stops of same species as face veneers.

F. If called for, wood louvers to be factory installed into properly prepared openings.

G. Pre-machine bevel on vertical edges of single doors or meeting stiles of pairs of doors.

H. Coordinate door light location with door hardware to assure no conflicts occur.

I. For door leaf 3’-6” to 4’-0” or wider, provide preparation for 2 pairs butt hinges or continuous hinge as specified.

3.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver: Protect doors at all times. Deliver doors to site after plaster and cement are dry And building has reached average prevailing relative humidity of locality.

B. Storage: Stack flat on 2 x 4 lumber, laid 12” from ends and across center. Under bottom door and over top of stack provide plywood or corrugated cardboard to protect door surface. Store doors in area where there will be no great variation in heat, dryness and humidity.

C. Handling: Do not drag doors across one another.

3.3 INSPECTION

A. Verify that door frames are of type required for door and are installed as required for proper installation of doors. Do not install doors in frames which would hinder the operation of the doors.

SPECIAL NOTE:
THERE CAN BE NO GLASS OR GLASS KITS IN DOORS THAT WILL INTERFERE WITH THE MOUNTING OF ANY FINISH HARDWARE. ENOUGH STILE AND RAIL MUST EXIST SO THAT NO SHIMS ARE NEEDED.

END OF SECTION

SECTION 08 31 13

CEILING / WALL ACCESS PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Provide all labor, materials and equipment necessary for the furnishing and installation of access panels as required in gypsum board ceilings and walls and in masonry walls for mechanical or electrical equipment access. Provide proper model for panels installed in materials other than gypsum board.

1.2 SUBMITTALS

A. Comply with Section 01 33 00.

PART 2 PRODUCTS

2.1 MANUFACTURER/MODEL

AXPNL-1

A. Bauco Access Panel Solutions, Bauco Plus II, 2'x2' Concealed Hardware Gypsum Wallboard Access Panel

B. Substitutions: Subject to compliance with requirements, one of the following may be substituted for that specified.
   1. Karp
   2. J.L. Industries
   3. Approved alternate.

C. Provide fire rated models of type required where installed in fire rated ceilings and walls, or where called for on drawings.

D. Panel size as needed for application, unless called out on drawings. Panel size and locations are to be approved by Architect prior to installation.

PART 3 EXECUTION

3.1 PREPARATION

A. Verify that rough openings are correctly installed to receive panels.

B. Make necessary preparation of surrounding materials to accept panel installation.

C. Coordinate locations and sizes of required access panels with Architect for approval.

3.2 INSTALLATION

A. Install panels in accordance with manufacturer's instructions and provide concealed framing as required to properly install access panel.

B. Adjust panel operation and locking mechanism to ensure all features of access panel operate smoothly.

3.3 FINISH

A. Paint panel per Section 09 91 00.

B. Recessed perimeter grooves of panels installed in gypsum board walls or ceilings to be clean and free of drywall mud prior to painting. Gypsum board infill and perimeter of panel to be flush with gypsum board finish surrounding panel.

END OF SECTION

SECTION 08 33 00

SIDE COILING SECURITY GRILLES

PART 1 GENERAL

1.1 GENERAL REQUIREMENTS

A. Provide all materials, labor, equipment and services necessary to furnish, deliver and install all work under this section as shown on the contract documents, specified herein, and as specified by the job conditions.

1.2 DESCRIPTION

A. Related work specified elsewhere:

1. Metal Fabrication.	Section 05 50 00
2. Rough Carpentry.	Section 06 10 00
3. Access Panels & Doors:	Section 08 31 00
4. Painting:	Section 09 91 00
5. Electrical:	Division 26

1.3 SUBMITTALS

A. Procedures: Furnish submittals in accordance with the general requirements specified.

B. Shop Drawing: Furnish shop drawings for architect's approval. Include elevations, sections, and details indicating dimensions, materials, finishes, conditions for anchorage and support of each side coiling grille.

C. Product Literature: Submit manufacturer's technical literature describing the product to be used under this section.

D. Maintenance and Operating Manuals: Furnish complete manuals describing the materials, devices and procedures to be followed in operating and maintaining all side coiling grilles under this section. Include manufacturer's brochures and parts lists describing the actual materials used in the product.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances and regulations of federal, state and municipal authorities having jurisdiction.

B. Manufacturer Requirements: Side coiling grille manufacturer shall have been in the business of and have experience in manufacturing the type of product covered under this specification section as well as giving credible service for a minimum of five (5) years. Provide list of at least ten (10) completed projects which include the products covered under this section.

1.5 DELIVERY, STORAGE AND HANDLING

A. General: Deliver and store materials in manufacturer's original packaging, labeled to show name, brand and type. Store materials in a protected dry location off the ground in accordance with manufacturer's instructions.

1.6 WARRANTY

A. Side Coiling Grille Warranty: Provide Two (2) Year Warranty signed by the manufacturer and installer agreeing to repair or replace work which has failed as a result of defects in materials or workmanship. Upon notification within the warranty period, such defects shall be repaired at no cost to the owner.

PART 2 PRODUCTS

SECDR-2

2.1 SIDE COILING SECURITY GRILLES

A. Manufacturer: Side coiling security grilles shall be the model SC3000G-SL9-A as manufactured by McKEON.

B. Substitution Procedures: Comply with Section 01 60 00.

2.2 MATERIALS

A. General: Each unit shall consist of an open type grille curtain designed to travel in a horizontal plane, smoothly and without binding. Curtain shall be driven to the open and close position by a positive action sprocket drive, without the use of cables or counterbalance weights.
   1. Grille Curtain: Shall be the SL9 pattern consisting of 5/16" diameter solid galvanized steel rods, encased by 3/8” aluminum tubular spacers 9” long. The horizontal links shall be fabricated of 1/8” x 5/8” aluminum strips and shall be set in a straight lattice pattern. The vertical spacing shall be 1½” while the horizontal spacing shall be 9”.

B. Leading Edge: Curtain shall be furnished with an aluminum member of tubular design to provide stiffness, limit deflection and provide for a tight fitting closure.

C. Receiving Edge: Shall be fabricated of an extruded aluminum member with sufficient depth, designed to accept the leading edge and form a tight fitting closure when the grille is the fully closed position.

D. Head Track: Shall be of not less than 1/8" thick steel and shall be provided with integral locking bars. The faying surface shall not be less than 38% of the flat plate area when the side coiling grille is in the closed position. Locking bars shall lock and retain the coiling curtain in place. Unit shall not require or utilize any type of floor track system.

E. Counterbalance Assemblies: The side coiling grille shall be counterbalanced by means of adjustable steel helical torsion springs attached to shaft enclosed in pipe with required mounting blocks for attachment of curtain. Torsion springs shall be anchored to the same shaft and held in position by the same adjusting wheel accessible from outside the barrel assemblies.

F. Coil Box: Shall be provided to entirely enclose coiled curtain and counterbalance assemblies.

Coil box cover shall be of a rectangular design fabricated of 22 gauge G90 galvanized sheet steel.

G. Electric Motor Operator: Side coiling grille shall be provided with a compact power unit designed and built by the side coiling grille manufacturer. Operator shall be equipped with an adjustable screw-type limit switch to break the circuit at termination of travel. High efficiency gearing running in an oil bath, shall be furnished together with a magnetic operated brake, completely housed to protect against damage, dust and moisture. An efficient overload protection device, which will break the power circuit and protect against damage to the motor windings shall be integral with the unit. Operator is to be housed in a NEMA type 1 enclosure.
    1. Motor: Shall be intermediate duty, thermally protected, ball bearing type with a class A or better insulation. Horsepower of motor is to be 1/3hp minimum or of manufacturer's recommended size, which ever is greater.
    2. Starter: Shall be size "0" magnetic reversing starter, across the line type with mechanical and electrical interlocks, with 10 amp continuous rating and 24 volt control circuit.
    3. Reducer: Spiral gear type, 70% efficiency minimum.
    4. Brake: Magnetically activated, integral within the operator's housing.
    5. Control Station: Provide flush mount key switch control station marked open, close and stop.

H. Obstruction Sensing Device: The side coiling grille shall be designed with a radio activated obstruction sensing safety edge. In the event that the safety edge meets an obstruction during the normal closing operation, the grille shall stop, reverse and return to the open position.

I. Finish After completion of fabrication, clean all metal surfaces to remove dirt and chemically treat to provide for paint adhesion. All steel components shall receive a coat of prime paint finish, all exposed aluminum shall be of a clear anodized.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces and field conditions to which this work is to be performed and notify architect if conditions of surfaces exist which are detrimental to proper installation and timely completion of work.

B. Verify all dimensions taken at job site affecting the work. Notify the architect in any instance where dimensions vary.

C. Coordinate and schedule work under this section with work of other sections so as not to delay job progress.

3.2 INSTALLATION

A. Perform installation using only factory approved and certified representatives of the side coiling grille manufacturer.

B. Install side coiling grille assemblies at locations shown in perfect alignment and elevation, plumb, level, straight and true.

C. Adjust side coiling grille installation to provide uniform clearances and smooth non-binding operation.

D. Install wiring in accordance with applicable local codes and the National Electrical Code Standard. Materials shall be UL listed.

3.3 PROTECTION AND CLEANING

A. Protect installed work using adequate and suitable means during and after installation until accepted by owner.

B. Remove, repair or replace materials which have been damaged in any way.

C. Clean surfaces of grime and dirt using acceptable and recommended means and methods.

END OF SECTION

SECTION 08 33 25

COILING STEEL INSULATED FIRE DOOR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, including General and Supplementary Conditions, and Division 1 General Requirements, apply to the work of this Section.

1.2 SUMMARY

A. The work of this Section includes rolling fire doors.

B. Related Sections: Other specification sections which directly relate to the work of this Section include, but are not limited to, the following:

1. Section 08 71 00 - Finish Hardware; key cylinders for locks.

2. Section 26 - Electrical; wiring.

1.3 SUBMITTALS

A. Comply with Section 01 33 00.

B. Product Data: Submit manufacturer’s product data and installation instructions for each type of rolling fire door. Include both published data and any specific data prepared for this project.

C. Shop Drawings: Submit shop drawings for approval prior to fabrication. Include detailed plans, elevations, details of framing members, required clearances, anchors, and accessories. Include relationship with adjacent materials.

1.4 QUALITY ASSURANCE

A. Manufacturer: Rolling fire doors shall be manufactured by a firm with a minimum of five years experience in the fabrication and installation of rolling fire doors. Manufacturers proposed for use, which are not named in these specifications, shall submit evidence of ability to meet performance and fabrication requirements specified, and include a list of five projects of similar design and complexity completed within the past five years.

B. Installer: Installation of rolling fire doors shall be performed by an authorized representative of the manufacturer.

C. Single-Source Responsibility: Provide doors, guides, motors, and related primary components from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

D. Pre-Installation Conference: Schedule and convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in labeled protective packages. Store and handle in strict compliance with manufacturer's instructions and recommendations. Protect from damage from weather, excessive temperatures and construction operations.

PART 2 PRODUCTS

OHDR-1

2.1 ACCEPTABLE MANUFACTURER

A. Series 634 FireKing Fire Doors by Overhead Door Corporation; Telephone 800-929-2553 or 717-248-0131; Fax 800-929-1274.

B. Substitutions: Comply with requirements of Section 01 60 00.

2.2 ROLLING FIRE DOORS

A. Label: Provide fire doors certified with the following listing.

1. Rolling fire doors up to 152 sq. ft. and 13'6" in width or height shall bear the UL 4-Hour Class A Label.
2. Rolling fire doors over 152 sq. ft. shall receive the UL Oversize Fire Door Label.
3. Rolling fire doors up to 120 sq. ft. and 12' in width or 10' in height shall bear the FM4-Hour Class A Label. (FM 1 1/2 Hour Class B Label for non-masonry fire walls.)
4. Rolling fire doors over 120 sq. ft. and not exceeding 18' in height or width shall Receive the Factory Mutual (FM) Label for Oversize Fire Doors.

B. If UL labeled smoke protection is required, then provide doors with Underwriters' Laboratories, Inc. label for "Leakage Rated Assembly" or "S" label.

1. Comply with NFPA 105 air leakage requirements.
2. Pass UL test procedure 1784.

C. Curtain: Interlocking roll-formed slats as specified following. Alternate wind-lock type end-locks shall be attached to each end of alternate slats to prevent lateral movement.

1. Flat profile type F-265 with a back cover through 24' width and 24' height fabricated of 24-gauge galvanized steel. (Optional 22 ga. Galvanized Steel). Mineral wool inserts will fill the slat assembly internal space.
2. Calculated R-Value: 4.5 (Hr.)(Ft.^2)(°F)/Btu
3. STC (Sound Transmission Class) Testing: STC (Sound Transmission Class) Testing STC Door Assembly 17 Door Assembly with brush seals 18 Curtain Only 23

D. Finish:

1. Galvanized Steel: Slats and hood shall be galvanized steel in accordance with ASTM A 653 and receive rust inhibitive, roll coating process, including bonderizing, 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester (powder coated) top coat. Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.

E. Color: Powder coating finish in white.

F. Bottom Bar: Two (galvanized) structural steel angles 1-1/2” by 1-1/2” by 1/8” minimum.

G. Guides: Guides will be three structural steel angles with a minimum thickness of 1/4" (6 mm) mounted to the face of the jamb. They also include a locking bar or "wind bar".

1. Fastening Guides to Masonry Fire Walls: UL listed expansion anchors, or by through- bolts on soft brick or hollow block walls, or by bolts on steel jambs, or welded in accordance with manufacturer’s listing.
2. Fastening Guides to Non-Masonry Fire Walls: Comply with the manufacturer’s listing.

H. Brackets: Steel plate to support counterbalance, curtain and hood.

I. Counterbalance: Helical torsion spring type. Counterbalance shall be housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03” per foot of span. Counterbalance shall be adjustable by means of an adjusting tension wheel.

J. Hood: 24-gauge galvanized primed steel minimum for wall openings thru 19’ wide. 22-gauge galvanized primed steel for wall openings over 19’ wide. Hood shall be equipped with thermally controlled, internal, galvanized steel flame baffle as required. Provide one intermediate support bracket for wall openings over 13’6” wide and two support brackets for wall openings over 19’-0” wide.

K. Manual Operation: Chain Hoist (Crank)

M. Electric Motor Operation: Provide UL listed electric operator, size as recommended by manufacturer to move door in either direction at not less than 2/3 foot nor more than 1 foot per second.

L. Automatic Closure: See Fire Sentinel specification for time delay release device.

M. Locking: Interior slide lock for electric operation with interlock switch.

N. Wall Mounting Condition: Between jambs mounting.

PART 3 EXECUTION

3.1 PREPARATION

A. Take field dimensions and examine conditions of substrates, supports, and other

conditions under which this work is to be performed. Do not proceed with work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Strictly comply with manufacturer's installation instructions and recommendations. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

B. Install rolling fire doors in compliance with requirements of NFPA 80. Test fire-release system and reset components after testing.

C. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

3.3 ADJUSTING AND CLEANING

A. Test rolling fire doors for proper operation and adjust as necessary to provide proper operation without binding or distortion.

B. Touch-up damaged coatings and finishes and repair minor damage. Clean exposed surfaces using non-abrasive materials and methods recommended by manufacturer of material or product being cleaned.

END OF SECTION

SECTION 08 42 26

FULL VISION GLASS WALL SYSTEM

PART 1 GENERAL

1.1 SUMMARY

A. Contractor to furnish labor and materials for Glass Wall System with Door and Hardware where shown on plans.

1.2 RELATED WORK

A. Section 08 71 00 – Door Hardware

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Frameless Glazed Interior Wall and Door Assemblies:
   1. C.R. Laurence Co., Inc.; CRL Clear View Series Frameless Glass Wall Office System: www.crl-arch.com.
B. Approved alternate.

2.2 GLAZING

A. Minimum ½ inch thick tempered clear glass with ground and polished edges. Manufacturer to provide thicker glazing as required for deflection requirements, depending on sizes.

2.3 DOOR HARDWARE

A. The following items are to be provided by door manufacturer:
   1. Pivot hinges (Door to be dual-swing, self closing)
   2. Back to back pull set
   3. Keyed/thumbturn lock and strike-bottom mounted (keying to match building door keying)

2.4 SYSTEM DESCRIPTION

GLSF-1

A. Frameless Glazed Interior Wall Assembly: Factory fabricated assemblies consisting of full-width and height glass panels fastened with low profile sidelite aluminum rail fittings on top and bottom edge of glass wall.
   1. Configuration: As indicated on drawings.

2. Full Length Top and Bottom Sidelite Rails: 2-5/16 inch (59 mm) high by 1-1/2 inch (38 mm) deep with end caps.
3. Sidelite Fittings, Clad Finish: Bright brushed anodized.
4. Glass Thickness: 1/2 inch (12.7 mm), tempered.
5. Designed to withstand normal operation without damage, racking, sagging, or deflection.
6. Coordinate wall and door assembly preparation and provide hardware as necessary for fully operable installation.
7. Finished metal surfaces protected with strippable film.
8. Factory assembled to greatest extent practical; may be disassembled to accommodate shipping constraints.

B. Pivoting Glass Doors: Full length dry glazed rail fittings.
1. Door Configuration: As indicated on drawings.
2. Full Length Top and Bottom Rails: 2-5/16 inch (59 mm) high by 1-1/2 inch (38 mm) deep with end caps.
3. Glass Thickness: 1/2 inch (12.7 mm), tempered.
4. Sidelite Rails: Match door rail sightlines and finish.
5. Aluminum Finish: Bright brushed anodized.
6. Door Hardware: Locking ladder pulls, brushed stainless steel.
7. Provide accessories as required for complete installation.
8. Basis of Design: C.R. Laurence Co., Inc; CRL Wedge-Lock Low Profile Door Rail System: www.crl-arch.com.

2.5 MATERIALS

A. Glass: Flat glass meeting requirements of ASTM C1036, Type I - Transparent Flat Glass, Class 2 - Tinted, Quality Q3, fully tempered in accordance with ASTM C1048, Kind FT, and as follows:
1. Thickness: As indicated.
2. Color: Clear.
3. Prepare glazing panels for indicated fittings and hardware before tempering.
4. Polish edges that will be exposed in finished work to bright flat polish.
5. Temper glass materials horizontally; visible tong marks or tong mark distortions are not permitted.

B. Aluminum Components: Conforming to ASTM B221 (ASTM B221M), Alloy 6063, T5 Temper.

C. Sealant: One-part silicone sealant, conforming to ASTM C920, clear.

2.6 FINISHES

A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that field measurements are as indicated.

B. Verify that track supports are properly braced, level within 1/4 inch (6 mm) of required position and parallel to the floor surface.

C. Verify floor flatness of 1/8 inch in 10 feet (3 mm in 3 m), non-cumulative.

D. Do not begin installation until supports and adjacent substrates have been properly prepared.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean substrates thoroughly prior to installation.

B. Prepare substrates using the methods recommended by the manufacturer for achieving acceptable result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with glazed interior wall and door assembly manufacturer's instructions.

B. Fit and align glazed interior wall and door assembly level and plumb.

3.4 ADJUSTING

A. Adjust glazed interior wall and door assembly to operate smoothly from sliding or pivoting positions.

B. Adjust swing door hardware for smooth operation.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before date of Substantial Completion.

3.6 WARRANTY

A. Full vision glass wall system is warranted for a minimum full one year.

END OF SECTION

SECTION 08 43 13

ALUMINUM STOREFRONT, DOORS, AND EXTERIOR FIXED UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Aluminum Storefront System, aluminum doors, accessories.

B. Anchors, brackets, brake metal, and attachments.

C. Door hardware.

1.2 RELATED SECTIONS

A. Section 07 92 00 - Joint Sealers: Perimeter sealant.

B. Section 08 71 00 - Finish Hardware: Cylinders.

C. Section 08 81 00 - Glazing.

D. Division 26 - Electrical Requirements

1.3 REFERENCES

A. ANSI/ASTM E283 - Rate of Air Leakage through Exterior Windows, Curtain Walls and Doors.

B. ANSI/ASTM E330 - Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

C. FS TT-P-31-Paint, Oil: Iron Oxide, Ready Mixed, Red and Brown.

D. FS-TT-P-641 - Primer Coating; Zinc Dust-Zinc Oxide (for Galvanized Surfaces).

E. Comply with State of Arkansas Adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

1.4 SUBMITTALS

A. Submit through Construction Manager to Architect.

B. Product Data: Submit manufacturer's installation instructions.

C. Shop Drawings: Include system and component dimensions; components within assembly; framed opening requirements and tolerances; anchorage and fasteners; glass; door hardware requirements; and affected related work.

1.5 PERFORMANCE

A. Each type of window system shall be designed and engineered by the manufacturer to meet or exceed the wind load criteria for the applicable building code with jurisdiction, based on the size, shape, performance and location of each window unit. Manufacturer shall provide all internal stiffeners, blocking, attachments, etc., as may be required to provide a complete system.

B. Design Wind Loads:
   1. Ultimate Design Wind Speed: 120 MPH
   2. Nominal Design Wind Speed: 93 MPH
   3. Exposure Category: C
   4. Internal Pressure Coefficient: +/- 0.18

1.6 QUALITY ASSURANCE

A. Manufacturer of aluminum storefront or curtainwall system shall have minimum of Ten (10) years experience in the manufacturing and installation of the system. Any substitutions shall follow requirements of Specification Section 01 60 00.

B. Installer Qualifications: The installer shall have successful experience with installation of the same or similar units required for this project and other projects of similar size and scope for a minimum of ten (10) years.

C. Source Limitations: Obtain aluminum framed storefront and or curtainwall systems through one source from a single manufacturer, as well as other framing systems involved in complete building framing package.

1.7 WARRANTY

A. Aluminum storefront/curtainwall system: manufacturer's two (2) year warranty.

B. Aluminum entrances: Manufacturer's two (2) year warranty from date of substantial completion. In addition, welded door corner construction shall be supported with a Limited Lifetime Construction Warranty for the life of the door.

C. Aluminum Storefront/Curtainwall Installer's Warranty: Installer shall provide a five (5) year warranty covering air and water leakage, system failure. Installer will provide signed copy of installer's warranty found at the end of this specification section.

1.8 DOOR HARDWARE/KEYING MEETING

A. Prior to ordering of hardware items, Contractor shall arrange meeting between, hardware supplier, Owner, and Architect to review and verify door hardware submittals and keying suggestions. This review meeting shall be considered as the submittal review. Any changes shall be incorporated in the hardware submittals and then resubmitted to Contractor and Architect as **record copy**. Contractor to notify all parties one (1) week prior to meeting date.

1.9 PRE-INSTALLATION CONFERENCE

A. Prior to aluminum storefront/curtainwall installation, Contractor will schedule pre-installation conference to review aluminum storefront/curtainwall system(s) and installation procedures. Required attendance shall include Contractor, aluminum storefront/curtainwall supplier and installer, Installer's foreman, aluminum storefront/curtainwall manufacturer's representative, and Architect. Owner may also attend if he desires. Contractor shall conduct conference in collaboration with manufacturer's representative.

B. An actual mockup of a typical aluminum storefront/curtainwall installation shall be performed on site by installer immediately following the conference to assure proper installation methods and procedures are followed.

1.10 MANUFACTURER SITE VISITS

A. Contractor will schedule periodic site visits with to aluminum storefront/curtainwall manufacturer's representative during installation to assure correct installation procedures are being followed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Kawneer Company, Inc.

B. Tubelite

C. YKK

D. OldCastle Building Envelope

2.2 EXTERIOR ALUMINUM STOREFRONT SYSTEM

ALSF-2

A. Framing: Shall be extruded aluminum flush glazed framing system Tri-Fab 451T451 "Front-Plane" with Kawneer "IsoLock" thermal break with a ¼" separation consisting of a two-part chemically curing, high density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections or similar systems by other named manufacturers.
   1. Thermal break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.

B. Doors: Shall be medium stile in sizes as indicated on drawings. Model 350 as manufactured by Kawneer or similar by other named manufacturers.
   1. Top Rail: 3-1/2"
   2. Mid Rail: N/A
   3. Bottom Rail: 10"
   4. Vertical Stiles: 3 1/2"

5. Provide manufacturer's standard 1 ¾" thick glazed doors with 0.0125-inch-thick extruded tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and filet welded at all 4 corners of door with lifetime warranty.

C. Finishes: Frame #1 shall be class I Fluropon Pure by Sherwin Williams, Color: Black, Extrusion 398A1632

D. Provide water deflector and high performance thermally broken "high performance" sill supplied by manufacturer. Provide bellows-type flexible expansion joint material at all sill flashing expansion joints.

E. Provide water deflectors at each end of intermediate horizontal members, installed per framing manufacturer's installation instructions. Provide "L" profile end dams at each end of extruded sill flashing. Extruded sill flashing should be an integral part of the storefront framing system. Set in manufacturer approved sealant, seal all penetrations accordingly per manufacturer's instructions.

F. Brake Metal: .125, .090 and .062 thick extruded aluminum, sizes as required for details and conditions as called for on drawings. Manufacturer to provide detailing at mullions for integral appearance. Match finish and color of storefront system.

G. Provide 1" insulated glass. Refer to Section 08 81 00.

ALSF-3

A. Framing: Shall be extruded aluminum flush glazed framing system Tri-Fab 601T Versa Glaze Framing "Front-Plane" with Kawneer "IsoLock" thermal break with a ¼" separation consisting of a two-part chemically curing, high density polyurethane, which is mechanically and adhesively joined to aluminum storefront sections or similar systems by other named manufacturers.
   1. Thermal break shall be designed in accordance with AAMA TIR-A8 and tested in accordance with AAMA 505.
   2. Framing to be 2"x6", heavy duty vertical profiles as determined by manufacturer.

B. Doors: Shall be medium stile in sizes as indicated on drawings. Model 350 as manufactured by Kawneer or similar by other named manufacturers.
   1. Provide manufacturer's standard 1 ¾" thick glazed doors with 0.0125 inch thick extruded tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and filet welded at all 4 corners of door with lifetime warranty.

C. Finishes: Frame #1 shall be class I Fluropon Pure by Sherwin Williams, Color: Black, Extrusion 398A1632

D. Provide water deflector and high performance thermally broken "high performance" sill supplied by manufacturer. Provide bellows-type flexible expansion joint material at all sill flashing expansion joints.

E. Provide water deflectors at each end of intermediate horizontal members, installed per framing manufacturer's installation instructions. Provide "L" profile end dams at each end of

extruded sill flashing. Extruded sill flashing should be an integral part of the storefront framing system. Set in manufacturer approved sealant, seal all penetrations accordingly per manufacturer's instructions.

F. Brake Metal: .125, .090 and .062 thick extruded aluminum, sizes as required for details and conditions as called for on drawings. Manufacturer to provide detailing at mullions for integral appearance. Match finish and color of storefront system.

G. Provide 1" insulated glass. Refer to Section 08 81 00.

2.3 INTERIOR ALUMINUM STOREFRONT SYSTEM

ALSF-1

A. Framing: Shall be extruded aluminum flush glazed framing system Tri-Fab Versa Glaze 451 "Front-Plane" with non-thermal break as manufactured by Kawneer or similar systems by other named manufacturers. Provide fully-captured mullions at verticals, typical, and SSG at any horizontals other than doors.

B. Doors: Shall be medium stile in sizes as indicated on drawings. Model 350 as manufactured by Kawneer or similar by other named manufacturers.
   1. Provide manufacturer's standard 1 ¾" thick glazed doors with 0.0125 inch thick extruded tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deep penetration and filet welded at all 4 corners of door with lifetime warranty.

C. Finishes: Frame #1 shall be class I Powder Coated White.

D. Brake Metal: .125 thick aluminum, sizes as required for details and conditions. Manufacturer to provide detailing at mullions for integral appearance. Match finish and color of storefront system.

E. Provide ¼" glass. Refer to Section 08 81 00.

2.4 HARDWARE

Refer to Section 08 71 00 for door hardware.

2.5 HARDWARE FINISHES

A. Aluminum Hardware items to match storefront finish.

B. Painted Hardware items to match storefront finish color.

PART 3 EXECUTION

3.1 PREPARATION

A. Prep all doors and aluminum storefront members to accept and support specified and scheduled hardware items.

3.2 FABRICATION

A. Fabricate doors and frames allowing for minimum clearances and shim spacing around perimeter of assembly, yet enabling installation.

B. Rigidly fit and secure joints and corners. Make joints and connections flush, hairline, and weatherproof.

C. Develop drainage holes with moisture pattern to exterior.

D. Prepare components to receive anchor devices. Fabricate anchorage items.

E. Arrange fasteners, attachments, and jointing to ensure concealment from view.

F. Prepare components with internal reinforcement for door hardware.

G. All exposed screws to be countersunk using flathead screws, flush with surface.

3.3 EXECUTION

A. Verify wall openings are ready to receive work of this Section.

B. Beginning of installation means acceptance of existing conditions.

3.4 INSTALLATION

A. Install doors, frames, glazing, and hardware called for in accordance with manufacturer's instructions.

B. Use anchorage devices to securely attach frame assembly to structure.

C. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.

D. Install sill flashings and end dams.

E. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

F. Install hardware using templates provided. Refer to Section 08 71 00 for cylinders and installation requirements.

G. Install perimeter flashings for storefront fabrications PRIOR TO storefront installation.

H. Install perimeter sealant, backing materials, and installation requirements in accordance with Section 07 92 00. Provide sealant. DO NOT INSTALL SEALANT AT SILL DRAINAGE HOLES AND SLOTS.

I. Adjust operating hardware and touch panels.

J. Closers to have through-bolt connections at door and frame.

K. Wiring for devices requiring electrical power shall be concealed within aluminum frame and doors.

L. Cut thresholds at door jamb around stops or jamb trim.

3.5 LATCH/LOCK GUARDS

A. Latch and lock guards are to be installed on each exterior door.

3.6 TOLERANCES

A. Variation from Plane: 0.03 inches per foot maximum or 0.25 inches per 30 feet whichever is less.

B. Misalignment of Two Adjoining Members Abutting in Plane: 0.015 inches.

3.7 DOOR HARDWARE SCHEDULE

A. Refer to section 08 71 00 for hardware sets and schedule.

END OF SECTION

COMPANY LETTERHEAD

CERTIFICATE OF GUARANTEE FROM INSTALLER

We, _____
(Name of Company or Contractor) agree to warranty aluminum storefront/curtainwall system on the below mentioned building for the period indicated. This agreement is to render the aluminum storefront/curtainwall system subject to the conditions outlined below.

OWNER OF BUILDING _____

Location of Building _____

City _____ Roof Area _____square feet_____

This Guarantee effective this _____day of _____ , 20_____, for the term of FIVE (5) years from this date, provided any air and water leakage and system defects result from defective material or workmanship and are not caused by other mechanics, fire, accidents, or by nature over which we have no control.

It is understood and agreed that the Contractor will not be responsible for leaks or failure of the aluminum storefront/curtainwall system due to sustained winds in excess of speeds stated in manufacturer's warranty, or any other conditions over which we have no control as stated in manufacturer's exclusions.

Signed _____
Name of Company

By _____

Position _____

Company is a _____
Corp./Partnership/Individual

NOTARY PUBLIC

Registered in the State of _____

SEAL

NOTE: Aluminum storefront/curtainwall system manufacturer's Two (2) year system warranty and Two (2) year door construction warranty from the manufacturer is to be submitted in addition to the guarantee from the installer found on this form. Manufacturer's Warranty is mandatory - **NO EXCEPTIONS**.

SECTION 08 71 00

FINISH DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware.
3. Automatic operators.

C. Related Sections:

1. Division 08 Section “Hollow Metal Doors and Frames”.
2. Division 08 Section “Flush Wood Doors”.
3. Division 08 Section “Aluminum-Framed Entrances and Storefronts”.
4. Division 08 Section “Automatic Door Operators”.

D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.
6. NFPA 105 - Installation of Smoke Door Assemblies.
7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
8. State Building Codes, Local Amendments.

E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.
h. Warranty information for each product.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings: Details of electrified access control hardware indicating the following:

1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

    a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    b. Complete (risers, point-to-point) access control system block wiring diagrams.
    c. Wiring instructions for each electronic component scheduled herein.

2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
3. Review sequence of operation narratives for each unique access controlled opening.
4. Review and finalize construction schedule and verify availability of materials.

5. Review the required inspecting, testing, commissioning, and demonstration procedures

I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:

a. Two Hinges: For doors with heights up to 60 inches.

b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.

4. Hinge Options: Comply with the following:

a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.

5. Manufacturers:

a. McKinney (MK) - TA/T4A Series, 5 knuckle.

B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 continuous geared hinge. with minimum 0.120-inch thick extruded 6063-T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

a. Pemko (PE).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Continuous Geared Transfer Hinges: Provide electrified transfer continuous geared hinges with a removable service panel cutout accessible without de-mounting door from the frame. Furnish with Molex™ standardized plug connectors with sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to

through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Manufacturers:

    a. Pemko (PE) - SER-QC (# wires) Option.

B. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.

1. Provide one each of the following tools as part of the base bid contract:

    a. McKinney (MK) - Electrical Connecting Kit: QC-R001.
    b. McKinney (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

    a. McKinney (MK) - QC-C Series.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: Provide products conforming to ANSI/BHMA A156.3 and A156.16, Grade 1.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8” in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

5. Manufacturers:

    a. Rockwood (RO).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 door pushes and pull units of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
2. Pulls, where applicable, shall be provided with a 10” clearance from the finished floor on the push side to accommodate wheelchair accessibility.
3. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

4. Manufacturers:

    a. Rockwood (RO).

2.5 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

1. Manufacturers:

    a. Match Existing, Field Verify.
    b. No Substitution.

B. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:

1. Threaded mortise cylinders with rings and cams to suit hardware application.
2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
4. Tubular deadlocks and other auxiliary locks.
5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
6. Keyway: Manufacturer’s Standard.Match Facility Standard.

C. Keying System: Each type of lock and cylinders to be factory keyed.

1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
3. Existing System: Field verify and key cylinders to match Owner's existing system.

D. Key Quantity: Provide the following minimum number of keys:

1. Change Keys per Cylinder: Two (2)

2. Master Keys (per Master Key Level/Group): Five (5).

E. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
2. Provide transcript list in writing or electronic file as directed by the Owner.

2.6 KEY CONTROL

A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:

a. Lund Equipment (LU).

2.7 MECHANICAL LOCKS AND LATCHING DEVICES

A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.

1. Heavy duty mortise locks shall have a ten-year warranty.

2. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 16 million cycles or greater.

3. Extended cycle test: Locks to have been cycle tested in ordinance with ANSI/BHMA 156.13 requirements to 12.3 million cycles or greater.

4. Where specified, provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180-degree viewing angle with protective covering to prevent tampering.

5. Manufacturers:

a. Corbin Russwin Hardware (RU) - ML2000 Series.
b. Sargent Manufacturing (SA) - 8200 Series.
c. Yale Commercial (YA) - 8800FL Series.

2.8 LOCK AND LATCH STRIKES

A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.9 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. Exit devices shall have a five-year warranty.

2. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.

3. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer’s catalog and template book for specific requirements.

4. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.

5. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.

6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.

    a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2” wide stiles.

9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.

10. Rail Sizing: Provide exit device rails factory sized for proper door width application.

11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.

B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets.

1. Exit devices shall have no catch points.
2. Exit devices shall have no visible plastic.
3. Exit devices shall have concealed hex key dogging.
4. Exit devices shall have dogging and chassis indicators as specified in the hardware sets. Chassis indicator to show locked/unlocked status of exterior trim, dogging indicator to have both passive and active options.
5. Exit devices to have heavy duty end caps with flush and overlapping options made of stainless steel, brass, or bronze with architectural finishes allowing for easy wire routing.
6. Exit Devices shall be constructed of all stainless steel.
7. Exit device latch to be stainless steel, pullman type, with deadlock feature and a 10-year warranty.
8. Exit devices shall have narrow or wide style exterior trim as specified in the hardware sets.
9. Concealed vertical rod exit devices shall have center case adjustability.
10. Exit devices shall not require wire routing through the door for electromechanical functions.

11. Manufacturers:

a. Corbin Russwin Hardware (RU) - PED4000 / PED5000 Series.
b. Sargent Manufacturing (SA) - PE80 Series.
c. Von Duprin (VD) - 35A/98 XP Series.

C. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.

1. Extended cycle test: Exit devices to have been cycle tested in ordinance with ANSI/BHMA 156.3 requirements to 5 million cycles or greater.

2. Manufacturers:

a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
b. Sargent Manufacturing (SA) - 80 Series.
c. Yale (YA) - 7000 Series.

D. Extruded Aluminum Removable Mullions: ANSI/BHMA A156.3 anodized, removable mullions with malleable-iron top and bottom retainers. Mullions to be provided standard with stabilizers and imbedded weatherstrip.

1. Manufacturers:

a. Same as exit device manufacturer.

2.10 ELECTROMECHANICAL EXIT DEVICES

A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.

1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.

2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.

3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.

4. Manufacturers:

a. Corbin Russwin Hardware (RU) - ED5000 Series.
b. Sargent Manufacturing (SA) - 80 Series.

c. Yale (YA) - 7000 Series.

2.11 DOOR CLOSERS

A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.

2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.

6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.

B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.

1. Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. LCN Closers (LC) - 4040XP Series.
c. Norton Rixson (NO) - 9500 Series.
d. Sargent Manufacturing (SA) - 281 Series.

C. Door Closers, Surface Mounted (Unitrol): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted closers with door stop mechanism to absorb dead stop shock on arm and top hinge. Hold-open arms to have a spring loaded

mechanism in addition to shock absorber assembly. Arms to be provided with rigid steel main arm and secondary arm lengths proportional to the door width.

1. Manufacturers:

    a. Corbin Russwin Hardware (RU) - Unitrol Series.
    b. Norton Rixson (NO) - Unitrol Series.
    c. Yale Commercial (YA) - Unitrol Series.

2.12 ELECTROHYDRAULIC DOOR OPERATORS

A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.

1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.

B. Standard: Conforming to ANSI/BHMA A156.19.

C. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.

D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.

E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.

F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.

G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.

H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.

I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Norton Rixson (NO) - 6000 Series.

2.13 DOOR STOPS AND HOLDERS

A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Manufacturers:

a. Rockwood (RO).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

a. Norton Rixson (RF).

2.14 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Manufacturers:

1. Pemko (PE).

2.15 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Manufacturers:

a. Securitron (SU) - DPS Series.

B. Intelligent Switching Power Supplies: Provide power supplies with single, dual or multi-voltage configurations at 12 and/or 24VDC. Power Supply shall have battery backup function with an integrated battery charging circuit. The power supply shall have a standard, integrated Fire Alarm Interface (FAI). The power supply shall provide capability for secondary voltage, power distribution, direct lock control and network monitoring through add on modules. The power supply shall be expandable up to 16 individually protected outputs. Output modules shall provide individually protected, continuous outputs and/or individually protected, relay controlled outputs. Network modules shall provide remote monitoring functions such as status reporting, fault reporting and information logging.

1. Manufacturers:

a. Securitron (SU) - AQL Series.

2.16 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.17 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.5 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.6 DEMONSTRATION

A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.7 DOOR HARDWARE SETS

A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.

2. The supplier is responsible for handing and sizing all products.

3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.

   At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

Hardware Sets

Set: 2.0

Doors: 220A, 220B, 220C, 220D

8	Hinge, Full Mortise, Hvy Wt	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2	Concealed Vert Rod Exit, Classroom	7160 TB626F Match Facility Keying	630	YA
2	Surface Closer Hold Open w/ Stop	UNI9500H w/ Mtg Plates / Brackets as Req'd	689	NO
2	Silencer	608-RKW		RO

Set: 2.1

Doors: 220

8	Hinge, Full Mortise, Hvy Wt	T4A3786 4-1/2" x 4-1/2"	US26D	MK
2	Concealed Vert Rod Exit, Classroom	7160 D TB626F Match Facility Keying	630	YA
2	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	689	NO
2	Silencer	608-RKW		RO
1	ElectroLynx Harness	QC-C1*** Per Door Size		MK
1	ElectroLynx Harness	QC-C1***P As Req'd		MK
2	Position Switch	DPS-M-BK		SU
1	Power Supply	AQL as Req'd		SU

Notes: Delayed Egress Exit devices with built-in alarm.

Set: 3.0

Doors: 213E

1	Continuous Hinge	BSPFM(Per Dr Hgt)SLI or F-HD1		PE
1	Continuous Hinge	BSPFM(Per Dr Hgt)SLI or F-HD1 SER		PE
1	Concealed Vert Rod Exit, Classroom	7220 TB506F Match Facility Keying	BSP	YA
1	Concealed Vert Rod Exit, Classroom	7220 MELR TB506F Match Facility Keying	BSP	YA
1	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	BSP	NO
1	Automatic Opener	6061	BSP	NO
1	Threshold	253x4BSPFG Verify flooring and opening conditions		PE
1	Sweep	315BSPN		PE
1	ElectroLynx Harness	QC-C1*** Per Door Size		MK
1	ElectroLynx Harness	QC-C1***P As Req'd		MK
2	Door Switch	503		NO
2	Position Switch	DPS-M-BK		SU
1	Power Supply	AQL as Req'd		SU

Notes: Exit device with electric latch retraction for access control and use with the automatic operator. Balance of weatherstrip by the aluminum door supplier. Credential reader, door position switch wiring, request to exit by security contractor. Door is normally closed, latched and secured. Valid credential for ingress, free egress at all times. Co-ordinate with security and electrical.

Set: 3.1

Doors: 201E

2	Continuous Hinge	BSPFM(Per Dr Hgt)SLI or F-HD1		PE
2	Concealed Vert Rod Exit, Classroom	7220 TB506F Match Facility Keying	BSP	YA
2	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	BSP	NO
1	Threshold	253x4BSPFG Verify flooring and opening conditions		PE
2	Sweep	315BSPN		PE
1	Position Switch	DPS-M-BK		SU

Notes: Balance of weatherstrip by the aluminum door supplier.

Set: 3.2

Doors: 223E, 226E

2	Continuous Hinge	BSPFM(Per Dr Hgt)SLI or F-HD1 SER		PE
2	Concealed Vert Rod Exit, Classroom	7220 D TB506F Match Facility Keying	BSP	YA
2	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	BSP	NO
1	Threshold	253x4BSPFG Verify flooring and opening conditions		PE
2	Sweep	315BSPN		PE
1	ElectroLynx Harness	QC-C1*** Per Door Size		MK
1	ElectroLynx Harness	QC-C1***P As Req'd		MK
2	Position Switch	DPS-M-BK		SU
1	Power Supply	AQL as Req'd		SU

Notes: Exit devices with delayed egress alarms. Balance of weatherstrip by the aluminum door supplier.

Set: 3.3

Doors: 212E

1	Continuous Hinge	BSPFM(Per Dr Hgt)SLI or F-HD1 SER		PE
1	Rim Exit Device, Nightlatch	7200 D 121NL Match Facility Keying	BSP	YA

1	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	BSP	NO
1	Threshold	253x4BSPFG Verify flooring and opening conditions		PE
1	Sweep	315BSPN		PE
1	ElectroLynx Harness	QC-C1*** Per Door Size		MK
1	ElectroLynx Harness	QC-C1***P As Req'd		MK
1	Position Switch	DPS-M-BK		SU
1	Power Supply	AQL as Req'd		SU

Notes: Exit device with delayed egress alarm. Balance of weatherstrip by the aluminum door supplier.

Set: 4.0

Doors: 128E

1	Hinge, Full Mortise, Hvy Wt	T4A3386 QC 4-1/2" x 4-1/2"	US32D	MK
2	Hinge, Full Mortise, Hvy Wt	T4A3386 NRP 4-1/2" x 4-1/2"	US32D	MK
1	Rim Exit Device, Classroom	7100 D TB626F Match Faciliyt Keying	630	YA
1	Surface Closer w/ Stop	UNI9500 w/ Mtg Plates / Brackets as Req'd	689	NO
1	Threshold	253x4BSPFG Verify flooring and opening conditions		PE
1	Rain Guard	346C		PE
1	Gasketing	290APK		PE
1	Door Bottom	217APK		PE
1	ElectroLynx Harness	QC-C1*** Per Door Size		MK
1	ElectroLynx Harness	QC-C1***P As Req'd		MK
1	Power Supply	AQL as Req'd		SU

Notes: Exit device with delayed egress alarm.

Set: 6.0

Doors: 201A, 221A

8	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Flush Bolt (Bottom)	555	US26D	RO
1	Flush Bolt (Top)	555- Per Door Hgt	US26D	RO

1	Dust Proof Strike	570	US26D	RO
1	Storeroom or Closet Lock	TBR3 8805RL Match Facility Keying	630	YA
2	Conc Overhead Hold Open	1-X26	630	RF
2	Silencer	608-RKW		RO

Set: 6.1

Doors: 219A

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Storeroom or Closet Lock	TBR3 8805RL Match Facility Keying	630	YA
1	Surf Overhead Stop	10-X36 Flush Mount Bracket as Req'd	630	RF
1	Surface Closer	7500	689	NO
3	Silencer	608-RKW		RO

Set: 6.2

Doors: 129, 219

3	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Storeroom or Closet Lock	TBR3 8805RL Match Facility Keying	630	YA
1	Surface Closer	9500	689	NO
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 7.0

Doors: 207, 208, 209, 209A, 211

3	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Entry Lock	TBR3 8807RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 7.1

Doors: 210, 210A

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Entry Lock	TBR3 8807RL Match Facility Keying	630	YA
1	Surf Overhead Stop	10-X36 Flush Mount Bracket as Req'd	630	RF

1	Surface Closer	7500	689	NO
3	Silencer	608-RKW		RO

Set: 7.3

Doors: 140B

3	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Entry Lock	TBR3 8807RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 8.0

Doors: 228, 232

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Pull	RM5200-12 Mtg-Type 5HD Back-to-Back	US26D	RO
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 8.1

Doors: 229, 230, 231

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Pull	RM5200-12 Mtg-Type 5HD Back-to-Back	US26D	RO
1	Conc Overhead Stop	1-X36	630	RF
3	Silencer	608-RKW		RO

Set: 9.0

Doors: 159

3	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Privacy Lock	TBR3 8802RL V20	630	YA
1	Surface Closer	9500	689	NO
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 9.1

Doors: 214, 225

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Privacy Lock	TBR3 8802RL V20	630	YA
1	Surface Closer	9500	689	NO
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 10.0

Doors: 217

3	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Storeroom or Closet Lock	TBR3 8805RL Match Facility Keying	630	YA
1	Kick Plate	K1050 10" x Width Req'd CSK BEV	US32D	RO
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 10.1

Doors: 221

3	Hinge, Full Mortise, Hvy Wt	T4A3786 4-1/2" x 4-1/2"	US26D	MK
1	Storeroom or Closet Lock	TBR3 8805RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 10.2 – Not Used

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Classroom Lock	TBR3 8808RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 11.0

Doors: 162, 163, 165, 166, 167, 168

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Classroom Lock	TBR3 8808RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO

3	Silencer	608-RKW		RO

Set: 11.1

Doors: 204, 205, 206

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Classroom Lock	TBR3 8808RL Match Facility Keying	630	YA
1	Conc Overhead Stop	1-X36	630	RF
3	Silencer	608-RKW		RO

Set: 11.2

Doors: 201, 215, 223, 224, 224A

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Classroom Lock	TBR3 8808RL Match Facility Keying	630	YA
1	Wall Stop	409	US32D	RO
3	Silencer	608-RKW		RO

Set: 13.0

Doors: 106

4	Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Intruder Classroom Lock	TBR3 8808-2RL Match Facility Keying	630	YA
1	Conc Overhead Stop	1-X36	630	RF
1	Surface Closer	7500	689	NO
3	Silencer	608-RKW		RO

Set: 14.0

Doors: 200, 213OH

1	Hardware by the	Overhead Door Supplier		OT

END OF SECTION

SECTION 08 81 00

GLASS AND GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, tools, equipment, services, operations and incidentals necessary to install, complete in every respect, all glass, glazing, and related work as indicated on Drawings and specified.

1.2 RELATED WORK DESCRIBED ELSEWHERE

A. Glass and glazing, as required under various Sections of these Specifications including, but not limited to:
   1. Hollow Metal Work: Section 08 11 13.
   2. Wood Doors: Section 08 14 16.
   3. Aluminum Storefront: Section 08 43 13

B. Installation materials specified in Sealants and Caulking: Section 07 92 00.

1.3 REFERENCES

A. ASTM C1048 “Standard Specification for Heat Treated Flat Glass – Kind HS, Kind FT Coated and Uncoated Glass.”

B. ASTM C1279 “Standard Test Method for Non-Destructive Photoelastic Measurement of Edge and Surface Stresses in Annealed, Heat-Strengthened, and Fully Tempered Glass” Requirements.

1.4 SUBMITTALS

A. General: Comply with the provision of Section 01 33 00.

B. Product Data: Within 30 calendar days after award of the Contract, submit:
   1. Complete materials list showing all items proposed to be furnished and installed under this Section.
   2. Sufficient data to demonstrate that all such materials meet or exceed the specified requirements.

C. Shop Drawings:
   1. Submit detailed shop and installation drawings of all work under this Section to Architect for approval prior to ordering materials.
   2. Indicate glass sizes, thickness, glazing details and where mirrors are to be installed in the building.
   3. Shop Drawings shall include engineering data on the Aluminum Entry/Storefront and other glazing systems, including the size and spacing of setting blocks under the glass and wind load.

1.5 FIELD MEASUREMENTS

A. Accurately field measure all openings to receive glass and cut glass to correspond to each measured opening. The General Contractor and Glazing Contractor shall be responsible for overall coordination and accuracy of the Field Measurements.

1.6 PRODUCT HANDLING

A. Protection: Use all means necessary to protect the materials of this Section before, during, and after installation and to protect the work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

1.7 GUARANTEE

A. Contractor shall furnish a written guarantee covering all mirror silvering from defects in material and workmanship for a period of five years from date of final acceptance of the building.

B. All glazing work performed under this Section shall be guaranteed against defects in materials and workmanship for a period of one year from date of final acceptance of the building. This guarantee, however, shall not cover accidental breakage of glass subsequent to acceptance except where breakage is due directly to defective materials and/or inferior workmanship.

C. All sealed insulating glass shall be warranted against failure of the air seal for a period of ten (10) years from the date of substantial completion.

PART 2 PRODUCTS

2.1 GLASS

A. General: Glass is called for by "type" (i.e. Insulated, wire, etc.) on Details and Schedules in the Drawings. The "types" are defined herein.

B. Tempered Glass: Provide Tempered Glass where called for on the Drawings or in these Specifications, and where such tempering would be required under provisions of the International Building Code, latest edition, or other applicable laws and regulations.

C. Heat Strengthened Glass: Unless Tempered glass is required by code, glass at exterior walls shall be heat treated to have a surface compression between 3,500 and 7,500 psi to increase its strength to resist impact, mechanical loads and thermal stress breakage.

D. All glass shall conform to the requirements of Federal Specification DD-G-451c, or as indicated with individual glass types.

E. Unless noted otherwise, Glass will be manufactured by Vitro (formerly PPG), Guardian Glass or approved alternate. Each light shall bear the manufacturer's label designating the type and thickness of glass. "AFPC V2 2701.1 "Each unit of tempered glass shall be permanently identified by the manufacturer. The identification shall be etched or ceramic fired on the glass and be visible when the unit is glazed. Tempered spandrel glass is exempted from permanent labeling. This type of glass shall be identified with a removable paper label by the manufacturer.

F. Individual glazed areas in hazardous locations shall meet requirements CPSC 16, CFR Part 1201.

G. Size: Sizes of glass indicated on Drawings are approximate, actual sizes of glass shall be taken from actual frames. Labels shall remain on glass until after inspection by the Architect.
   1. Actual design sizing shall be the responsibility of the glass manufacturer. Sizes indicated herein and on the Drawings are approximate only. Where required, the manufacturer's recommended changes shall be made. Note all such changes or revisions on the Shop Drawings submitted for approval.

2.2 GLASS TYPES

A. **GL-1**
Single Thickness Plate Glass: Shall be 1/4" thick clear glazing quality float glass, where captured all sides. 1/2" thick clear glazing at GLSF (Top/Bottom support only).

B. **GL-1T** Tempered/Safety Glazing: Shall be 1/4" thick clear Tuf-flex Tempered Safety Glass to meet the requirements of Federal Specifications DD-G-1403B, ANSI Z97, 1-1984 and the Federal Standard 15 CFR 1201. 1/2" thick clear glazing at GLSF (Top/Bottom support only.

C. Laminated (shatter resistant) Glass: Shall be 7/16" thick clear composed of 3/16" (5mm) clear float glass, 0.06" clear PVB and 3/16" (5mm) clear float glass. Cat II (CPSC 16 CFR 1201, ANSI Z97.1) and UL972. 1/2" thick clear glazing at GLSF (Top/Bottom support only.

D. Insulated Glazing: Shall be 1" thick Thermopane Insulating Glass as follows, refer to drawings for locations:
   1. **IGU-1 Clear/Clear Low-E Glass**
      a. Solarban 70 (2) Clear ¼" (6mm), ½" Air Space, Clear ¼" (6mm). Manuf. By Vitro
      b. SHGC= 0.23
      c. U value= 0.28
   2. **IGU-1T Clear/Clear Low-E Glass**
      a. Solarban 70 (2) Clear ¼" (6mm), ½" Air Space, Clear ¼" (6mm). Manuf. By Vitro
      b. SHGC= 0.23
      c. U value= 0.28
         i. Fully Tempered Safety Glass
   3. **IGU-2 Clear/Clear Low-E Spandrel Glass**

a. Solarban 70 (2) Clear ¼" (6mm), ½" Air Space, 3-4051 (Spencer) ¼" (6mm). Manuf. by Vitro
b. SHGC= 0.23
c. U value= 0.28
i. Opaque Spandrel Glazing

E. **FILM-1** Window Film: Skyline Design, Film Studio, 58" W x 45' L, PVC-Free Polyester Film, solid etch, pattern: gradient mid, backing: water-based pressure-sensitive adhesive. Refer to elevations for locations and sizes.

2.3 GLAZING COMPOUNDS AND SEALANTS

A. General: Use glazing compounds and preformed glazing sealant approved for the particular application as described herein and shown on the Drawings or specified in the Related Work referenced in Paragraph 1 b) of the Section, unless otherwise noted.

B. Glazing Compound shall be GE SILGLAZE, clear or neutral color, unless approved otherwise by the Architect.

C. Setting Blocks and Gaskets shall be extruded hard neoprene, clear or neutral color unless noted otherwise.

D. Tape shall be polyisobutylene base elastic compound with gauze reinforcement, equal to Presstite 162 Elastic Compound Tape, clear or neutral color unless noted otherwise.

E. Sealants used for glazing shall be G.E. Silicone, Dow-Corning Silicone Structural Sealant, or as approved by the Architect. Silicone shall be clear or neutral color as approved by Architect.

2.4 GLAZING ACCESSORIES

A. Provide all glazing accessories required to supplement those accessories which accompany the items to be glazed, and as needed to provide a complete installation, including glazing points, clips, shims, angles, beads, settling blocks, and spacer strips. Use ferrous metal, which will be exposed in the finished work, which has a finish that will not corrode or stain while in service.

2.5 INSPECTION

A. Examine the areas and conditions under which work of this Section will be installed. Correct conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.

B. Verify all field dimension openings prior to glass fabrication and cutting. Cut pieces to fit actual opening sizes.

PART 3 EXECUTION

3.1 INSTALLATION

A. General:
   1. All glass shall be accurately cut or sized to fit openings and locations and shall be set by skilled glazers. Extreme care shall be exercised in sizing the insulating glass to allow recommended clearances around glass.
   2. Cut and install glass with any visible lines or waves running in horizontal direction.
   3. Fix movable and operating items securely, or in a closed, locked position until glazing compound has thoroughly set.
   4. Use insulating units which do not have corners or edges ground, nipped, cut, or fitted after leaving the factory. Do not subject units to springing, forcing, or twisting during setting. Handle so as not to strike the setting frames or other objects.
   5. Use beads or stops furnished with the items to be glazed to secure the glass in place.
   6. Items to be glazed shall be shop-glazed or field-glazed with glass of the quality and thickness specified.

3.2 GLASS SETTING

A. Wood Doors and Wood Frames: Field glaze all wood doors and wood frames with glazing sealant and flush solid wood stops as indicated on Drawings. (Metal stops where required for fire rating)
   1. Use sufficient glazing sealant to ensure a complete seal between glass and stop.
   2. After stops have been installed and pulled up tight, trim bead of sealant resulting from setting operations away from face of glass. Retouch damaged compound after glazing.

B. Aluminum Doors, Frames, Storefront and Windows:
   1. All openings shall be field-glazed in strict conformance with aluminum door frame and window manufacturer's written instructions.
   2. Install glass types as indicated on Drawings and described in this Section.
   3. Extruded EPDM elastomeric glazing gaskets shall be supplied with each aluminum door, frame or window by the manufacturer.
   4. All installations shall be completely watertight when finished.

3.3 REPLACEMENT AND CLEANING

A. Replacement: Glass broken or glass damaged before completion of the building operations shall be replaced with glass of the like kind and quality at no cost to the Owner.

B. Cleaning: Upon completion of all construction work and approval of all glazing installations, remove from the glass surfaces, surrounding framing materials and mirrors all labels, sealant and caulking compound smears, spots, etc. Do not use cleaning materials or agents which will damage glass or surrounding surfaces. After cleaning, wash all glass and mirrors completely.

END OF SECTION

SECTION 09 01 70

PAINTING AND FINISHING (TOUCH-UP)

PART 1 GENERAL

1.1 SUMMARY

A. The work to be performed under this heading includes all labor, materials, equipment, and services necessary for and reasonably incidental for touch-up painting for all wood, metal, masonry, or other surfaces that are existing, to make a thoroughly complete job in every respect.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Follow manufacturer's recommendations for temperature range in which coatings may be applied.

B. Comply with National Volatile Organic Compound Emission Standards for Architectural coatings, Rule 40 CFR, Part 59, established by Environmental Protection Agency for VOC limits unless stricter local regulations are required.

PART 2 PRODUCTS

2.1 MATERIALS

A. All paint and stain used in touch up shall match existing materials. Manufacturer’s colors, and types will be available from Architect if needed.

B. All materials shall be the best of their respective kinds and thoroughly mixed in the proper proportions to secure the best results.

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. General: Temporarily remove items interfering with surface to be painted for complete painting of such items and adjacent areas.
   1. See other sections of the specifications for requirements for surface conditions and prime coat.
   2. Surfaces to be finished shall be dry, clean, smooth and prepared as specified.
   3. Materials and methods used for cleaning shall be compatible with the substrate and specified finish. Remove any residue remaining from cleaning agents used.
   4. Method of surface preparation is optional provided results of finish painting produce solid even color and texture specified.

B. Wood: Sand to a smooth even surface and then dust off.
   1. Where transparent finish is specified, finish sanding shall be with 220 grit sandpaper. Wipe surface with a tack rag prior to applying finish.
   2. Surface to be painted with an opaque finish shall have all knots, sap and pitch streaks coated with knot sealer before applying any coat of paint. Apply two coats of knot sealer over large knots.
   3. Surfaces showing raised grain shall be sanded smooth between each coat.
   4. After application of prime or first coat of stain, fill all cracks, nail and screw holes, depressions and similar defects with patching compound. Sand to make smooth and flush with surrounding surface.
   5. Before applying finish coat, reapply patching compound if required, and lightly sand surface to remove surface blemishes.

C. Steel and Iron: Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter by use of solvents, emulsions, cleaning compounds, or by steam cleaning.
   1. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, except where high temperature aluminum paint is used, the surface shall be prepared in accordance with the manufacturer's instructions.
   2. Fill all dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with patching compound. Finish flush with adjacent surfaces.
   3. Spot prime all abraded and damaged areas in shop prime coat which expose the bare metal, with same type of paint used for prime coat. Feather edge of spot prime as required to produce smooth finish coat. Spot prime all abraded and damaged areas which exposed the bare metal of factory finished items with paint as recommended by the manufacturer.

D. Masonry, Concrete, Cement Plaster and Stucco: Remove all dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
   1. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. The use of solvents, acid, or steam is not permitted.
   2. Remove all loose mortar in masonry work.
   3. Replace mortar and fill all open joints, holes, cracks and depressions with patching compound, finished flush with adjacent surface, with texture to match texture of adjacent surface.
   4. Concrete floors to be stained or sealed shall be etched and prepped per manufacturer’s instructions. Allow required time to dry between applications.
   5. Concrete shall have all broken and spalled edged repaired with patching compound to match adjacent surfaces. Remove projections to level of adjacent surface by grinding or similar methods.

E. Gypsum Plaster and Drywall: Remove efflorescence, loose and chalking plaster. Remove dust, dirt, and other deterrents to paint adhesion.
   1. Fill holes, cracks, and other depressions with patching compound, finished flush with adjacent surface, with texture to match texture of adjacent surface.

3.2 APPLICATIONS

A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.
B. Unless otherwise specified, paint shall be applied in three coats, prime, body, and finish.

C. Before application of body and finish coats, surfaces shall be primed, except as otherwise specified. For primers to be used for field application, see Article PRIMERS, para. 7.

D. Additional field applied prime coats over shop or factory applied prime coats are not required, except for exterior steel which shall have a field applied prime coat in addition to the shop prime coat.

E. Retouch damaged and abraded painted surfaces before applying succeeding coats.

F. Apply each coat evenly and in full covering body.

G. Not less than 48 hours shall elapse between application of succeeding coats except as allowed by the manufacturer's printed instructions, and approved by the Architect.

H. Finish painted surfaces shall have solid even color, free from runs, lumps, brush marks, laps, or other defects.

I. To prevent items from sticking in the shut position, operable items such as access doors and panels, window sashes rolling doors, and similar items shall not be painted when in the closed position.

J. Painted or otherwise finished surfaces of wood doors, including top and bottom edges, which are cut for fitting or for other reasons shall be given two coats of primer.

K. Surfaces of finishing woodwork, except shop fabricated or assembled millwork and surfaces specified to have varnish, stain or natural finish shall be given one coat of primer as soon as delivered to the site.

L. Back prime and seal ends of exterior woodwork, and edges of exterior plywood specified to be finished. Primer shall be same kind of primer specified for exposed face surface.

M. Prime rebates for stop and face glazing of wood, and for face glazing of steel.

N. Paint may be applied by brush, or roller. SPRAY PAINTING SHALL NOT BE ALLOWED, EXCEPT UNDER THE FOLLOWING CONDITIONS:
   1. Spray painting will be allowed if occupied portion of the building completely sealed off and approved by the Architect.
   2. Painting materials specifically required by the manufacturer to be applied by spraying shall be so applied.
   3. In areas, where paint is applied by spray, all items specified in Article, Work Not To Be Painted, motors, controls, telephone, and electrical equipment, and similar items shall be masked, or enclosed with polyethelene, or similar air tight material with all edges and seams continuously sealed.

3.3 WALL TEXTURE:

A. Match existing.

B. Texture to be uniform on walls throughout remodeled area.

3.4 PRIMERS:

A. After surface preparation, apply prime coat to various materials as follows: NOTE: Prime coat is not required for acrylic emulsion and latex emulsion finish.
   1. Steel and iron: Red lead primer
   2. Exterior Wood: Oil base primer.
   3. Interior Wood: (except for transparent finish: Enamel undercoat, thinned as recommended by the manufacturer.
   4. Cement plaster, Concrete, and Masonry: Latex emulsion except use two coats of latex primer when substrate has aged less than six months.
   5. Drywall: Latex primer, except use pigmented sealer in shower, dressing and locker rooms.

3.5 EXTERIOR FINISHES:

A. On properly prepared and primed surfaces, apply the following finish coats. Prime coat is not required for acrylic emulsion finish.
   1. Wood: Two coats of exterior oil paint generally on exposed surfaces, except where transparent finish is specified and as follows:
      a. Two coats of exterior latex on plywood, wood siding and similar surfaces.
      b. Do not apply finish coats on surfaces concealed after installation, top and bottom edges of wood doors and sash, or on edges on wood framed insect screens.
      c. That portion of the sash runs of double hung wood windows, concealed by the sash when in a closed position, shall receive two coats of boiled linseed oil mixed with not more than 1/4 pint of dryer per gallon.
   2. Metal: Two coats of exterior alkyd enamel paint.
   3. Concrete, Concrete Masonry Units: Refer to Section 09800, Special Coatings.

3.6 INTERIOR FINISHES

A. On properly prepared and primed surface, apply the following finish coats. Prime coat is not required on concrete for floor enamel finish.
   1. Metal Work: Apply two coats of Alkyd Semi-gloss (SG) on exposed surfaces, including surfaces of ferrous metal louvers and ferrous metal hardware, except as follows:
      a. Two coats of alkyd gloss on specified surfaces, color as selected.
      b. Omit body and finish coats on surfaces concealed after installation
      c. One coat of enamel undercoat plus one coat of alkyd semi-gloss on exposed interior surfaces of alkyd-amine enamel finished windows.
   2. Drywall: One coat of latex sealer plus one coat of latex eggshell on exposed surfaces, except as follows:
      a. Two coats of alkyd flat on specified surfaces, color as selected.

b. One coat of enamel undercoat plus one coat of alkyd semi-gloss on surfaces specified, color as selected.

3. Masonry and Concrete Walls: Two coats of latex eggshell, except as follows:
   a. Two coats of low-luster enamel over block filler on surfaces where specified.
   b. Third coat will be required on accent colors for adequate coverage.

3.7 SPECIAL APPLICATIONS

A. All exposed piping, conduit, ductwork, etc., exposed on interior of rooms shall be painted in with walls or ceiling.

B. Epoxy Coating
   1. All interior gypsum board surfaces shown to receive epoxy paint shall be taped, floated and sanded smooth to provide a smooth, even surface and CMU walls cleaned before receiving epoxy coating in strict accordance with the coating manufacturer's directions. The coating material required for the gypsum board and CMU wall surfaces shall be Type Moorecraft Super Spec Acrylic Epoxy Coating #256-86 epoxy semi-gloss coating as manufactured by Benjamin Moore Co. Other approved manufacturers are Sherwin-Williams, Pittsburg, or approved equal. Approved equal manufacturers must provide water based epoxy coating with semi-gloss finish.
   2. Finish coating shall have a vitreous-hard, tile-like surface with high resistance to impact, abrasion, stain chemical and acid corrosion and with a flame spread rating of not more than 15 when tested in accordance with ASTM Standard Specification E-84-61. Application on all surfaces shall be in solid color to be selected by the Architect.

C. Application of epoxy coating under this heading shall be done by trained applicators who are experienced in the use of the specific materials to be applied. Coating shall be applied in such quantity as will result in a dry film thickness of minimum 4 to 6 mils in uniform solid color or colors as selected. Floors and other adjacent surfaces which are not to be coated shall be protected during application, and special coating applicator shall clean and repair any adjacent surfaces damaged by his work.

3.8 TRANSPARENT FINISHES ON WOOD

A. General:
   1. Open grained wood such as oak, walnut, ash and mahogany shall be filled with a paste wood filler, colored as required to achieve finish specified. Thin filler accordance with manufacturer's instructions as required for application. Remove excess filler, wipe as clean as possible, allow to dry and sand lightly with 220 grit sandpaper.
   2. Stain shall be of type and color required to achieve finish specified. Stains may be used when transparent finishes are specified to change the color of sapwood to match heartwood, and to enhance or even the color of the wood as required to match the finish specified. Varnish or polyurethane type stains will not be allowed.
   3. Sealers shall be polyurethane, same as used for top coats, thinned with thinner recommended by the manufacturer at the rate of about one part of thinner to four parts of polyurethane. Sealer may be omitted where pigmented, penetrating, or wiping stains containing resins are used.
   4. Sealers and polyurethane shall be sanded between coats. Allow manufacturer's recommended drying time before sanding, but in no case less than 24 hours (36 hours in damp or muggy weather). Sanding shall be done using 220 grit sandpaper. Sand enough

to scarify the surface to assure good adhesion of the subsequent coat to level roughly applied sealer and to knock off the "whiskers" of any raised grain as well as dust pinnacles. Sanding blocks shall be used for between coat sanding.

5. Finish application shall be done only in clean areas and in still air. Before finishing, the area shall be vacuumed and dusted. Immediately before applying finish, the surfaces shall be wiped down with a tack rag.

B. Stain Finish: Apply in successive coats as follows:
   1. One coat of stain.
   2. One coat of sealer.
   3. Two coats of satin polyurethane finish.

C. Natural Finish: Apply in successive coats as follows:
   1. One coat of sealer.
   2. Two coats of satin polyurethane finish.

Note: Individual specification sections or notes on drawings may call for finishes or prefinished items different from what is specified in this section (i.e. factory finished; factory stained, etc.). Unless otherwise called for, abide by those finishes as noted or specified on drawings or specification sections.

3.9 REFINISHING

A. Existing interior and exterior work to be refinished shall include the following:
   1. Interior:
      a. Existing painted surfaces of rooms, areas and spaces in which alterations occur under this contract.
      b. Existing surfaces of rooms, areas and spaces specified to be painted as selected.
      c. All other rooms, areas and spaces noted on the drawings to be refinished.
   2. Exterior: Existing painted surfaces damaged, altered or disturbed as result of work performed under this contract and surfaces specified to be painted, color as selected.

B. Except as otherwise specified or noted on drawings, refinished rooms, areas and spaces shall be refinished as follows:
   1. Patched and damaged surfaces of walls shall receive prime, body and finish coats.
   2. Patched and damaged surfaces of ceilings, except prefabricated acoustical unit ceilings shall receive prime and finish coats.
   3. Undisturbed surfaces of patched and damaged walls and ceilings, except prefabricated acoustical unit ceilings shall receive body and finish coats.
   4. In corridors, paint refinished walls and ceilings to the nearest natural break (ie; corner, reveal, door frame, etc.)
   5. Painted windows (interior surfaces only), doors, door frames, convectors, railings, and all other previously painted items and trim shall receive body and finish coats.

C. In existing rooms and areas where new prefabricated acoustical units are required, clean any existing surfaces free of dust, dirt, grease, and other deterrents to adhesion.

D. In existing rooms and areas where alterations occur, clean existing stained and natural finished window, doors, door frames and trim; retouch abraded surfaces and then give entire

surface one coat of varnish as required to match existing. After the varnish has fired, buff with fine (Grade 4/0) steel wool to eliminate any accumulated dust particles.

E. Existing exterior wood and metal work shall be painted one body coat and one finish coat as specified for similar new work.

F. Color and texture of paint, and color and texture of stain and varnish for clear finishes on wood shall match existing, unless otherwise selected.

3.10. WORKMANSHIP OF REFINISHED SURFACES:

A. Rating work to be refinished shall have surfaces prepared and made smooth before refinishing.

B. Surfaces shall be clean and dry before refinishing.

C. Abraded, peeled and bare spots shall be touched-up before painting or refinishing.

D. Refinishing of existing surfaces shall include preparation of surfaces to receive new finishes including removal of any existing finishes that may preclude application of new finishes. Remove all paint spots from hardware, signs, fixtures, and other similar items not required to be finished.

E. Remove loose particles of dirt, dust, paint film, rust, scale, and similar deterrents to paint adhesion by scraping, brushing, sanding, vacuuming, or other suitable methods.

F. Remove grease, soil, and other deterrents to paint adhesion with a cleaning compound, or solvent compatible with substrate and subsequent coats. The use of solvents, acid, or steam will not be permitted on concrete and masonry. Remove any traces of cleaning agents which will effect paint adhesion.

G. Properly cut out loose or broken glazing compound on glazed doors, sash, etc. to sound material. Clean cut-outs and neatly re-putty with glazing compound.

H. Holes, cracks, and other surface indentations shall be neatly filled with patching compound compatible with substrate and subsequent coats, appropriate for the surface texture required and finished to match adjacent surface texture.

I. Knots, pitch streaks, etc., showing through old finish shall be coated with knot sealer before refinishing.

J. Sand or dull glossy surfaces prior to painting. Sand existing paint to a feather edge so that transition between new and existing finish will not show in the finished work.

K. Workmanship and material shall be equal to that specified for new work of similar character as required to match adjoining work.

3.11 SCAFFOLDS

A. This Contractor shall provide all ladders, scaffolds, staging, etc., required for the proper execution of the work.

3.12 PROTECTION:

A. Protect all work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

3.13 CLEAN UP

A. Upon completion, clean paint from all hardware, glass and other surfaces and items not required to be painted.

B. Before final inspection, any work which has become damaged or discolored shall be touched-up or refinished in a manner to produce solid even color and finish texture, free from defects.

END OF SECTION

SECTION 09 22 16

NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Non-load bearing metal studs and accessories for wall assemblies.

B. Wood Blocking for wall-mounted items.

C. Shaft wall framing products.

1.2 RELATED SECTIONS

A. Section 03 35 20 - Polished Concrete

B. Section 05 40 00 - Cold-Formed Metal Framing.

C. Section 07 92 00 Joint Sealants-Sill Sealer below bottom track at exterior walls

D. Section 09 24 00 - Gypsum Plaster: Interior plaster applications.

E. Section 09 29 00 - Drywall: Gypsum interior sheathing.

F. Section 09 29 00 - Drywall: Shaft Walls and Area Separation Wall

1.3 REFERENCES

A. AISI - Standard for Cold-Formed Steel Framing General Provisions.

B. AISI - North American Specification (NASPEC) for the Design of Cold-Formed Steel Structural Members - 2001.

C. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

D. ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

E. ASTM A 1003 - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.

F. ASTM C 645 - Standard Specification for Nonstructural Steel Framing Members - 2006.

G. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.

H. ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

I. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building

Materials.

J. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.

K. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

L. ASTM E 413 - Classification for Rating Sound Insulation.

M. GA-600 - Fire Resistance Design Manual.

1.4 DESIGN REQUIREMENTS

A. Design steel in accordance with American Iron and Steel Institute Publication "Specification for the Design of Cold-Formed Steel Structural Members" or the North American Specification for the Design of Cold-Formed Steel Structural members, except as otherwise shown or specified.

B. Design loads: As indicated on the Architectural Drawings. 5 PSF minimum design lateral load is required for interior walls by the building code. Shaftwall framing minimum design lateral load is typically 5 - 15 PSF.

C. Design framing systems to withstand design loads without deflections greater than the following:
   1. Interior Non-Load Bearing Walls: Lateral deflection of: L/240. *(for gyp. bd.)*
   2. Interior Non-Load Bearing Walls: Lateral deflection of: L/360. *(cer. tile & mas. veneer)*

D. Design framing system to accommodate deflection of primary building structure and construction tolerances.

E. Responsibilities: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by, and displaying a classification label from, an independent testing agency acceptable to the authority having jurisdiction.
   1. Construct fire-resistance-rated partitions in compliance with tested assembly requirements indicated in drawings.
   2. Rated assemblies to be substantiated, from applicable testing using the proposed products, by Contractor.
   3. Both metal framing & wallboard manufacturers must submit written confirmation that they accept the other manufacturer’s product as a suitable component in the assembly. Acceptance is as follows:
      a. If installation of both products is proper, no adverse effect will result in the performance of one manufacturer’s product by the other’s products.
      b. Combining products can be substantiated by required assembly tests.

1.5 SUBMITTALS

A. Submit under provisions of Section 01 33 00.

B. Submit manufacturer's product literature and data sheets for specified products.

C. Manufacturer's certification of product compliance with codes and standards.

1.6 QUALITY ASSURANCE

A. Contractor shall provide effective, full time quality control over all fabrication and erection complying with the pertinent codes and regulations of government agencies having jurisdiction.

B. Contractor to conduct pre-installation meeting to verify project requirements, substrate conditions, and manufacturer's installation instructions.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Notify manufacturer of damaged materials received prior to installing.

B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

C. Store materials protected from exposure to rain, snow or other harmful weather conditions, at temperature and humidity conditions per the recommendations of ASTM C754 section 8.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. ClarkDietrich Building Systems, 9100 Pointe Drive, Suite 210, West Chester, OH. Phone: 513-870-1100. www.clarkdietrich.com, info@clarckdietritrich.com.
   2. Other manufacturers as referenced in this section for specific products.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

C. All products to be manufactured by current members of the Steel Stud Manufacturers Association (SSMA), Steel Framing Industry Associates (SFIA), or the Certified Steel Stud Association (CSSA).

2.2 MATERIALS

A. Steel: Galvanized Steel meeting or exceeding the requirements of ASTM A 1003.

   1. Coating: Galvanized G60 (Z180) coating minimum or equivalent, complying with ASTM C 645. **Stud finish MUST be hot dipped galvanized. Galvanneal finish is not acceptable. G60 must be used at all EXTERIOR locations. G40 finish is allowed at interior locations.**

2.3 COMPONENTS

A. Nonstructural Studs:
   1. Flange Length: 1 1/4 inch (32mm) 125 flange.
   2. Web Depth: As indicated on drawings.
   3. Minimum Material Thickness: Gauge as required by stud legend shown on drawings.

4. Punch Outs: 12 inches (305mm) from base and every 48 inches (1219mm) thereafter.

B. Nonstructural Track: Cold-Formed galvanized steel runner tracks
   1. Flange Length: 1 1/4 inch (32 mm) T125 flange.
   2. Web: Track web to match stud web size.
   3. Minimum Material Thickness: Unless noted otherwise on drawings match stud gauge.
   4. Minimum Material Thickness: Track thickness to match wall stud thickness.
   5. Flexible Track: Contour Track, manufactured by ClarkDietrich Building Systems, Flex-C Trac manufactured by Flex-Ability Concepts, P.O. Box 7145, Edmond, OK 73083, (405) 302-0645, www.flexc.com, or approved alternate. Provide in depths as required to meet stud depth. Install flexible track per manufacturer's instructions.
      a. Gauge 20 gauge minimum.
      b. Depth- Refer to drawings.

C. Deflection Track: Cold-Formed Deep Leg Runner Slotted Slip Track.
   1. Leg Length: 2 inch (51 mm) T200 flange.
   2. Leg Length: 2 1/2 inch (63 mm) T250 flange.
   3. Leg Length: 3 inch (76mm) T300 flange.
   4. Leg Length: 3 1/2 inch (89 mm) T350 flange.
   5. Leg Length: As required by design.
   6. Minimum Material Thickness: As required by design.
   7. Minimum Yield Strength: 33ksi (227 MPa) (for 33mils through 118mils).
   8. Minimum Yield Strength: 50ksi (345 MPa) (optional for 54mils and up).
   9. Minimum Yield Strength: As required by design.

D. U-Channel (CRC Cold Rolled Channel):

E. Furring Channel: Furring existing walls and suspended ceiling applications.
   1. Size: 087F125-30 7/8 inch (22mm) Furring Channel 30mils (20ga Drywall).
   2. Size: 087F125-33 7/8 inch (22mm) Furring Channel 33mils (20ga Structural).
   3. Size: 150F125-30 1 1/2 inch (38mm) Furring Channel 30mils (20ga Drywall).
   4. Size: 150F125-33 1 1/2 inch (38mm) Furring Channel 33mils (20ga Structural).

F. Shaft Wall System: Coordinate materials found in this section with applications and materials found in Section 09 29 00. Complies with ASTM C 754 for the conditions indicated. Non-Load bearing gypsum wall assemblies for use in the following areas:
   1. Shaft Wall Application: Fire Separation Wall.
   2. Shaft Wall Width: CH-Stud & E-Stud with J-Runner, 2 1/2 inch Wide (64 mm).
   3. Shaft Wall Width: CH-Stud & E-Stud with J-Runner, 4 inch Wide (102 mm).
   4. Shaft Wall Width: CH-Stud & E-Stud with J-Runner, 6 inch Wide (152 mm).
   5. Shaft Wall Material Thickness: 20 gauge (33 mils).
   6. Shaft Wall Deflection: L/240.

G. Framing Accessories: Provide accessories as required in this project.
   1. Flat Strapping for Backing Strip.
   2. Flat Strapping and bridging for lateral bracing.
   3. L-Angles.
   4. SwiftClip Fixed Connection Angles.
   5. Deflection Slip ConnectorsClarkDietrich™ Building Systems-Deflection Clips: Fast Strut™ / Fast Top™ Clips / FastClip™ Slide Clips / QuickClip™ / Slide Clip™

(SD), or approved alternate. Provide clip as required for each situation to compensate for deflection of structure.

H. Fire or Draft Stop Blocking: Where fire or draft stop blocking is required or called for under this section or called for on drawings, provide blocking equal to prefabricated fire blocking manufactured by Metal-Lite, Inc., Placentia, CA (800) 886-6824. Provide blocking same width as metal stud.
   1. As an option to the prefabricated metal blocking, mineral wool fire safing may be provided. Refer to Section 07 84 00 Firestopping.

I. Fasteners: Self-drilling, self-tapping screws; complying with ASTM C 1513 - Standard Specification for Steel Tapping Screws for Cold-Formed Steel Framing Connections.

J. Touch-Up Paint: Complying with ASTM A 780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

PART 3 EXECTION

3.1 INSPECTION

A. Inspect supporting substrates and structures for compliance of proper conditions for installation and performance of the cold-formed structural framing.

3.2 PREPARATION

A. Prepare attachment surfaces so that they are plumb, level, and in proper alignment for accepting the cold-formed structural framing.

3.3 COORDINATION WITH OTHER TRADES

A. It will be a requirement of this section to verify and coordinate work with other trades and specification sections. Do not begin work on concrete slabs on grade or elevated concrete slabs until minimum strength and cure time has been reached.

B. Procedure and preparation for exposed concrete and/or polished concrete floors
   1. Concrete floors in whole or in part as shown on drawings, are scheduled to be Polished or Dyed Polished Concrete. No stud walls are to begin installation until concrete slab received initial grind from floor polishing contactor. Refer to Sections 03 35 20 for requirements. This requirement includes slabs-on-grade as well as elevated slabs.
   2. Any equipment used on slabs to be sealed or polished, shall meet the requirements of Sections 03 35 20 concerning diapering and tire marks.

3.3 FABRICATION

A. Prior to fabrication of framing, submit product submittal sheets to the architect or engineer to obtain approval.

B. Framing components may be preassembled into panels prior to erecting. Prefabricate panels so they are square, with components attached in a manner which prevents racking and minimizes distortion during lifting and transport.

C. Cut all framing components square for attachment to perpendicular members or as required for an angular fit against abutting members.

D. Plumb, align and securely attach studs to flanges of both upper and lower runners, except that in the case of interior, non-load bearing walls where studs need not be attached to upper or lower runners.

E. Splices in members other than top and bottom runner track are not permitted.

F. Provide temporary bracing where required, until erection is complete. Fastening of components shall be with welding or with minimum 1 #8 screw both sides of flange. Welds shall conform to the requirements of AWS D.1.1, AWS D.1.3 and AISI Manual Section 4.2. All welds shall be touched up using zinc-rich paint. Wire tying will not be permitted.

G. Cutting of steel framing members may be accomplished with a saw or shear. Torch cutting of load bearing studs will not be permitted.

H. Install headers in all openings in axially loaded walls that are larger than the stud spacing in the wall. Form headers as shown on drawings.

I. Unless shown otherwise on drawings, brace top of metal stud walls to structure above at max. 4'-0" O.C. with minimum 20 gauge stud bracing.

J. Insulation equal to that specified elsewhere shall be provided in all double jamb studs and doubled headers not accessible to insulation contractors.

K. Care should be taken to allow for additional studs at intersections, corners, doors, windows, steel joists, diagonal bracing and as called for in the shop drawings.

3.4 INSTALLATION – DEFLECTION TRACKS AND DEFLECTION SLIDE CLIPS

A. Unless noted otherwise, deflection tracks are to be installed at top of interior and exterior walls terminating directly below and/or attaching to beams joists, roof or floor deck, purlins, or other items subject to deflection.

B. Provide deflection slip connectors attached to stud walls from structure where studs extend vertically past a structural item such as but not limited to a beam or elevated floor edge angle.

3.5 INSTALLATION - SHAFTWALL FRAMING: RUNNERS, STUDS AND LINER BOARDS

A. Attach J-Runners plumb with one another, long leg on shaft side, at floor and structure overhead using power-driven fasteners located 2 inches (51mm) from each end and 24 inches (610mm) o.c. between. Cut jamb J-Runners or E-Studs not less than 3/8 inch (10mm) nor more than 1/2 inch (13mm) less than distance from floor to structure above. Position J-Runners or E-Studs at wall structural jambs. Do not attach to floor or overhead J-Runners.

B. With steel frame construction attach J-Runners to beams and J-Runners or E-Studs to

columns prior to fireproofing application. Where fireproofing is more than 1 in. thick, position Z-Clips at jambs no more than 4 inches (102mm) from floor and structure above and no more than 24 inches (610mm) o.c. between. Attach Z-Clips to steel frame with power-driven fasteners. Attach J-Runners and E-Studs to Z-Clips with two (2) 1/2 inch (13mm) type S-12 screws. Remove excess fireproofing from insides of J-Runners and E-Studs before installing liner boards.

C. Cut liner boards 1 inch (25mm) less than distance from floor to structure above; erect vertically into floor and overhead J-Runners, and into jamb J-Runner or E-Stud. Where wall height exceeds maximum length of liner board, position board end joints within upper and lower 1/3 of height from floor to structure above; stagger joints in adjacent boards. Achieve tight fit at mating board ends.

D. Cut C-H Studs not less than 3/8 inches (10mm) nor more than 1/2 inch (13mm) less than distance from floor to structure above. Fit first C-H Stud over leading edge of first liner board. Install remaining liner boards and C-H Studs. Do not attach C-H Studs to J-Runners.

E. Do not splice C-H Studs or E-Studs. For wall heights exceeding 16 feet (4877mm) attach C-H studs, E-Studs, or jamb J-runners to floor and overhead J-Runners with two (2) 1/2 inch (13mm) Type S-12 screws on shaft side and one (1) on floor side. Always fit liner boards tightly into studs or jamb runners. Always fit studs or jamb runners tightly over liner boards.

F. Corners and intersections: Position jamb J-Runners or E-Studs at corners and T-intersections.

G. Door openings: Install E-Studs plumb at each jamb of swinging doors. Install jamb struts plumb with long legs on shaft side at each jamb of elevator doors. Attach jamb strut studs to floor and overhead J-Runners with two (2) 3/8 in (10mm) Type S-12 screws pan head on shaft side and one (1) on floor side. Attach strut studs to door jamb anchors with two (2) 1/2 inch (13mm) Type S-12 pan head screws per anchor.

H. For walls above doors miter-cut J-Runners legs and position J-Runner horizontally to fit tightly between strut studs to serve as opening head. At each jamb extend J-Runner upward into overhead J-Runner. Attach J-Runner webs to strut stud webs with 3/8 inch (10mm) Type S-12 screws spaced not more than 12 inch (305mm) oc, 2 inches (51mm) above opening head, and not more than 4 inches (102mm) from overhead J-Runner, using not less than 3 screws per jamb. Install C-H Studs horizontally at not less than 24 inches (610mm) o.c.; attach to each mitered jamb J-Runner one (1) 3/8 inch (10mm) Type S-12 screw shaft side and one (1) floor side.

I. Provide additional liner boards, gypsum shims and fillers at elevator door frames as necessary to maintain fire integrity of the tested labeled frame construction. Construct opening in conformance with frame manufacturer's fire test report; secure copy of fire test report from frame manufacturer and maintain on site for elevator inspector.

J. Small openings: Frame openings with E-Studs or J-Runners at jambs; frame heads and sills with J-Runners. Attach head and sill J-Runners to jambs with two (2) 3/8 inch (10mm) Type S-12 screws on shaft side and one (1) on floor side.

K. Do not exceed allowable stresses in C-H Studs, E-studs or J-Runners.

3.6 SILL SEALER

A. Install continuous bead of sill sealer as specified in Section 07 92 00 below bottom tracks of all exterior stud walls.

3.7 FIRE OR DRAFT STOP BLOCKING

A. Install fire or draft stop blocking at elevated floors where studs pass by floor, and at roof plane where studs pass by roofs to form parapets. Install between each stud.

3.8 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before substantial completion of final installation.

END OF SECTION

SECTION 09 29 00

DRYWALL

PART 1 GENERAL

1.1 SUMMARY

A. Furnish materials and labor to complete installation of all interior drywall and miscellaneous metal trim items as indicated on plans and specified herein.

B. Gypsum board surface texturing

C. Exterior sheathing board

D. Reveal Moldings

E. Wood Blocking

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 RELATED SECTIONS

A. Section 05 40 00 - Cold Formed Framing

B. Section 07 27 26 - Fluid-Applied Weather Barrier System

C. Section 09 22 16 - Non-Load Bearing Metal Stud Wall Framing

D. Section 09 91 00 - Painting

1.4 REFERENCES

A. ASTM C1396-Standard specification for gypsum board

B. ASTM E90- Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements (ISO 140, Part 3)

1.5 ACOUSTICAL PERFORMANCE

A. Gypsum board wall assemblies for academic and office areas to have a minimum sound transmission class (STC) of 41.

PART 2 PRODUCTS

2.1 MATERIALS:

A. **GBD-1** All gypsum board at rated walls shall be type “X” fire code, manufactured by Gold Bond, USG, or CertainTeed, non-rated walls won’t require type “X”. Thickness as indicated on drawings. Provide glass-mat-facer in damp areas and where called for. All gyp board shall be installed in accordance with manufacturer's printed instructions and as specified herein. Use water resistant materials in shower areas. Gypsum board at ceiling locations should be type “C” where fire rated, refer to drawings for locations.

B. **SHTG-1** Exterior Sheathing Board
   1. Exterior stud walls - 1/2" or 5/8” weather resistant sheathing board, in lengths as long as practical to minimize joints, refer to drawings for locations. Product to be Dens-Glass Exterior Sheathing manufactured by Georgia-Pacific, GlasRoc Sheathing manufactured by CertainTeed, “Securock “Glass Mat Sheathing manufactured by USG, “GreenGlass” fiberglass-faced Gypsum sheathing, manufactured by Temple-Inland, or approved alternate product and manufacturer. Use Type “X” sheathing at rated exterior walls.

C. Cementitious Fiber-Mat Reinforced Sheathing (Cement Board): ASTM C 1325, ANSI A118.9, cementitious backer.

   1. Product: DUROCK Brand Cement Board by United States Gypsum Company, “Fiberock Aqua Tough” by USG, or approved alternate.
   2. Type and Thickness 5/8 inch thick.
   3. Size: Supplier’s choice.

D. Flexible Gypsum Board:
   1. 1/4” high flex wallboard, manufactured by Gold Bond Gypsum Wallboard Products, or approved equal. Installation at radiused areas shall be done in accordance to printed instructions as supplied by manufacturer. Installation shall consist of minimum 2 layers unless noted otherwise. Provide at curved walls and arches where shown on drawings.

E. **GBD-2** Shaft Liner Panels:
   1. 1” thick by 24” wide by 8’ to 14’ long type “X” fire code gypsum board manufactured by USG or approved alternate.

F. Gypsum board thickness
   1. Unless noted otherwise in this specification or on drawings, gypsum board thickness to be 5/8”.

PART 3 EXECUTION

3.1 INSTALLATION:

A. <u>Painted Gypsum Board:</u>
   1. In areas calling for painted gypsum wallboard 5/8 thick, apply with length parallel to the studs in lengths sufficient to extend from floor to ceiling with no horizontal joints.
   2. Attachment to be by screws 12 inch o.c. in the field and 8 inch o.c. along vertical abutting edges, and 7 inch o.c. on ceiling areas. Type `X' shall be attached 7 inch o.c. edges, ends, and field.
   3. All taping shall be done in accordance to printed instructions as supplied by Gold Bond and approved by the Architect.

4. At metal stud sound walls with multiple layers of gypsum board on one or both sides, each layer is to be taped and floated to deck. Outer layer to be finished as well. At deck, cut gypsum board to fit profile of deck. Seal joint at deck with continuous bead of polyurethane sealant.
5. Provide metal “J” mold where edge of gypsum board abuts a different material or edge of gypsum board is to remain exposed.
6. All painted gypsum board will be finished per this specification unless noted otherwise.
7. Suspended drywall framing shall be attached to structure with No. 12 gauge hanger wires spaced not more than 2'-0" on center in one direction and 2'-0" on center in the other.

B. Exterior Sheathing Board
1. Wall sheathing shall be attached with electric-driven screwdriver with screws no closer than 3/8" from edges and ends. Apply sheathing in lengths as long as practical to minimize horizontal joints. Keep horizontal joints as high on wall as possible.
2. Install all sheathing board in strict accordance with manufacturer's instruction.

C. Cement Board
1. Install cement board backer in areas where wall tile is scheduled to be installed. Attach with screws, complying with Manufacturer’s recommendation and instruction.
2. Prep for ceramic tile installation in accordance with applicable requirements of The Tile Council of North America.

D. Stud Framing
1. Align floor and ceiling tracks to assure plumb partition. Secure the track with suitable fasteners at 24" O.C. maximum. Stud spacing to be 16" o.c. for door and window openings up to 4'-0" wide, reinforcing shall occur through use of a 20 gauge stud screw attached to frame anchors. On openings 4'-0" wide and over, use 2-20 gauge studs back to back against frame and securely attached.

3.2 GYPSUM BOARD SURFACE FINISHING:

A. Where exposed to view, provide level 4 finish on gypsum board surfaces and where called for on drawings unless noted otherwise.
1. Provide two 2’ x 2’ mockup boards with finish for Architect’s and Owner’s review and approval.

B. Wall to have level 4 finish or better.

C. Contractor to apply orange peel texturing to sample mockup panel and be approved by Architect prior to any further application

3.3 CONTROL JOINTS

A. Galvanized metal control joint, Model 093 by USG or approved alternate.

B. Control joints are to be provided at approximately 30’-0” o.c. horizontally and vertically at wall, ceiling, light coves and furrdown installations. Joints should be located at corner of door or window heads if spacing allows and where shown or called for on drawings. These shall be considered minimum requirements.

C. Drywall contractor will repair any cracks in drywall for the one-year warranty period.

3.4 WOOD BLOCKING

A. Install wood blocking in walls where concealed behind drywall for anchoring of wall-mounted items such as (but not limited to) wall mounted door hardware, markerboards, tackboards, projector screens, TV brackets, etc. **Metal plate backing will not be accepted for anchoring of wall-mounted items.**

B. Provide blocking treated for fire resistance where required by code and as specified or called for.

3.5 CLEAN-UP

A. The Contractor shall be responsible for complete clean up on his contract at completion of same.

END OF SECTION

SECTION 09 31 13

CERAMIC TILE/PORCELAIN TILE

PART 1 GENERAL

1.1 SUMMARY

A. Section 03 30 00 - Cast-In Place Concrete: Concrete slab moisture mitigation

B. Furnish all materials, labor, tools, equipment, services, operations and incidentals necessary to complete all ceramic tile work as indicated in the drawings and specified.

C. Pre-Install meeting

1.2 RELATED SECTIONS:

A. Gypsum Drywall Systems: Section 09 29 00.

B. Wall Tile Backer Board: Section 09 29 00

C. Sealing of Joints: Section 07 92 00

1.3 QUALITY ASSURANCE:

A. Standards: Comply with standards specified in this section.

B Subcontractor / supplier providing work under this section will install work specified in this section with their company's own installers, employed by the company. **Subcontracting of installation will not be allowed unless approved by Architect prior to bid.**

C. Qualifications of Manufacturer: Products used in the work of this section shall be produced by manufacturer regularly engaged in manufacture of similar items and with a history of successful production.

D. Qualifications of Installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

1.4 SUBMITTALS:

A. Submit through Contractor to Architect, comply with Section 01 33 00.

B. Manufacturers' Data: As soon as possible after award of the Contract, submit:
   1. Complete materials list of all items proposed to be furnished and installed under this section, including manufacturer's recommended installation procedures.
   2. Manufacturers' specifications and other data required to demonstrate compliance with the specified requirements.

1.5 SAMPLES:

A. Contractor shall submit samples of all ceramic and porcelain tile to be used on this work.

1.6 GUARANTEE:

A. All work under this section shall be guaranteed free from defects in material and workmanship for a period of one (1) year from date of final acceptance.

1.7 PRE-INSTALL MEETING:

A. Prior to tile installation, Contractor will schedule a meeting with the tile installer, Owner and Architect.

B. Items for discussion will be topics such as expectations, tile patterns, verification of tile and grout colors, special conditions, and other items as deemed necessary.

PART 2 PRODUCTS

2.1 MATERIALS:

A. Tile: Tile shall be Standard Grade in accordance with applicable requirements of the tile Council of North America (TCNA) 137.1-(current edition). Furnish a properly executed certificate of grade in the standard form of Master Grade Certificate. Tile shall be delivered to the work in the manufacturer's unopened package sealed with standard grade certificates, and shall be branded with or have sealed within the shipping marks and other designations corresponding to the information given on the executed certificate of grade.

B. Unless specifically called for, tile shall be equal to those described below as manufactured by: Dal Tile, The American Olean Tile Company, Trinity Tile Company, or approved alternate.

2.2 TILE TYPES:

The following tiles as manufactured by the Company listed, shall be the standard of equality design and color. Other manufacturers must meet or exceed the tile NOTED in each case and be approved by Architect. Appearance will be a definite factor in selection.

A. Wall Tile:
TL-1A: Mosa Core Collection Terra, Shapes, Color: Chalk White, 12”x24”
TL-1B: Mosa Core Collection Solids, Shapes, Color: Vivid White, 12”x24”
TL-2A: Mosa Core Collection Solids, Shapes, Color: Vivid White, 19”x10”
TL-2B: Mosa Core Collection Solids, Shapes, Color: Cool Porcelain White, 19”x10”
TL-3: Mosa Core Collection Solids, Color: Vivid White, 24”x24”
TL-5: To match existing – Dal Tile, Glazed Wall Tile, Color: 0170 Bombay, 6”x6”x1/4”

B. Wall Base:
TL-4: Mosa Core Collection Solids, Color: Vivid White, 4”x24”

C. Edge Trim: Provide “Dilex-AHK” series satin nickel anodized aluminum edge manufactured by Schluter or approved alternate at inside wall corners and floor/wall transitions. Provide “Dilex-AHKA” series satin nickel anodized aluminum edge manufactured by Schluter or approved alternate at wall tile to concrete floor transition. Provide “Jolly Edge” series satin nickel anodized aluminum edge manufactured by Schluter or approved alternate as edge protection at outside wall corners and edges.
    a. **TLA-1**: Schluter Dilex-AHK 1S 125 AT, Satin nickel anodized aluminum, 1/2”
    b. **TLA-2**: Schulter Dilex-AHKA 125 AT, Satin nickel anodized aluminum, 1/2”
    c. **TLA-3**: Schulter Jolly Edge Trim A125ATGB, Satin nickel anodized aluminum, 1/2”

2.3 MORTAR

A. Mortar/Adhesive: Tile wall-installation (interior non-wet areas):
    1. Manufacturer/Product:
        a. Mapei KB/KL or Ultraflex LFT
        b. Laticrete #272 Premium Floor-N-Wall thin-set mortar with #333 super flexible additive, or Laticrete 4XLT, meeting ANSI A108.1A, A108.1B, A108.1C, A118.4, A118.11, and A118.15.
        c. Approved alternate

B. Mortar/Adhesive for tile slab-on-grade concrete floor-installation (Interior non-wet areas):
    1. Manufacturer/Product:
        a. Mapei KB/KL or Ultraflex LFT
        b. Laticrete #272 Premium Floor-N-Wall thin-set mortar with #333 super flexible additive, or Laticrete 4XLT, meeting ANSI A108.1A, A108.1B, A108.1C, A118.4, A118.11, andA118.15.
        c. Approved alternate

C. Mortar/Adhesive: Tile wall and floor installation (Interior wet areas):
    1. Manufacturer/Product:
        a. Mapei
        b. Laticrete Latapoxy SP-100 (700 series), meeting ANSI A108.6 and A118.3.
        c. Approved alternate
    2. Provide where installing tile in shower enclosures, toilets or similar areas with a potential of water intrusion.

2.4 GROUT

A. Following setting and curing of installed floor and wall tile, grout joints with epoxy grout for tile installation on interior walls and floors:
    1. Manufacturer/Product:
        a. Mapei Kerapoxy CQ, meeting ANSI A118.3.
        b. Laticrete Spectralock Pro Premium, meeting ANSI A118.3.
        c. Approved alternate.

B. Cure installed tile as per manufacturer’s written instructions prior to installation of grout.

C. Water shall be fresh, clean and free from deleterious amounts of acid, alkali, or any organic matter.

D. Grout color as selected by Architect from Mapei or Laticrete standard color selection. In room where more than one grout type is used, color grout shall be consistent throughout.

E. Sealants for Tile:
   1. 100 percent silicone sealant, Mapei “Mapesil T” silicone sealant, Laticrete “Latisil” silicone sealant, or approved alternate.
   2. Provide sealant in place of grout where wall tile butts hollow metal or aluminum door and window frames.

2.5 GROUT SEALER

A. Water-based grout sealer, “Ultracare” manufactured by Mapei, (800)426-2734, Aqua Mix Grout Sealer manufactured by Custom Building Products, 800-272-8786, or approved alternate.

2.6 WATERPROOFING AND CRACK PREVENTION MEMBRANE

A. At showers, utilize rapid drying, liquid applied elastomeric, waterproofing and crack prevention membrane, RedGard Waterproofing and Crack Prevention Membrane manufactured by Custom Building Products, (800)272-8786, or approved alternate.

PART 3 EXECUTION

3.1. INSPECTION:

A. Examine the areas and conditions under which work of this section will be installed. Correct conditions detrimental to the proper and timely completion of the work.

B. Calcium Chloride Moisture and ph Testing is required to be performed to the floor prior to tile installation. Perform test following industry standards. Architect to be notified of results as soon as results are ready.

C. Do not begin work until surfaces scheduled to receive tile are acceptable. Surfaces shall be true with maximum variation not exceeding 1/8" in eight feet.

D. Coordinate wall tile layout with ceiling installer to assure there will be no gaps between finished ceiling and wall tile.

3.2 INSTALLATION:

A. General:
   1. Thoroughly mix all materials and install mortar, tile and grout as per the manufacturer’s written instructions.
   2. All tile shall be set, grouted and cleaned in accordance with Tile Council of North America Specifications for Installation of Ceramic Tile for adhesive and grout specified and ANSI A108.1 A-C, A108.4-.13, A118.1-.10 and A136.1 (current addition).
   3. At stud walls, thin-set wall tile will be installed over cement board. Refer to Section 09 29 00.

B. Tile shall be neatly cut for proper fitting around all fixtures, pipe, accessories, etc. Rub cut edges with an abrasive stone to bring edge of glaze slightly back from body of tile. Where pipes pass through tile occurring on walls thoroughly caulk with sealant to completely seal around opening. Sealant shall be clear or match color of tile.

C. Floor levelness uniformity at wall perimeter where floor tile is to be installed shall be verified prior to floor and wall tile being installed. Where floor is not uniform at perimeter walls, install floor leveling product compatible with tile and concrete so that perimeter is uniform about the perimeter of the room or area.

D. When grout has thoroughly cured, apply minimum 2 coats grout sealer per manufacturer's instructions. Clean sealer from tile.

E. If wall mirrors are specified, coordinate tile pattern and layout to accommodate mirrors. Mirror to be installed on single plane.

F. Where tile is installed over cement board substrate, align with control joints and fill tile joints where control joints occur with polyurethane sealant, custom colored to match grout color.

G. Refer to drawings for installation patterns of wall tiles.

3.3 CLEANING AND PROTECTION:

A. All work shall be thoroughly cleaned when completed.

B. Contractor shall protect the work of other trades and shall be held responsible for any damage thereto.

C. Protect tile surfaces for a minimum of 48 hours until tile is firmly set.

D. Seal grout with clear approved sealer.

END OF SECTION

SECTION 09 51 00

ACOUSTICAL TILE CEILINGS

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish labor, materials, tools, equipment, scaffolding devices and incidentals necessary or required to install all acoustical tile ceilings and suspension system where shown or scheduled on the drawings.

1.2 RELATED WORK

A. Gypsum Wallboard: Section 09 29 00

B. Air Distribution Systems: Division 23

C. Lighting: Division 26

1.3 REFERENCES:

A. ASTM E1264 – Classification For Acoustic Ceilings

B. ASTM E84 – Surface Burning Characteristics

C. ASTM C367 – Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-In Ceiling Panels

D. ASTM C423 – Sound Absorption

E. ASTM C636 – Standard Practice for Installation of Metal Suspensions Systems for Acoustical Tile and Lay-In Panels

F. ASTM E1414 – Sound Attenuation

G. 2010 Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions for Indoor Sources. Using Environmental Chambers – Version 1.1 – California

H. ASTM C518-10 – Thermal Transmission Properties

1.4 SUBMITTALS:

A. Comply with Requirements of Section 01 33 00.

B. Submit through Contractor to Architect:

1.5 SAMPLES

A. Submit one 6 inch x 6 inch piece of each type of acoustical tile to Architect for approval.

B. Label tile with manufacturer's name, light reflection and noise reduction coefficient, flame spread rating and locations to be installed.

C. Submit a sample of adequate size to show all component parts of the suspension assembly, including perimeter angles.

1.6 ACOUSTICAL PERFORMANCE

A. Acoustical ceiling tiles in academic and office areas to have a minimum noise reduction coefficient (NRC) rating of 0.55 and a minimum ceiling attenuation class (CAC) rating of 35.

1.7 GUARANTEE

A. Acoustical ceiling boards shall have a manufacturer’s limited system performance warranty against warping, shrinking or sagging, for minimum Thirty (30) years from date of final acceptance of the building. Grid system to be carry a manufacturer’s Thirty (30) year guarantee.

B. All work under this section shall be guaranteed free from defects in materials and workmanship for a period of one (1) year from date of final acceptance of the building, except where longer periods of time are specified.

C. If during the material guarantee period, shrinkage, buckling or warping of acoustical ceiling occurs, tighten all joints, replace defective acoustical boards as required to maintain tight, neat ceiling.

PART 2 PRODUCTS

2.1 MATERIAL

A. Acoustical Panel Ceiling System

ACCL-1
Acoustical ceiling panel as called for on plans to be exposed dual reveal profile grid system, 24" x 72" x 1" non-combustible, mineral fiber, white ceiling board with washable and scrubbable finish. USG Mars High-NRC Logix Acoustical Panels, Fineline Bevel edge, or approved alternate, Class 'A', flame spread of 25, NRC rating: 0.90 CAC rating: 30, in 9/16” flat white USG Indentitee DXI grid with stabilizer bars.

ACCL-2
Acoustical tile ceilings as called for on plans to match existing ceiling grid and tile. Ceilings to be exposed grid system, non-combustible, mineral fiber, white ceiling board. Class 'A', flame spread of 25. 24" x 24" x 7/8" Mars Acoustical Panels, non-directional pattern, Tegular Edge, by USG, or approved alternate. NRC rating: 0.80 in USG DX white grid.

ACCL-3

Acoustical tile ceilings as called for on plans to be semi-concealed grid system, non-combustible, mineral fiber, white ceiling board. Class 'A', flame spread of 25. 24" x 24" x 1" Acoustic SF Acoustical Panels, non-directional pattern, by USG, or approved alternate. NRC rating: 0.70 in USG DX Semi-concealed white 15/16” grid.

B. All suspended ceilings systems shall be grid system as specified above or approved equal manufacturer. Components shall be formed from cold rolled steel, electrozinc coated and prepainted white. Main tee shall be double web design, .020 gauge, 1 1/2" in height. Wall angle shall be hemmed edge .024 gauge for galvanized grids.

C. Fire rated ceiling assemblies shall be as called out above except system shall be equivalent to DXL system by USG, Interiors. System shall meet requirements of U.L. Laboratories.

D. Provide hold down clips on all fire rated ceilings, vestibules where ceiling tile is installed, and on other areas where called for.

E. In remodeled areas where existing grid is modified, use matching grid sections salvaged from demolition operations. Any new grid sections used in remodeled areas shall match existing.

F. Drywall Suspension System: Suspended gypsum board ceilings are to DGL or DGLW drywall suspension system by USG Interiors. Components shall be manufacturer's standard components and installed in strict accordance with manufacturer's specifications.

PART 3 EXECUTION

3.1 HANDLING OF MATERIALS

A. Deliver materials to job in manufacturer's original containers, properly store and protect before, during and after installation. Damaged or defective materials shall be removed and replaced.

3.2 EXAMINATION OF EXISTING CONDITIONS

A. Contractor shall be responsible for examination and acceptance of all surfaces and conditions affecting installation of suspension system and acoustical ceilings. Unsatisfactory conditions shall be corrected before proceeding with the work.

B. Start no work until glazing is complete, exterior openings closed in, cement work, plastering or other wet work is completed and dried out. **HVAC SYSTEM MUST BE IN PLACE AND PROPERLY OPERATING BEFORE ANY CEILING TILE IS INSTALLED**

C. Uniform temperature of 60 degrees F. minimum shall be maintained before, during and after acoustical material installation. Humidity level shall not be any more that what is required by manufacturer’s instructions for installation.

3.3 INSTALLATION OF SUSPENDED SYSTEMS

A. Exposed grid suspension system:

1. Wall molding shall be attached to all perimeter walls in accordance with manufacturer's recommendations.
2. Main runners shall be attached to structure with No. 12 gauge hanger wires spaced not more than 4'-0" on center in one direction and 4'-0" on center in the other.
3. Suspended drywall tees or framing shall be attached to structure with No. 12 gauge hanger wires spaced not more than 2'-0" on center in one direction and 2'-0" on center in the other.
4. Cross tees shall be installed at 24" on center and mechanically fastened to main runners.
5. The suspension system shall be installed to permit border units of the greatest possible size, but no less than 4” wide.
6. All members shall be aligned for true, level surface and straight lines.

3.4 INSTALLATION OF ACOUSTICAL TILE CEILINGS

A. Install units to sub-surfaces from set out points and to pattern shown. Verify location of work of other trades so their items occur within a whole unit or at joints as shown. Make cutouts for recessed items provided by other trades.

B. Provide additional hangers at two adjacent corners of 2'x 4' light fixtures. Provide two at each strip fixture or incandescent fixture.

C. Install units in place, fitting snugly. Provide spacers or hold-down clips where required and within 12' of exterior doors.

D. Paint all rivets exposed to view to match suspension system finish. After installation, clean any soiled surfaces. Replace any damaged units.

E. Coordination with Ceramic Wall Tile: Ceiling installer shall coordinate with ceramic tile installer to assure when wall tile extends to finished ceiling, there is no gap between tile and ceiling.

F. EXTRA STOCK: At project completion, provide one additional box of each type of acoustical unit specified, for maintenance use by the owner. These tiles are not to be used to replace tiles damaged as a result of failure of other items under warranty (i.e. roofing systems, HVAC systems, etc.)

G. SALVAGED STOCK: During demolition, use care to salvage existing ceiling tile. Store in area as directed by Owner.

3.5 CLEANING

A. Following installation, clean soiled and discolored surfaces of units.

B. Remove and replace units, which are damaged or improperly installed. Do not use owner’s extra stock for replacing damaged ceiling tiles damaged during construction and damage resulting from failed building components or assemblies during the warranty period.

END OF SECTION

SECTION 09 65 00

RESILIENT FLOORING

PART 1 PRODUCTS

1.1 SUMMARY:

A. Section includes:
   1. Linoleum flooring
   2. Resilient base

1.2 RELATED SECTIONS:

A. Section 03 30 00 - Cast-In Place Concrete: Floor substrate surface and Concrete slab moisture mitigation

B. Section 06 41 16 – Cabinet Work & Shelving

C. Section 09 68 00 - Carpeting.

D. Section 06 10 00 - Rough Carpentry: Floor substrate surface.

1.3 SUBMITTALS:

A. Comply with Requirements of Section 01 33 00.

B. Submit through Construction Manager to Architect:
   1. Samples: Provide properly identified, actual samples of each material for approval and color selection prior to installation.
   2. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping and re-waxing.

1.4 QUALITY ASSURANCE:

A. Regulatory Requirements: Conform to applicable code for flame/fuel/smoke rating requirements in accordance with ASTM E84.

B. Subcontractor / supplier providing work under this section will install work specified in this section with their company's own installers, employed by the company. **Subcontracting of installation will not be allowed unless approved by Architect prior to bid.**

1.5 ENVIRONMENTAL REQUIREMENTS:

A. Store materials for three days prior to installation in area of installation to achieve temperature stability.

B. Maintain ambient temperature required by adhesive manufacturer three days prior to, during and 48 hours after installation of materials.

C. Furnish tile in 45-piece boxes. Do not deliver in bulk.

1.6 WARRANTY:

A. Rubber Base, Rubber stair tread/riser: Provide manufacturer's one-year warranty.

B. Rubber Flooring: provide manufacturer's 10 year wearability warranty.

C. Sheet Vinyl and VCT: Provide manufacturer's five-year limited warranty.

D. Luxury Vinyl Flooring: Provide 10 year limited wear warranty.

PART 2 PRODUCTS

2.1 MATERIAL

A. Linoleum:
1. **RFL-1A**: Duracryl, Corques Liquid Linoleum, Color W301-H, .08" Thick.
2. **RFL-2A**: Duracryl, Corques Liquid Linoleum, Color B343, .08" Thick.
3. Other manufacturers or series only if approved by Architect as per Supplemental Conditions.

B. Coved Rubber Base
Style Varies per Flooring:
1. Style and Location:
   a. Straight: Provide in areas with carpet.
   b. Cove: Provide in areas with resilient floor coverings.
2. **RB-1A**: Johnsonite, Baseworks, Stone Cottage, 4".
3. **RB-1B**: Johnsonite, Baseworks, Stormcloud, 4".
4. **RB-1C**: Johnsonite, Baseworks, Sandstorm CB, 4".
5. **RB-1D**: Johnsonite, Baseworks, Canvas WB, 4".
6. ASTM F-1861, Type TP or better, group 1 (solid); 4" high, 1/8" thickness; class C fire resistance, with matching pre-molded outside corner units; top-set coved or straight base; color as selected by Architect. Pre-molded corner units to match exactly, rubber base color selected. **"Preformed" outside corners will not be allowed. Pre-molded outside corners must be provided.**
7. Provide base material in continuous rolls.
8. Adhesive: Porous surfaces: Tarkett #960 Acrylic Cove base Adhesive; Non-porous surfaces: Tarkett #945 Contact Bond Adhesive. Provide adhesives for approved alternate products as approved by manufacturer for each substrate application.

PART 3 EXECUTION

3.1 EXAMINATION:

A. Verify concrete floors are dry and clean and meet acceptance for installation per manufacturer's requirements. Moisture testing of concrete slabs is required to be performed

in strict accordance with ASTM F2170 to determine in-situ Relative Humidity (RH) prior to resilient floor covering installation. Perform test following industry standards.
Do not proceed until satisfactory conditions have been achieved. Test reports are to be sent to Architect.

B. Due to the many additives being used in or on concrete slabs. A bond test is to be performed prior to actual installation of resilient flooring to determine adhering quality. Some treatments could repel adhesive.

C. Beginning of installation means acceptance of existing substrate and site conditions.

D. Where new resilient material is to be installed over existing concrete floor, prepare surface as required to receive new resilient flooring material.

3.2 PREPARATION:

A. Areas to receive flooring material will be clean, fully enclosed, weathertight and temperature maintained at 65 degrees F for a minimum of three days before installation begins and 48 hours after installation. This also includes adhesives, which will be conditioned in same manner.

B. Cleaning: Immediately prior to installation of the work of this section, vacuum clean substrate. Thoroughly clean substrate and remove all wax, oil, grease, paint, varnish hardeners, and other items which would adversely affect the bond of the adhesive.

C. Apply adhesive only to bare concrete substrates that are sound, smooth, dry and clean. Remove all existing adhesive residues, dirt, dust, paint, curing and sealing compounds and other foreign materials by use of mechanical means only, such as scraping, bead blasting, grinding or sanding. Be sure to follow all local, state and federal regulations for mechanical removal. Adhesive cannot be used over substrates that have been chemically cleaned.

D. Remove subfloor edges and bumps. Fill low spots, cracks, joints, holes and other defects with subfloor filler. Transitions at construction joints or adjoining slabs to be smooth and uniform.

E. Apply, trowel and float filler to leave smooth, flat, hard surface.

F. Prohibit traffic until filler is cured.

3.3 INSTALLATION

A. ADHESIVE APPLICATION
1. Substrate preparation, moisture and alkalinity testing must comply with ASTM F710, industry standards, and floor-covering manufacturer's guidelines. The installation site must be acclimated with HVAC in operation. The floor and room temperature, as well as flooring materials and adhesive, must be maintained at 65°- 95° F, and the humidity below 65% for 48 hours prior to, during, and after the testing and installation. Follow the flooring manufacturer's guidelines for installation for proper adhesive application rate. Tiles and vinyl plank can be installed over non-porous substrates by allowing the adhesive to dry completely before placing flooring. Flooring should be rolled with a 100 lb. roller,

ensuring 100% contact with adhesive. Loss of adhesion can result if the flooring is not installed within the working time of the adhesive.

B. BASE MATERIAL:

1. Areas to receive base will be clean, fully enclosed, weathertight and temperature maintained at 65 degrees F for a minimum of three days before installation begins and 48 hours prior to and after installation. This also includes adhesives, which will be conditioned in same manner. Use only Adhesive that is approved by rubber base manufacturer for specific substrate application.
2. Coiled wall base will be uncoiled and laid out flat for at least 24 hours at 65 degrees.
3. Installer to verify substrate rubber base is to be adhered to and coordinate with other trades. Do not install epoxy paint where rubber base is to be installed.
4. Fit joints tight and vertical. Maintain minimum measurement of 18 inches between joints. Install continuous rolls with as few joints as possible. Use pre-molded corner units.
5. Install base on solid backing. Bond tight to wall and floor surfaces.
6. Scribe to fit door frames and other interruptions.
7. Install pre-molded corner units on all outside corners. Do not extend continuous base around outside corners unless approved by Architect.
8. Base will be mitered at all inside corners.
9. Pieces of base less than 8" not allowed.
10. Install at toe space at base of all cabinets unless otherwise shown.

3.4 PROTECTION

A. Prohibit traffic on floor finish for 48 hours after installation.

3.5 CLEANING AND FINISHING:

A. Allow tile adhesive to dry prior to mopping. Follow tile manufacturer’s instruction for drying time.
B. Remove excess adhesive from floor, base, and wall surfaces without damage.

C. Mop with cleaning solution and then rinse leaving floor ready for waxing by Owner.

END OF SECTION

SECTION 09 68 00

CARPETING

PART 1 GENERAL

1.1 DESCRIPTION:

A. Provide all carpeting and accessories complete, in place, as shown on the drawings, specified herein, and needed for a proper and complete installation.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In Place Concrete: Concrete slab moisture mitigation

1.3 QUALITY ASSURANCE:

A. Qualifications of manufacturer: Products used in the work of this section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production.

B. Qualifications of installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this section.

C. Subcontractor / supplier providing work under this section will install work specified in this section with their company's own installers, employed by the company. **Subcontracting of installation will not be allowed unless approved by Architect prior to bid.**

1.4 REFERENCES

A. ASTM D2859 - Standard Test Method for Flammability of Finished Textile Floor Covering Materials.

B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. CRI 104 - Standard for Installation of Commercial Textile Floor-covering Materials; Carpet and Rug Institute.

1.5 SUBMITTALS:

A. General: Comply with the provisions of Section 01 33 00.

B. Product data: As soon as possible after award of the Contract, submit:
1. Complete materials list of all items proposed to be furnished and installed under this section.

2. Manufacturer's specifications and other data required to demonstrate compliance with specified requirements.
3. Shop drawings showing location of all seams and location and types of all carpet material and accessories.
4. Samples of the following carpet products and of exposed edge accessories available from the proposed manufacturer within the specified allowance qualities.
5. Manufacturer's recommended installation procedures.

C. The manufacturer's recommended installation procedures, will become the basis for inspection and accepting or rejecting actual installation procedures used on the work.
   1. Dealers/Installers must follow manufacturer's procedures for installation, using the recommended glues, seam sealers, and floor sealers (if needed).

D. Recycling Plan and Certification:
   1. Manufacturer shall maintain and operate a recycling effort capable of reclaiming installed carpet. First choice is repurposing, provided carpet is in usable condition. Second choice is closed loop recycling turning carpet into carpet
   2. A written plan must be approved by owner in writing prior to award.
   3. Flooring contractor to provide Owner a report of all recycling activity prior to final payment.
   4. Certification: A certificate verifying the reclamation of the carpet and the pounds of material diverted from the landfill will be furnished upon request.

PART 2 PRODUCTS

2.1 MANUFACTURERS:

A. **CPT-1**
   1. Product and Manufacturer: Interface Obligato
   2. Color: Travertine 106714
   3. Backing: C-Quest Bio X
   4. Dimensions: 25cm x 1m
   5. Installation: Ashlar
   6. Adhesive: Tac-tiles per manufacturer's instructions.

B. **CPT-2**
   1. Product and Manufacturer: Interface Diminuendo
   2. Color: Travertine 106700
   3. Backing: C-Quest Bio X
   4. Dimensions: 25cm x 1m
   5. Installation: Ashlar
   6. Adhesive: Tac-tiles per manufacturer's instructions.

C. **CPT-3**
   1. Product and Manufacturer: Shaw Inside Shapes Impression 1 Tile
   2. Color: Warm Light, IM002
   3. Backing: Ecoworx
   4. Dimensions: 24"x24"
   5. Installation: Refer to drawings for pattern

6. Adhesive: Lokdots per manufacturer's instructions for flooring application. Use Shaw 3800 adhesive per manufacturer's instructions for wall application.

D. **CPT-4**
   1. Product and Manufacturer: Interface Broome Street
   2. Color: Coral Glass 106210
   3. Backing: C-Quest Bio X
   4. Dimensions: 50cm x 50cm
   5. Installation: Monolithic
   6. Adhesive: Tac-tiles per manufacturer's instructions.

E. **CPT-5**
   1. Product and Manufacturer: Interface Mercer Street
   2. Color: Concrete Circle 105762
   3. Backing: C-Quest Bio X
   4. Dimensions: 50cm x 50cm
   5. Installation: Monolithic
   6. Adhesive: Tac-tiles per manufacturer's instructions.

F. **CPT-6**
   1. Product and Manufacturer: Shaw Bottle Floor Felted 5T455
   2. Color: Velveteen 665
   3. Backing: Ecoworx
   4. Dimensions: 9" x 36"
   5. Installation: Ashlar
   6. Adhesive: Lokdots per manufacturer's instructions.

G. **CPT-7**
   1. Product and Manufacturer: Interface Look Both Ways, Step This Way
   2. Color: Alba 106323
   3. Backing: C-Quest Bio X
   4. Dimensions: 50cm x 50cm
   5. Installation: Ashlar
   6. Adhesive: Tac-tiles per manufacturer's instructions.

2.2 MATERIALS

A. All materials shall be new.

B. All carpet shall be of first quality, of American manufacture and permanently mothproofed by manufacturer. Carpet must also have static controlled capabilities.

C. Colors to be selected from manufacturer's standard range.

D. All modular carpet to have manufacturer recommended backing. Modular secondary backing for the useful life of the original installation against product failure from:
   1. Tuft Bind (edge ravel, yarn pulls, zippering)
   2. Delamination
   3. Moisture Penetration

4. Dimensional Stability

E. Edge Trim: Provide transition types as shown in drawings, Schluter or approved alternate metal edge, typical.

F. **FLA-1** Edge Guard: Roppe Rubber Accessory Edge Guard, #34 Underlap Carpet Edge 3/16", Color: 174 Smoke, Radius 6'-0".

G. Recycled Content and Recyclability:
   1. Products shall include post-consumer recycled and/or bio-based content in both backing and fibers.
   2. Products shall be closed-loop recyclable back into flooring.
   3. Products shall be installed with methods that will not materially damage the sub-floor when later removed.

2.3. ADHESIVES:

A. Modular Carpet: Provide self adhering or manufacturer-approved adhesive, recommended by carpet manufacturer, compatible with carpet specified and provided, for releasable installation.

B. Provide letter with carpet submittal, stating that adhesive for each type of carpet provided is approved by manufacturer for substrate in which it is applied.

PART 3 EXECUTION

3.1 INSPECTION:

A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until satisfactory conditions have been achieved.

B. Calcium Chloride Moisture and ph Testing is required to be performed to the floor prior to carpet installation. Perform test following industry standards.
   1. Maximum acceptable moisture emission rate for concrete sub floors (unless carpet manufacturer requires more stringent rate):
      a. Carpet – 3 lbs/1,000 sq. ft. per 24 hours or less

   Do not proceed until satisfactory conditions have been achieved.

3.2 SURFACE PREPARATION:

A. Cleaning: Immediately prior to installation of the work of this section, thoroughly clean all substrate and remove all wax, oil, grease, paint, varnish hardeners, and other items which would adversely affect the bond of the adhesive.

B. Slabs must be thoroughly cured, and free of curing agents, hydrostatic pressure, excessive alkali as determined by manufacturer, and moisture.

C. Smoothing: Make all substrate level and free from irregularities. Assure one constant floor height after carpet is installed, grinding high spots and filling in low spots as required.

D. For areas where carpet is to be installed outdoors, surface must be kept dry for at least 96 hours prior to installation.

3.3 PRODUCT HANDLING:

A. Protection: Use all means necessary to protect the materials of this section before, during and after installation and to protect the work and materials of all other trades.

B. Replacement: In the event of damage, immediately make all repairs and replacements needed at no additional cost to the Owner.

3.4 INSTALLATION:

A. General:
   1. Install carpeting and accessories in strict accordance with the manufacturer's recommendations.
   2. Align the lines of broadloom carpet as woven, using no fill strips less than 16" in width, laying all carpet in same direction.

B. Seams:
   1. Locate seams to the maximum practicable out of traffic.
   2. Unless noted otherwise, locate carpet seams between rooms under bottom end of door where butting carpet of alike or different types, pattern, or color.
   3. Fabricate seams by the compression method, using a butt joint, and properly bed and seal all carpet edges and seams. Do not stretch seams. Provide seam adhesive at all seams at least 6" wide.
   4. Apply carpet tab-type adhesive as recommended by carpet manufacturer for the specified backing type.

C. Cleaning up: In addition to the requirements of Section 01 77 00, thoroughly clean all carpet surfaces prior to final acceptance of the carpeted areas by the Owner.

3.5 PROTECTION:

A. Provide a heavy non-staining paper or plastic walkway as required over carpeting in direction of foot traffic, maintaining intact until carpeted space is accepted by the Owner.

3.6 ATTIC STOCK:

A. Provide one additional box of carpet tile of each color and type for attic stock.

END OF SECTION

SECTION 09 72 16

VINYL AND OTHER FABRIC WALL COVERINGS

PART 1 GENERAL

1.1 SUMMARY

A. Provide wall covering and tackable wall fabric as shown and specified and in accordance with the Contract Documents.

1.2 RELATED SECTIONS

A. Section 01 21 13 - Cash Allowances

B. Section 07 21 00 - Insulation

C. Section 09 29 00 - Drywall

1.3 QUALITY ASSURANCE:

A. Qualifications of Installers: Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Fire Performance Characteristics; Provide wall coverings with flame spread of 25 or less and smoke developed of 450 or less (Class A. in compliance with ASTM E 84 or UL or other testing and inspecting organizations acceptable to authorities having jurisdiction. Identify wall coverings with appropriate markings of applicable testing and inspecting organization.

1.4 SUBMITTALS:

A. Comply with requirements of Section 01 33 00.

B. Samples: Submit 8" x 10" sample of each type and color to be installed, for the Architect's approval.

C. The manufacturer's recommended installation procedures, approved samples, and Acceptance/Performance Criteria described herein will become the basis for inspecting and accepting or rejecting actual installation procedures used on the Work.

PART 2 PRODUCTS

2.1 PRODUCT HANDLING:

A. Deliver all materials in manufacturer's cartons, properly labeled and identified.

B. Store wall covering in undamaged condition as packaged by manufacturer.

C. Take care to prevent damage during delivery, handling and storage.

D. Store all materials flat in a clean, dry storage area where temperature shall be maintained above 40 degrees F. with normal humidity. Do not store materials in an upright position.

2.2 MATERIALS:

A. **WCVG-1**: Carnegie Xorel Meteor, Color 717

B. **WCVG-2A**: Designtex Bespoke Surface Imaging, DW11 DNA Wallcovering, Architect to provide custom art, 54" width, Content: 50% Virgin Wood Pulp, 40% Synthetic Latex, 10% Polyester Fiber.

C. **WCVG-2B**: Designtex Bespoke Surface Imaging, DW11 DNA Wallcovering, Architect to provide custom art, 54" width, Content: 50% Virgin Wood Pulp, 40% Synthetic Latex, 10% Polyester Fiber.

D. **WCVG-3**: Designtex Wannabe, 5% Polyester (Preconsumer recycled, solution dyed), 95% Polyester (Postconsumer recycled, solution dyed), Color: Hint, 63" Width, 6646-702, Installation: straight hang, random match, vertical seams; Use manufacturer recommend water-based adhesive.

E. **WCBG-4**: Koroseal Walltalkers, 48" width, Color: Acorn 86, Installation: Vertical seams, straight match, reverse hang; Use manufacturer recommended water-based adhesive.

F. Substitutions may be submitted for approval per Section 01 60 00.

G. Provide with 4-year manufacturer's limited warranty.

2.3 ACCESSORIES:

A. **WA-2**: Roppe Rubber Accessory Cove Cap, Style: #46 Cove Cap 1/8", Color: 131 Bisque

PART 3 EXECUTION

3.1 INSPECTION:

A. Install wall coverings on areas indicated on the Drawings and Finish Schedule.

B. Areas to receive wall covering shall have a constant temperature of at least 55 degrees F. for three days before, and all during application period.

C. Examine all surfaces to receive wall coverings before beginning work to determine that they are sound, dry, clean, and ready to receive final finish. Correct defects that could affect quality of finished work.

3.2 SURFACE PREPARATION:

A. Remove all foreign matter and correct any defects.

B. For drywall construction with field applied fabric, a coat of Drywall Primer may be applied to the surface before application of wall covering, for ease of subsequent removal.

C. Gypsum wallboard to receive field applied fabrics, shall have all nails and screws recessed, with all joint and nail depressions taped and spackled, sanded and primed with one coat of primer.

3.3 INSTALLATION:

A. Follow manufacturer's directions for mixing and applying adhesive and primer.

B. Before cutting, examine pattern and color and determine that they match approved samples. Examine patterned material for repeat in design.

C. Install panels on the hanging surface, reversing every other panel of non-match patterns unless otherwise instructed by the manufacturer.

D. Vertical joints shall not occur less than 6" from outside or inside corners.

E. Where applicable, install wall covering before installation of plumbing, casing, bases, cabinets, etc.

3.4 CLEAN-UP:

A. Upon completion of the work, remove surplus materials, rubbish and debris resulting from the operations under this Section including equipment and implements of service, and leave the entire structure and site insofar as the work of this Section is concerned in a neat, clean and acceptable condition.

END OF SECTION

SECTION 09 77 00

SPECIAL WALL SURFACES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pre-manufactured panel system including mounting hardware and specified accessories.

1.2 RELATED SECTIONS

A. Section 06 10 00 - Rough Carpentry: furring, blocking, and other carpentry work that is not exposed to view.

B. Section 09 29 00 - Drywall: Gypsum Board Assemblies; for metal support systems not included in this section.

1.3 REFERENCES

A. American Society for Testing and Materials (ASTM) E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

B. Architectural Woodwork Institute (AWI) Quality Standards.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Shop drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with adjacent work.

D. Selection Samples: For each finish product specified, one complete set of color chips representing manufacturer's standard range of available colors and patterns. If color(s) have been selected, submit the selected color(s) for approval.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Firm experienced in successful production of wall system similar to that indicated for the Project, with sufficient production capacity to produce required units without causing delay in the work.
   2. Provide certificate signed by panel manufacturer certifying that products comply with specified requirements.

B. Installer Qualifications: Demonstrate successful experience in installing architectural woodwork similar in type and quality to those required for this project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver wall system until painting, wet work, grinding, and similar operations that could damage, soil, or deteriorate wall system have been completed in installation areas as specified by AWI 1700-G-3.

B. If panels are stored prior to installation, store them flat in completely enclosed areas, out of the weather. If panels must be stored in other than installation areas, store only in areas where environmental conditions comply with manufacturers recommendations. Do not expose panels to continuous direct sunlight, nor to extremes in temperature and humidity. Store products in manufacturer's packaging until ready for installation.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT CONDITIONS

A. Do not deliver or install wall system until building is enclosed, wet work is complete and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period as specified by AWI 1700-G-3.

B. Do not install wall system until normal lighting conditions exist. Normal lighting conditions are described as those in place when the project is finished. This includes, but not limited to, design lighting (wall washers, spot lights and flood lights, and similar fixtures) and natural lighting.

C. Wall, ceilings, floors, and openings must be level, plumb, straight, in-line and square as specified by AWI 1700-G-3.

D. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits. Panels shall be conditioned in the environment in which they will be installed for a minimum of 72 hours prior to installation. The recommended environment is 75 degrees F (24 degrees C) and 45 percent relative humidity.

E. Environmental Conditions: Comply with Woodwork Manufacturer's recommendations for optimum temperature and humidity conditions for woodwork during its storage and installation. Do not install woodwork until these conditions have been attained and stabilized so that woodwork is within plus or minus 1.0 percent of optimum moisture content from date of installation through remainder of construction period.

1.8 WARRANTY

A. Manufacturer warrants any product it has manufactured and sold against defects in materials or workmanship for a period of five years from the date of original purchase and acceptance for use. This warranty extends to products assembled / installed and used in the manner intended and does not cover damage or failure caused by: misuse, abuse or accidents, exposure to extreme temperature, improper

installation, improper maintenance and exposure to water or excessive humidity or excessive moisture.

PART 2 PRODUCTS

2.1 MATERIALS

A. **WCVG-2A**: Designtex Bespoke Surface Imaging, DW11 DNA Wallcovering. Pattern artwork to be provided by architect.

B. **WCVG-2B**: Designtex Bespoke Surface Imaging, DW11 DNA Wallcovering. Pattern artwork to be provided by architect.

C. **WCVG-3**: Designtex Wannabe, Color: Hint. Installation: straight hang, random match, vertical seams.

D. **WCVG-4:** Koroseal Walltalkers, 48", Color: Acorn 86. Installation: vertical seams, straight match, reverse hang.

2.2 EXAMINATION

A. Do not begin installation until substrates have been properly prepared according to AWI 1700-G-3.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

2.3 FIELD DIMENSIONS

A. Where wall system is indicated to be fitted to other construction, check actual dimensions of other constructions by accurate field measurements before manufacturing wall system; show recorded measurements on final shop drawings. Coordinate manufacturing schedule with construction progress to avoid delay of work.

B. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with manufacture of wall system without field measurements coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

2.4 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

2.5 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. When interior paneling is on an exterior wall or in a wet area, provide a barrier sheet of plastic film between the outside wall and the panels in order to prevent condensation affecting the stability of the panels.

C. Field cutting of all wall systems should be accomplished using carbide tools. All face penetrations should have a minimal 1/8 inch (3 mm) radius according to NEMA Standards Publication LD 3-2005.

D. All wall systems should receive an "S" bead of panel mastic on the back of the panel during installation.

E. For vertical applications, wall systems shall be mechanically fastened to horizontal furring strapping spaced 24 inches (610 mm) O.C. Furring straps shall be no less than 18 gauge 3-1/2 inches (89 mm) wide, continuously. For horizontal applications, wall systems shall be mechanically fastened to horizontal furring strapping spaced 24 inches (610 mm) o.c.and/or mechanically fastened to studs. Furring straps shall be no less than 18 gauge 3-1/2 inches (89 mm) wide, continuously.

2.6 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 09 84 14

ACOUSTICAL WALL AND CEILING TREATMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Acoustical Wall and Ceiling Panels, Hanging Baffles and Grids.

1.2 RELATED SECTIONS

A. Section 09 51 00 -Acoustical Tile Ceilings.

1.3 REFERENCES

A. ANSI Z97.1 - Safety Glazing Materials Used in Buildings - Safety Performance Specifications and Methods of Test.

B. American Society for Testing and Materials (ASTM):
   1. ASTM C411 - Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
   2. ASTM C423 - Sound Absorption by Reverberation Room Method.
   3. ASTM C1304 - Standard Test Method for Assessing the Odor Emission of Thermal Insulation Materials.
   4. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
   5. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
   6. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
   7. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.
   8. ASTM E413 - Classification for Rating Sound Insulation.
   9. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
   10. ASTM G22 - Standard Practice for Determining Resistance of Plastics to Bacteria.

C. National Fire Protection Association (NFPA) 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials

D. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.

3. Installation methods.

C. Test Reports: Upon request submit certified test reports from recognized test laboratories.

D. Certificates: Submit manufacturer's certificate that products meet or exceed specified requirements.

E Shop Drawings: Submit shop drawings in detail of all work in scale to indicate size, location and attachment methods required for the installation of the required work.

F. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square representing actual product, color, and patterns.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5-year experience manufacturing similar products.

B. Installer Qualifications: Minimum 2-year experience installing projects of similar size and complexity.

C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship is approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.6 PRE-INSTALLATION MEETINGS

A. Convene minimum two weeks prior to starting work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver material in the manufacturer's original, unopened, undamaged containers with identification labels intact.

B. Provide labels indicating brand name, source of procurement, style, size and thickness.

C. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

D. Handling: Handle materials to avoid damage.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's recommended limits.

1.9 SEQUENCING

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.10 WARRANTY

A. MPSTM warrants the hardware and mounting equipment for ten (10) years and acoustic material for two (2) years to be free from defects in materials and workmanship from the date of purchase. This warranty does not apply to components not manufactured by MPSTM, which are subject to the specific warranties of those manufacturers, if any.

B. MPSTM cannot be held responsible for reasonable variations in dye lot from order to order or within a shipment. PET Felt uses a traditional ‘felting’ process to create its panels. This often results in a pleasing heathered effect, where multiple tones are present in the fiber. Slight and consistent variations in color should be expected when using sustainable material.

PART 2 PRODUCTS

2.1 MATERIAL

A. Acoustic Panel

ACP-1A
Product: Baux Wood Wool Panel
Style: Lines
Color: Heat Rust Red
Size: 1160mm x 580mm x 25mm thick
Installation: Refer to drawings for pattern.

ACP-1B
Product: Baux Wood Wool Panel
Style: Arch
Color: Heat Rust Red
Size: 1160mm x 580mm x 25mm thick
Installation: Refer to drawings for pattern.

ACP-1C
Product: Baux Wood Wool Panel
Style: Curve

Color: Heat Rust Red
Size: 1160mm x 580mm x 25mm thick
Installation: Refer to drawings for pattern.

B. Acoustic Wrapped Panel

ACP-2A
Product: Kinetics Hardside
Thickness: 1”
Edge: Radius
Size: 4’x10’ max panel size, refer to drawings for dimensions
Mounting: Z-Clip
Fabric: Guilford of Maine, FR701 2100, Quartz 380

ACP-2B
Product: Kinetics Hardside
Thickness: 1”
Edge: Radius
Size: 4’x10’ max panel size, refer to drawings for dimensions
Mounting: Z-Clip
Fabric: Camira Blazer, Aberlour – CUZ1J

ACP-3
Product: Kinetics Tad Panel
Thickness: 1-1/8”
Edge: Radius
Size: 4’x8’
Mounting: Z-Clip
Fabric: Guilford of Maine, FR701 2100, Quartz 380

C. Substitutions: Comply with Section 01 60 00.

D. Refer to drawings for panel designations specified under this specification section.

PART 3 EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions:
   1. Examine surfaces scheduled to receive furred out or directly attached acoustical units for unevenness, irregularities and dampness that would affect quality and execution of work.
   2. Do not proceed with installation of acoustical panels until unacceptable conditions are corrected.

B. Environmental Requirements:
   1. Do not install acoustical panels until building is closed in and HVAC system is operational.

3.2 INSTALLATION – GENERAL

A. General: Do not begin installation until materials sufficient to complete an entire room are received and are ready for installation.
   1. Install acoustical wall panels in accordance with quantity and lay-outs as shown on the architectural drawings.
   2. Acoustical wall panels shall be adhesively or mechanically mounted in accordance with manufacturer's recommendations and/or as detailed on the drawings.

B. Manufacturer's Instructions:
   1. Comply with the instructions and recommendations of the acoustical panel manufacturer.
   2. Install materials in accordance with governing regulations, fire resistance rating requirements and industry standards applicable to work.

3.3 PANEL MOUNTING

A. Panels are to be installed per manufactures recommendation.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel to comply with manufacturer's instructions for cleaning.

3.5 PROTECTION

A. Protect installed work from damage due to subsequent construction activity, including temperature and humidity limitations and dust control, so that the work will be without damage and deterioration at the time of acceptance by the Owner.

END OF SECTION

SECTION 09 91 00

PAINTING AND FINISHING

PART 1 GENERAL

1.1 SUMMARY

A. The work to be completed under this heading includes all labor, materials, equipment, and services necessary for and reasonably incidental for painting throughout the building, both exterior and interior, for all wood, metal, masonry, or other surfaces as specified, to make a thoroughly complete job in every respect.

B. Term "exposed" used herein refers to surfaces exposed at exterior of building and surfaces visible within building unless specifically called out. Materials in pipe chases, pipe tunnels and concealed above finish ceiling shall not be considered "exposed".

C. Items included but not limited to - Exposed concrete surfaces (as called for on the interior finish schedule. Exposed concrete masonry units, interior and exterior. Exposed ferrous metals at exterior and interior of building not specified to receive factory applied finish of baked-on enamel. Concealed ferrous metals, except for fasteners and electrical and mechanical items, shall have minimum of one coat of corrosion-resistant paint. Exposed aluminum: galvanized steel roof vents, exhaust fans, grilles and registers shall not be painted unless otherwise designated.

D. Exposed insulated piping, ductwork and mechanical equipment shall be painted unless supplied from the factory with a finish coat in compliance with building decor and this specification.

E. Exposed wood, hardboard and plywood surfaces unless otherwise designated shall be painted or stained. Walls requiring patching or showing defects shall be painted in their entirety.

G. There shall be no painting of copper, prefinished aluminum, or other finished metal, except iron.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 ENVIRONMENTAL REQUIREMENTS

A. Follow manufacturer's recommendations for temperature range in which coatings may be applied.

B. Comply with National Volatile Organic Compound Emission Standards for Architectural coatings, Rule 40 CFR, Part 59, established by Environmental Protection Agency for VOC limits unless stricter local regulations are required.

1.4 PAINTING AND FINISHING PRE-INSTALLATION MEETING

A. Prior to any wall or ceiling preparation, Contractor will schedule a pre-installation meeting. Required attendance will be Contractor or CM, Architect, Painter and drywall finisher, and suspended ceiling installer Contractor to conduct meeting.

B. Discussion items:
   1. Gypsum board texturing and mockups
   2. Paint application.
   3. Protection of floors and surrounding finished items and finishes.
   4. Progression of installation following application of finished coat of paint. (i.e. switch and receptacle covers, millwork light fixtures, etc.)
   5. Accent painting clarification.
   6. Finishing of hollow metal doors and frames. (spray finish, not brushed.)
   7. Transparent finishes for woodwork, wood doors, etc.
   8. Other discussion items

PART 2 PRODUCTS

2.1 MATERIALS

A. All paint and stain shall be manufactured by Benjamin Moore, Pittsburg or Sherwin Williams as specified.
   1. Other manufacturers listed below are approved, but must meet or exceed specifications for each type of paint or stain as specified in this specification.
      a. Glidden
      b. Kelly-Moore
      c. Kwal.
   2. Substitutions: Comply with Specification Section 01 60 00.
   3. All colors shall be as selected by the Architect if not called out on drawings or specifications.

B. All paint materials shall be delivered to the job in original unbroken manufacturer's packages with the labels intact and be kept in a locked room to which the Architect shall have access at all times.

C. All materials shall be the best of their respective kinds and thoroughly mixed in the proper proportions to secure the best results.

2.2 SAMPLE PANELS

A. After painters' materials have been approved and before any painting or finishing is done, submit panels as follows:
   1. Panels showing color and finish coat.
   2. Panels showing clear finishes.

B. Panels to show color: Composition board, 4 inch by 11 inch by 1/8 inch to show each color selected.

C. Panel to show transparent finishes: Wood of same species and grain pattern as wood approved for use, 4-inch by 11-inch face by 1/4-inch-thick minimum, and where both flat and edge grain will be exposed, 11 inches long by sufficient size (two by two inch minimum or actual wood member) to show complete finish. Panels shall show each type of finish specified.

D. Attach labels to each panel stating where material is to be used, mfg. of finish material, and color or number of finish.

2.3 PAINTING AND FINISHING SCHEDULE

A. **Paint Schedule provides for minimum two-coat application in addition to primer or filler coat.** Additional coat may be required for certain items to give complete coverage and uniform appearance. Omit primer for items shop primed.

B. See following paint color schedule that coordinates with _ of paint numbers below, ie PT-5A is PT-5 for galvanized metal and A color White Dove.
1. PT-_A: Benjamin Moore, White Dove, OC-17, LRV: 85.38.
2. PT-_B: Benjamin Moore, Clay Beige, OC-11, LRV: 62.87.
3. PT-_C: Benjamin Moore, Lambskin, OC-3, LRV: 71.
4. PT-_D: Benjamin Moore, Pale Oak, OC-20, LRV: 69.
5. PT-_E: Benjamin Moore, Potters Clay, 1221.
6. PT-_F: Benjamin Moore, Burgundy Rose, 1280.
7. PT-_G: Benjamin Moore, Terra Cotta, 1202.
8. PT-_H: Benjamin Moore, Black color to match SMF-1 / SMF-2.

2.4 EXTERIOR FINISHING SCHEDULE:

A. **PT-5_** Galvanized Metal:
1st Coat: Benjamin Moore PO4 Acrylic Metal Primer, Pittsburg "Pitt-Tech" 90-712 Int./Ext. Primer/Finish DTM Industrial Finish, or Sherwin Williams SW Pro-Cryl B66-310 primer.
2nd & 3rd Coat: Benjamin Moore P28 Super Spec, 100 percent Acrylic, semi-gloss, Pittsburg Pitt-Tech 90-374 Int./Ext. High Gloss DTM Industrial Enamel or Sherwin Williams Pro Industrial Acrylic Coating, gloss B66-660.
1. Paint inside galvanized surfaces of guttering.

2.5 INTERIOR FINISHING SCHEDULE:

A. **PT-4_** Ferrous Metals:
1st Coat: MPI #107 X-Green
2nd and 3rd Coat: MPI #147 X-Green (standard performance) or MPI #141 X-Green (high performance)

B. **PT-1_** and **PT-2_** Gypsum Board & Plaster: After finishing.
1st Coat: Benjamin Moore 354 "Super Hide" Interior Latex Primer, Pittsburg "Speedhide 6-2 Interior Latex Sealer or Sherwin Williams ProMar 200 0 VOC Primer B28W2600

2nd & 3rd Coat: Benjamin Moore 537 Ultra Spec 500 Interior Low Sheen Finish, Pittsburg "Speedhide" 6-3511-3517 Series Interior Acrylic Latex Satin Finish or Sherwin Williams ProMar 200 0 VOC Low Gloss Flat Sheen (**PT-1_**) and Egg Shell (**PT-2_**) B24-2600.

C. **PT-3_** Wood (Painted):
   1st Coat: MPI #137 X-Green
   2nd & 3rd Coat: MPI #147 X-Green (standard performance) or MPI #141 X-Green (high performance)

D. Wood (Transparent):
   1st Coat: Benjamin Moore 1AS.12XX Alkyd Wiping Stain, Pittsburg "Deft" DFT400 Series Interior Oil-Based Wood Stain or Sherwin Williams SW Wood Classics Oil Stain A49 Series.
   2nd Coat: Benjamin Moore N422 "Stays Clear" Acrylic Polyurethane Gloss, Clear (non-yellowing), Pittsburg "Deft" DFT157 Acrylic Polyurethane, Gloss Clear (non-yellowing) or Sherwin Williams SW Wood Classics WB Polyurethane A68V91.
   3rd & 4th Coat: Benjamin Moore N423 "Stays Clear" Acrylic Polyurethane Low-luster, Clear (non-yellowing), Pittsburg "Deft" DFT159 Acrylic Polyurethane, Satin Clear (non-yellowing) or Sherwin Williams SW Wood Classics WB Polyurethane A68V91.
   1. Top, bottom, and edges of all doors shall be finished as above.

E. **FAFL-1** Concrete Floors:
   1. Covertec StrongSeal Plus, Matte, Clear, VOC: <50/GL. Additive: Covergrip Ultrafine for .68 High Slip Resistance for all new concrete in restrooms. Refer to finish floor plans for locations of topping slabs.

PART 3 EXECUTION

3.1 MATERIAL AND SPACE CONDITIONS

A. Do not apply to wet or damp surfaces. Wait a minimum of 30 days or more as required by paint manufacturer before applying to new concrete or masonry. Follow manufacturer's procedures to apply appropriate coatings prior to 30 days to other substrate surfaces. Painter is required to test new concrete or masonry for moisture content prior to beginning of painting with a certified digital PH testing meter approved by Architect. If moisture content is above manufacturer's minimum, surface must be allowed to dry to within levels required by paint manufacturer.

B. Interior of building must be dried in prior to painter primer application. Do not begin painting of surface when temperature is at or below or temperature is predicted to drop below that required by paint manufacturer before required paint drying period.

3.2 SURFACE PREPARATION

A. General: Temporarily remove items interfering with surface to be painted for complete painting of such items and adjacent areas.

1. See other sections of the specifications for requirements for surface conditions and prime coat.
2. Surfaces to be finished shall be dry, clean, smooth and prepared as specified.
3. Materials and methods used for cleaning shall be compatible with the substrate and specified finish. Remove any residue remaining from cleaning agents used.
4. Method of surface preparation is optional provided results of finish painting produce solid even color specified.

B. Wood: Sand to a smooth even surface and then dust off.
   1. Where transparent finish is specified, finish sanding shall be with 220 grit sandpaper. Wipe surface with a tack rag prior to applying finish.
   2. Surface to be painted with an opaque finish shall have all knots, sap and pitch streaks coated with knot sealer before applying any coat of paint. Apply two coats of knot sealer over large knots.
   3. Surfaces showing raised grain shall be sanded smooth between each coat.
   4. After application of prime or first coat of stain, fill all cracks, nail and screw holes, depressions and similar defects with patching compound. Sand to make smooth and flush with surrounding surface.
   5. Before applying finish coat, reapply patching compound if required, and lightly sand surface to remove surface blemishes.

C. Steel and Iron:
   1. Remove oil, grease, soil, drawing and cutting compounds, flux and other detrimental foreign matter by use of solvents, emulsions, cleaning compounds, or by steam cleaning.
   2. Verify that all factory or field welds where exposed have been grinded to achieve smooth consistent surface and that primer has been applied on bare steel. Apply appropriate filler material where voids occur at welds and finish to achieve smooth consistent surface.
   3. Remove loose mill scale, rust, and paint, by hand or power tool cleaning, except where high temperature aluminum paint is used, the surface shall be prepared in accordance with the manufacturer's instructions.
   4. Fill all dents, holes and similar voids and depressions in flat exposed surfaces of hollow steel doors and frames, access panels, roll-up steel doors and similar items specified to have semi-gloss or gloss finish with patching compound. Finish flush with adjacent surfaces.
   5. Spot prime all abraded and damaged areas in shop prime coat which expose the bare metal, with same type of paint used for prime coat. Feather edge of spot prime as required to produce smooth finish coat. Spot prime all abraded and damaged areas which exposed the bare metal of factory finished items with paint as recommended by the manufacturer.

D. Zinc-coated (Galvanized, Metal, Terne-Plate, Zinc, Lead, Aluminum, Copper and Copper Alloys): Surfaces specified to be painted shall be cleaned of all grease, oil and other deterrents to paint adhesion, with toluene, xylene or similar solvents.
   1. Spot prime all abraded and damaged areas of zinc-coating which expose the bare metal, using zinc rich paint on hot-dip zinc-coated items and zinc dust primer on all others.

2. Spot prime, with red lead prime, all abraded and damaged areas of terne-plate which exposed the base metal.

E. Masonry, Concrete, Cement Plaster and Stucco: Remove all dust, dirt, oil, grease efflorescence, form release agents, laitance, and other deterrents to paint adhesion.
   1. Use emulsion type cleaning agents to remove oil, grease, paint and similar products. The use of solvents, acid, or steam is not permitted.
   2. Remove all loose mortar in masonry work.
   3. Replace mortar and fill all open joints, holes, cracks and depressions with patching compound, finished flush with adjacent surface, with texture to match texture of adjacent surface.
   4. Concrete floors to be stained or sealed shall be etched and prepped per manufacturer's instructions. Allow required time to dry between applications.
   5. Concrete shall have all broken and spalled edged repaired with patching compound to match adjacent surfaces. Remove projections to level of adjacent surface by grinding or similar methods.

F. Gypsum Plaster and Drywall: Remove efflorescence, loose and chalking plaster. Remove dust, dirt, and other deterrents to paint adhesion.
   1. Fill holes, cracks, and other depressions with patching compound, finished flush with adjacent surface, with texture to match texture of adjacent surface.

3.3 APPLICATIONS

A. Start of surface preparation or painting will be construed as acceptance of the surface as satisfactory for the application of materials.

B. Unless otherwise specified, paint shall be applied in three coats, prime, body, and finish.

C. Before application of body and finish coats, surfaces shall be prepped and primed, except as otherwise specified. For primers to be used for field application, see **PRIMERS** paragraph in this specification.

D. Additional field applied prime coats over shop or factory applied prime coats are not required, except for exterior steel which shall have a field applied prime coat in addition to the shop prime coat.

E. Retouch damaged and abraded painted surfaces before applying succeeding coats.

F. Apply each coat evenly and in full covering body.

G. Not less than 48 hours shall elapse between application of succeeding coats except as allowed by the manufacturer's printed instructions, and approved by the Architect.

H. Finish painted surfaces shall have solid even color, free from runs, lumps, brush marks, laps, or other defects.

I. To prevent items from sticking in the shut position, operable items such as access doors and panels, window sashes rolling doors, and similar items shall not be painted when in the closed position.

J. Painted or otherwise finished surfaces of wood doors, including top and bottom edges, which are cut for fitting or for other reasons shall be given two coats of primer.

K. Surfaces of finishing woodwork, except shop fabricated or assembled millwork and surfaces specified to have varnish, stain or natural finish shall be given one coat of primer as soon as delivered to the site.

L. Back prime and seal ends of exterior woodwork, and edges of exterior plywood specified to be finished. Primer shall be same kind of primer specified for exposed face surface.

M. Prime rebates for stop and face glazing of wood, and for face glazing of steel.

N. Paint is to be applied by brush, or roller on all surfaces except metal. SPRAY PAINTING MUST BE USED ON METAL SURFACES AND IS SUBJECT TO THE FOLLOWING:
   1. Spray painting will be allowed if occupied portion of the building completely sealed off and approved by the Architect.
   2. Painting materials specifically required by the manufacturer to be applied by spraying shall be so applied.
   3. In areas, where paint is applied by spray, all items specified in Article, Work Not To Be Painted, motors, controls, telephone, and electrical equipment, and similar items shall be masked, or enclosed with polyethylene, or similar air tight material with all edges and seams continuously sealed.

3.4 PRIMERS:

A. After surface preparation, apply prime coat to various materials as follows: NOTE: Prime coat is not required for acrylic emulsion and latex emulsion finish.
   1. Steel and iron: Red lead primer
   2. Zinc-Coated Steel and Iron: Zinc dust primer.
   3. Aluminum: Zinc chromate primer.
   4. Lead and Terne Metal: Red lead primer.
   5. Copper and Copper Alloys: Zinc chromate primer
   6. Exterior Wood: Oil base primer.
   7. Interior Wood: (except for transparent finish: Enamel undercoat, thinned as recommended by the manufacturer.
   8. Gypsum Plaster Block Filler: Pigmented sealer, except use latex emulsion for alkyd flat finish.
   9. Cement plaster, Concrete, and Masonry: Latex emulsion except use two coats of latex primer when substrate has aged less than six months.
   10. Drywall: Latex primer, except use pigmented sealer in shower, dressing and locker rooms.

3.5 EXTERIOR FINISHES:

A. On properly prepared and primed surfaces, apply the following finish coats. Prime coat is not required for acrylic emulsion finish.
   1. Wood: Two coats of specified paint generally on exposed surfaces, except where transparent finish is specified and as follows:
      a. Two coats of exterior specified paint on plywood, wood siding and similar surfaces.
      b. Do not apply finish coats on surfaces concealed after installation, top and bottom edges of wood doors and sash, or on edges on wood framed insect screens.
      c. That portion of the sash runs of double hung wood windows, concealed by the sash when in a closed position, shall receive two coats of boiled linseed oil mixed with not more than 1/4 pint of dryer per gallon.
   2. Metal: Two coats of specified paint.
      a. **NOTE: All metal surfaces to receive paint shall be spray applied. No exceptions!**
   3. Concrete, Concrete Masonry Units: Refer to Section 09 97 26, Special Coatings.

3.6 INTERIOR FINISHES

A. On properly prepared and primed surface, apply the following finish coats. Prime coat is not required on concrete for floor enamel finish.
   1. Metal Work: Apply two coats of specified paint on exposed surfaces, including surfaces of ferrous metal louvers and ferrous metal hardware, except as follows:
      a. Two coats of high gloss sheen specified paint on specified surfaces, color as selected.
      b. Omit body and finish coats on surfaces concealed after installation
      c. NOTE: All metal surfaces to receive paint shall be spray applied. No exceptions!
   2. Plaster: One coat of latex sealer plus two coats of latex satin on exposed surfaces.
   3. Drywall: One coat of latex sealer plus two coats of specified paint on exposed surfaces.
   4. Masonry and Concrete Walls: One coat of specified paint over block filler on surfaces where scheduled.
      a. Third coat will be required on surfaces where accent colors are scheduled for adequate coverage.
   5. Dry-Fall Paint Application: Apply over pre-primed surfaces. If steel surfaces are not primed, apply compatible primer for metal surface for dry-fall paint.

3.7 SPECIAL APPLICATIONS

A. Unless noted otherwise, all exposed piping, conduit, ductwork, etc., exposed on interior of rooms shall be painted, matching color of walls or ceiling item is attached or adjacent to.

B. Epoxy Paint
   1. Application of epoxy coating under this heading shall be done by trained applicators who are experienced in the use of the specific materials to be applied. Coating shall be applied in such quantity as will result in a dry film thickness of minimum 4 to 6 mils in uniform solid color or colors as selected. Floors and other adjacent surfaces

which are not to be coated shall be protected during application, and special coating applicator shall clean and repair any adjacent surfaces damaged by his work.
2. Coordinate termination of epoxy paint with installation of rubber base. No epoxy paint is to be applied where rubber base is to be installed.

3.8 REFINISHING

A. Existing interior and exterior work to be refinished shall include the following:
   1. Interior:
      a. Existing painted surfaces of rooms, areas and spaces in which alterations occur under this contract.
      b. Existing surfaces of rooms, areas and spaces specified to be painted as selected.
      c. All other rooms, areas and spaces noted on the drawings to be refinished.
   2. Exterior: Existing painted surfaces damaged, altered or disturbed as result of work performed under this contract and surfaces specified to be painted, color as selected.

B. Except as otherwise specified or noted on drawings, refinished rooms, areas and spaces shall be refinished as follows:
   1. Patched and damaged surfaces of walls shall receive prime, body and finish coats.
   2. Patched and damaged surfaces of ceilings, except prefabricated acoustical unit ceilings shall receive prime and finish coats.
   3. Undisturbed surfaces of patched and damaged walls and ceilings, except prefabricated acoustical unit ceilings shall receive body and finish coats.
   4. In corridors, paint refinished walls and ceilings to the nearest natural break (ie; corner, reveal, door frame, etc.)
   5. Painted windows (interior surfaces only), doors, door frames, convectors, railings, and all other previously painted items and trim shall receive body and finish coats.

C. In existing rooms and areas where new prefabricated acoustical units are required, clean any existing surfaces free of dust, dirt, grease, and other deterrents to adhesion.

D. In existing rooms and areas where alterations occur, clean existing stained and natural finished window, doors, door frames and trim; retouch abraded surfaces and then give entire surface one coat of varnish as required to match existing. After the varnish has fired, buff with fine (Grade 4/0) steel wool to eliminate any accumulated dust particles.

E. Existing exterior wood and metal work shall be painted one body coat and one finish coat as specified for similar new work.

F. Color and texture of paint, and color and texture of stain and varnish for clear finishes on wood shall match existing, unless otherwise selected.

1.9 WORKMANSHIP OF REFINISHED SURFACES:

A. Rating work to be refinished shall have surfaces prepared and made smooth before refinishing.

B. Surfaces shall be clean and dry before refinishing.

C. Abraded, peeled and bare spots shall be touched-up before painting or refinishing.

D. Refinishing of existing surfaces shall include preparation of surfaces to receive new finishes including removal of any existing finishes that may preclude application of new finishes. Remove all paint spots from hardware, signs, fixtures, and other similar items not required to be finished.

E. Remove loose particles of dirt, dust, paint film, rust, scale, and similar deterrents to paint adhesion by scraping, brushing, sanding, vacuuming, or other suitable methods.

F. Remove grease, soil, and other deterrents to paint adhesion with a cleaning compound, or solvent compatible with substrate and subsequent coats. The use of solvents, acid, or steam will not be permitted on concrete and masonry. Remove any traces of cleaning agents which will affect paint adhesion.

G. Properly cut out loose or broken glazing compound on glazed doors, sash, etc., to sound material. Clean cut-outs and neatly re-putty with glazing compound.

H. Holes, cracks, and other surface indentations shall be neatly filled with patching compound compatible with substrate and subsequent coats, appropriate for the surface texture required and finished to match adjacent surface texture.

I. Knots, pitch streaks, etc., showing through old finish shall be coated with knot sealer before refinishing.

J. Sand or dull glossy surfaces prior to painting. Sand existing paint to a feather edge so that transition between new and existing finish will not show in the finished work.

K. Workmanship and material shall be equal to that specified for new work of similar character as required to match adjoining work.

3.11 SCAFFOLDS

A. This Contractor shall provide all ladders, scaffolds, staging, etc., required for the proper execution of the work.

3.12 PROTECTION:

A. Protect all work from paint droppings and spattering by use of masking, drop cloths, removal of items or by other approved methods.

3.13 EXTRA STOCK:

A. Provide minimum one full gallon of each type and each color of paint specified and used on project. Each paint container to be properly labeled, identifying type and color.

3.14 CLEAN UP

A. Upon completion, clean paint from all hardware, glass and other surfaces and items not required to be painted.

B. Before final inspection, any work which has become damaged or discolored shall be touched-up or refinished in a manner to produce solid even color and finish texture, free from defects.

END OF SECTION

SECTION 10 00 00

MISCELLANEOUS SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Furnish all items listed and specified below and where shown on drawings. Install per manufacturer's instructions.

B. Section includes:
   1. **PNL-1** Metal Pegboard
   2. **WA-1** Art Rail
   3. **WGD-1** Chair Rail
   4. **WGD-2** Corner Guards

1.2 QUALITY ASSURANCE

A. Qualifications of Manufacturer: Products used in the work of this Section shall be produced by manufacturers regularly engaged in manufacture of similar items and with a history of successful production acceptable to the Architect.

1.3 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

B. General: Submittals showing all details of script, fabrication, and installation.

C. The manufacturer's recommended installation procedures, when approved by the Architect, will become the basis for inspecting and accepting or rejecting actual installation procedures used on the Work.

1.4 PRODUCT HANDLING

A. Protection: Use all means necessary to protect materials of this Section before, during and after installation and to protect installed work and materials of all other trades.

B. Replacements: In the event of damage, immediately make all repairs and replacements necessary to the approval of the Architect and at no additional cost to the Owner.

PART 2 PRODUCTS

2.1 MATERIALS

A. **PNL-1** Metal Pegboard
   1. Diamond Life Gear, Pegboard MX, Steel, Bone White, 4'x8', backing: backingboard.

B. **WA-1** Art Rail

1. AS Hanging Display Systems, Click Rail Track A1050, Warm White, 20 lbs/ft. capacity. Includes (8) each Click & Connect connectors, #6 x 1.25" screws and TripleGrip anchors.

C. **WGD-1** Chair Rail
   1. R.C. Musson Rubber Co., Flat Wall Guard, WG-6 (Verify height matches existing), Clip-on mounting system, Finish to match existing. Provide bullnose end caps at openings.

D. **WGD-2** Corner Guards
   1. Inpro Corner Guard, SAS-1824H-304, 2" wings, 48" high, screen-on install, 304 stainless with no. 4 satin.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify that area to receive product is ready for installation.

B. Install items in strict accordance with manufacturer's instructions.

C. If required, provide training to owner.

END OF SECTION

SECTION 10 21 13

TOILET COMPARTMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Work includes:
   1. Partitions for #4 brushed stainless steel toilet compartments.
   2. #4 brushed stainless steel urinal screens.
   3. Attachment hardware.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

B. On Product List, indicate which manufacturer, model, and color proposed.

C. Shop Drawings: Clearly indicate partition layouts, swing of doors, elevations, anchorage and mounting details, panel construction, components hardware, finishes, and all relevant dimensions.

1.3 WARRANTY

A. Written Guarantee
   1. The Toilet Partition manufacturer shall guarantee all Toilet Partitions by written certification, for a period of (1) year from date of certified substantial performance of the project, against any defects in design, materials and workmanship. Any defects as described will be made good by the manufacturer at no additional cost to the owner.

PART 2 PRODUCTS

TPTN-1

2.1 MANUFACTURERS/PRODUCTS

A. Toilet Compartments: (type 304 embossed stainless steel)
   1. Overhead braced by Hadrian, Inc., Mentor, OH, (216)974-7120
   2. Approved alternate.

B. Urinal Screens: (type 304 embossed stainless steel) 2’-0” wide
   1. Floor mounted by Hadrian, Inc., with wide type pilaster.
   2. Approved alternate.

2.2 MATERIALS

A. Construction Features: Doors, Panels and Pilasters shall be constructed of two sheets of panel flatness type 304, embossed stainless steel, laminated under pressure to a "Verticel" (1/2") honeycomb core for impact resistance, rigidity and sound deadening. Formed edges to be

welded together and interlocked, under tension, with a roll-formed oval crown stainless steel locking bar, mitred, welded and ground smooth at the corners. Honeycomb to be of virgin, long fiber paper with a maximum 12.5mm (1/2") cell size.

B. Doors: Shall be 25mm (1”) thick with cover sheets not less than 22 ga. (0.8mm).

C. Panels: Shall be 25mm (1”) thick with cover sheets not less than 22 ga. (0.8mm).

D. Pilasters: Shall be 32mm (1.25”) thick with cover sheets not less than 22 ga. (0.8mm). Pilaster tops shall be reinforced with 20 ga. channel to create extra strength and twist free rigidity along with minimizing damage by handling and/or shipping.

E. Headrail: Shall be 25mm (1”) by 41mm (1.625”) extruded anodized aluminum with double ridge anti-grip design. Wall thickness to be 1.5mm (.060”) and shall be securely attached to wall and pilasters with manufacturer’s fittings in such a way as to make a strong and rigid installation. All joints in headrails shall be made at a pilaster.

F. Pilaster Fastening Method: Pilasters shall be rigidly fastened to structural steel or pre-cast concrete supporting member (Note: wood support is not acceptable) by means of two heavy hanging studs permitting vertical adjustment between bottom of supporting member and finished ceiling line. Hadrian supplied ceiling studs MUST be used to create a secure installation. The bottoms of all pilasters shall be truly aligned, and the top connection shall be concealed by a 102mm (4”) high, die-formed stainless steel pilaster shoe.

G. Hardware and Fittings: All panel and pilaster brackets and all door hardware shall be chrome plated zinc die castings, standard. Fasteners are 12 x 1-3/4” and 12 x 5/8” TR-27 6-lobe security screws. Doors shall be equipped with a gravity type continuous hinge mounted on the lower pilaster hinge bracket. Door hinges shall be the wrap around type and adjustable to permit the door to come to rest at any position when not latched. Each door to be fitted with a combined coat hook and bumper and a concealed latch, with face mortised flush with edge strip of door. The combined stop and keeper shall have a 19mm (0.75”) diameter bumper locked in place. Threaded door top hinge pin shall have a metal core and self-lubricating nylon sleeve to ensure smooth, quiet operation. Levers to be ADA compliant.

2.3 FINISH

A. Type 304, embossed stainless steel finish.

PART 3 EXECUTION

3.1 PREPARATION

A. Take site dimensions affecting this work. Verify correct spacing of plumbing fixtures.

B. Verify correct location of built-in framing, anchorage, and bracing, where required.

3.2 INSTALLATION

A. Install partitions secure, plumb, level, and square.

B. Leave 1/2 inch space between wall and panels, unless using continuous wall bracket, and between wall and end pilasters. Attach panel brackets securely to walls using anchor devices.

C. Attach panels and pilasters to bracket with through sleeve tamper proof bolts and nuts.

D. Anchor urinal screen panels to walls as recommended by manufacturer to suit supporting wall construction. In addition, all urinal screens to be floor supported with pilaster and shoe, and head supported and braced to structure above.

E. Provide for adjustment of ceiling variations with screw jack through steel saddles integral with pilaster. Conceal ceiling fastenings with stainless steel shoes.

F. Equip each door with hinges, one door latch, and one coat hook and bumper. Adjust and align hardware to uniform clearance at vertical edges of doors not exceeding 3/16". Each handicapped compartment door is to have latch meeting ADA requirements.

G. Adjust hinges to locate doors in closed position when unlatched.

3.3 CLEANING

A. Remove protective masking. Clean surfaces.

END OF SECTION

SECTION 10 28 13

TOILET AND BATH ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. The work to be completed under this heading consists of furnishing all labor, materials, equipment and services necessary for and reasonably incidental to the furnishing and application of all miscellaneous items as shown and as specified.

B. All items shall be delivered in sound condition, properly installed and shall be clean, undamaged, and in proper working order.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

1.3 REFERENCES

A. Comply with State of Arkansas Adopted ADA Accessible Guidelines in regard to accessible or handicapped features.

PART 2 PRODUCTS

2.1 TOILET ACCESSORIES:

A. Mop Racks: (One for each mop or service sink shown on drawings.)
   1. Stainless steel, satin finish; anti-slip mop holders with spring loaded, rubber cam w/3 holders.
      a. Bobrick Washroom Equipment, Inc., Model B-223 x 24
      b. Bradley Corp. Model 9953.
      c. Approved alternate.

B. **TA-1** Toilet Tissue Dispenser – Type 1 (one for each water closet)
   1. Acceptable Product:
      Bobrick Washroom Equipment, Inc., Model B-2840
      Approved alternate.

C. **TA-2** Sink Trap Cover
   1. Snap-on stainless steel trap cover.
   2. Acceptable Products
      a. Lacava Trap Cover, RA098, 21 Brushed Stainless Steel, 4 5/8” x 4 ¾” x 11 ¾”.

D. **TA-8** Paper Towel Dispenser/Waste Receptacle: (one each toilet room)
   1. Recessed, combination folding towel dispenser/waste receptacle, stainless steel construction, satin finish.
   2. Acceptable Products:

a. Bobrick Washroom Equipment, Inc., Model B3803 + 368-60 Interchangeable Receptacle.
b. Approved alternate.

E. **TA-11** Liquid Soap Dispenser: Refer to plumbing schedule.

F. **TA-12** Grab Bar-Toilet Rooms: (One set at each handicapped water closet.)
1. 14 gage stainless steel; 1 1/2" diameter, safety grip surface; concealed mounting. One at each handicapped water closet.
a. Model No. B6806.99 x 42, B6806.99 x 36 & B6806.99 x 18 by Bobrick.
b. Model No. 8122-00142, 8122-00136 & 8122-00118 by Bradley.
c. Or approved alternate.

G. **TA-14** Sanitary Napkin Disposal:
1. Surface-mounted sanitary napkin disposal shall be Type-304 stainless steel with all-welded construction; exposed surfaces shall have satin finish. Door shall be Type-304, 20-gauge (0.9mm) stainless steel with satin-finish. Secured to cabinet with two rivets and equipped with a magnet catch and cable door-swing limiter. Waste receptacle shall be Type-304, heavy-gauge stainless steel. All-welded construction with a capacity of 0.6-gal. (2.3-L).
2. Bobrick B-35159 or approved alternate.

H. **TA-16** Surface-Mounted Toiletry Shelf:
1. Surface mounted, stainless steel, 24 inches long, 8” deep, concealed mounting.
2. Acceptable Products
a. Shelfology Aksel Radius Ash Floating Shelf, Color: clear sealed ash.
b. Approved alternate.

I. Pre-manufactured Wall Mounted Mirrors: (One at each wall-hung lavatory.)
1. **TA-17B** Standard Stainless Steel Mirrors:
a. Surface mounted, center over each lavatory, 304 stainless steel, satin finish frame with No. 1 quality ¼” glass, mirror warranted against silver spoilage for 15yrs. Galvanized steel back, 24”x36”. Secure to concealed wall hanger with theft-resistant mounting. Mounting height as scheduled on Drawings.
b. Acceptable Products:
Bobrick Washroom Equipment, Inc. - Model B—1658 2436.
2. **TA-17A** Powder-coated framed mirror:
a. Renwil Webster, Iron – Black powder-coated finish, Model MT2394, 26”x40”x0.5”.

J. **TA-19** Coat Hook
1. Surface mounted coat hook.
2. Acceptable Products
a. Bobrick Fino Coat Hook, B-9542, Stainless Steel.

K. **TA-20** Shower Curtain Rod
1. Heavy-duty Shower Curtain Rod with Concealed Mounting
2. Acceptable Products
a. Bobrick Curtain Rod, B-207, Stainless Steel.

L. **TA-23** Hand Dryer (refer to enlarged floor plans for location and quantity.)
   1. Automatic operation, deck mounted installation, brushed stainless steel, 110 – 120 ac, 50/60Hz.
      a. Splash Lab Ribbon Series Hand Dryer, TSL.R.030.CS.E120.H.
      b. Approved alternate
   2. Provide five (5) year limited warranty.

M. **TA-24** Baby Changing Stations: Wall mounted baby changing stations and associated accessories.
   1. Size:
      a. Surface mounted unit: 33-7/8” by 18-7/8” by 3-7/8” deep.
   2. Mounting: Surface
      a. Mounting height: 35” to changing surface from floor.
   3. Special Features:
      a. Graphic instructions
      b. Identifying door plaque
      c. Provide with wall mounted liner dispenser.
   4. Acceptable product/manufacturer: CP0016HCS BabyMedi Baby Changing Station, Model KB200, horizontal unit, manufactured by Saniflow or approved alternate.
   5. Provide with five (5) year manufacturer’s limited warranty.
   6. Color to be satin stainless steel and white.

N. Toilet Seat Cover Dispenser
   1. Recessed toilet seat cover dispenser.
   2. Acceptable Products
      a. Bobrick Recessed Toilet Seat Cover Dispenser, Stainless Steel, B-3013.

PART 3 EXECUTION

3.1 FABRICATION:

A. Stamped names or labels on exposed faces of toilet accessory units are not permitted. Wherever locks are required for particular type of accessory, provide same keying throughout project. Furnish two keys for each lock, properly identified.

B. Surface Mounted Accessories: Fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous piano hinge or minimum of two 1 1/2" pin hinges of same metal as unit cabinet. Provide concealed anchorage wherever possible.

3.2 INSTALLATION:

A. Install toilet accessory units in accordance with manufacturer's instructions, using fasteners appropriate to substrate and recommended by manufacturer of unit.

B. Install units at location and heights as shown on drawings. Install as to comply with all national, state, and local codes and regulations. Units shall be plumb and level, firmly anchored.

C. If mirrors are installed on ceramic tile, coordinate tile pattern and layout to accommodate mirrors. Mirror to be installed on single plane.

D. Molly-type anchors are not acceptable for securing accessories to walls or partitions. Secure to gypsum board partitions with screws anchored in wood blocking. Anchor accessories to masonry walls with screws set in epoxy.

E. Where mounting grab bars to existing gypsum board walls, anchor with Winglt model 251-4 wall anchor, manufactured by Winglt Innovations, Inc. Install per manufacturer's instructions.

F. Verify and coordinate location and installation of wood blocking concealed in gypsum board walls for attachment of wall-mounted toilet accessories.

3.3 ADJUSTING AND CLEANING:

A. Adjust toilet accessories for proper operation and verify that mechanisms function smoothly.

B. Clean and polish all exposed surfaces after removing protective coatings.

END OF SECTION

SECTION 10 44 00

FIRE EXTINGUISHERS & CABINETS

PART 1 GENERAL

1.1 SUMMARY

A. Work under this heading consists of furnishing all labor, materials, equipment and services necessary to install fire extinguisher and cabinets as shown or called out on drawings.

1.2 SUBMITTALS

A. Comply with requirements of Section 01 33 00.

PART 2 PRODUCTS

2.1 MATERIALS

FEC-1

A. Furnish where called for on drawings, Larsen Architectural Series, Solid, Fully-recessed, white enameled steel case with Type A, black lettering, or approved alternate.

FEC-2

B. Furnish where called for on drawings, Larsen Architectural Series, Solid, Flat trim, Semi-recessed, white enameled steel case with Type A, black lettering, or approved alternate.

C. Furnish multi-purpose dry chemical extinguisher, Larsen MP10, J.L. Industries Cosmic 10E, or approved equal in each fire extinguisher cabinet.

D. Provide extinguishers with wall mounted brackets where called for on drawings.

PART 3 EXECUTION

3.1 INSTALLATION:

A. Accurately locate all items, install level, plumb, and true. See Plans for required locations. Rigidly attach to the supporting surfaces in the manner recommended by the manufacturer. Install cabinet as required to provide 48” from finished floor to extinguisher handle.

END OF SECTION

SECTION 12 22 00

Drapes

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Drapes – **DRPY-1**
B. Drapery Tracks

1.2 SUBMITTALS

A. Submit under provisions of Section 01 33 00

B. Product Data: Manufacturer's data sheets on each product specified, including:
   1. Maximum weights of drapes that can be supported.

C. Shop Drawings:
   1. Drapery Tracks: Show installation and anchorage details and locations of controls.
   2. Drapes: Show sizes, locations, and details of installation.

D. Samples:
   1. Drapery Tracks: 18 inches long, with carriers, controls, and accessories.
   2. Drapery Fabrics: For each color and pattern indicated, full width by 36 inches long, from dye lot to be used for the Work and with specified textile treatments applied. Show complete pattern repeat if any. Mark top and face of fabric.
   3. Textile Trims: For each color and pattern indicated, 18 inches long.
   4. Drape Fabrication: For each heading, fabric, color, and pattern indicated, a complete full-size panel to verify details of fabrication and thread colors.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: For drapery track installation; reflected ceiling plans drawn to scale and coordinating track installation with openings and ceiling-mounted items.

B. Product certificates.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: For drapes and drapery tracks, fabricator of drapes.

PART 2 PRODUCTS

2.1 DRAPERY TRACKS

A. Basis of Design: SilentGliss Model SG3840
    a. Description: Heavy-duty recessed track, hand operated.
    b. Operation: Cord.
    c. Color: White.
    d. Includes: Standard Wave accessories with carrier for draw rod with wave curtain tape.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    a. Forest Group USA, Inc.
    b. Kirsch Window Fashions; a Newell Rubbermain brand.
    c. Silent Gliss, Incl.
    d. Springs Window Fashions; SWFcontract.

C. Construction: Extruded aluminum, slotted for mounting at interval of not more than 24 inches o.c., and bendable to radii indicated.
    a. Lengths and Configurations: As indicated on Drawings.
    b. Support Capability: As required for drapery fabric and drapery length, mounted on track length indicated.
    c. Finish: White baked enamel.

D. Mounting brackets: Aluminum, of type suitable for fastening track to surface indicated and designed to support weight of track assembly and drape plus force applied to operate track.
    a. Size: Adjustable.

E. Installation Fasteners: Sized to support track assembly and drape, and fabricated from metal compatible with track, brackets, and supporting construction. Provide two fasteners to fasten each bracket to supporting construction.

F. Operation: Baton.

G. Carriers: As selected by Architect.

H. End Stops: Manufacturer’s standard with track end cap.

I. Pulleys: Heavy Duty.

J. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 Drapes – **DRPY-1**

A. Polyester Drapery:

1. Manufacturer: Carnegie
2. Product: Bijoux 6868

3. Color: 2
4. Content: 100% FR Polyester
5. Type: Ripplefold, 4”
6. Width: 55”
7. Lining: None
8. Fullness: 100%
9. Track Style: Ceiling or wall

2.3 DRAPE FABRICATION

A. Fabricate drapes in heading styles and fullness indicated. Fabricate headings to stand erect. If less than a full width of fabric is required to produce panel of specified fullness, use equal widths of not less than one-half width of fabric located at ends of panel.
   1. One-way stacking drapes: Add 5 inches to overall width for returns.
   2. Center-opening drapes: Add 10 inches to overall width for overlap.

B. Seams: Sew vertical seams with twin-needle sewing machine with selvage trimmed and overlocked. Join widths so that patterns match and vertical seams lay flat and straight without puckering. Horizontal seams are unacceptable.

C. Side Hems: Double-turned, 1-1/2 inch wide hems consisting of three layers of fabric, and blindstitched so that stitches are invisible on face of drape.

D. Bottom Hems: Double-turned, 4-inch wide hems consisting of three layers of fabric and weighted and blindstitched so that weights and stitches are invisible on face of drape.
   1. Sew in square lead weights at each seam and at end panel corners.

PART 3 EXECUTION

3.1 DRAPERY TRACK INSTALLATION

A. Install track systems according to manufacturer’s written instructions, level and plumb, and at height and location in relation to adjoining openings as indicated on Drawings.

B. Isolate metal parts of tracks and brackets from concrete, masonry, and mortar to prevent galvanic action. Use tape or another method recommended in writing by track manufacturer.

3.2 DRAPE INSTALLATION

A. Where drapes abut overhead construction, hang drapes so that clearance between headings and overhead construction is 1/4 inch.

B. Where drapes extend to floor, install so that bottom hems clear finished floor by not more than 1 inch and not less than 1/2 inch.

C. Where drapes extend to windowsill, install so that bottom hems hang above sill line and clear sill line by not more than 1/2 inch.

D. After hanging drapes, do the following:
   1. Test and adjust each drapery track to produce unencumbered, smooth operation.
   2. Steam and dress down drapes as required to produce crease- and wrinkle-free installation.
   3. Remove and replace drapes that are stained or soiled.

END OF SECTION

SECTION 12 24 15

WINDOW SHADES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Manually operated, roll-up fabric interior window shades including mounting and operating hardware.

B. Motorized, roll-up fabric interior window shades including mounting and operating hardware.

1.2 RELATED SECTIONS

A. Section 05 40 00 - Cold Formed Metal Framings

B. Section 06 10 00 - Rough Carpentry.

C. Section 07 90 00 - Joint Protection.

D. Section 09 21 16 - Gypsum Board Shaft Wall Assemblies

E. Section 09 22 16 - Non-Structural Metal Framing

F. Section 09 29 00 - Drywall

G. Section 09 51 00 - Acoustical Tile Ceilings

1.3 REFERENCES

A. NFPA 70 - National Electrical Code.

B. NFPA 701-99 - Fire Tests for Flame-Resistant Textiles and Films.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 33 00

B. Product Data: Manufacturer's data sheets on each product specified, including:
   1. Preparation instructions and recommendations.
   2. Installation and maintenance instructions.
   3. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
   4. Storage and handling requirements and recommendations.
   5. Mounting details and installation methods.

C. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances, wiring diagrams and relationship to adjacent work.

D. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings, field verified window dimensions, quantities, type of shade, controls, fabric, and color, and include opening sizes and key to typical mounting details.

E. Selection Samples: For each finish product specified, two complete sets of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.

F. Verification Samples: For each finish product specified, two complete sets of shade components, unassembled, demonstrating compliance with specified requirements. Shade fabric sample and aluminum finish sample as selected, representing actual product, color, and patterns. Mark face of material to indicate interior faces.

G. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

H. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.

B. NFPA Flame-Test: Passes NFPA 701. Materials tested shall be identical to products proposed for use.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver window shades until building is enclosed and construction within spaces where shades will be installed is substantially complete.

B. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.

C. Label containers and shades according to Window Shade Schedule.

D. Store products in manufacturer's unopened packaging until ready for installation.

1.7 SEQUENCING

A. Ensure that locating templates and other information required for installation of products of this section are furnished to affected trades in time to prevent interruption of construction progress.

B. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

1.8 PROJECT CONDITIONS

A. Install roller shades after finish work and ambient temperature, humidity and ventilation conditions are maintained at levels recommended for project upon completion.

1.9 WARRANTY

A. Hardware and Shade Fabric: Draper's standard twenty-five year limited warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Draper, Inc., which is located at: 411 S. Pearl P. O. Box 425 ; Spiceland, IN 47385-0425; Toll Free Tel: 800-238-7999; Tel: 765-987-7999; Email: request info; Web: www.draperinc.com

B. Acceptable Manufacturers: MechoSystems,Inc., Springs Window Fashions, Inc.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00

2.2 MANUALLY OPERATED WINDOW SHADES

WT-2

A. Manually Operated Window Shades with Independent Control: Manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Manual FlexShade as manufactured by Draper, Inc.
   1. Operation: Bead chain and clutch operating mechanism allowing shade to stop when chain is released. Designed never to need adjustment or lubrication. Provide limit stops to prevent shade from being raised or lowered too far.
      a. Clutch mechanism: Fabricated from high carbon steel and molded fiberglass reinforced polyester or injected molded nylon. White or Black color as selected by Architect.
      b. Bead chain loop: Stainless steel bead chain hanging at side of window.
      c. Idler Assembly: Provide roller idler assembly of molded nylon with adjustable or spring-loaded length idler pin to facilitate easy installation, and removal of shade for service.
      d. Bead Chain Hold Down: P-Clip (standard).
   2. Roller Tube: Fabricated from extruded aluminum, galvanized steel, or enameled steel. Diameter, wall thickness, and material selected by manufacturer to accommodate shade type and size. Fabric connected to the roller tube with LSE (low surface energy) double sided adhesive specifically developed to attach coated textiles to metal. Adhesive attachment to eliminate horizontal impressions in fabric.
   3. Shade slat: Slat encased in heat seamed hem.
   4. Mounting:

a. Mounting brackets.
b. Endcaps and fascia.

5. Brackets: Plated stamped steel. Provide size compatible with roller size.
6. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.
   a. Endcap covers: To match fascia color.
7. Fascia: L shaped aluminum extrusion to conceal shade roller and hardware.
   a. Attachment: Snaps onto endcaps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands. No notching is required.
   b. Shape: Square Fascia Panel.
   c. Color: Architect to select from manufacturer's standard colors palate.

WT-3

B. Manually Operated Window Shades with Independent Control: ANSI/WCMA A100.1 compliant, manually operated, vertical roll-up, fabric window shade with components necessary for complete installation; Cordless FlexShade® roller-operated shade as manufactured by Draper, Inc.
   1. Operation: Spring roller operating mechanism with metal roller containing heavy duty spring with positive locking mechanism permitting shade to be stopped at each half turn of roller. Spring sized by manufacturer to accommodate shade size.
   2. Mounting brackets: Metal. Provide size compatible with roller size.
      a. Mounted to top door rail above glass.
   3. Roller Tube: Fabricated from extruded aluminum. Diameter, wall thickness, and material selected by manufacturer to accommodate shade type and size. Roller outer diameter 1.5 inches (38 mm).
   4. Fabric to tube attachment: Connected to the roller tube with LSE (low surface energy) double sided adhesive specifically developed to attach coated textiles to metal. Adhesive attachment to eliminate horizontal impressions in fabric.
   5. Roller Spring Tension: To be adjustable from the roller brackets to ensure correct tension for proper retraction.
   6. Shade slat:
      a. Small flat exposed hem bar: 7/8 inch by 5/16 inch (22 mm by 8 mm) aluminum rectangular hem bar with plastic end caps, with hem bar hold downs for door install, white.

2.3 MOTORIZED WINDOW SHADES **(WT-1A/WT-1B)**

A. Type: Motorized vertical roll-up, fabric, window shade with motors, controls, mounting brackets, and other components necessary for complete installation; Motorized FlexShade as manufactured by Draper, Inc.
   1. Mounting brackets.
   2. Endcaps and fascia.
   3. Endcaps and headbox.
   4. Ceiling pocket.

B. Shade Motor and Control System
   1. Standard Motor: 110 VAC, single phase, 60 HZ, instantly reversible, lifetime lubricated, and equipped with internal thermal overload protector, electric brake, and pre-set accessible limit switches. Tubular motor concealed inside

each shade roller tube.

a. Group Control:
    1) ISO relay – ETL component. One ISO relay per motor. Allows 110-120V group switching via toggle switch. Allows for up to 12 motors on one switch.
b. Individual Control, Group Control and Individual and Group Control:
    1) Single channel wireless handheld transmitter-White.
    2) Plug-In:
        a) 1 Motor – Wall Type.
    3) Power Panel:
        a) 5 Motors.

C. Roller: Fabricated from extruded aluminum or steel. Diameter, wall thickness, and material selected by manufacturer to accommodate shade size. Provide with roller idler assembly of molded nylon and zinc-plated steel pin. Sliding pin to allow easy installation and removal of roller. Fabric connected to the roller tube with LSE (low surface energy) double sided adhesive specifically developed to attach coated textiles to metal. Adhesive attachment to eliminate horizontal impressions in fabric.

D. Endcaps: Stamped steel with universal design suitable for mounting to ceiling, wall, and jamb. Provide size compatible with roller size.

E. Endcap covers to match fascia/headbox finish.

F. Brackets: 1/8 inch thick stamped steel, black powder coat, idler height adjuster, field adjustable to wall or ceiling mount.
    1. Mounted to jamb.

G. Coupling system: Couplings to join motorized shade rollers to allow operation by single motor. FlexShade Coupling System as manufactured by Draper, Inc. Provide endcaps to receive couplers and support multiple shades.

H. Shade slat:
    1. 1-5/8 inch (41 mm) hem bar encased in heat-seamed hem.

I. Fascia: L shaped aluminum extrusion to conceal shade roller and hardware.
    1. Attachment: Snaps onto end caps without requiring exposed fasteners of any kind. Fascia can be mounted continuously across two or more shade bands.
        a. Shape: Square Fascia Panel.
    2. Finish: Custom powder coat as selected by the Architect.

J. Light Gap Reduction Channels
    1. L Angle – 3/4 inch by 1 inch (19 mm by 25 mm).

2.4 FABRIC

WT-1A/WT-2

A. Light-Filtering Fabrics
    1. SheerWeave® Infinity2 3%: sustainable window treatment fabric eco-friendly basketweave. Core yarn and coating are PVC-free, lead-free and 100 percent recycable. Fire classification: ASTM E-84 (Class I), NFPA 701-2004 TM#1

(small scale), NFPA 101 (Class A Rating) and CAN/ULC-S 109-03 Large, UL GREENGUARD®, GREENGUARD Gold®. Average 3 percent open. Average Fabric Thickness: .031 inch (.79 mm) Average Fabric Weight: 13.69 ounces per square yard. Color: Cotton.

WT-1B

B. Room Darkening Fabrics (Blackout)

1. Flocké® by Mermet®: Opaque, PVC-free fiberglass textile with acrylic flocked backing. Antistatic treated. Fire rating: NFPA 701-10 TM#1, California U.S. Title 19, CAN/ULC-S109-03 Small & Large Flame Test. Environmental Benefits: Certified to UL GREENGUARD® and GREENGUARD Gold® standards for low chemical emissions into indoor air during product usage. RoHS compliant – lead free. Bacterial and fungal resistance: ASTM E2180, ASTM G21. Draper shades made with this fabric are GreenSpec® listed. Opaque, .020 inches thick, 15.93 oz/square yard. Color: Sahel.
   a. Side Channels: Double chamber fabricated from 0.06 inch (1.5 mm) thick extruded aluminum sections. One chamber accepts fabric and contains groove for fabric retainer. Other chamber accepts fabric guide and channel locator.
   b. Sill channel: 0.06 inch (1.5 mm) thick extruded aluminum channel to receive slat bar and prevent light leakage.
   c. Slat bar: Extruded aluminum bar attached to bottom of shade. Bar does not retract into headbox.
   d. Channel locator: Injected molded nylon insert to align side and sill channels with headbox.
   e. Fabric guide: Plated steel transition for fabric rolling into side channel.
   g. Fabric retainer: System designed to prevent disengagement of fabric from side channels due to normal variations of air pressure caused by doors opening, HVAC systems, and temperature differences between room and window well. System consists of horizontal steel stays installed in shade, covered with fabric, and spaced at regular intervals. Grommets installed through stays are held within groove of side channel chamber.

WT-3

C. Room Darkening Fabrics (Blackout)

1. Flocké® by Mermet®: Opaque, PVC-free fiberglass textile with acrylic flocked backing. Antistatic treated. Fire rating: NFPA 701-10 TM#1, California U.S. Title 19, CAN/ULC-S109-03 Small & Large Flame Test. Environmental Benefits: Certified to UL GREENGUARD® and GREENGUARD Gold® standards for low chemical emissions into indoor air during product usage. RoHS compliant – lead free. Bacterial and fungal resistance: ASTM E2180, ASTM G21. Draper shades made with this fabric are GreenSpec® listed. Opaque, .020 inches thick, 15.93 oz/square yard. Color: Sahel (facing into room).

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Coordinate requirements for blocking and structural supports to ensure adequate means for installation of window shades.

B. Coordinate requirements for power supply conduit, and wiring required for window shade motors and controls.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install roller shades level, plumb, square, and true. Allow proper clearances for window operation hardware. Install the following items to conceal roller and operating mechanism. Do not use exposed fasteners.
   1. Fascias
   2. Closure panels.
   3. Endcaps.

C. Position shades level, plumb, and at proper height relative to adjacent construction. Secure with fasteners recommended by manufacturer.

D. Position so that fascia front aligns with plane of interior gypsum wall board finish.

3.4 TESTING AND DEMONSTRATION

A. Test window shades to verify that interface to other building systems and other operating components are functional. Correct deficiencies.
   1. Chain and clutch.

B. Demonstrate operation of shades to Owner's designated representatives.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.6 SCHEDULES

A. Refer to Drawings for shade types and locations.

END OF SECTION

SECTION 21 05 17

SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers:
   1. Jay R. Smith Mfg. Co.
   2. Zurn Industries, LLC
   3. (Owner Selection)

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

   1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers:
   1. Advanced Products and Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company
   4. (Owner Selection)

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

   1. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Carbon steel.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers:
   1. Advanced Products and Systems, Inc.
   2. CALPICO, Inc.
   3. Metraflex Company
   4. (Owner Selection)

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:

    a. Piping Smaller Than NPS 6: Sleeve-seal fittings.
    b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.

2. Exterior Concrete Walls below Grade:

    a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

    b. Piping NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system.

        1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

    a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 Galvanized-steel-pipe sleeves with sleeve-seal system.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:

a. Piping Smaller Than NPS 6: PVC-pipe sleeves.
b. Piping NPS 6 PVC-pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6 PVC-pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 21 05 18

ESCUTCHEONS FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
i. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.

2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 21 05 23

GENERAL-DUTY VALVES FOR FIRE PROTECTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Two-piece ball valves with indicators.
2. Bronze butterfly valves with indicators.
3. Iron butterfly valves with indicators.
4. Check valves.
5. Bronze OS&Y gate valves.
6. Iron OS&Y gate valves.
7. NRS gate valves.
8. Indicator posts.
9. Trim and drain valves.

1.3 DEFINITIONS

A. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

B. NRS: Nonrising stem.

C. OS&Y: Outside screw and yoke.

D. SBR: Styrene-butadiene rubber.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, and weld ends.
3. Set valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

D. Protect flanges and specialties from moisture and dirt.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. UL Listed: Valves shall be listed in UL's "Online Certifications Directory" under the headings listed below and shall bear UL mark:

1. Main Level: HAMV - Fire Main Equipment.

    a. Level 1: HCBZ - Indicator Posts, Gate Valve.
    b. Level 1: HLOT - Valves.

        1) Level 3: HLUG - Ball Valves, System Control.
        2) Level 3: HLXS - Butterfly Valves.
        3) Level 3: HMER - Check Valves.
        4) Level 3: HMRZ - Gate Valves.

2. Main Level: VDGT - Sprinkler System & Water Spray System Devices.

    a. Level 1: VQGU - Valves, Trim and Drain.

B. FM Global Approved: Valves shall be listed in its "Approval Guide," under the headings listed below:

1. Automated Sprinkler Systems:

    a. Indicator posts.
    b. Valves.

        1) Gate valves.
        2) Check valves.

            a) Single check valves.

        3) Miscellaneous valves.

C. Source Limitations for Valves: Obtain valves for each valve type from single manufacturer.

D. ASME Compliance:

1. ASME B16.1 for flanges on iron valves.
2. ASME B1.20.1 for threads for threaded-end valves.
3. ASME B31.9 for building services piping valves.

E. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.

F. NFPA Compliance: Comply with NFPA 24 for valves.

G. Valve Pressure Ratings: Not less than the minimum pressure rating indicated or higher as required by system pressures.

H. Valve Sizes: Same as upstream piping unless otherwise indicated.

I. Valve Actuator Types:

1. Worm-gear actuator with handwheel for quarter-turn valves, except for trim and drain valves.
2. Handwheel: For other than quarter-turn trim and drain valves.
3. Handlever: For quarter-turn trim and drain valves NPS 2 and smaller.

2.2 TWO-PIECE BALL VALVES WITH INDICATORS

A. Manufacturers:
1. Nibco Inc.
2. Victaulic Company
3. (Owner Selection)

B. Description:

1. UL 1091, except with ball instead of disc and FM Global standard for indicating valves (butterfly or ball type), Class Number 1112.
2. Minimum Pressure Rating: 175 psig.
3. Body Design: Two piece.
4. Body Material: Forged brass or bronze.
5. Port Size: Full or standard.
6. Seats: PTFE.
7. Stem: Bronze or stainless steel.
8. Ball: Chrome-plated brass.
9. Actuator: Worm gear or traveling nut.
10. Supervisory Switch: Internal or external.
11. End Connections for Valves NPS 1 through NPS 2: Threaded ends.
12. End Connections for Valves NPS 2-1/2: Grooved ends.

2.3 BRONZE BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers:
1. Globe Fire Sprinkler Corp.
2. Fivalco Inc.
3. Milwaukee Valve Company
4. (Owner Selection)

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 1112.
2. Minimum: Pressure rating: 175 psig.
3. Body Material: Bronze.

4. Seat Material: EPDM.
5. Stem Material: Bronze or stainless steel.
6. Disc: Bronze or Stainless steel with EPDM coating.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Ends Connections for Valves NPS 1 through NPS 2: Threaded ends.
10. Ends Connections for Valves NPS 2-1/2: Grooved ends.

2.4 IRON BUTTERFLY VALVES WITH INDICATORS

A. Manufacturers:
1. Nibco Inc.
2. Globe Fire Sprinkler Corp.
3. Victaulic Company
4. (Owner Selection)

B. Description:

1. Standard: UL 1091 and FM Global standard for indicating valves, (butterfly or ball type), Class Number 112.
2. Minimum Pressure Rating: 175 psig.
3. Body Material: Cast or ductile iron with nylon.
4. Seat Material: EPDM.
5. Stem: Stainless steel.
6. Disc: Ductile iron.
7. Actuator: Worm gear or traveling nut.
8. Supervisory Switch: Internal or external.
9. Body Design: Lug or wafer, Grooved-end connections.

2.5 CHECK VALVES

A. Manufacturers:
1. Victaulic Company
2. Viking Corp.
3. Nibco Inc.
4. (Owner Selection)

B. Description:

1. Standard: UL 312 and FM Global standard for swing check valves, Class Number 1210.
2. Minimum Pressure Rating: 175 psig.
3. Type: Single swing check.
4. Body Material: Cast iron, ductile iron, or bronze.
5. Clapper: Bronze, ductile iron, or stainless steel.
6. Clapper Seat: Brass, bronze, or stainless steel.
7. Hinge Shaft: Bronze or stainless steel.
8. Hinge Spring: Stainless steel.
9. End Connections: Flanged, grooved, or threaded.

2.6 BRONZE OS&Y GATE VALVES

A. Manufacturers:

1. Nibco Inc.
2. Zurn Industries, LLC
3. United Brass Works
4. (Owner Selection)

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Bronze or brass.
4. Wedge: One-piece bronze or brass.
5. Wedge Seat: Bronze.
6. Stem: Bronze or brass.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Threaded.

2.7 IRON OS&Y GATE VALVES

A. Manufacturers:
1. Zurn Industries
2. Nibco Inc.
3. Victaulic Company
4. (Owner Selection)

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig (1200 kPa).
3. Body and Bonnet Material: Cast or ductile iron.
4. Wedge: Cast or ductile iron, or bronze with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coating.
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Grooved or Threaded.

2.8 NRS GATE VALVES

A. Manufacturers:
1. Zurn Industries
2. Nibco Inc.
3. Victaulic Company
4. (Owner Selection)

B. Description:

1. Standard: UL 262 and FM Global standard for fire-service water control valves (OS&Y- and NRS-type gate valves).
2. Minimum Pressure Rating: 175 psig.
3. Body and Bonnet Material: Cast or ductile iron.

4. Wedge: Cast or ductile iron with elastomeric coating.
5. Wedge Seat: Cast or ductile iron, or bronze with elastomeric coatin].
6. Stem: Brass or bronze.
7. Packing: Non-asbestos PTFE.
8. Supervisory Switch: External.
9. End Connections: Grooved or Threaded.

2.9 INDICATOR POSTS

A. Manufacturers:
1. Mueller Co.
2. Nibco Inc.
3. (Owner Selection)

B. Description:

1. Standard: UL 789 and FM Global standard for indicator posts.
2. Type: Wall.
3. Base Barrel Material: Cast or ductile iron.
4. Extension Barrel: Cast or ductile iron.
5. Cap: Cast or ductile iron.
6. Operation: Handwheel.

2.10 TRIM AND DRAIN VALVES

A. Ball Valves:

1. Manufacturers:
   a. Victaulic Company
   b. Nibco Inc.
   c. Potter Roemer
   d. (Owner Selection)

2. Description:

   a. Pressure Rating: 250 psig.
   b. Body Design: Two piece.
   c. Body Material: Forged brass or bronze.
   d. Port size: Full or standard.
   e. Seats: PTFE.
   f. Stem: Bronze or stainless steel.
   g. Ball: Chrome-plated brass.
   h. Actuator: Handlever.
   i. End Connections for Valves NPS 1 through NPS 2-1/2: Threaded ends.
   j. End Connections for Valves NPS 1-1/4 and NPS 2-1/2: Grooved ends.

B. Angle Valves:

1. Manufacturers:
   a. Nibco Inc.
   b. United Brass Works, Inc.
   c. (Owner Selection)

2. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Brass or bronze.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron, bronze, or aluminum.

C. Globe Valves:

1. Manufacturers:
a. Nibco Inc.
b. United Brass Works, Inc
c. (Owner Selection)

2. Description:

a. Pressure Rating: 175 psig.
b. Body Material: Bronze with integral seat and screw-in bonnet.
c. Ends: Threaded.
d. Stem: Bronze.
e. Disc Holder and Nut: Bronze.
f. Disc Seat: Nitrile.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 GENERAL REQUIREMENTS FOR VALVE INSTALLATION

A. Comply with requirements in the following Sections for specific valve installation requirements and applications:

1. Division 21 "Facility Fire-Suppression Water-Service Piping" for application of valves in fire-suppression water-service piping outside the building.
2. Division 21 "Fire-Suppression Standpipes" for application of valves in fire-suppression standpipes.
3. Division 21 "Wet-Pipe Sprinkler Systems" for application of valves in wet-pipe, fire-suppression sprinkler systems.
4. Division 21 "Dry-Pipe Sprinkler Systems" for application of valves in dry-pipe, fire-suppression sprinkler systems.
5. Division 21 "Foam-Water Systems" for application of valves in AFFF piping.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Install valves having threaded connections with unions at each piece of equipment arranged to allow easy access, service, maintenance, and equipment removal without system shutdown. Provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the pipe center.

F. Install valves in position to allow full stem movement.

G. Install valve tags. Comply with requirements in Division 21 "Identification for Fire-Suppression Piping and Equipment" for valve tags and schedules and signs on surfaces concealing valves; and the NFPA standard applying to the piping system in which valves are installed. Install permanent identification signs indicating the portion of system controlled by each valve.

H. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire-department connections.

I. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

END OF SECTION

SECTION 21 05 33

HEAT TRACING FOR FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes heat tracing for fire-suppression piping with the following electric heating cables:

1. Plastic insulated, series resistance.
2. Self-regulating, parallel resistance.

B. Related Requirements:

1. Division 22 "Heat Tracing for Plumbing Piping."
2. Division 23 "Heat Tracing for HVAC Piping."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.

1. Warranty Period: **Five** years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLASTIC-INSULATED, SERIES-RESISTANCE HEATING CABLES

A. Manufacturers:
1. Easy Heat
2. Delta-Therm Corp.
3. Watts Radiant
4. (Owner Selection)

B. Comply with IEEE 515.1.

C. Heating Element: Single- or dual-stranded resistor wire. Terminate with waterproof, factory-assembled nonheating leads with connectors at both ends.

D. Electrical Insulating Jacket: Minimum 4.0-mil Kapton with silicone, Tefzel, or polyolefin.

E. Cable Cover: Aluminum braid hylar outer jacket.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 and NFPA 13, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 6 W/ft..
2. Piping Diameter: NPS.
3. Spiral Wrap Pitch: 1 inch.
4. Electrical Characteristics for Single-Circuit Connection:

a. Volts: 120.
b. Phase: 1.
c. Hertz: 60.
d. Full-Load Amperes: 1.
e. Minimum Circuit Ampacity: 20.
f. Maximum Overcurrent Protection: 20.

2.2 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Manufacturers:
1. Easy Heat
2. Delta-Therm Corp.

3. Brisk Heat
4. (Owner Selection)

B. Comply with IEEE 515.1.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F.

G. Maximum Exposure Temperature (Power Off): 185 deg F.

H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

I. Capacities and Characteristics:

1. Maximum Heat Output: 8 W/ft.
2. Piping Diameter: NPS.
3. Spiral Wrap Pitch: 1 inch.
4. Electrical Characteristics for Single-Circuit Connection:

a. Volts: 120.
b. Phase: 1.
c. Hertz: 60.
d. Full-Load Amperes: 1.
e. Minimum Circuit Ampacity: 20.
f. Maximum Overcurrent Protection: 20.

2.3 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F.

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.4 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer or as recommended in writing by manufacturer.

B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches, 3/4 inch minimum.
2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches or Larger: 1-1/2 inches minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.

1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable where indicated and according to NFPA 70 and NFPA 13.

B. Install electric heating cable across expansion joints according to manufacturer's written instructions; use cable to allow movement without damage to cable.

C. Install electric heating cables after piping has been tested and before insulation is installed.

D. Install electric heating cables according to IEEE 515.1.

E. Install insulation over piping with electric cables according to Division 21 "Fire-Suppression Systems Insulation."

F. Install warning tape on piping insulation where piping is equipped with electric heating cables.

G. Set field-adjustable switches and circuit-breaker trip ranges.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

C. Connect heat-tracing controls to fire-alarm system according to NFPA 13. Comply with requirements in Division 28 "Digital, Addressable Fire-Alarm System." "Zoned (DC Loop) Fire-Alarm System."

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
2. Test cables for electrical continuity and insulation integrity before energizing.
3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

D. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.

E. Cables will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed heating cables, including nonheating leads, from damage during construction.

B. Remove and replace damaged heat-tracing cables.

END OF SECTION

SECTION 21 05 53

IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.

D. Valve Schedules: Valve numbering scheme.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

2. Material and Thickness: anodized aluminum, 0.032 inch thick, with predrilled holes for attachment hardware.

3. Letter Color: White.
4. Background Color: Red.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Red.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inchfor name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
8. Fasteners: Stainless-steel rivets or self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.

C. Letter Color: White.

D. Background Color: Red.

E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inchfor viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

H. Fasteners: Stainless-steel rivets or self-tapping screws.

I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

J. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction according to ASME A13.1.

C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

D. Self-adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

E. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

   1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

F. Pipe-Label Colors:

   1. Background Color: Safety Red.
   2. Letter Color: White.

2.4 STENCILS

A. Stencils for Piping:

1. Manufacturers:
   a. Brimar Industries, Inc.
   b. Craftmark Pipe Markers
   c. Kolbi Pipe Marker Co.
   d. (Owner Selection)

2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
3. Stencil Material: Fiberboard or metal.
4. Stencil Paint: Safety Red, exterior, gloss, acrylic enamel. Paint may be in pressurized spray-can form.
5. Identification Paint: White, exterior, acrylic enamel. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

B. Description: Stamped or engraved with 1/4-inchletters for piping-system abbreviation and 1/2-inchnumbers.

   1. Tag Material: Stainless steel, 0.032 inch thick, with predrilled holes for attachment hardware.
   2. Fasteners: Brass beaded chain or S-hook.
   3. Valve-Tag Color: Safety Red.
   4. Letter Color: White.

C. Valve Schedules: For each piping system, on 8-1/2-by-11-inchond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

   1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Manufacturers:
   a. Brady Corp.
   b. LEM Products Inc.
   c. Craftmark Pipe Markers
   d. (Owner Selection)

B. Description: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

   1. Size: Approximately 4 by 7 inches.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Safety Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of incompatible primers, paints, and encapsulants, as well as dirt, oil, grease, release agents, and other substances that could impair bond of identification devices.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be installed.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping: Painting of piping is specified in Division 09 "Interior Painting."

B. Stenciled Pipe-Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit a view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes including pipes where flow is allowed in both directions.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in fire-suppression piping systems. List tagged valves in a valve-tag schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:

1. Valve-Tag Size and Shape:

a. Fire-Suppression Standpipe: 2 inches, round.
b. Wet-Pipe Sprinkler System: 2 inches, round.
c. Dry-Pipe Sprinkler System: 2 inches, round.
d. Foam-Water System: 2 inches, round.
e. Clean-Agent Fire-Extinguishing System: 2 inches, round.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 21 11 19

FIRE-DEPARTMENT CONNECTIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Flush-type fire-department connections.
   2. Yard-type fire-department connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each fire-department connection. Contractor to coordinate type of FDC, location and finish with local AHJ.

PART 2 - PRODUCTS

2.1 FLUSH-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers:
   1. Elkhart Brass Mfg. Co.
   2. American Fire Hose and Cabinet
   3. Fire End & Croker Corp.
   4. (Owner Selection)

B. Standard: UL 405.

C. Type: Flush, for wall mounting.

D. Pressure Rating: 175 psig minimum.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Rectangular, brass, wall type.

I. Outlet: With pipe threads.

J. Body Style: Horizontal.

K. Number of Inlets: Two.

L. Outlet Location: Back.

M. Escutcheon Plate Marking: Similar to "AUTO SPKR"

N. Finish: Polished chrome plated.

O. Outlet Size: NPS 4 or NPS 5 or NPS 6 or NPS 8.

2.2 YARD-TYPE FIRE-DEPARTMENT CONNECTION

A. Manufacturers:
1. Elkhart Brass Mfg. Co.
2. American Fire Hose and Cabinet
3. Fire End & Croker Corp.
4. (Owner Selection)

B. Standard: UL 405.

C. Type: Exposed, freestanding.

D. Pressure Rating: 175 psig.

E. Body Material: Corrosion-resistant metal.

F. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

G. Caps: Brass, lugged type, with gasket and chain.

H. Escutcheon Plate: Round, brass, floor type.

I. Outlet: Bottom, with pipe threads.

J. Number of Inlets: Two.

K. Sleeve: Not required.

L. Sleeve Height: 18 inches.

M. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE"

N. Finish: Polished chrome plated.

O. Outlet Size: [NPS 4] [NPS 5] [NPS 6].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of fire-department connections.

B. Examine roughing-in for fire-suppression standpipe system to verify actual locations of piping connections before fire-department connection installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall-type fire-department connections.

B. Install yard-type fire-department connections in concrete slab support. Comply with requirements for concrete in Division 03 "Cast-in-Place Concrete."

C. Install two protective pipe bollards around each fire-department connection. Comply with requirements for bollards in Division 05 "Metal Fabrications."

D. Install automatic (ball-drip) drain valve at each check valve for fire-department connection.

END OF SECTION

SECTION 21 13 13

WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Cover system for sprinkler piping.
3. Specialty valves.
4. Sprinklers.
5. Alarm devices.
6. Manual control stations.
7. Control panels.
8. Pressure gages.

B. Related Requirements:

1. Division 21 "Fire Department Connections" for exposed-, flush-, and yard-type fire department connections.
2. Division 23 "General-Duty Valves for Water-Based Fire-Suppression Piping" for ball, butterfly, check, gate, post-indicator, and trim and drain valves.

1.3 DEFINITIONS

A. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig, but not higher than 250 psig.

B. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175-psig maximum.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings: For wet-pipe sprinkler systems.

1. Include plans, elevations, sections, and attachment details.
2. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For wet-pipe sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping.
4. Items penetrating finished ceiling include the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.

B. Qualification Data: For qualified Installer and professional engineer.

C. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.

D. Welding certificates.

E. Fire-hydrant flow test report.

F. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."

G. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wet-pipe sprinkler systems and specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

1.8 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding Qualifications: Qualify procedures and operators according to 2010 ASME Boiler and Pressure Vessel Code.

1.9 FIELD CONDITIONS

A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:

1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of sprinkler service.
2. Do not proceed with interruption of sprinkler service without Construction Manager's and Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13.

B. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

C. High-Pressure Piping System Component: Listed for 250-psig minimum working pressure.

D. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design wet-pipe sprinkler systems.

1. Sprinkler system design shall be approved by authorities having jurisdiction.

a. Margin of Safety for Available Water Flow and Pressure: 5 PSI percent, including losses through water-service piping, valves, and backflow preventers.
b. Sprinkler Occupancy Hazard Classifications: According to NFPA 13 recommendations unless otherwise indicated or determined by authorities having jurisdiction.

1) Automobile Parking Areas: Ordinary Hazard, Group 1.
2) Building Service Areas: Ordinary Hazard, Group 1.
3) Electrical Equipment Rooms: Ordinary Hazard, Group 1.

4) General Storage Areas: Ordinary Hazard, Group 1.
5) Libraries except Stack Areas: Light Hazard.
6) Library Stack Areas: Ordinary Hazard, Group 2.
7) Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
8) Office and Public Areas: Light Hazard.

2. Minimum Density for Automatic-Sprinkler Piping Design: According to NFPA 13 recommendations & UL listing unless otherwise indicated or determined by authorities having jurisdiction

a. Residential (Dwelling) Occupancy: 0.05 gpm over 400-sq. ft. area.
b. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.
c. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
d. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. area.
e. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. area.
f. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. area.
g. Special Occupancy Hazard: As determined by authorities having jurisdiction.

3. Maximum Protection Area per Sprinkler: According to NFPA 13 recommendations & UL listing unless otherwise indicated or determined by authorities having jurisdiction.

a. Residential Areas: 400 sq. ft.
b. Office Spaces: 120 sq. ft.
c. Storage Areas: 130 sq. ft.
d. Mechanical Equipment Rooms: 130 sq. ft.
e. Electrical Equipment Rooms: 130 sq. ft.
f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

E. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

2.2 STEEL PIPE AND FITTINGS

A. Standard-Weight, Galvanized and Black-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Galvanized and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated-Steel Couplings: ASTM A 865/A 865M, threaded.

E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

1. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or EPDM rubber gasket.

    a. Class 125 and Class 250, Cast-Iron, Flat-Face Flanges: Full-face gaskets.
    b. Class 150 and Class 300, Ductile-Iron or -Steel, Raised-Face Flanges: Ring-type gaskets.

2. Metal, Pipe-Flange Bolts and Nuts: Carbon steel unless otherwise indicated.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers:
    a. Anvil International
    b. Tyco Fire Products
    c. Victaulic Company
    d. Approved Equal

2. Pressure Rating: 250-psig minimum.
3. Painted Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting, with dimensions matching steel pipe.
4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213 rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

K. Steel Pressure-Seal Fittings: UL 213, FM Global-approved, 175-psig pressure rating with steel housing, rubber O-rings, and pipe stop; for use with fitting manufacturers' pressure-seal tools.

1. Manufacturers:
    a. Victaulic Company
    b. Approved Equal

L. Alarm Valves:

1. Manufacturers:
    a. Reliable Automatic Sprinkler Co, Inc.
    b. Victaulic Company
    c. Viking Corp.
    d. Approved Equal

2. Standard: UL 193.
3. Design: For horizontal or vertical installation.
4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
7. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

M. Automatic (Ball Drip) Drain Valves:

1. Manufacturers:
    a. Reliable Automatic Sprinkler Co, Inc.
    b. Tyco Fire Products
    c. (Owner Selection)

2. Standard: UL 1726.
3. Pressure Rating: 175-psig minimum.
4. Type: Automatic draining, ball check.
5. Size: NPS 3/4 .
6. End Connections: Threaded.

N. Flow Detection and Test Assemblies:

1. Manufacturers:
    a. Reliable Automatic Sprinker Co,Inc.
    b. Tyco Fire Products
    c. Victaulic Company
    d. Approved Equal

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded or grooved.

O. Sprinkler Inspector's Test Fittings:

1. Manufacturers:
    a. Tyco Fire Products
    b. Victaulic Company
    c. Viking Corp.

2. Standard: UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."
3. Pressure Rating: 175-psig minimum.
4. Body Material: Cast- or ductile-iron housing with sight glass.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

P. Flexible Sprinkler Hose Fittings:

1. Manufacturers:
    a. Victaulic
    b. Approved Equal

2. Standard: UL 1474.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175-psig minimum.
5. Style 108 Coupling

2.3 SPRINKLERS

A. Manufacturers:
   1. Victaulic Company
   2. Tyco Fire Products
   3. Viking Company

B. Listed in UL's "Fire Protection Equipment Directory" or FM Global's "Approval Guide."

C. Pressure Rating for Residential Sprinklers: 175-psig maximum.

D. Pressure Rating for Automatic Sprinklers: 175-psig minimum.

E. Pressure Rating for High-Pressure Automatic Sprinklers: 250-psig minimum.

F. Automatic Sprinklers with Heat-Responsive Element:

   1. Early-Suppression, Fast-Response Applications: UL 1767.
   2. Nonresidential Applications: UL 199.
   3. Residential Applications: UL 1626.
   4. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

G. Open Sprinklers with Heat-Responsive Element Removed: UL 199.

   1. Nominal Orifice: 1/2 inch, with discharge coefficient K between 5.3 and 5.8.
   2. Nominal Orifice: 17/32 inch with discharge coefficient K between 7.4 and 8.2.

H. Sprinkler Finishes: Chrome plated, bronze AND/OR painted. REF ARCH.

I. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

   1. Ceiling Mounting: Chrome-plated steel, one piece, flat, Chrome-plated steel, two piece, with 1-inch vertical adjustment.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

J. Sprinkler Guards:

   1. Manufacturers:
      a. Victaulic Company
      b. Tyco Fire Products
      c. Viking Company

   2. Standard: UL 199.
   3. Type: Wire cage with fastening device for attaching to sprinkler.

2.4 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm:

1. Manufacturers:
   a. Victaulic Company
   b. Tyco Fire Products
   c. Viking Company
2. Standard: UL 753.
3. Type: Mechanically operated, with Pelton wheel.
4. Alarm Gong: Cast aluminum with red-enamel factory finish.
5. Size: 8-1/2-inches diameter.
6. Components: Shaft length, bearings, and sleeve to suit wall construction.
7. Inlet: NPS 3/4.
8. Outlet: NPS 1 drain connection.

C. Electrically Operated Alarm Bell:

1. Manufacturers:
   a. Fire-Lite Alarms, Inc.
   b. Notifier
   c. Potter Electric Signal Company
   d. Approved Equal

2. Standard: UL 464.
3. Type: Vibrating, metal alarm bell.
4. Size: 6” diameter.
5. Finish: Red-enamel factory finish, suitable for outdoor use.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Water-Flow Indicators:

1. Manufacturers:
   a. System Sensor
   b. Viking Corp.
   c. Potter Electric Signal Company
   d. Approved Equal

2. Standard: UL 346.
3. Water-Flow Detector: Electrically supervised.
4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
5. Type: Paddle operated.
6. Pressure Rating: 250 psig.
7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Manufacturers:
   a. System Sensor
   b. Viking Corp.
   c. Potter Electric Signal Company
   d. Approved Equal
2. Standard: UL 346.

3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Manufacturers:
   a. Fire-Lite Alarms, Inc.
   b. Potter Electric Signal Company
   c. System Sensor
   d. (Owner Selection)

2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.
6. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.5 PRESSURE GAGES

A. Manufacturers:
1. Ashcroft, Inc.
2. AMETEK, Inc.
3. AGF Manufacturing Inc.
4. Approved Equal

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0- to 250-psig minimum.

E. Label: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 21 "Facility Fire-Suppression Water-Service Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 "Facility Fire-Suppression Water-Service Piping."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 "Domestic Water Piping."

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated on approved working plans.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
2. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Piping Standard: Comply with NFPA 13 requirements for installation of sprinkler piping.

C. Install seismic restraints on piping. Comply with NFPA 13 requirements for seismic-restraint device materials and installation.

D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13. In seismic-rated areas, refer to Division 21 "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment."

M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 and with soft-metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they are not subject to freezing.

N. Fill sprinkler system piping with water.

O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation "Fire-Suppression Systems Insulation."

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 "Escutcheons for Fire-Suppression Piping."

3.5 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

I. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

J. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

K. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

3.6 VALVE AND SPECIALTIES INSTALLATION

A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. Install valves in vertical position for proper direction of flow, in main supply to system.
2. Install alarm valves with bypass check valve and retarding chamber drain-line connection.
3. Install deluge valves in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.7 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels.

B. Install heat trace on sprinkler piping subject to freezing. Upon approval from AHJ and Engineer, contractor may elect to provide dry-type sprinklers with water supply from heated space if the contractor coordinates and accepts all additional cost associated with this change from all affected disciplines. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

C. Install sprinklers into flexible, sprinkler hose fittings, and install hose into bracket on ceiling grid.

3.8 IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
4. Energize circuits to electrical equipment and devices.
5. Coordinate with fire-alarm tests. Operate as required under the direction of low voltage technician.
6. Coordinate with fire-pump tests. Operate as required under the direction of low voltage technician.

7. Verify that equipment hose threads are same as local fire department equipment.

B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Clean dirt and debris from sprinklers.

B. Only sprinklers with their original factory finish are acceptable. Remove and replace any sprinklers that are painted or have any other finish than their original factory finish.

3.11 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain specialty valves and pressure-maintenance pumps.

3.12 PIPING SCHEDULE

A. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Copper-tube, extruded-tee connections may be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

D. CPVC pipe, Schedule 40 CPVC fittings, and solvent-cemented joints may be used for light-hazard and residential occupancies.

E. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weigh, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with plain ends; uncoated, plain-end-pipe fittings; and twist-locked joints.
4. Standard-weight, galvanized-steel pipe with plain ends; galvanized, plain-end-pipe fittings; and twist-locked joints.
5. Standard-weight, black-steel pipe with [cut-] [or] [roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
6. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
7. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

F. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with [cut-] [or] [roll-]grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

G. Standard-pressure, wet-pipe sprinkler system, NPS 5 and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, galvanized-steel pipe with threaded ends; galvanized, gray-iron threaded fittings; and threaded joints.
3. Standard-weight, black-steel pipe with cut or roll grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
4. Standard-weight, galvanized-steel pipe with cut-grooved ends; galvanized, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
5. Standard-weight, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.13 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Recessed sprinklers unless indicated otherwise.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Sidewall, dry sprinklers unless indicated otherwise.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
2. Flush Sprinklers: Bright chrome, with painted white escutcheon.
3. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
4. Residential Sprinklers: Dull chrome.
5. Upright, Pendent and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.

END OF SECTION

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Rubber union connector packless expansion joints.
2. Flexible-hose packless expansion joints.
3. Metal-bellows packless expansion joints.
4. Externally pressurized metal-bellows packless expansion joints.
5. Rubber packless expansion joints.
6. Grooved-joint expansion joints.
7. Alignment guides and anchors.
8. Pipe loops and swing connections.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
3. Alignment Guide Details: Detail field assembly and attachment to building structure.
4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.

B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKLESS EXPANSION JOINTS

A. Rubber Union Connector Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.
   b. Flexicraft Industries.
   c. Mason Industries, Inc.

2. Material: Twin reinforced-rubber spheres with external restraining cables.
3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
4. End Connections for NPS 2 and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Flex-Hose Co., Inc.
   b. Mason Industries, Inc.
   c. Metraflex Company (The).

2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

   a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
   b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.

5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.

6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.

8. Expansion Joints for Steel Piping NPS 8 to NPS 12: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
    b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

9. Expansion Joints for Steel Piping NPS 14 and Larger: Carbon-steel fittings with flanged end connections.

    a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

C. Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Flex-Hose Co., Inc.
    b. Mason Industries, Inc.
    c. Metraflex Company (The).

2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
3. Type: Circular, corrugated bellows with external tie rods.
4. Minimum Pressure Rating: 200 psig, unless otherwise indicated.
5. Configuration: double joint with base class(es), unless otherwise indicated.
6. Expansion Joints for Copper Tubing: multi- ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.

a. End Connections for Copper Tubing NPS 2 and Smaller: threaded.
b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: threaded.
c. End Connections for Copper Tubing NPS 5 and Larger: Flanged.

7. Expansion Joints for Steel Piping: multi- ply stainless-steel bellows, steel pipe ends, and carbon-steel shroud.

a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
b. End Connections for Steel Pipe NPS 2-1/2 and Larger: Flanged.

D. Externally Pressurized Metal-Bellows Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Mason Industries, Inc.
c. Metraflex Company (The).

2. Minimum Pressure Rating: 300 psig, unless otherwise indicated.
3. Description:

a. Totally enclosed, externally pressurized, multi-ply, stainless-steel bellows isolated from fluid flow by an internal pipe sleeve.
b. Carbon-steel housing.
c. Drain plugs and lifting lug for NPS 3 and larger.
d. Bellows shall have operating clearance between the internal pipe sleeves and the external shrouds.
e. Joints shall be supplied with a built-in scale to confirm the starting position and operating movement.
f. Joint Axial Movement: 4 inches of compression and 0.75 inch of extension.

4. Permanent Locking Bolts: Set locking bolts to maintain joint lengths during installation. Temporary welding tabs that are removed after installation in lieu of locking bolts are not acceptable.
5. End Connection Configuration: Flanged; one raised, fixed and one floating flange.

E. Rubber Packless Expansion Joints:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Mason Industries, Inc.
c. Metraflex Company (The).

2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
4. Arch Type: multiple arches with external control rods.
5. Spherical Type: multiple spheres with external control rods.
6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.

9. Material for Fluids Containing Acids, Alkalis, or Chemicals: Chlorosulfonyl-polyethylene rubber.
10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Chlorosulfonated polyethylene synthetic rubber.
11. Material for Water: Chlorosulfonated polyethylene synthetic rubber.
12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.3 GROOVED-JOINT EXPANSION JOINTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Anvil International.

B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.

C. Standard: AWWA C606, for grooved joints.

D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.

E. Couplings: 12, flexible type for steel-pipe dimensions. Include ferrous housing sections, ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

2.4 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Flex-Hose Co., Inc.
b. Mason Industries, Inc.
c. Metraflex Company (The).

2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.

a. Stud: Threaded, zinc-coated carbon steel.
b. Expansion Plug: Zinc-coated steel.
c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.

    a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
    c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

A. Install expansion joints of sizes matching sizes of piping in which they are installed.

B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

C. Install rubber packless expansion joints according to FSA-PSJ-703.

D. Install grooved-joint expansion joints to grooved-end steel piping.

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

C. Attach guides to pipe, and secure guides to building structure.

D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

E. Anchor Attachments:

1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.

F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.

1. Anchor Attachment to Steel Structural Members: Attach by welding.
2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.

G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.

E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel.
3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

    a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Galvanized-steel wall sleeves

2. Exterior Concrete Walls below Grade:

   a. Galvanized-steel-pipe sleeves with sleeve-seal system

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

   a. Galvanized-steel wall sleeves with sleeve-seal system.

      1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   a. Galvanized-steel-pipe sleeves.

5. Interior Partitions:
   a. Galvanized-steel-sheet sleeves.

END OF SECTION

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plate finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
c. Insulated Piping: One-piece, stamped-steel type.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass finish.
i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.

2. Escutcheons for Existing Piping:

a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
i. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.

B. Related Requirements:

1. Division 22 "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
2. Division 22 "Domestic Water Piping Specialties" for water meters.
3. Division 22 "General-Service Compressed-Air Piping" for compressed air gages.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Standard: ASME B40.200.

B. Case: Liquid-filled and sealed type(s); stainless steel with 3-inch 5-inch nominal diameter.

C. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

D. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

E. Connector Size: 1/2 inch with ASME B1.1 screw threads.

F. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

G. Window: Plain glass.

H. Ring: Stainless steel.

I. Element: Bimetal coil.

J. Pointer: Dark-colored metal.

K. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel 4-1/2-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

B. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, plastic 4-1/2-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.

5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

C. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel 4-1/2-inch nominal diameter with flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Stainless steel.
9. Connector Type(s): Union joint, with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1percent of scale range.

D. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, plastic 4-1/2-inch nominal diameter with flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint, threaded, with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum; 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum or brass and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic;6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

a. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.

5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Stainless steel and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 LIGHT-ACTIVATED THERMOMETERS

A. Direct-Mounted, Light-Activated Thermometers:
1. Case: Metal 7-inch nominal size unless otherwise indicated.
2. Scale(s): Deg F and deg C.
3. Case Form: Adjustable angle
4. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
5. Stem: Aluminum and of length to suit installation.

    a. Design for Thermowell Installation: Bare stem.

6. Display: Digital.
7. Accuracy: Plus or minus 2 deg F.

B. Remote-Mounted, Light-Activated Thermometers:
1. Case: Plastic, for wall mounting.
2. Scale(s): Deg F and deg C.
3. Sensor: Bulb and thermister wire.

    a. Design for Thermowell Installation: Bare stem.

4. Display: Digital.
5. Accuracy: Plus or minus 2 deg F.

2.5 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.6 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Liquid-filled or Sealed; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: plus or minus 2 percent of middle half of scale range.

B. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: plus or minus 2 percent of middle half of scale range.

C. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Liquid-filled or Sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Accuracy: plus or minus 2 percent of middle half of scale range.

D. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 4-1/2-inch nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.

9. Accuracy: plus or minus 2 percent of middle half of scale range.

2.7 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and surge-dampening device. Include extension for use on insulated piping.

B. Valves: Brass ball, with NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe threads.

2.8 TEST PLUGS

A. Description: Test-station fitting made for insertion into piping tee fitting.

B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

C. Thread Size: NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe thread.

D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.9 TEST-PLUG KITS

A. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

B. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.10 SIGHT FLOW INDICATORS

A. Description: Piping inline-installation device for visual verification of flow.

B. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

C. Minimum Pressure Rating: 150 psig.

D. Minimum Temperature Rating: 200 deg F.

E. End Connections for NPS 2 and Smaller: Threaded.

F. End Connections for NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

H. Install remote-mounted pressure gages on panel.

I. Install valve and snubber in piping for each pressure gage for fluids.

J. Install test plugs in piping tees.

K. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Inlets and outlets of each domestic water heat exchanger.
3. Inlet and outlet of each domestic hot-water storage tank.
4. Inlet and outlet of each remote domestic water chiller.

L. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F.

B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F.

C. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F

D. Retain one or more of first three paragraphs below. If retaining more than one scale range, indicate location of each on Drawings.

E. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg.

F. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F.

G. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F.

H. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg.

I. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi.

B. Scale Range for Water Service Piping: 0 to 160 psi.

C. Scale Range for Water Service Piping: 0 to 200 psi.

D. Scale Range for Domestic Water Piping: 0 to 100 psi.

E. Scale Range for Domestic Water Piping: 0 to 160.

F. Scale Range for Domestic Water Piping: 0 to 200 psi.

G. Scale Range for Domestic Water Piping: 0 to 300 psi.

END OF SECTION

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Bronze ball valves.
3. Iron, single-flange butterfly valves.
4. Bronze swing check valves.
5. Iron swing check valves.
6. Iron gate valves.
7. Iron globe valves.
8. Chainwheels.

B. Related Sections:

1. Division 22 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
2. Division 22 "Facility Water Distribution Piping" for valves applicable only to this piping.
3. Division 22 "Domestic Water Piping" for valves applicable only to this piping.
4. Division 22 "General-Service Compressed-Air Piping" for valves applicable only to this piping.
5. Division 22 "Compressed-Air Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.
6. Division 22 "Vacuum Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.
7. Division 22 "Gas Piping for Laboratory and Healthcare Facilities" for valves applicable only to this piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

B. Valve Sizes: Same as upstream piping unless otherwise indicated.

C. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

D. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

E. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. American Valve, Inc.
b. NIBCO INC.

2. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: PTFE or TFE.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

2.3 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. American Valve, Inc.
b. Conbraco Industries, Inc.; Apollo Valves.
c. Crane Co.; Crane Valve Group; Crane Valves.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Cooper Cameron Valves; a division of Cooper Cameron Corporation.
c. Crane Co.; Crane Valve Group; Jenkins Valves.
d. Crane Co.; Crane Valve Group; Stockham Division.
e. Hammond Valve.
f. Milwaukee Valve Company.
g. NIBCO INC.
h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
e. Seat: EPDM.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

2.5 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.6 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Stockham Division.
c. Hammond Valve.
d. NIBCO INC.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Clear or full waterway.
d. Body Material: ASTM A 126, gray iron with bolted bonnet.
e. Ends: Flanged.
f. Trim: Composition.
g. Seat Ring: Bronze.
h. Disc Holder: Bronze.
i. Disc: PTFE or TFE.
j. Gasket: Asbestos free.

2.7 IRON GATE VALVES

A. Class 125, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.

d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-70, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Disc: Solid wedge.
g. Packing and Gasket: Asbestos free.

2.8 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Milwaukee Valve Company.
f. NIBCO INC.
g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A 126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.

2.9 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Babbitt Steam Specialty Co.
2. Roto Hammer Industries.
3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
2. Attachment: For connection to butterfly valve stems.
3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for butterfly, gate, and globe valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Ball valves.
2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service: Globe , ball, or butterfly valves.
4. Pump-Discharge Check Valves:

    a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
    b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
4. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
5. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Bronze Angle Valves: Class 125, nonmetallic disc.
3. Ball Valves: Two piece, full port, bronze with bronze trim.
4. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
4. Iron Gate Valves: Class 125, NRS.
5. Iron Globe Valves: Class 125.

END OF SECTION

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

B. Related Sections:

1. Division 05 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 22 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Hot-dipped galvanized.
7. Paint Coating: Epoxy.
8. Plastic Coating: Epoxy.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Coating: Zinc.

2.4 FIBERGLASS STRUT SYSTEMS

A. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.

1. Channels: Continuous slotted fiberglass channel with inturned lips.
2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. High-Type, Single-Pipe Stand:

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
2. Base: Stainless steel.
3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.

F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

G. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 "Roof Accessories" for curbs.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.

J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

M. Install lateral bracing with pipe hangers and supports to prevent swaying.

N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

Q. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 "Exterior Painting." "Interior Painting." "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and fiberglass strut systems and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F pipes NPS 4 to NPS 24 requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

    a. Light (MSS Type 31): 750 lb.
    b. Medium (MSS Type 32): 1500 lb.
    c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.
    b. Vertical (MSS Type 55): Mounted vertically.
    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION

SECTION 22 05 48.13

VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Elastomeric hangers.
11. Spring hangers.

B. Related Requirements:

1. Division 21 "Vibration Controls for Fire-Suppression Piping and Equipment" for devices for fire-suppression equipment and systems.
2. Division 23 "Vibration Controls for HVAC" for devices for HVAC equipment and systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. nVent (CADDY).

2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: elastomeric.

    a. Surface Pattern: Smooth pattern.
    b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.

b. Mason Industries, Inc.
c. nVent (CADDY).

2. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. nVent (CADDY).

2. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. nVent (CADDY).

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. nVent (CADDY).

2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top housing with elastomeric pad.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. nVent (CADDY).

2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

    a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Top plate with elastomeric pad.
    c. Internal leveling bolt that acts as blocking during installation.

3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Kinetics Noise Control, Inc.
    b. Mason Industries, Inc.
    c. nVent (CADDY).

2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable snubbers to limit vertical movement.

    a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.

1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
2. Maximum Load Per Support: 500 psigon isolation material providing equal isolation in all directions.

2.9 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. nVent (CADDY).

2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.11 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Kinetics Noise Control, Inc.
b. Mason Industries, Inc.
c. nVent (CADDY).

2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03 "Cast-in-Place Concrete." "Miscellaneous Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Material and Thickness: anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 STENCILS

A. Stencils for Piping:

1. Lettering Size: Size letters according to ASME A13.1 for piping.
2. Stencil Material: Aluminum.
3. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
4. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link chain or beaded chain or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.

1. Size: 3 by 5-1/4 inches minimum.
2. Fasteners: Reinforced grommet and wire or string.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

A. Piping Color Coding: Painting of piping is specified in Division 09 "Interior Painting." or "High-Performance Coatings."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

E. Pipe Label Color Schedule:

1. Low-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

2. High-Pressure Compressed Air Piping:

   a. Background: Safety blue.
   b. Letter Colors: White.

3. Domestic Water Piping

   a. Background: Safety green.
   b. Letter Colors: White.

4. Sanitary Waste Piping:

   a. Background Color: Safety black.
   b. Letter Color: White.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

   a. Cold Water: 2 inches round.
   b. Hot Water: 2 inches round.
   c. Low-Pressure Compressed Air: 2 inches round.
   d. High-Pressure Compressed Air: 2 inches round.

2. Valve-Tag Colors:

   a. Cold Water: Safety green.
   b. Hot Water: Safety green.
   c. Low-Pressure Compressed Air: Safety blue.

d. High-Pressure Compressed Air: Natural.

3. Letter Colors:

a. Cold Water: White.
b. Hot Water:[White.
c. Low-Pressure Compressed Air: White.
d. High-Pressure Compressed Air: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

SECTION 22 07 16

PLUMBING EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing equipment:

1. Domestic water boiler breechings.
2. Domestic water heat exchangers.
3. Domestic water converters.
4. Domestic water, hot-water pumps.
5. Domestic water storage tanks.
6. Domestic water filter housings.

B. Related Sections:

1. Division 22 "Plumbing Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections and access panels.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Sheet Form Insulation Materials: 12 inches square.
2. Sheet Jacket Materials: 12 inches square.
3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. The material descriptions listed in the section may not all be used on this project. Refer to the Insulation Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

B. Comply with requirements in "Domestic Water Boiler Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Calcium Silicate:
1. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Block Insulation: ASTM C 552, Type I.
2. Special-Shaped Insulation: ASTM C 552, Type III.
3. Board Insulation: ASTM C 552, Type IV.
4. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

I. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

J. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

L. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

M. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

N. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

O. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

P. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

F. Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
2. Service Temperature Range: 0 to 180 deg F.
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F.
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F.
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a low VOC content.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants for Cellular-Glass Products:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.

4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

5. PVDC Jacket for Outdoor Applications: 6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in.) for covering equipment.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. in a Leno weave, for equipment.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
2. Color: White or Color as selected by Architect.
3. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

    a. Sheet and roll stock ready for shop or field sizing or factory cut and rolled to size.
    b. Finish and thickness are indicated in field-applied jacket schedules.
    c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft.
    d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    a. Material, finish, and thickness are indicated in field-applied jacket schedules.
    b. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.
    c. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
    1. Width: 3 inches.
    2. Thickness: 11.5 mils.
    3. Adhesion: 90 ounces force/inch in width.
    4. Elongation: 2 percent.
    5. Tensile Strength: 40 lbf/inch in width.
    6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
    1. Width: 3 inches.l
    2. Thickness: 6.5 mils.
    3. Adhesion: 90 ounces force/inch in width.
    4. Elongation: 2 percent.
    5. Tensile Strength: 40 lbf/inch in width.
    6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
    1. Width: 2 inches.
    2. Thickness: 6 mils.
    3. Adhesion: 64 ounces force/inch in width.
    4. Elongation: 500 percent.
    5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
    1. Width: 2 inches.
    2. Thickness: 3.7 mils.
    3. Adhesion: 100 ounces force/inch in width.
    4. Elongation: 5 percent.
    5. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
    1. Width: 3 inches.

2. Film Thickness: 6 mils.
3. Adhesive Thickness: 1.5 mils.
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:
1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   b. Spindle: Stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.
   a. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   b. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   c. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

   a.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.

d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a.
b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not over compress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
f. Impale insulation over anchor pins and attach speed washers.
g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from stainless steel, at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Domestic Water Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. 33-1/2-inch circumference limit allows for 2-inch overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 "Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

B. Round, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

C. Rectangular, exposed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.

2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

D. Rectangular, concealed breeching and connector insulation shall be one of the following:

1. Calcium Silicate: 4 inches thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

3.11 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Heat-exchanger (water-to-water for domestic water heating service) insulation shall be one of the following:

1. Calcium Silicate: 3 inches thick.
2. Cellular Glass: 3 inches thick.
3. Mineral-Fiber Blanket: 2 inches thick and 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 6-lb/cu. ft. nominal density.
5. Mineral-Fiber Pipe and Tank: 2 inches thick.
6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.

D. Steam-to-hot-water converter insulation shall be one of the following:

1. Calcium Silicate: inches thick.
2. Cellular Glass: 3 inches thick.
3. Mineral-Fiber Blanket: 2 inches thick and 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 6-lb/cu. ft. nominal density.
5. Mineral-Fiber Pipe and Tank: 2 inches thick.
6. Mineral-Fiber Preformed Pipe Insulation, Type I: 2 inches thick.

E. Domestic water pump insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber Blanket: 1 inch thick 6-lb/cu. Ft nominal density.
3. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.

F. Domestic chilled-water (potable) pump insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Blanket: 2 inches thick and 6-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

G. Domestic hot-water pump insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Mineral-Fiber Blanket: 1 inch thick and 6-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1 inch 6-lb/cu. ft. nominal density.

H. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Blanket: 1 thick and 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. Ft nominal density.
5. Mineral-Fiber Pipe and Tank: 1 inch thick.
6. Polyolefin: 1 inch thick.

I. Domestic hot-water storage tank insulation shall be one of the following, of thickness to provide an R-value of 12.5.

1. Cellular glass.
2. Mineral-Fiber Blanket: 6-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 6-lb/cu. ft. nominal density.
4. Mineral-fiber pipe and tank.

J. Domestic water storage tank insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Blanket: 1 inch thick and 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.
5. Mineral-Fiber Pipe and Tank: 1 inch thick.
6. Polyolefin: 1 inch thick.

K. Domestic chilled-water (potable) storage tank insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Blanket: 1 inch thick 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Board: 1 inch thick and 6-lb/cu. ft. nominal density.
5. Mineral-Fiber Pipe and Tank: 1 inch thick.
6. Polyolefin: 1 inch thick.

L. Domestic water filter-housing insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Blanket: 2 inches thick and 6-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
4. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:
1. PVC, Color-Coded by System: 30 mils thick.
2. Aluminum, Stucco Embossed: 0.020 inch thick.
3. Painted Aluminum, Embossed: 0.020 inch thick.

4. Stainless Steel, Type 304 or Type 316, Stucco Embossed: 0.020 inch 0.024 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches

1. None.
2. PVC, Color-Coded by System: 30 mils thick.
3. Aluminum, Stucco Embossed: 0.032 inch thick.
4. Painted Aluminum, Stucco Embossed: 0.032 inch thick.
5. Stainless Steel, Type 304 or Type 316, Stucco Embossed: 0.024 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
1. Painted Aluminum, Stucco Embossed: 0.032 inch thick.
2. Stainless Steel, Type 304 or Type 316, Stucco Embossed: 0.024 inch thick.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:
1. PVC, Color-Coded by System: 30 mils thick.
2. Aluminum, Stucco Embossed: 0.032 inch thick.
3. Painted Aluminum, Stucco Embossed 0.032 inch thick.
4. Stainless Steel, Type 304 or Type 316, Stucco Embossed: 0.024 inch thick.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.
2. Stainless Steel, Type 304 or Type 316, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.

E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, Stucco Embossed: 0.032 inch thick.
2. Stainless Steel, Type 304 or Type 316, Stucco Embossed 0.024 inch thick.
3. <Insert jacket type>.

END OF SECTION

SECTION 22 07 19

PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Domestic chilled-water piping for drinking fountains.
5. Sanitary waste piping exposed to freezing conditions.
6. Storm-water piping exposed to freezing conditions.
7. Roof drains and rainwater leaders.
8. Supplies and drains for handicap-accessible lavatories and sinks.

B. Related Sections:

1. Section 22 07 16 "Plumbing Equipment Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties, equipment connections, and access panels.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

2. Jacket Materials for Pipe: 12 inches long by NPS 2.
3. Sheet Jacket Materials: 12 inches square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

a. One 10-foot section of NPS 2 straight pipe.
b. One each of a 90-degree threaded, welded, and flanged elbow.
c. One each of a threaded, welded, and flanged tee fitting.
d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
e. Four support hangers including hanger shield and insert.
f. One threaded strainer and one flanged strainer with removable portion of insulation.
g. One threaded reducer and one welded reducer.
h. One pressure temperature tap.
i. One mechanical coupling.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.

3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

D. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Piping Insulation Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Block Insulation: ASTM C 552, Type I.
   2. Special-Shaped Insulation: ASTM C 552, Type III.
   3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
   4. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
   5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Preformed Pipe Insulation:
   1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Phenolic:
   1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
   2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
   3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
   4. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.

K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
   4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   2. Service Temperature Range: 0 to 180 deg F
   3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
   4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   2. Service Temperature Range: Minus 50 to plus 220 deg F.
   3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
   4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
   2. Service Temperature Range: Minus 20 to plus 180 deg F.
   3. Solids Content: 60 percent by volume and 66 percent by weight.
   4. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 deg F.
4. Color: White.

2.6 SEALANTS

A. Joint Sealants for Cellular-Glass and Phenolic Products:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Permanently flexible, elastomeric sealant.
3. Service Temperature Range: Minus 100 to plus 300 deg F.
4. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: Color-code jackets based on system or Color as selected by Architect.
   3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

      a. Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
      e. Factory-Fabricated Fitting Covers:

         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Valve covers.
         8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

   2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

      a. Factory cut and rolled to size.
      b. Material, finish, and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
      e. Factory-Fabricated Fitting Covers:

         1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Width: 3 inches.
2. Thickness: 6.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Width: 2 inches.
2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch closed seal.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers
1. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures
1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 "Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

END OF SECTION

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Copper tube and fittings.
2. Ductile-iron pipe and fittings.
3. Galvanized steel pipe and fittings.
4. Stainless-steel piping
5. CPVC piping.
6. PVC pipe and fittings.
7. PP pipe and fittings.
8. Piping joining materials.
9. Encasement for piping.
10. Transition fittings.
11. Dielectric fittings.

B. Related Requirements:

1. Division 22 "Facility Water Distribution Piping" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.3 ACTION SUBMITTALS

A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

A. System purging and disinfecting activities report.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner’s representative no fewer than five days in advance of proposed interruption of water service.
2. Do not interrupt water service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Piping Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

C. Comply with NSF Standard 372 for low lead.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L and ASTM B 88, Type M water tube, drawn temper.

B. Soft Copper Tube: ASTM B 88, Type K and ASTM B 88, Type L water tube, annealed temper.

C. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.

D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

F. Copper Unions:

1. MSS SP-123.
2. Cast-copper-alloy, hexagonal-stock body.
3. Ball-and-socket, metal-to-metal seating surfaces.
4. Solder-joint or threaded ends.

G. Copper Pressure-Seal-Joint Fittings:
1. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
2. Fittings for NPS 2-1/2 to NPS 4 Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

H. Copper Push-on-Joint Fittings:
1. Description:

a. Cast-copper fitting complying with ASME B16.18 or wrought-copper fitting complying with ASME B 16.22.
b. Stainless-steel teeth and EPDM-rubber, O-ring seal in each end instead of solder-joint ends.

I. Copper-Tube, Extruded-Tee Connections:
   1. Description: Tee formed in copper tube according to ASTM F 2014.

J. Appurtenances for Grooved-End Copper Tubing:
   1. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
   2. Mechanical Couplings for Grooved-End Copper Tubing:

      a. Copper-tube dimensions and design similar to AWWA C606.
      b. Ferrous housing sections.
      c. EPDM-rubber gaskets suitable for hot and cold water.
      d. Bolts and nuts.
      e. Minimum Pressure Rating: 300 psig.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe:

   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Standard-Pattern, Mechanical-Joint Fittings:

   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Compact-Pattern, Mechanical-Joint Fittings:

   1. AWWA C153/A21.53, ductile iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

D. Push-on-Joint, Ductile-Iron Pipe:

   1. AWWA C151/A21.51.
   2. Push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.

E. Standard-Pattern, Push-on-Joint Fittings:

   1. AWWA C110/A21.10, ductile or gray iron.
   2. Gaskets: AWWA C111/A21.11, rubber.

F. Compact-Pattern, Push-on-Joint Fittings:

   1. AWWA C153/A21.53, ductile iron.
   2. Gaskets: AWWA C111/A21.11, rubber.

G. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

H. Appurtenances for Grooved-End, Ductile-Iron Pipe:

1. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions that match pipe.
2. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:

    a. AWWA C606 for ductile-iron-pipe dimensions.
    b. Ferrous housing sections.
    c. EPDM-rubber gaskets suitable for hot and cold water.
    d. Bolts and nuts.
    e. Minimum Pressure Rating:

        1) NPS 14 to NPS 18: 250 psig.
        2) NPS 20 to NPS 46: 150 psig.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

1. ASTM A 53/A 53M, Type E, Standard Weight.
2. Include ends matching joining method.

B. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.

C. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Malleable-Iron Unions:

1. ASME B16.39, Class 150.
2. Hexagonal-stock body.
3. Ball-and-socket, metal-to-metal, bronze seating surface.
4. Threaded ends.

E. Flanges: ASME B16.1, Class 125, cast iron.

F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:
1. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
2. Fittings for Grooved-End, Galvanized-Steel Pipe:

    a. AWWA C606 for steel-pipe dimensions.
    b. Ferrous housing sections.
    c. EPDM-rubber gaskets suitable for hot and cold water.
    d. Bolts and nuts.
    e. Minimum Pressure Rating:

        1) NPS 8 and Smaller: 600 psig.
        2) NPS 10 and NPS 12: 400 psig.
        3) NPS 14 to NPS 24: 250 psig..

2.5 STAINLESS-STEEL PIPING

A. Potable-water piping and components shall comply with NSF 61 Annex G.

B. Stainless-Steel Pipe: ASTM A 312/A 312M, Schedule 40.

C. Stainless-Steel Pipe Fittings: ASTM A 815/A 815M.

D. Appurtenances for Grooved-End, Stainless-Steel Pipe:
   1. Fittings for Grooved-End, Stainless-Steel Pipe: Stainless-steel casting with dimensions matching stainless-steel pipe.
   2. Mechanical Couplings for Grooved-End, Stainless-Steel Pipe:

      a. AWWA C606 for stainless-steel-pipe dimensions.
      b. Stainless-steel housing sections.
      c. Stainless-steel bolts and nuts.
      d. EPDM-rubber gaskets suitable for hot and cold water.
      e. Minimum Pressure Rating:

         1) NPS 8 and Smaller: 600 psig.
         2) NPS 10 and NPS 12 : 400 psig.
         3) NPS 14 to NPS 24: 250 psig.

2.6 CPVC PIPING

A. CPVC Pipe: ASTM F 441/F 441M, Schedule 40 and Schedule 80.

   1. CPVC Socket Fittings: ASTM F 438 for Schedule 40 and ASTM F 439 for Schedule 80.
   2. CPVC Threaded Fittings: ASTM F 437, Schedule 80.

B. CPVC Piping System: ASTM D 2846/D 2846M, SDR 11, pipe and socket fittings.

C. CPVC Tubing System: ASTM D 2846/D 2846M, SDR 11, tube and socket fittings.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings ASTM F 1960, cold expansion fittings and reinforcing rings.

E. Fittings: ASSE 1061, push-fit fittings.

F. Manifold: Multiple-outlet, plastic or corrosion-resistant-metal assembly complying with ASTM F 876; with plastic or corrosion-resistant-metal valve for each outlet.

2.7 PVC PIPE AND FITTINGS

A. PVC Pipe: ASTM D 1785, Schedule 40 and Schedule 80.

B. PVC Socket Fittings: ASTM D 2466 for Schedule 40 and ASTM D 2467 for Schedule 80.

C. PVC Schedule 80 Threaded Fittings: ASTM D 2464.

2.8 PP PIPE AND FITTINGS

A. PP Pipe: ASTM F 2389, SDR 7.4 and SDR 11.

B. PVC Socket Fittings: ASTM F 2389.

2.9 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

E. Brazing Filler Metals: AWS A5.8M/A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

F. Solvent Cements for Joining CPVC Piping and Tubing: ASTM F 493.

G. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Plastic, Pipe-Flange Gaskets, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

2.10 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: tube.

C. Color: Black or natural.

2.11 TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

D. Plastic-to-Metal Transition Fittings:
1. Description:

a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

E. Plastic-to-Metal Transition Unions:
   1. Description:

      a. CPVC or PVC four-part union.
      b. Brass or stainless-steel threaded end.
      c. Solvent-cement-joint or threaded plastic end.
      d. Rubber O-ring.
      e. Union nut.

2.12 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:
   1. Standard: ASSE 1079.
   2. Pressure Rating: 250 psig.
   3. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
   1. Standard: ASSE 1079.
   2. Factory-fabricated, bolted, companion-flange assembly.
   3. Pressure Rating: 125 psig minimum at 180 deg F 300 psig.
   4. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:
   1. Nonconducting materials for field assembly of companion flanges.
   2. Pressure Rating: 150 psig.
   3. Gasket: Neoprene or phenolic.
   4. Bolt Sleeves: Phenolic or polyethylene.
   5. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:
   1. Standard: IAPMO PS 66.
   2. Electroplated steel nipple complying with ASTM F 1545.
   3. Pressure Rating and Temperature: 300 psig at 225 deg F.
   4. End Connections: Male threaded or grooved.
   5. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and

calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5.

E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in "Domestic Water Piping Specialties."

F. Install shutoff valve immediately upstream of each dielectric fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Division 22 "Domestic Water Piping Specialties."

H. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping to permit valve servicing.

O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.

P. Install piping free of sags and bends.

Q. Install fittings for changes in direction and branch connections.

R. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

S. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 22 05 19 "Meters and Gages for Plumbing Piping."

T. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22 "Domestic Water Pumps."

U. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22 "Meters and Gages for Plumbing Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.

E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

F. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

G. Push-on Joints for Copper Tubing: Clean end of tube. Measure insertion depth with manufacturer's depth gage. Join copper tube and push-on-joint fittings by inserting tube to measured depth.

H. Extruded-Tee Connections: Form tee in copper tube according to ASTM F 2014. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

I. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.

J. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

K. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

L. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

M. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
3. PVC Piping: Join according to ASTM D 2855.

N. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
2. Fittings for NPS 2 and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings or unions.

3.5 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits or nipples.

D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger, support products, and installation in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
4. NPS 2-1/2: 108 inches with 1/2-inch rod.
5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
6. NPS 6: 10 feet with 5/8-inch rod.
7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6: 12 feet with 3/4-inch rod.
8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 :12 feet with 3/4-inch rod.

8. NPS 8 to NPS 12:12 feet with 7/8-inch rod.

J. Install supports for vertical stainless-steel piping every 15 feet.

K. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

L. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

M. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

N. Install supports for vertical PVC piping every 48 inches.

O. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
5. NPS 6: 48 inches with 3/4-inch rod.
6. NPS 8: 48 inches with 7/8-inch rod.

P. Install supports for vertical PP piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.

Q. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Division 22 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.

c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.10 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

    a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
    b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:

    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:

        1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
        2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.

d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.12 PIPING SCHEDULE

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.

B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

3.13 VALVE SCHEDULE

A. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated, water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water-hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.
18. Specialty valves.
19. Flexible connectors.
20. Water meters.

B. Related Requirements:

1. Division 22 "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 "Domestic Water Piping" for water meters.
3. Division 22 "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Division 22 "Medical Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Division 22 "Emergency Plumbing Fixtures" for water tempering equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

B. The product descriptions listed in the section may not all be used on this project. Refer to the Product Schedules and details on the drawings for the specific application for each product or material. Products shown on the schedule for a specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

2.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
1. Standard: ASSE 1001.
2. Size: NPS 1/4 to NPS 3, as required to match connected piping.
3. Body: Bronze.
4. Inlet and Outlet Connections: Threaded.
5. Finish: Chrome plated.

B. Pressure Vacuum Breakers:
1. Standard: ASSE 1020.
2. Operation: Continuous-pressure applications.
3. Pressure Loss: 5 psig maximum, through middle third of flow range.
4. Pressure Loss at Design Flow Rate: 5 psi max.
5. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.4 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Standard: ASSE 1003.
2. Pressure Rating: Initial working pressure of 150 psig.
3. Design Flow Rate: See Drawings.
4. Design Inlet Pressure: See Drawings.
5. Design Outlet Pressure Setting: See Drawings:
6. Body: Bronze with chrome-plated finish for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
7. Valves for Booster Heater Water Supply: Include integral bypass.
8. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

B. Water-Control Valves:
1. Description: Pilot-operated, diaphragm-type, single-seated, main water-control valve.
2. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
3. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
   a. Pattern: Angle or Globe-valve design.
   b. Trim: Stainless steel.

4. Design Flow: See Drawings.
5. Design Inlet Pressure: See Drawings.
6. Design Outlet Pressure Setting: See Drawings.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

2.5 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
2. Body: Brass or bronze.
3. Size: Same as connected piping, but not larger than NPS 2.
4. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:
1. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
2. Size: Same as connected piping, but not smaller than NPS 2-1/2.

C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

D. Memory-Stop Balancing Valves:
1. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 2 or smaller.
4. Body: Copper alloy.
5. Port: Standard or full port.
6. Ball: Chrome-plated brass.
7. Seats and Seals: Replaceable.

8. End Connections: Solder joint or threaded.
9. Handle: Vinyl-covered steel with memory-setting device.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:

    a. Strainers NPS 2 and Smaller: 0.033 inch.
    b. Strainers NPS 2-1/2 to NPS 4 0.045 inch.
    c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: Factory-installed, hose-end drain valve.

2.7 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS ¾.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS ¾ threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.8 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: 150-psig minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.9 SPECIALTY VALVES

A. Comply with requirements for general-duty metal valves in Division 22 "Ball Valves for Plumbing Piping," "Butterfly Valves for Plumbing Piping," "Check Valves for Plumbing Piping," and "Gate Valves for Plumbing Piping."

B. CPVC Union Ball Valves:
1. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature: 150 psig 73 deg F.
c. Body Material: CPVC.
d. Body Design: Union type.
e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.
g. Ball: CPVC; full port.
h. Seals: PTFE or EPDM-rubber O-rings.
i. Handle: Tee shaped.

C. PVC Union Ball Valves:
1. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature:150 psig 73 deg F.
c. Body Material: PVC.
d. Body Design: Union type.
e. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
f. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.
g. Ball: PVC; full port.
h. Seals: PTFE or EPDM-rubber O-rings.
i. Handle: Tee shaped.

D. CPVC Non-union Ball Valves:
1. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature:150 psig 73 deg F.
c. Body Material: CPVC.
d. Body Design: Non-union type.
e. End Connections: Socket or threaded.
f. Ball: CPVC; full or reduced port.
g. Seals: PTFE or EPDM-rubber O-rings.
h. Handle: Tee shaped.

E. PVC Non-union Ball Valves:
1. Description:

a. Standard: MSS SP-122.
b. Pressure Rating and Temperature: 150 psig at 73 deg F.
c. Body Material: PVC.
d. Body Design: Non-union type.
e. End Connections: Socket or threaded.
f. Ball: PVC; full or reduced port.
g. Seals: PTFE or EPDM-rubber O-rings.
h. Handle: Tee shaped.

F. CPVC Butterfly Valves:
1. Description:

a. Pressure Rating and Temperature: 150 psig at 73 deg F.
b. Body Material: CPVC.
c. Body Design: Lug or wafer type.
d. Seat: EPDM rubber.
e. Seals: PTFE or EPDM-rubber O-rings.
f. Disc: CPVC.
g. Stem: Stainless steel.
h. Handle: Lever.

G. PVC Butterfly Valves:
1. Description:

a. Pressure Rating and Temperature: 150 psig at 73 deg F Insert temperature.
b. Body Material: PVC.
c. Body Design: Lug or wafer type.
d. Seat: EPDM rubber.
e. Seals: PTFE or EPDM-rubber O-rings.
f. Disc: PVC.
g. Stem: Stainless steel.
h. Handle: Lever.

H. CPVC Ball Check Valves:
1. Description:

a. Pressure Rating and Temperature: 150 psig at 73 deg F.
b. Body Material: CPVC.
c. Body Design: Union-type ball check.
d. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
e. End Connections for Valves NPS 2-1/2 to NPS 4 Detachable, socket or threaded.
f. Ball: CPVC.
g. Seals: EPDM- or FKM-rubber O-rings.

I. PVC Ball Check Valves:
   1. Description:

      a. Pressure Rating and Temperature: 150 psig at 73 deg F.
      b. Body Material: PVC.
      c. Body Design: Union-type ball check.
      d. End Connections for Valves NPS 2 and Smaller: Detachable, socket or threaded.
      e. End Connections for Valves NPS 2-1/2 to NPS 4: Detachable, socket or threaded.
      f. Ball: PVC.
      g. Seals: EPDM- or FKM-rubber O-rings.

J. CPVC Gate Valves:
   1. Description:

      a. Pressure Rating and Temperature: 150 psig at 73 deg F.
      b. Body Material: CPVC.
      c. Body Design: Nonrising stem.
      d. End Connections for Valves NPS 2 and Smaller: socket or threaded.
      e. End Connections for Valves NPS 2-1/2 to NPS 4: Socket or threaded.
      f. Gate and Stem: Plastic.
      g. Seals: EPDM rubber.
      h. Handle: Wheel.

K. PVC Gate Valves:
   1. Description:

      a. Pressure Rating and Temperature: 150 psig at 73 deg F.
      b. Body Material: PVC.
      c. Body Design: Nonrising stem.
      d. End Connections for Valves NPS 2 and Smaller: Socket or threaded.
      e. End Connections for Valves NPS 2-1/2 to NPS 4: Socket or threaded.
      f. Gate and Stem: Plastic.
      g. Seals: EPDM rubber.
      h. Handle: Wheel.

2.10 FLEXIBLE CONNECTORS

A. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

   1. Working-Pressure Rating: Minimum 250 psig.
   2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
   3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.

   1. Working-Pressure Rating: Minimum 250 psig.
   2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.11 WATER METERS

A. Displacement-Type Water Meters:
   1. Description:

      a. Standard: AWWA C700.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: Nutating disc; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. End Connections: Threaded.

B. Turbine-Type Water Meters:
   1. Description:

      a. Standard: AWWA C701.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: Turbine; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. End Connections for Meters NPS 2 and Smaller: Threaded.
      g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

C. Compound-Type Water Meters:
   1. Description:

      a. Standard: AWWA C702.
      b. Pressure Rating: 150-psig working pressure.
      c. Body Design: With integral mainline and bypass meters; totalization meter.
      d. Registration: In gallons or cubic feet as required by utility company.
      e. Case: Bronze.
      f. Pipe Connections: Flanged.

D. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

E. Remote Registration System: Encoder type complying with AWWA C707; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.

   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe

diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.

3. Do not install bypass piping around backflow preventers.

B. Install water regulators with inlet and outlet shutoff valvesand bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.

C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

D. Install balancing valves in locations where they can easily be adjusted.

E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

F. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve, and pump.

G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06 "Rough Carpentry."

H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06 "Rough Carpentry."

I. Install ground hydrants with 1 cu. yd. of crushed gravel around drain hole. Set ground hydrants with box flush with grade.

J. Install draining-type post hydrants with 1 cu. yd. of crushed gravel around drain hole. Set post hydrants in concrete paving or in 1 cu. ft. of concrete block at grade.

K. Set nonfreeze, nondraining-type post hydrants in concrete or pavement.

L. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.

M. Install water-hammer arresters in water piping according to PDI-WH 201.

N. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

O. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

P. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

Q. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Comply with requirements for ground equipment in Division 26 "Grounding and Bonding for Electrical Systems."

B. Fire-retardant-treated-wood blocking is specified in Division 26 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. Pressure vacuum breakers.
2. Intermediate atmospheric-vent backflow preventers.
3. Reduced-pressure-principle backflow preventers.
4. Double-check, backflow-prevention assemblies.
5. Carbonated-beverage-machine backflow preventers.
6. Dual-check-valve backflow preventers.
7. Reduced-pressure-detector, fire-protection, backflow-preventer assemblies.
8. Double-check, detector-assembly backflow preventers.
9. Water pressure-reducing valves.
10. Calibrated balancing valves.
11. Primary, thermostatic, water mixing valves.
12. Manifold, thermostatic, water mixing-valve assemblies.
13. Photographic-process, thermostatic, water mixing-valve assemblies.
14. Primary water tempering valves.
15. Outlet boxes.
16. Hose stations.
17. Supply-type, trap-seal primer valves.
18. Trap-seal primer systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test each pressure vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.

B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION

SECTION 22 11 23.21

INLINE, DOMESTIC-WATER PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. In-line, sealless centrifugal pumps.
2. Horizontally mounted, in-line, separately coupled centrifugal pumps.
3. Horizontally mounted, in-line, close-coupled centrifugal pumps.
4. Vertically mounted, in-line, close-coupled centrifugal pumps.

B. Related Requirements:

1. Division 22 "Domestic-Water Packaged Booster Pumps" for booster systems.
2. Division 33 "Potable Water Supply Wells" for well pumps.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction materials, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Detail pumps and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members to which pumps will be attached.
2. Size and location of initial access modules for acoustical tile.

B. Seismic Qualification Data: Certificates, for inline, domestic-water pumps, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For inline, domestic-water pumps to include in operation and maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written instructions for handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent

2.2 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: UL 778 for motor-operated water pumps.

C. Drinking Water System Components - Health Effects and Drinking Water System Components - Lead Content Compliance: NSF 61 and NSF 372.

D. Seismic Performance: Inline, domestic-water pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.3 IN-LINE, SEALLESS CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps.

B. Capacities and Characteristics: Refer to requirements on plans.

C. Pump Construction:

1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
2. Minimum Working Pressure: 125 psig.
3. Maximum Continuous Operating Temperature: 220 deg F.
4. Casing: Bronze, with threaded or companion-flange connections.
5. Impeller: stainless steel.
6. Motor: Three speed.

2.4 HORIZONTALLY MOUNTED, IN-LINE, SEPARATELY COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, separately coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shafts mounted horizontal.

A. Capacities and Characteristics: Refer to requirements on plans.

B. Pump Construction:

1. Casing:

a. Radially split bronze with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: permanently lubricated ball type.
7. Minimum Working Pressure: 175 psig.
8. Continuous Operating Temperature: 200 deg F.

C. Motor: Single speed, with permanently lubricated ball bearings; and resiliently mounted to pump casing.

2.5 HORIZONTALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

A. Capacities and Characteristics: Refer to requirements on plans.

B. Pump Construction:

1. Casing:

a. Radially split bronze with threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections.
b. Built to permit servicing of pump internals without disturbing the casing or the suction and discharge piping.
c. Gauge port tappings at suction and discharge nozzles.

2. Impeller: Bronze, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: Steel shaft with deflector, with copper-alloy shaft sleeve. Include water slinger on shaft between motor and seal.
4. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket.
6. Bearings: permanently lubricated ball type.
7. Minimum Working Pressure: 175 psig.
8. Continuous Operating Temperature: 225 deg F.

C. Motor: Single speed, with grease-lubricated ball bearings; resiliently mounted to pump casing.

2.6 VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS

A. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted vertical.

A. Capacities and Characteristics: Refer to requirements on plans.

B. Pump Construction:

1. Casing: Radially split bronze, with wear rings and threaded companion-flange connections for pumps with NPS 2 pipe connections and flanged connections for pumps with NPS 2-1/2 pipe connections. Include pump manufacturer's base attachment for mounting pump on concrete base.
2. Impeller: Bronze, statically and dynamically balanced, closed, and keyed to shaft.
3. Shaft and Shaft Sleeve: stainless-steel shaft, with copper-alloy shaft sleeve.
4. Shaft Coupling: Flexible or rigid type if pump is provided with coupling.
5. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
6. Bearings: Oil-lubricated; bronze-journal or ball type.
7. Minimum Working Pressure: 175 psig.
8. Continuous Operating Temperature: 225 deg F.

C. Motor: Single speed, with grease-lubricated ball bearings; rigidly mounted to pump casing.

2.7 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.8 CONTROLS

A. Pressure Switches: Electric, adjustable for control of water-supply pump.

1. Type: Water-immersion pressure sensor, for installation in piping.
2. Enclosure: NEMA 250, Type 4X.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V ac.
6. Settings: Start pump at adjustable pressure and stop pump at adjustable pressure.

B. Thermostats: Electric; adjustable for control of hot-water circulation pump.

1. Type: Water-immersion temperature sensor, for installation in piping.
2. Range: 50 to 200 deg F.
3. Enclosure: NEMA 250, Type 4X.
4. Operation of Pump: On or off.
5. Transformer: Provide if required.
6. Power Requirement: 120 V ac.
7. Settings: Start pump at adjustable temperature and stop pump at adjustable temperature.

C. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120 V ac.
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days.

D. Time-Delay Relays: Electric, for control of hot-water circulation pump between water heater and connected hot-water storage tank.

1. Type: Adjustable time-delay relay.
2. Range: Up to five minutes.
3. Setting: Five minutes.
4. Enclosure: NEMA 250, Type 4X.
5. Operation of Pump: On or off.
6. Transformer: Provide if required.
7. Power Requirement: 120 V ac.
8. Programmable Sequence of Operation: Limit pump operation to periods of burner operation, plus maximum five minutes after the burner stops.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for domestic-water-piping system to verify actual locations of piping connections before pump installation.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Mount pumps in orientation complying with manufacturer's written instructions.

C. Pump Mounting:

1. Install vertically mounted, in-line, close-coupled centrifugal pumps with cast-iron base mounted on concrete base using vibration isolation type and deflection as specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment." & "Vibration Controls for Plumbing Piping and Equipment." Comply with requirements for concrete base specified in Division 03 "Cast-in-Place Concrete."
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.

D. Install continuous-thread hanger rods and vibration isolation of size required to support pump weight.

1. Comply with requirements for vibration isolation devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment." & "Vibration Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required.
2. Comply with requirements for hangers and supports specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

E. Install pressure switches in water-supply piping.

F. Install thermostats in hot-water return piping.

G. Install timers on wall in engineer's office.

H. Install time-delay relays in piping between water heaters and hot-water storage tanks.

3.3 PIPING CONNECTIONS

A. Comply with requirements for piping specified in Division 22 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to inline, domestic-water pumps, allow space for service and maintenance.

C. Connect domestic-water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.

1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:

a. Horizontally mounted, in-line, separately coupled centrifugal pumps.

b. Horizontally mounted, in-line, close-coupled centrifugal pumps.
c. Vertically mounted, in-line, close-coupled centrifugal pumps.
d. Comply with requirements for flexible connectors specified in Division 22 "Domestic Water Piping."

D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for strainers specified in Division 22 "Domestic Water Piping Specialties." Comply with requirements for valves specified in the following Division 22:

1. "Ball Valves for Plumbing Piping."
2. "Butterfly Valves for Plumbing Piping."
3. "Check Valves for Plumbing Piping."
4. "Gate Valves for Plumbing Piping."
5. Install pressure gauge and snubber at suction of each pump and pressure gauge and snubber at discharge of each pump. Install at integral pressure-gauge tappings where provided or install pressure-gauge connectors in suction and discharge piping around pumps. Comply with requirements for pressure gauges and snubbers specified in Division 22 "Meters and Gages for Plumbing Piping."

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between temperature controllers and devices.

C. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

3.5 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment" for identification of pumps.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

F. Inline, domestic-water pump will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.8 ADJUSTING

A. Adjust inline, domestic-water pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust initial temperature set points.

C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Requirements:

1. Division 22 "Facility Sanitary Sewers" for sanitary sewerage piping and structures outside the building.
2. Division 22 "Sanitary Sewerage Pumps" for effluent and sewage pumps.
3. Division 22 "Chemical-Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For hubless, single-stack drainage system. Include plans, elevations, sections, and details.

1.4 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For waste and vent piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.5 FIELD CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner's Representative no fewer than 5 days in advance of proposed interruption of sanitary waste service.
2. Do not proceed with interruption of sanitary waste service without Owner's written permission.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Soil, Waste, and Vent Piping: 10-foot head of water.
2. Waste, Force-Main Piping: 100 psig.

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

2.2 PIPING MATERIALS

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. The product descriptions listed in the section may not all be used on this project. Refer to the Piping Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS-EPOXY LINED

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

D. Epoxy Coating:
   1. Interior of pipe shall have a minimum of 5 mil thickness epoxy coating.
   2. The exterior of the pipe shall have a minimum of 2.5 mil thickness of resin coating.
   3. Per EN877 Coatings Requirements, the epoxy coated cast iron soil pipe shall be:
      a. Chemical resistant from 2 pH to 12 pH for 30 days at ambient temperature.
      b. Resist hot water at 203˚F for 24 hours.
      c. Salt spray tested for 1,500 hours.
      d. Tested for temperature cycling by 1,500 cycles of 60˚F and 203˚F water.
      e. Adhesion tested to achieve interior coating Level 1 and exterior coating Level 2 per EN ISO 2409.

2.5 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:

   1. Standards: ASTM C 1277 and CISPI 310.
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

   1. Standards: ASTM C 1277 and ASTM C 1540.
   2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

   1. Standard: ASTM C 1277.
   2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.6 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS-EPOXY LINED

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Single-Stack Aerator Fittings: ASME B16.45, hubless, cast-iron aerator and deaerator drainage fittings.

C. CISPI, Hubless-Piping Couplings:

   1. Standards: ASTM C 1277 and CISPI 310.
   2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Heavy-Duty, Hubless-Piping Couplings:

   1. Standards: ASTM C 1277 and ASTM C 1540.

2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

E. Cast-Iron, Hubless-Piping Couplings:

1. Standard: ASTM C 1277.
2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

F. Epoxy Coating:
1. Interior of pipe shall have a minimum of 5 mil thickness epoxy coating.
2. The exterior of the pipe shall have a minimum of 2.5 mil thickness of resin coating.
3. Per EN877 Coatings Requirements, the epoxy coated cast iron soil pipe shall be:
   a. Chemical resistant from 2 pH to 12 pH for 30 days at ambient temperature.
   b. Resist hot water at 203˚F for 24 hours.
   c. Salt spray tested for 1,500 hours.
   d. Tested for temperature cycling by 1,500 cycles of 60˚F and 203˚F water.
   e. Adhesion tested to achieve interior coating Level 1 and exterior coating Level 2 per EN ISO 2409.

2.7 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.

B. Cast-Iron Drainage Fittings: ASME B16.12, threaded.

C. Steel Pipe Pressure Fittings:

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:

1. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
2. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.8 STAINLESS-STEEL PIPE AND FITTINGS

A. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.

B. Internal Sealing Rings: Elastomeric gaskets shaped to fit socket groove.

2.9 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-on-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot ends unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint, ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping: AWWA C151/A21.51, with round-cut-grooved ends according to AWWA C606.

D. Ductile-Iron, Grooved-End Pipe Appurtenances:

1. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings, with dimensions matching AWWA C110/A 21.10 ductile-iron pipe or AWWA C153/A 21.53 ductile-iron fittings, and complying with AWWA C606 for grooved ends.
2. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.10 COPPER TUBE AND FITTINGS

A. Copper Type DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M, water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.

2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.11 ABS PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

C. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

D. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

E. Solvent Cement: ASTM D 2235.

2.12 PVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

C. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

D. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

E. Adhesive Primer: ASTM F 656.

F. Solvent Cement: ASTM D 2564.

2.13 CPVC PIPE AND FITTINGS

A. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

B. Solid-Wall CPVC Pipe: ASTM Cell Classification 23447 in accordance with ASTM Standard D 1784, drain, waste, and vent.

C. CPVC Socket Fittings: ASTM Cell Classification 23447 in accordance with ASTM Standard D 1784, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656 or as recommended by piping manufacturer.

E. Solvent Cement: ASTM F 4983 or as recommended by piping manufacturer.

2.14 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
2. Unshielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1173.
b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.
d. Sleeve Materials:

1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

3. Shielded, Nonpressure Transition Couplings:

a. Standard: ASTM C 1460.
b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
c. End Connections: Same size as and compatible with pipes to be joined.

4. Pressure Transition Couplings:

a. Standard: AWWA C219.
b. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
c. Center-Sleeve Material: Manufacturer's Standard.
d. Gasket Material: Natural or synthetic rubber.
e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. Dielectric Unions:

a. Description:

1) Standard: ASSE 1079.
2) Pressure Rating: 125 psig minimum at 180 deg F.
3) End Connections: Solder-joint copper alloy and threaded ferrous.

2. Dielectric Flanges:

a.

b. Description:

1) Standard: ASSE 1079.
2) Factory-fabricated, bolted, companion-flange assembly.
3) Pressure Rating: 125 psig minimum at 180 deg F.
4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

3. Dielectric-Flange Insulating Kits:

a. Description:

1) Nonconducting materials for field assembly of companion flanges.
2) Pressure Rating: 150 psig.
3) Gasket: Neoprene or phenolic.
4) Bolt Sleeves: Phenolic or polyethylene.
5) Washers: Phenolic with steel backing washers.

4. Dielectric Nipples:

a. Description:

1) Standard: IAPMO PS 66.
2) Electroplated steel nipple.
3) Pressure Rating: 300 psig at 225 deg F.
4) End Connections: Male threaded or grooved.
5) Lining: Inert and noncorrosive, propylene.

2.15 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105/A 21.5.

B. Material: high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.

C. Form: tube.

D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.

1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
2. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.

    a. Straight tees, elbows, and crosses may be used on vent lines.

3. Do not change direction of flow more than 90 degrees.
4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.

    a. Reducing size of waste piping in direction of flow is prohibited.

L. Lay buried building waste piping beginning at low point of each system.

1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
3. Maintain swab in piping and pull past each joint as completed.

M. Install soil and waste and vent piping at the following minimum slopes unless otherwise indicated:

1. Building Sanitary Waste: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Waste Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

O. Install steel piping according to applicable plumbing code.

P. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

Q. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

R. Install aboveground ABS piping according to ASTM D 2661.

S. Install aboveground PVC piping according to ASTM D 2665.

T. Install underground ABS and PVC piping according to ASTM D 2321.

U. Install engineered soil and waste and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Hubless, Single-Stack Drainage System: Comply with ASME B16.45 and hubless, single-stack aerator fitting manufacturer's written installation instructions.
3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

V. Install underground, ductile-iron, force-main piping according to AWWA C600.

1. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints.
2. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
3. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

W. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105/A 21.5.

X. Install force mains at elevations indicated.

Y. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping.

    a. Comply with requirements for backwater valves specified in Division 22 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.

a. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
b. Comply with requirements for cleanouts specified in Division 22 "Sanitary Waste Piping Specialties."

3. Install drains in sanitary waste gravity-flow piping.

a. Comply with requirements for drains specified in Division 22 "Sanitary Waste Piping Specialties."

Z. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

AA. Install sleeves for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for sleeves specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install sleeve seals for piping penetrations of concrete walls and slabs.

1. Comply with requirements for sleeve seals specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

CC. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Division 22 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1.

1. Cut threads full and clean using sharp dies.
2. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
c. Do not use pipe sections that have cracked or open welds.

E. Join stainless-steel pipe and fittings with gaskets according to ASME A112.3.1.

F. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

G. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

H. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

I. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 appendixes.
4. CPVC Piping: Join using a two-step solvent cement joining process with primer conforming to ASTM F656 and solvent cement conforming to ASTM F493.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4 Use dielectric flange kits or nipples.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. Comply with requirements in Division 22 "Ball Valves for Plumbing Piping," "Butterfly Valves for Plumbing Piping," "Check Valves for Plumbing Piping," and "Gate Valves for Plumbing Piping" for general-duty valve installation requirements.

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Floor Drains: Drain outlet backwater valves unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Comply with requirements for backwater valve specified in Division 22 "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Install individual, straight, horizontal piping runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 84 inches with 3/8-inch rod.
2. NPS 3: 96 inches with 1/2-inch rod.
3. NPS 4: 108 inches with 1/2-inch rod.
4. NPS 6: 10 feet with 5/8-inch rod.

K. Install supports for vertical stainless-steel piping every 10 feet.

L. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

M. Install supports for vertical copper tubing every 10 feet.

N. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

O. Install supp Install hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 36 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 54 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 54 inches with 7/8-inch rod.

P. Supports for vertical ABS, PVC, and CPVC piping every 48 inches.

Q. Support piping and tubing not listed above according to MSS SP-58 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect waste and vent piping to the following:

1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
5. Install horizontal backwater valves in pit with pit cover flush with floor.
6. Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 "Sanitary Waste Piping Specialties."
7. Equipment: Connect waste piping as indicated.

    a. Provide shutoff valve if indicated and union for each connection.
    b. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping.

B. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.

    a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.

    a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    c. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

    a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
    b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
    c. Air pressure must remain constant without introducing additional air throughout period of inspection.
    d. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved.

    a. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials.

    a. Isolate test source and allow to stand for four hours.
    b. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

D. Exposed ABS, PVC, and CPVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

E. Repair damage to adjacent materials caused by waste and vent piping installation.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backwater valves.
2. Cleanouts.
3. Air-admittance valves.
4. Roof flashing assemblies.
5. Through-penetration firestop assemblies.
6. Miscellaneous sanitary drainage piping specialties.
7. FOG disposal systems.

B. Related Requirements:

1. Division 22 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
2. Division 33 "Storm Utility Drainage Piping" for storm drainage piping and piping specialties outside the building.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene.

B. FOG: Fats, oils, and greases.

C. PVC: Polyvinyl chloride.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include rated capacities, operating characteristics, and accessories for the following:

1. FOG disposal systems.

B. Shop Drawings:

1. Show fabrication and installation details for frost-resistant vent terminals.
2. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For FOG disposal systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Cultures: Provide 1-gal. bottles of bacteria culture recommended by manufacturer of FOG disposal systems equal to 200 percent of amount installed, but no fewer than two 1-gal. bottles.

PART 2 - PRODUCTS

2.1 The product descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules and details on the drawings for the specific application for each product or material. Products not shown on the schedule or details for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

2.2 ASSEMBLY DESCRIPTIONS

A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 14 for plastic sanitary waste piping specialty components.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

2.3 BACKWATER VALVES

A. Horizontal, Cast-Iron Backwater Valves:

1. Standard: ASME A112.14.1.
2. Size: Same as connected piping.
3. Body: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Hub and spigot or hubless.
6. Type Check Valve: Removable, bronze, swing check, factory assembled, or field modified to hang open for airflow unless subject to backflow condition.
7. Extension: ASTM A 74, Service class; full-size, cast-iron, soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Drain-Outlet Backwater Valves:

1. Size: Same as floor drain outlet.
2. Body: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
3. Check Valve: Removable ball float.
4. Inlet: Threaded.
5. Outlet: Threaded or spigot.

C. Horizontal, Plastic Backwater Valves:

1. Size: Same as connected piping.
2. Body: ABS or PVC.
3. Cover: Same material as body with threaded access to check valve.
4. Check Valve: Removable swing check.
5. End Connections: Socket type.

2.4 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected drainage piping
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping per the piping schedules on drawings.
4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Stainless-Steel Exposed Cleanouts:

1. Standard: ASME A112.3.1.
2. Size: Same as connected drainage piping
3. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.
4. Closure: Stainless-steel plug with seal.

C. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M heavy-duty, adjustable housing, adjustable housing cleanout.
2. Size: Same as connected branch.
3. Body or Ferrule: Cast iron.
4. Clamping Device: Required.
5. Outlet Connection: Same type as pipe.
6. Closure: Brass plug.
7. Adjustable Housing Material: Cast iron with threads, setscrews or other device.

8. Frame and Cover Material and Finish: Polished bronze material and finish.
9. Frame and Cover Shape: Round.
10. Top Loading Classification: Extra Heavy Duty.
11. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

D. Stainless-Steel Exposed Floor Cleanouts:

1. Standard: ASME A112.3.1.
2. Size: Same as connected branch.
3. Housing: Stainless steel.
4. Closure: Stainless steel with seal.
5. Riser: ASTM A 74, Extra-Heavy stainless-steel drainage pipe fitting and riser to cleanout.
6. Body or Ferrule: Stainless steel.
7. Clamping Device: Required.
8. Outlet Connection: Same as pipe.
9. Closure: Brass plug.
10. Adjustable Housing Material: Cast iron with threads, setscrews or other device.
11. Frame and Cover Material and Finish: Polished bronze.
12. Frame and Cover Shape: Round.
13. Top Loading Classification: Extra Heavy Duty.

E. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure Plug:

    a. Brass.
    b. Countersunk or raised head.
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as or not more than one size smaller than cleanout size.

5. Wall Access: Round, stainless-steel cover plate with screw.

F. Plastic Floor Cleanouts:

1. Size: Same as connected branch.
2. Body: PVC.
3. Closure Plug: PVC.
4. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.5 AIR-ADMITTANCE VALVES

A. Fixture Air-Admittance Valves:

1. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected fixture or branch vent piping.

B. Stack Air-Admittance Valves:

1. Standard: ASSE 1050 for vent stacks.
2. Housing: Plastic.
3. Operation: Mechanical sealing diaphragm.
4. Size: Same as connected stack vent or vent stack.

C. Wall Box for Air-Admittance Valves:

1. Description: White plastic housing with white plastic grille, made for recessed installation. Include bottom pipe connection and space to contain one air-admittance valve.
2. Size: Approximately 9 inches wide by 8 inches high by 4 inches deep.

2.6 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:

1. Description: Manufactured assembly made of 6.0-lb/sq. ft., 0.0938-inch-thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

a. Low-Silhouette Vent Cap: With vandal-proof vent cap.

2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.
3. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting for plastic stacks: ASTM A 48/A 48M, gray-iron, hubless-pattern wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

5. Special Coating for corrosion-resistant plastic stacks: Corrosion resistant on interior of fittings.

2.8 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.

a. NPS 2: 4-inch- minimum water seal.
b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:

1. Standard: ASME A112.6.4.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.9 FOG DISPOSAL SYSTEMS

A. FOG Disposal Systems:

1. Standard: ASME A112.14.6, for removing solids from and breaking down and digesting suspended fats, oils, and greases from food-preparation or processing wastewater.
2. Flow-Control Fitting: Matching unit size.
3. Strainer Unit: Stainless-steel housing with aluminum cover and removable-basket-type, stainless-steel, wire-mesh strainer. Include pressure plug instead of cover. Include extra basket. Include stainless-steel extension.
4. Media Chamber: Stainless-steel housing and aluminum cover, with internal baffles, piping, plastic coalescing surfaces, and clarifier section with test ports. Include stainless-steel extension.
5. Shelf: Stainless steel, 19-1/2 inches wide by 13 inches high by 8-3/4 inches deep, for metering pump, control devices, and culture bottle.
6. Culture Metering Pump, Timer, Control, and Tubing: Proprietary.
7. Culture: Include 1-gal. bottle, as recommended by unit manufacturer.
8. Piping: Waste and vent piping is specified in Division 22 "Sanitary Waste and Vent Piping."

2.10 MOTORS

A. General requirements for motors are specified in Division 22 "Common Motor Requirements for Plumbing Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, motor shall be large enough, so driven load will not require motor to operate in service factor range above 1.0.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Equipment Mounting:

1. Install FOG disposal systems on cast-in-place concrete equipment base(s).

a. Comply with requirements for equipment bases and foundations specified in Division 33 "Cast-in-Place Concrete.

2. Comply with requirements for vibration-isolation and seismic-control devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
3. Comply with requirements for vibration-isolation devices specified in Division 22 "Vibration Controls for Plumbing Piping and Equipment."

B. Install backwater valves in building drain piping.

1. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Division 07 "Sheet Metal Flashing and Trim."

G. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

1. Comply with requirements in Division 07 "Penetration Firestopping."

H. Assemble open drain fittings and install with top of hub 2 inches above floor.

I. Install deep-seal traps on floor drains and other waste outlets, if indicated.

J. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

K. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

L. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.

M. Install vent caps on each vent pipe passing through roof.

N. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

O. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

P. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.

Q. Assemble components of FOG disposal systems and install on floor.

1. Install trap, vent, fresh-air inlet, and flow-control fitting according to authorities having jurisdiction.
2. Install shelf fastened to reinforcement in wall construction and adjacent to unit, unless otherwise indicated.

3. Install culture bottle, culture metering pump, timer, and control on shelf. Install tubing between culture bottle, metering pump, and chamber.

R. Install wood-blocking reinforcement for wall-mounting-type specialties.

S. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Division 22 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. FOG Disposal Systems: Connect inlet and outlet to unit, connect flow-control fitting and fresh-air inlet piping to unit inlet piping, and connect vent piping between trap and media chamber. Connect electrical power.

D. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FLASHING INSTALLATION

A. Comply with requirements in Division 07 "Sheet Metal Flashing and Trim."

B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.

C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

D. Set flashing on floors and roofs in solid coating of bituminous cement.

E. Secure flashing into sleeve and specialty clamping ring or device.

F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 "Sheet Metal Flashing and Trim."

G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:

1. FOG disposal systems.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit.

1. Nameplates and signs are specified in Division 07 "Identification for Plumbing Piping and Equipment."

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled FOG disposal systems and their installation, including piping and electrical connections, and to assist in testing.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.6 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain FOG disposal systems. Refer to Division 01 "Demonstration and Training."

END OF SECTION

SECTION 22 14 13

FACILITY STORM DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.
3. Encasement for underground metal piping.

B. Related Sections:

1. Division 22 "Sump Pumps" for storm drainage pumps.
2. Division 33 "Storm Utility Drainage Piping" for storm drainage piping outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm Drainage Piping: 10-foot head of water.
2. Storm Drainage, Force-Main Piping: 100 psig.

B. Seismic Performance: Storm drainage piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For controlled-flow or siphonic roof drainage system. Include calculations, plans, and details.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For storm drainage piping, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Field quality-control reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping System Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm-Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Owner' Representative no fewer than five days in advance of proposed interruption of storm-drainage service.
2. Do not proceed with interruption of storm-drainage service without Owner Representative's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Piping Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy classes.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. CISPI, Hubless-Piping Couplings:

1. Standards: ASTM C 1277 and CISPI 310.
2. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

C. Heavy-Duty, Hubless-Piping Couplings:
1. Standards: ASTM C 1277 and ASTM C 1540.
2. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:
1. Standard: ASTM C 1277.
2. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight. Include square-cut-grooved or threaded ends matching joining method.

B. Galvanized-Cast-Iron Drainage Fittings: ASME B16.12 threaded.

C. Steel-Pipe Pressure Fittings:

1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Schedule 40, seamless steel pipe. Include ends matching joining method.
2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, standard pattern.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

E. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
1. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 536 ductile-iron castings, ASTM A 47/A 47M malleable-iron castings, ASTM A 234/A 234M forged-steel fittings, or ASTM A 106/A 106M steel pipes with dimensions matching ASTM A 53/A 53M steel pipe, and complying with AWWA C606 for grooved ends.
2. Grooved Mechanical Couplings for Galvanized-Steel Piping: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber gasket suitable for hot and cold water; and bolts and nuts.

2.5 DUCTILE-IRON PIPE AND FITTINGS

A. Ductile-Iron, Mechanical-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, mechanical-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.

3. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Ductile-Iron, Push-On-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
2. Ductile-Iron Fittings: AWWA C110/A21.10, push-on-joint ductile- or gray-iron standard pattern or AWWA C153/A21.53, ductile-iron compact pattern.
3. Gaskets: AWWA C111/A21.11, rubber.

C. Ductile-Iron, Grooved-Joint Piping:

1. Ductile-Iron Pipe: AWWA C151/A21.51 with round-cut-grooved ends according to AWWA C606.
2. Ductile-Iron-Pipe Appurtenances:
   a. Grooved-End, Ductile-Iron Fittings: ASTM A 536 ductile-iron castings with dimensions matching AWWA C110/A21.10 ductile-iron pipe or AWWA C153/A21.53 ductile-iron fittings and complying with AWWA C606 for grooved ends.
   b. Grooved Mechanical Couplings for Ductile-Iron Pipe: ASTM F 1476, Type I. Include ferrous housing sections with continuous curved keys; EPDM-rubber center-leg gasket suitable for hot and cold water; and bolts and nuts.

2.6 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast-copper fittings or ASME B16.29, wrought-copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.

E. Copper Pressure Fittings:

1. Copper Fittings: ASME B16.18, cast-copper-alloy fittings or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.7 ABS PIPE AND FITTINGS

A. Solid-Wall ABS Pipe: ASTM D 2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F 628, Schedule 40.

C. ABS Socket Fittings: ASTM D 2661, made to ASTM D 3311, drain, waste, and vent patterns.

D. Solvent Cement: ASTM D 2235.

2.8 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Cellular-Core PVC Pipe: ASTM F 891, Schedule 40.

C. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

D. Adhesive Primer: ASTM F 656.

E. Solvent Cement: ASTM D 2564.

2.9 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified-piping-system fitting.
3. Unshielded, Nonpressure Transition Couplings:
    a. Standard: ASTM C 1173.
    b. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    c. Sleeve Materials:

        1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
        2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
        3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:
    a. Standard: ASTM C 1460.
    b. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:
    a. Standard: AWWA C219.
    b. Description: Metal, sleeve-type couplings same size as, with pressure rating at least equal to and ends compatible with, pipes to be joined.
    c. Center-Sleeve Material: To match pipe type.
    d. Gasket Material: Natural or synthetic rubber.
    e. Metal Component Finish: Corrosion-resistant coating or material.

B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
   a. Description:

      1) Standard: ASSE 1079.
      2) Pressure Rating: 150 psig at 180 deg F (82 deg C).
      3) End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Flanges:

   a.
   b. Description:

      1) Standard: ASSE 1079.
      2) Factory-fabricated, bolted, companion-flange assembly.
      3) Pressure Rating: 150 psig.
      4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

4. Dielectric-Flange Insulating Kits:
   a. Description:

      1) Nonconducting materials for field assembly of companion flanges.
      2) Pressure Rating: 150 psig.
      3) Gasket: Neoprene or phenolic.
      4) Bolt Sleeves: Phenolic or polyethylene.
      5) Washers: Phenolic with steel-backing washers.

5. Dielectric Nipples:

   a. Description:

      1) Electroplated steel nipple complying with ASTM F 1545.
      2) Pressure Rating: 300 psig.
      3) End Connections: Male threaded or grooved.
      4) Lining: Inert and noncorrosive, propylene.

2.10 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Material: High-density, crosslaminated PE film of 0.004-inch or LLDPE film of 0.008-inch minimum thickness.

C. Form: Sheet or tube.

D. Color: Black.

PART 3 - EXECUTION

3.1 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31 "Earth Moving."

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

K. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

M. Install storm drainage piping at the following minimum slopes unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 2 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

O. Install steel piping according to applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

Q. Install aboveground ABS piping according to ASTM D 2661.

R. Install aboveground PVC piping according to ASTM D 2665.

S. Install underground ABS and PVC piping according to ASTM D 2321.

T. Install engineered controlled-flow and siphonic drain specialties and storm drainage piping in locations indicated.

U. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

V. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

W. Install force mains at elevations indicated.

X. Plumbing Specialties:

1. Install backwater valves in storm drainage gravity-flow piping. Comply with requirements for backwater valves specified in Division 22 "Storm Drainage Piping Specialties."
2. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping. Comply with requirements for cleanouts specified in Division 22 "Storm Drainage Piping Specialties."
3. Install drains in storm drainage gravity-flow piping. Comply with requirements for drains specified in Division 22 "Storm Drainage Piping Specialties."

Y. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Z. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

AA. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

BB. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hub-and-Spigot, Cast-Iron Soil Piping Calked Joints: Join according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Hubless, Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Join copper tube and fittings with soldered joints according to ASTM B 828 procedure. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

F. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fittings. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

G. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

H. Plastic, Nonpressure-Piping, Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendices.
3. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendices.

3.4 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in ODs.
2. In Drainage Piping: Shielded, nonpressure transition couplings.
3. In Aboveground Force-Main Piping: Fitting-type transition couplings.
4. In Underground Force-Main Piping:

    a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
    b. NPS 2 and Larger: Pressure transition couplings.

B. Dielectric Fittings:

1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.

2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or flange kits.
4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 "Ball Valves for Plumbing Piping," "Check Valves for Plumbing Piping," and "Gate Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sump pump discharge.

1. Install gate or full-port ball valve for piping NPS 2 and smaller.
2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing-check valve, between pump and shutoff valve, on each sump pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type unless otherwise indicated.
2. Install backwater valves in accessible locations.
3. Comply with requirements for backwater valves specified in Division 22 "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for seismic-restraint devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Comply with requirements for pipe hanger and support devices and installation specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical Piping: MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:

    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.

7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
6. Spacing for 10-foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 84 inches with 3/8-inch rod.
2. NPS 1-1/2: 108 inches with 3/8-inch rod.
3. NPS 2: 10 feet with 3/8-inch rod.
4. NPS 2-1/2: 11 feet with 1/2-inch rod.
5. NPS 3: 12 feet with 1/2-inch rod.
6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
3. NPS 2-1/2: 108 inches with 1/2-inch rod.
4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
5. NPS 6: 10 feet with 5/8-inch rod.
6. NPS 8: 10 feet with 3/4-inch rod.

K. Install supports for vertical copper tubing every 10 feet.

L. Install hangers for ABS and PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
2. NPS 3: 48 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

M. Install supports for vertical ABS and PVC piping every 48 inches.

N. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Install test tees (wall cleanouts) in conductors near floor, and floor cleanouts with cover flush with floor.
2. Install horizontal backwater valves with cleanout cover flush with floor or in pit with pit cover flush with floor.
3. Comply with requirements for backwater valves, cleanouts, and drains specified in Division 22 "Storm Drainage Piping Specialties."

D. Connect force-main piping to the following:

1. Storm Sewer: To exterior force main.
2. Sump Pumps: To sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.8 IDENTIFICATION

A. Identify exposed storm drainage piping. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.
4. Backwater valves.
5. Trench drains.
6. Channel drainage systems.
7. Through-penetration firestop assemblies.
8. Flashing materials.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

PART 3 - See “Writing Guide” Article in the Evaluations for a discussion of this Section's organization and the most efficient way to revise this Section.

3.1 The product descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

3.2 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Adaptors:

1. Description: Manufactured, gray-iron casting, for attaching to horizontal-outlet, parapet roof drain and to exterior, sheet metal downspout.
2. Size: Inlet size to match parapet drain outlet.

B. Downspout Boots:

1. Description: Manufactured, ASTM A 48/A 48M, gray-iron casting, with strap or ears for attaching to building; NPS 4 outlet; and shop-applied bituminous coating.
2. Size: Inlet size to match downspout and NPS 4 outlet.

C. Conductor Nozzles:

1. Description: Bronze body with threaded inlet and bronze wall flange with mounting holes.
2. Size: Same as connected conductor.

D. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk or raised head, brass.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

3.3 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

1. Standard: ASME A112.14.1, for backwater valves.
2. Size: Same as connected piping.
3. Body Material: Cast iron.
4. Cover: Cast iron with bolted or threaded access check valve.
5. End Connections: Match pipe type.
6. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang open for airflow unless subject to backflow condition.
7. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:
   1. Size: Same as floor drain outlet.
   2. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.
   3. Check Valve: Removable ball float.
   4. Inlet: Threaded.
   5. Outlet: Threaded or spigot.

C. Plastic, Horizontal Backwater Valves:
   1. Standard: ASME A112.14.1, for backwater valves.
   2. Size: Same as connected piping.
   3. Body Material: ABS or PVC.
   4. Cover: Same material as body with threaded access to check valve.
   5. Check Valve: Removable swing check.
   6. End Connections: Socket type.

3.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Standard: ASTM E 814, for through-penetration firestop assemblies.
   2. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
   3. Size: Same as connected pipe.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   6. Special Coating: Corrosion resistant on interior of fittings.

3.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M,12 oz./sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

PART 4 - EXECUTION

4.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top 12 inches above grade. Secure to building wall.

D. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
4. Locate cleanouts at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

N. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

O. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

4.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

4.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. lead sheets, 0.0938-inch thickness or thicker. Solder joints of 4.0-lb/sq. ft. lead sheets, 0.0625-inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

4.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 23 11

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig minimum unless otherwise indicated.
2. Service Regulators: 65 psig minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

    a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. PE Pipe: ASTM D 2513, SDR 11.

1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering. Vent casing aboveground.
    c. Aboveground Portion: PE transition fitting.
    d. Outlet shall be threaded or suitable for welded connection.
    e. Tracer wire connection.
    f. Ultraviolet shield.
    g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

4. Transition Service-Line Risers: Factory fabricated and leak tested.

    a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    b. Outlet shall be threaded or suitable for welded connection.
    c. Bridging sleeve over mechanical coupling.
    d. Factory-connected anode.

e. Tracer wire connection.
f. Ultraviolet shield.
g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller.
3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 125 psig.

D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig.
2. Threaded Ends: Comply with ASME B1.20.1.

3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated brass.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Separate packnut with adjustable-stem packing threaded ends.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Lee Brass Company.
   b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Kerotest Manufacturing Corp.
   b. Lyall, R. W. & Company, Inc.
   c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: 80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

G. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage and suitable for natural gas.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.

4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Actaris.
b. American Meter Company.
c. Eclipse Combustion, Inc.
d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
e. Invensys.
f. Maxitrol Company.
g. Richards Industries; Jordan Valve Div.

2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Canadian Meter Company Inc.
b. Eaton Corporation; Controls Div.
c. Harper Wyman Co.
d. Maxitrol Company.
e. SCP, Inc.

2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

2.6 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Capitol Manufacturing Company.
    b. Central Plastics Company.
    c. Hart Industries International, Inc.
    d. Jomar International Ltd.
    e. Matco-Norca, Inc.
    f. McDonald, A. Y. Mfg. Co.
    g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    h. Wilkins; a Zurn company.

2. Description:

    a. Standard: ASSE 1079.
    b. Pressure Rating: 125 psig minimum at 180 deg F.
    c. End Connections: Solder-joint copper alloy and threaded ferrous.

2.7 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 OUTDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 "Earth Moving" for excavating, trenching, and backfilling.

1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.

C. Install underground, PE, natural-gas piping according to ASTM D 2774.

D. Steel Piping with Protective Coating:

1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
3. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gage downstream from each service regulator. Pressure gages are specified in Division 23 "Meters and Gages for HVAC Piping."

3.2 INDOOR PIPING INSTALLATION

A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

Q. Connect branch piping from top or side of horizontal piping.

R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.

S. Do not use natural-gas piping as grounding electrode.

T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

U. Install pressure gage downstream from each line regulator. Pressure gages are specified in Division 22 "Meters and Gages for Plumbing Piping."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 "Sleeves and Sleeve Seals for Plumbing Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.3 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing or copper connector.

B. Install underground valves with valve boxes.

C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

D. Install earthquake valves aboveground outside buildings according to listing.

E. Install anode for metallic valves in underground PE piping.

3.4 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

F. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

G. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hangers and supports specified in Division 22 "Hangers and Supports for Plumbing Piping and Equipment."

B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:

1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.

3.6 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.7 LABELING AND IDENTIFYING

A. Comply with requirements in Division 22 "Identification for Plumbing Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.8 FIELD QUALITY CONTROL

A. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.

B. Natural-gas piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 PAINTING

A. Comply with requirements in Division 09 "Exterior Painting" and "Interior Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.

    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel (flat).
    d. Color: Gray.

C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 OUTDOOR PIPING SCHEDULE

A. Underground natural-gas piping shall be one of the following:

1. See piping schedule on drawings.

2. PE pipe and fittings joined by heat fusion; service-line risers with tracer wire terminated in an accessible location.
3. Coat pipe and fittings with protective coating for steel piping.

B. Aboveground natural-gas piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints.
2. Steel pipe with wrought-steel fittings and welded joints.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.11 INDOOR PIPING SCHEDULE

A. See piping schedule on drawings.

3.12 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

B. Underground: PE valves.

3.13 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

B. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

C. Valves in branch piping for single appliance shall be one of the following:

1. One-piece, bronze ball valve with bronze trim.
2. Two-piece, full-port, bronze ball valves with bronze trim.
3. Bronze plug valve.

END OF SECTION

SECTION 22 34 00

FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Commercial, atmospheric, gas-fired, storage, domestic-water heaters.
2. Commercial, power-burner, gas-fired, storage, domestic-water heaters.
3. Commercial, power-vent, gas-fired, storage, domestic-water heaters.
4. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
5. Commercial, coil-type, finned-tube, gas-fired, domestic-water heaters.
6. Commercial, grid-type, finned-tube, gas-fired, domestic-water heaters.
7. Gas-fired, tankless, domestic-water heaters.
8. Residential, atmospheric, gas-fired, storage, domestic-water heaters.
9. Residential, direct-vent, gas-fired, storage, domestic-water heaters.
10. Residential, power-vent, gas-fired, storage, domestic-water heaters.
11. Commercial, oil-fired, storage, domestic-water heaters.
12. Commercial, large-volume, oil-fired, domestic-water heaters.
13. Residential, oil-fired, storage, domestic-water heaters.
14. Commercial, gas- and oil-fired, domestic-water heaters.
15. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings:

1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of equipment domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.
b. Faulty operation of controls.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: Two year(s).

b. Commercial, Finned-Tube, Gas-Fired, Domestic-Water Heaters:

1) Heat Exchanger: Five years.
2) Controls and Other Components: Two year(s).
3) Separate Hot-Water Storage Tanks: Five years.

c. Gas-Fired, Tankless, Domestic-Water Heaters:

1) Heat Exchanger: Five years.
2) Controls and Other Components: Three years.

d. Residential, Gas-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Controls and Other Components: One years.

e. Commercial, Oil-Fired, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Burner: Two year(s).
3) Controls and Other Components: Two Three year(s).

f. Residential, Oil-Fired, Storage, Domestic-Water Heaters:

1) Storage Tank: Five years.
2) Burner: One year(s).
3) Controls and Other Components: One years.

g. Commercial, Gas- and Oil-Fired, Domestic-Water Heaters:

1) Storage Tank: Five years.

2) Burner: Two year(s).
3) Controls and Other Components: Two years.

h. Compression Tanks: Five years.

PART 2 - PRODUCTS

2.1 The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

C. Heat-Trap Fittings: ASHRAE 90.2.

D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.

E. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

F. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.

G. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

H. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

I. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.

1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.
2. Oil-Fired, Domestic-Water Heaters: ASME rated and stamped.

J. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

K. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Provide dimension that will support bottom of domestic-water heater a minimum of 18 inches (457 mm) above the floor.

L. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 "Quality Requirements" for retesting and reinspecting requirements and "Execution" for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03 "Cast-in-Place Concrete."

1. Exception: Omit concrete bases for commercial domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
2. Maintain manufacturer's recommended clearances.
3. Arrange units so controls and devices that require servicing are accessible.
4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Install anchor bolts to elevations required for proper attachment to supported equipment.
8. Anchor domestic-water heaters to substrate.

B. Residential, Domestic-Water Heater Mounting: Install residential domestic-water heaters on water-heater stand on floor or domestic-water heater mounting bracket as indicated on plans.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

C. Tankless, Domestic-Water Heater Mounting: Install tankless, domestic-water heaters at least 18 inches, or as indicated on plans, above floor on wall bracket.

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Anchor domestic-water heaters to substrate.

D. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 22 "Ball Valves for Plumbing Piping," "Butterfly Valves for Plumbing Piping," and "Gate Valves for Plumbing Piping."

E. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Division 22 "Facility Natural-Gas Piping." or "Facility Liquefied-Petroleum Gas Piping."

F. Install oil-fired, domestic-water heaters according to NFPA 31.

1. Install shutoff valves on fuel-oil supply piping to oil-fired water-heater burners without shutoff valves. Comply with requirements for shutoff valves specified in Division 23 "Facility Fuel-Oil Piping."

G. Install commercial domestic-water heaters with seismic-restraint devices. Comply with requirements for seismic-restraint devices specified in Division 22 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

H. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

I. Install combination temperature-and-pressure relief valves in water piping for domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

J. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water

heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Division 22 "Domestic Water Piping Specialties."

K. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 22 "Meters and Gages for Plumbing Piping."

L. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet. Comply with requirements for valves specified in Division 22 "Ball Valves for Plumbing Piping," "Butterfly Valves for Plumbing Piping," and "Gate Valves for Plumbing Piping," and comply with requirements for thermometers specified in "Meters and Gages for Plumbing Piping."

M. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

N. Fill domestic-water heaters with water.

O. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Division 22 "Domestic Water Piping."

B. Comply with requirements for fuel-oil piping specified in Division 23 "Facility Fuel-Oil Piping."

C. Comply with requirements for gas piping specified in Division 22 "Facility Natural-Gas Piping." Or "Facility Liquefied-Petroleum Gas Piping."

D. Drawings indicate general arrangement of piping, fittings, and specialties.

E. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Division 22 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 "Quality Requirements" for retesting and reinspecting requirements and "Execution" for requirements for correcting the Work.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, gas-fired, tankless, commercial, oil-fired, and commercial, gas- and oil-fired, domestic-water heaters.

END OF SECTION

SECTION 22 41 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bathtubs.
2. Faucets.
3. Whirlpool baths.
4. Walk-in baths.
5. Bidets.
6. Lavatories.
7. Showers.
8. Bar sinks.
9. Kitchen sinks.
10. Laundry trays.
11. Dishwasher air-gap fittings.
12. Laminar-flow, faucet-spout outlets.
13. Disposers.
14. Hot-water dispensers.
15. Water closets.
16. Toilet seats.
17. Supply fittings.
18. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.

B. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For plumbing fixtures and faucets to include in emergency, operation, and operation and maintenance manuals.

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

a. Servicing and adjustments of whirlpool and walk-in baths.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.
3. Flushometer-Tank Repair Kits: Equal to 5 percent of amount of each type installed, but no fewer than two of each type.
4. Toilet Seats: Equal to 5 percent of amount of each type installed, but no fewer than one of each type.

1.7 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of walk-in baths and whirlpool baths that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures of unit shell.
b. Faulty operation of controls, blowers, pumps, heaters, and timers.
c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period for Shells: 20 years from date of Substantial Completion.
3. Warranty Period for Pumps and Blowers: Five years from date of Substantial Completion.
4. Warranty Period for Electronic Controls: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLUMBING EQUIPMENT:

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing-fixture installation.

B. Examine walls, floors, cabinets, and counters for suitable conditions where fixtures will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install plumbing fixtures level and plumb according to roughing-in drawings.

B. Install floor-mounted water closets on closet flange attachments to drainage piping.

C. Install counter-mounting fixtures in and attached to casework.

D. Install pedestal lavatories on pedestals and secured to wood blocking in wall.

E. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball or gate valves if supply stops are not specified with fixture.

F. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

G. Install toilet seats on water closets.

H. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

I. Install shower flow-control fittings with specified maximum flow rates in shower arms.

J. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes unless otherwise indicated.

K. Install disposer in outlet of each sink indicated to have a disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

L. Install dishwasher air-gap fitting at each sink indicated to have air-gap fitting. Connect inlet hose to dishwasher and outlet hose to disposer.

M. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.

N. Set bathtubs and shower receptors in leveling bed of cement grout.

O. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sink. Comply with requirements in Division 22 "Plumbing Piping Insulation."

P. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Division 22 "Escutcheons for Plumbing Piping."

Q. Seal joints between plumbing fixtures, counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07 "Joint Sealants."

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Division 22 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Division 22 "Sanitary Waste and Vent Piping."

D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories and sink**s**. Comply with requirements in Division 22 "Plumbing Piping Insulation."

3.4 ADJUSTING

A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of plumbing fixtures, inspect and repair damaged finishes.

B. Clean plumbing fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed plumbing fixtures and fittings.

D. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

A. Comply with NEMA MG 1 unless otherwise indicated.

B. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Premium efficient, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
2. Motors Smaller Than 15 HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

B. Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.
2. Split phase.
3. Capacitor start, inductor run.
4. Capacitor start, capacitor run.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type.

E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 05 14

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. LED: Light-emitting diode.

F. NC: Normally closed.

G. NO: Normally open.

H. OCPD: Overcurrent protective device.

I. PID: Control action, proportional plus integral plus derivative.

J. RFI: Radio-frequency interference.

K. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.
   1. Include dimensions and finishes for VFCs.
   2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated.
   1. Include mounting and attachment details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Required working clearances and required area above and around VFCs.
   2. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements.
   3. Show support locations, type of support, and weight on each support.
   4. Indicate field measurements.

B. Qualification Data: For testing agency.

C. Product Certificates: For each VFC from manufacturer.

A. Harmonic Analysis Report: Provide manufacturer's statement of compliance with IEEE 519 and manufacturer's harmonic analysis study and report based upon conditions as described in Division 26. These conditions include but are not limited to the POCC, harmonic limits, normal power / emergency power modes, cable length, and transformer / generator data.

B. Source quality-control reports.

C. Field quality-control reports.

D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

      a. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and motor-circuit protector trip settings.
      b. Manufacturer's written instructions for setting field-adjustable overload relays.
      c. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
      d. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
      e. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.
      f. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. ABB Inc.
   2. Danfoss Inc; Danfoss Drives Div.
   3. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Business Unit.
   4. Fuji Electric.
   5. Siemens Energy & Automation, Inc.
   6. Yaskawa Electric America, Inc.
   7. Trane
   8. Emerson

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:
   1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
   2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

B. Application: Constant torque and variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
   1. Units suitable for operation of NEMA MG 1, Design A and Design B motors, as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
   2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
   3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 5 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Ambient Temperature Rating: Not less than 32 deg F and not exceeding 104 deg F.
7. Humidity Rating: Less than 95 percent (noncondensing).
8. Altitude Rating: Not exceeding 3300 feet.
9. Vibration Withstand: Comply with NEMA ICS 61800-2.
10. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
11. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
12. Speed Regulation: Plus or minus 5 percent.
13. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
14. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.

I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:
1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: UL 489, molded-case switch, with power fuse block and current-limiting fuses or NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

2.3 CONTROLS AND INDICATION

A. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

B. Historical Logging Information and Displays:
   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

C. Indicating Devices: Digital display and additional readout devices as required, mounted flush in VFC door and connected to display VFC parameters including, but not limited to:
   1. Output frequency (Hz).
   2. Motor speed (rpm).
   3. Motor status (running, stop, fault).
   4. Motor current (amperes).
   5. Motor torque (percent).
   6. Fault or alarming status (code).
   7. PID feedback signal (percent).
   8. DC-link voltage (V dc).
   9. Set point frequency (Hz).
   10. Motor output voltage (V ac).

D. Control Signal Interfaces:
   1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: 0- to 10-V dc, 4- to 20-mA dc, or operator-selectable "x"- to "y"-mA dc.
b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

a. 0- to 10-V dc.
b. 4- to 20-mA dc.
c. Potentiometer using up/down digital inputs.
d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:

a. Output frequency (Hz).
b. Output current (load).
c. DC-link voltage (V dc).
d. Motor torque (percent).
e. Motor speed (rpm).
f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.
b. Set point speed reached.
c. Fault and warning indication (overtemperature or overcurrent).
d. PID high- or low-speed limits reached.

E. BAS Interface: Factory-installed hardware and software shall interface with BAS to monitor, control, display, and record data for use in processing reports. VFC settings shall be retained within VFC's nonvolatile memory.

1. Communication Interface: Comply with ASHRAE 135. Communication shall interface with BAS to remotely control and monitor lighting from a BAS operator workstation. Control features and monitoring points displayed locally at lighting panel shall be available through the BAS.

2.4 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Based on the manufacturer's harmonic analysis study and report, provide input filtering, as required, to limit total demand (harmonic current) distortion and total harmonic voltage demand at the defined point of common coupling to meet IEEE 519 recommendations.

B. The VFD shall have internal 5% equivalent impedance to reduce the harmonics to the power line and to add protection from AC line transients. The 5% impedance may be from dual (positive and negative DC bus) reactors, or 5% AC line reactors. VFD’s with only one DC reactor shall add an AC line reactor.

C. Output Filtering: Verify voltage does not exceed motor pulse withstand capability.

2.5 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

2.6 OPTIONAL FEATURES

A. Sleep Function: Senses a minimal deviation of a feedback signal and stops the motor. On an increase in speed-command signal deviation, VFC resumes normal operation.

B. Motor Preheat Function: Preheats motor when idle to prevent moisture accumulation in the motor.

C. Remote digital operator kit.

D. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

2.7 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

2.8 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
   1. Push Buttons: Covered.
   2. Pilot Lights: Push to test.
   3. Selector Switches: Rotary type.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
   1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Supplemental Digital Meters:
   1. Elapsed-time meter.
   2. Kilowatt meter.
   3. Kilowatt-hour meter.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 and Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

F. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R and Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

G. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grills; 120-V ac; obtained from integral CPT.

H. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.

2.9 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
   1. Test each VFC while connected to a motor that is comparable to that for which the VFC is rated.
   2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance of the Work.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 "Hangers and Supports for Electrical Systems."

B. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 "Cast-in-Place Concrete."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in each fusible-switch VFC.

E. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 "Fuses."

F. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

G. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

H. Comply with NECA 1.

I. Utilize metal type of conduit (refer to division 26) for line, load and control wiring. Do not mix line, load, and control wiring in the same conduit.

3.3 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 "Low Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switches are in manual-control position.
   2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

3.4 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 "Identification for Electrical Systems."
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each VFC with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges

F. Set field-adjustable pressure switches.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION

SECTION 23 05 17

SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.
6. Silicone sealants.

B. Related Requirements:

1. Division 07 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Pipe Sleeves: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop collar.

B. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, anti-corrosion coated or zinc coated, with plain ends and integral welded waterstop collar.

C. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

D. PVC Pipe Sleeves: ASTM D1785, Schedule 40.

E. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

A. Description: Manufactured, Dura-coated or Duco-coated galvanized cast-iron sleeve with integral cast flashing flange for use in waterproof floors and roofs. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Description:

1. Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
2. Designed to form a hydrostatic seal of 20-psig.
3. Sealing Elements: EPDM-rubber, High-temperature-silicone, Nitrile (Buna N)] interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size.
4. Pressure Plates: Stainless steel, Type 316.
5. Connecting Bolts and Nuts: Stainless steel, Type 316, of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Description:

1. Manufactured plastic, sleeve-type, waterstop assembly, made for imbedding in concrete slab or wall.
2. Plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

A. Description: Nonshrink, recommended for interior and exterior sealing openings in nonfire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.6 SILICONE SEALANTS

A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant, ASTM C920, Type S, Grade NS, Class 25, use NT.

B. Silicone, S, P, 25, T, NT: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade P, Class 25, Uses T and NT. Grade P Pourable (self-leveling) formulation is for opening in floors and other horizontal surfaces that are not fire rated.

C. Silicone Foam: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
2. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout or silicone sealant, seal space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use sealants appropriate for size, depth, and location of joint.

E. Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke-Barrier Penetrations: Maintain indicated fire or smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping and fill materials specified in Division 07 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 3 inches above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using waterproof silicone sealant, seal space between top hub of stack-sleeve fitting and pipe.

B. Fire-Resistance-Rated, Horizontal Assembly, and Smoke Barrier Penetrations: Maintain indicated fire or smoke rating of floors at pipe penetrations. Seal pipe penetrations with fire- and smoke-stop materials. Comply with requirements for firestopping specified in Division 07 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal-system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings as new walls and slabs are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout or silicone sealant, seal space around outside of sleeve-seal fittings.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Leak Test: After allowing for a full cure, test sleeves and sleeve seals for leaks. Repair leaks and retest until no leaks exist.

B. Sleeves and sleeve seals will be considered defective if they do not pass tests and inspections.

3.6 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls Above Grade:

a. Piping Smaller Than NPS 6 :Sleeve-seal fittings.
b. Piping NPS 6 and Larger: Sleeve-seal fittings.

2. Exterior Concrete Walls Below Grade:

a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Sleeve-seal fittings.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:

a. Piping Smaller Than NPS 6: Sleeve-seal fittings.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

b. Piping NPS 6 and Larger: Sleeve-seal fittings.

1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs Above Grade:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Steel pipe sleeves.

5. Interior Partitions:

a. Piping Smaller Than NPS 6: Steel pipe sleeves.
b. Piping NPS 6 and Larger: Galvanized-steel sheet sleeves.

END OF SECTION

SECTION 23 05 18

ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.2 DEFINITIONS

A. Existing Piping to Remain: Existing piping that is not to be removed and that is not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Steel Type: With polished, chrome-plated or polished brass finish and setscrew fastener.

B. One-Piece, Stainless-Steel Type: With polished stainless-steel finish.

C. One-Piece, Cast-Brass Type: With chrome-plated or polished brass finish and setscrew fastener.

D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped steel with polished, chrome-plated finish and spring-clip fasteners.

E. One-Piece, Stamped-Steel Type: With polished, chrome-plated finish and spring-clip fasteners.

F. Split-Plate, Stamped-Steel Type: With polished, chrome-plated finish; concealed and exposed-rivet hinge; and spring-clip fasteners.

2.2 FLOOR PLATES

A. Split Floor Plates: Steel with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping and Relocated Existing Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep pattern.
b. Chrome-Plated Piping: One-piece brass or split-plate steel with polished, chrome-plated finish.
c. Insulated Piping: One-piece steel with chrome-plated or polished brass finish.
d. Insulated Piping: One-piece stainless steel with polished stainless-steel finish.
e. Insulated Piping: One-piece cast brass with chrome-plated or polished brass finish.
f. Insulated Piping: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
g. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece steel with chrome-plated polished brass finish.
h. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
i. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece cast brass with chrome-plated or polished brass finish.
j. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
k. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece steel with or chrome-plated or polished brass finish.
l. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stainless steel with polished stainless-steel finish.
m. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece cast brass with chrome-plated or polished brass finish.
n. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
o. Bare Piping in Unfinished Service Spaces: One-piece steel with polished, chrome-plated finish.
p. Bare Piping in Unfinished Service Spaces: One-piece cast brass with polished, chrome-plated or rough-brass finish.
q. Bare Piping in Unfinished Service Spaces: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
r. Bare Piping in Equipment Rooms: One-piece steel with polished, chrome-plated finish.
s. Bare Piping in Equipment Rooms: One-piece cast brass chrome-plated or rough-brass finish.
t. Bare Piping in Equipment Rooms: One-piece stamped steel or split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

2. Escutcheons for Existing Piping to Remain:

a. Chrome-Plated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

b. Insulated Piping: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped steel with exposed-rivet hinge with polished, chrome-plated finish.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.
f. Bare Piping in Equipment Rooms: Split-plate, stamped steel with concealed hinge with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping and Relocated Existing Piping: Split floor plate.
2. Existing Piping to Remain: Split floor plate.

3.2 FIELD QUALITY CONTROL

A. Using new materials, replace broken and damaged escutcheons and floor plates.

END OF SECTION

SECTION 23 05 19

METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Duct-thermometer mounting brackets.
6. Thermowells.
7. Dial-type pressure gages.
8. Gage attachments.
9. Test plugs.
10. Test-plug kits.
11. Sight flow indicators.
12. Flowmeters.
13. Thermal-energy meters.

B. Related Requirements:

1. Division 23 "Facility Natural-Gas Piping" for gas meters.
2. Division 23 "Steam and Condensate Piping Specialties" for steam and condensate meters.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of meter and gage.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Blue Ribbon Corp.
3. WATTS.
4. Weksler Glass Thermometer Corp.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: 1/2 inch with ASME B1.1 screw threads.

G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ashcroft Inc.
2. Weiss Instruments, Inc.

B. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel 5-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.

8. Ring: Stainless steel.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

C. Direct-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, plastic 5-inch nominal diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

D. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, cast aluminum or drawn steel 6-inch nominal diameter with flange and holes for panel mounting.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint,; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range.

E. Remote-Mounted, Plastic-Case, Vapor-Actuated Thermometers:
1. Standard: ASME B40.200.
2. Case: Sealed type, plastic 6-inch nominal diameter with flange and holes for panel mounting.

3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Pointer: Dark-colored metal.
7. Window: Glass.
8. Ring: Metal.
9. Connector Type(s): Union joint, threaded,; with ASME B1.1 screw threads.
10. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

11. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. Weksler Glass Thermometer Corp.

B. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and blue or red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

C. Plastic-Case, Compact-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic 6-inch nominal size.
3. Case Form: Back angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and red organic liquid.
5. Tube Background: Nonreflective with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass or plastic.
7. Stem: Aluminum or brass and of length to suit installation.

    a. Design for Air-Duct Installation: With ventilated shroud.
    b. Design for Thermowell Installation: Bare stem.

8. Connector: 3/4 inch, with ASME B1.1 screw threads.

9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

D. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Cast aluminum 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens and red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

E. Plastic-Case, Industrial-Style, Liquid-in-Glass Thermometers:
1. Standard: ASME B40.200.
2. Case: Plastic 7-inch nominal size unless otherwise indicated.
3. Case Form: Adjustable angle unless otherwise indicated.
4. Tube: Glass with magnifying lens red organic liquid.
5. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
6. Window: Glass.
7. Stem: Aluminum and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

8. Connector: 1-1/4 inches, with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.4 LIGHT-ACTIVATED THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. Weksler Glass Thermometer Corp.

B. Direct-Mounted, Light-Activated Thermometers:
1. Case: Plastic 7-inch nominal size unless otherwise indicated.
2. Scale(s): Deg F and deg C.
3. Case Form: Adjustable angle.
4. Connector: 1-1/4 inches with ASME B1.1 screw threads.
5. Stem: Aluminum and of length to suit installation.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

6. Display: Digital.

7. Accuracy: Plus or minus 2 deg F.

C. Remote-Mounted, Light-Activated Thermometers:
1. Case: Plastic, for wall mounting.
2. Scale(s): Deg F and deg C.
3. Sensor: Bulb and thermister wire.

a. Design for Air-Duct Installation: With ventilated shroud.
b. Design for Thermowell Installation: Bare stem.

4. Display: Digital.
5. Accuracy: Plus or minus 2 deg F.

2.5 DUCT-THERMOMETER MOUNTING BRACKETS

A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.6 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion in piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES or CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.7 DIAL-TYPE PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. WATTS.
b. Weksler Glass Thermometer Corp.

B. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Liquid-filled Sealed type(s); cast aluminum or drawn steel 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS ½ ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.

6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

C. Direct-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Sealed type; plastic 6-inch nominal diameter.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

D. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Liquid-filled Sealed type; cast aluminum or drawn steel 6-inch nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Metal.
10. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

E. Remote-Mounted, Plastic-Case, Dial-Type Pressure Gages:
1. Standard: ASME B40.100.
2. Case: Sealed type; plastic; 6-inch nominal diameter with flange and holes for panel mounting.
3. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
4. Pressure Connection: Brass, with NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.8 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/2, ASME B1.20.1 pipe threads and piston type surge-dampening device. Include extension for use on insulated piping.

B. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/2 pipe threads.

C. Valves: Brass ball, with NPS 1/2, ASME B1.20.1 pipe threads.

2.9 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Nexus Valve, Inc.
2. WATTS.
3. Weksler Glass Thermometer Corp.

B. Description: Test-station fitting made for insertion in piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/2, ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.10 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Nexus Valve, Inc.
2. WATTS.

B. Furnish one test-plug kit(s) containing one thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.

D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.

E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch diameter dial and probe. Dial range shall be at least 0 to 200 psig.

F. Carrying Case: Metal or plastic, with formed instrument padding.

2.11 SIGHT FLOW INDICATORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Pentair Valves & Controls; Penberthy Brand.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 125 psig 150 psig.

E. Minimum Temperature Rating: 200 deg F.

F. End Connections for NPS 2 and Smaller: Threaded.

G. End Connections for NPS 2-1/2 and Larger: Flanged.

2.12 FLOWMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ABB (Industrial Automation Division).
b. ONICON Incorporated.

B. Orifice Flowmeters:
1. Description: Flowmeter with sensor, hoses or tubing, fittings, valves, indicator, and conversion chart.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Wafer-orifice-type, calibrated, flow-measuring element; for installation between pipe flanges.

a. Design: Differential-pressure-type measurement for gas, oil, steam, or water.
b. Construction: Cast-iron body, brass valves with integral check valves and caps, and calibrated nameplate.
c. Minimum Pressure Rating: 300 psig.
d. Minimum Temperature Rating: 250 deg F.

4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected sensor and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to sensor.

a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected sensor and having two 12-foot hoses, with carrying case.

a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Conversion Chart: Flow rate data compatible with sensor and indicator.
8. Operating Instructions: Include complete instructions with each flowmeter.

C. Pitot-Tube Flowmeters:
1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.

3. Sensor: Insertion type; for inserting probe in piping and measuring flow directly in gallons per minute.

    a. Design: Differential-pressure-type measurement for oil or water.
    b. Construction: Stainless-steel probe of length to span inside of pipe, with integral transmitter and direct-reading scale.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 250 deg F.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Integral Transformer: For low-voltage power connection.
6. Accuracy: Plus or minus 3 percent.
7. Display: Shows rate of flow, with register to indicate total volume in gallons.
8. Operating Instructions: Include complete instructions with each flowmeter.

D. Turbine Flowmeters:
1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Impeller turbine; for inserting in pipe fitting or for installing in piping and measuring flow directly in gallons per minute.

    a. Design: Device or pipe fitting with inline turbine and integral direct-reading scale for gas, oil, steam, or water.
    b. Construction: Bronze or stainless-steel body, with plastic turbine or impeller.
    c. Minimum Pressure Rating: 150 psig.
    d. Minimum Temperature Rating: 180 deg F.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Accuracy: Plus or minus 1-1/2 percent.
6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Operating Instructions: Include complete instructions with each flowmeter.

E. Venturi Flowmeters:
1. Description: Flowmeter with calibrated flow-measuring element, hoses or tubing, fittings, valves, indicator, and conversion chart.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Venturi-type, calibrated, flow-measuring element; for installation in piping.

    a. Design: Differential-pressure-type measurement for gas, oil, steam, or water.
    b. Construction: Bronze, brass, or factory-primed steel, with brass fittings and attached tag with flow conversion data.
    c. Minimum Pressure Rating: 250 psig.
    d. Minimum Temperature Rating: 250 deg F.
    e. End Connections for NPS 2 and Smaller: Threaded.
    f. End Connections for NPS 2-1/2 and Larger: Flanged or welded.
    g. Flow Range: Flow-measuring element and flowmeter shall cover operating range of equipment or system served.

4. Permanent Indicators: Meter suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having 6-inch-diameter, or equivalent, dial with fittings and copper tubing for connecting to flowmeter element.

    a. Scale: Gallons per minute.

b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of scale range.

5. Portable Indicators: Hand-held, differential-pressure type, calibrated for connected flowmeter element and having two 12-foot hoses, with carrying case.

a. Scale: Gallons per minute.
b. Accuracy: Plus or minus 2 percent between 20 and 80 percent of scale range.

6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Conversion Chart: Flow rate data compatible with sensor.
8. Operating Instructions: Include complete instructions with each flowmeter.

F. Vortex-Shedding Flowmeters:
1. Description: Flowmeter with sensor and indicator.
2. Flow Range: Sensor and indicator shall cover operating range of equipment or system served.
3. Sensor: Inline type; for installing between pipe flanges and measuring flow directly in gallons per minute.

a. Design: Flow obstruction device, vortex-measurement type for gas, steam, and liquids.
b. Construction: Stainless-steel body, with integral transmitter and direct-reading scale.
c. Minimum Pressure Rating: 1000 psig.
d. Minimum Temperature Rating: 500 deg F.
e. Integral Transformer: For low-voltage power operation.

4. Indicator: Hand-held meter; either an integral part of sensor or a separate meter.
5. Accuracy: Plus or minus 0.25 percent for liquids and 0.75 percent for gases.
6. Display: Shows rate of flow, with register to indicate total volume in gallons.
7. Operating Instructions: Include complete instructions with each flowmeter.

2.13 THERMAL-ENERGY METERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

a. ONICON Incorporated.

B. Impeller-Turbine, Thermal-Energy Meters:
1. Description: System with strainer, flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
2. Flow Sensor: Impeller turbine with corrosion-resistant-metal body and transmitter; for installing in piping.

a. Design: Total thermal-energy measurement.
b. Minimum Pressure Rating: 150 psig.
c. Minimum Temperature Range: 40 to 250 deg F.

3. Temperature Sensors: Insertion-type transducer.
4. Indicator: Solid-state, integrating-type meter with integral battery pack; for wall mounting.

a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
b. Battery Pack: Five-year lithium battery.

5. Accuracy: Plus or minus 1 percent.
6. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
7. Strainer: Full size of main line piping.
8. Operating Instructions: Include complete instructions with each thermal-energy meter system.

C. Ultrasonic, Thermal-Energy Meters:
1. Description: Meter with flow sensor, temperature sensors, transmitter, indicator, and connecting wiring.
2. Flow Sensor: Transit-time ultrasonic type with transmitter.
3. Temperature Sensors: Insertion-type or strap-on transducer.
4. Indicator: Solid-state, integrating-type meter with integral battery pack.

a. Data Output: Six-digit electromechanical counter with readout in kilowatts per hour or British thermal units.
b. Battery Pack: Five-year lithium battery.

5. Accuracy: Plus or minus 1 percent.
6. Display: Visually indicates total fluid volume in gallons and thermal-energy flow in kilowatts per hour or British thermal units.
7. Operating Instructions: Include complete instructions with each thermal-energy meter system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install thermowells with socket extending a minimum of 2 inches into fluid one-third of pipe diameter to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

I. Install remote-mounted pressure gages on panel.

J. Install valve and snubber in piping for each pressure gage for fluids (except steam).

K. Install valve and syphon fitting in piping for each pressure gage for steam.

L. Install test plugs in piping tees.

M. Install flow indicators in piping systems in accessible positions for easy viewing.

N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.

O. Install flowmeter elements in accessible positions in piping systems.

P. Install wafer-orifice flowmeter elements between pipe flanges.

Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.

R. Install permanent indicators on walls or brackets in accessible and readable positions.

S. Install connection fittings in accessible locations for attachment to portable indicators.

T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.

U. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.
3. Two inlets and two outlets of each chiller.
4. Inlet and outlet of each hydronic coil in air-handling units.
5. Two inlets and two outlets of each hydronic heat exchanger.
6. Inlet and outlet of each thermal-storage tank.
7. Outside-, return-, supply-, and mixed-air ducts.

V. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Inlet and outlet of each chiller chilled-water and condenser-water connection.
3. Suction and discharge of each pump.
4. <Insert location>.

3.2 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow space for service and maintenance of meters, gages, machines, and equipment.

B. Connect flowmeter-system elements to meters.

C. Connect flowmeter transmitters to meters.

D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

A. After installation, calibrate meters according to manufacturer's written instructions.

B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

C. Thermometers at inlets and outlets of each chiller shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

D. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

E. Thermometers at inlets and outlets of each hydronic heat exchanger shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

F. Thermometers at inlet and outlet of each hydronic heat-recovery unit shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.

4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

G. Thermometers at inlet and outlet of each thermal-storage tank shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.
5. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

H. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:

1. Liquid-filled Sealed, bimetallic-actuated type.
2. Remote-mounted, metal-case, vapor-actuated type.
3. Industrial-style, liquid-in-glass type.
4. Remote-mounted, light-activated type.

I. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: Minus Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C.

B. Scale Range for Chilled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

C. Scale Range for Chilled-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

D. Scale Range for Chilled-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

E. Scale Range for Condenser-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

F. Scale Range for Condenser-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

G. Scale Range for Condenser-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

H. Scale Range for Condenser-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

I. Scale Range for Condenser-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

J. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

K. Scale Range for Heating, Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

L. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

M. Scale Range for Heating, Hot-Water Piping: 50 to 400 deg F and 0 to 200 deg C.

N. Scale Range for Heating, Hot-Water Piping: 50 to 550 deg F and 10 to 300 deg C.

O. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F and 0 to 150 deg C.

P. Scale Range for Steam and Steam-Condensate Piping: 20 to 240 deg F and 0 to 150 deg C.

Q. Scale Range for Steam and Steam-Condensate Piping: 30 to 240 deg F and 0 to plus 115 deg C.

R. Scale Range for Steam and Steam-Condensate Piping: 50 to 400 deg F and 0 to 200 deg C.

S. Scale Range for Air Ducts: Minus 40 to plus 110 deg F and minus 40 to plus 45 deg C.

T. Scale Range for Air Ducts: Minus 40 to plus 160 deg F and minus 40 to plus 100 deg C.

U. Scale Range for Air Ducts: 0 to 100 deg F and minus 20 to plus 50 deg C.

V. Scale Range for Air Ducts: 0 to 150 deg F and minus 20 to plus 70 deg C.

W. Scale Range for Air Ducts: 0 to 250 deg F and 0 to 150 deg C.

X. Scale Range for Air Ducts: 20 to 240 deg F and 0 to 150 deg C.

Y. Scale Range for Air Ducts: 30 to 240 deg F and 0 to plus 115 deg C.

Z. Scale Range for Air Ducts: 50 to 400 deg F and 0 to 200 deg C.

3.6 PRESSURE-GAGE SCHEDULE

A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
1. Sealed direct mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

B. Pressure gages at inlet and outlet of each chiller chilled-water and condenser-water connection shall be one of the following:
1. Sealed direct mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

C. Pressure gages at suction and discharge of each pump shall be one of the following:
1. Sealed direct-mounted, metal case.
2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Chilled-Water Piping: 30-in. Hg to 15 psi and minus 100 to 0 kPa.

B. Scale Range for Chilled-Water Piping: 0 to 30 psi and 0 to 240 kPa.

C. Scale Range for Chilled-Water Piping: 0 to 100 psi and 0 to 600 kPa.

D. Scale Range for Chilled-Water Piping: 0 to 160 psi and 0 to 1100 kPa.

E. Scale Range for Chilled-Water Piping: 0 to 200 psi and 0 to 1400 kPa.

F. Scale Range for Chilled-Water Piping: 0 to 300 psi and 0 to 2500 kPa.

G. Scale Range for Chilled-Water Piping: 0 to 600 psi and 0 to 4000 kPa.

H. Scale Range for Condenser-Water Piping: 30-in. Hg to 15 psi and minus 100 to 0 kPa.

I. Scale Range for Condenser-Water Piping: 0 to 30 psi and 0 to 240 kPa.

J. Scale Range for Condenser-Water Piping: 0 to 100 psi and 0 to 600 kPa.

K. Scale Range for Condenser-Water Piping: 0 to 160 psi and 0 to 1100 kPa.

L. Scale Range for Condenser-Water Piping: 0 to 200 psi and 0 to 1400 kPa.

M. Scale Range for Condenser-Water Piping: 0 to 300 psi and 0 to 2500 kPa.

N. Scale Range for Condenser-Water Piping: 0 to 600 psi and 0 to 4000 kPa.

O. Scale Range for Heating, Hot-Water Piping: 30-in. Hg to 15 psi and minus 100 to 0 kPa.

P. Scale Range for Heating, Hot-Water Piping: 0 to 30 psi and 0 to 240 kPa.

Q. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi and 0 to 600 kPa.

R. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi and 0 to 1100 kPa.

S. Scale Range for Heating, Hot-Water Piping: 0 to 200 psi and 0 to 1400 kPa.

T. Scale Range for Heating, Hot-Water Piping: 0 to 300 psi and 0 to 2500 kPa.

U. Scale Range for Heating, Hot-Water Piping: 0 to 600 psi and 0 to 4000 kPa.

V. Scale Range for Steam Piping: 30-in. Hg to 15 psi 30-in. Hg to 15 psi and minus 100 to 0 kPa.

W. Scale Range for Steam Piping: 0 to 30 psi and 0 to 240 kPa.

X. Scale Range for Steam Piping: 0 to 100 psi and 0 to 600 kPa.

Y. Scale Range for Steam Piping: 0 to 160 psi and 0 to 1100 kPa.

Z. Scale Range for Steam Piping: 0 to 200 psi and 0 to 1400 kPa.

AA. Scale Range for Steam Piping: 0 to 300 psi and 0 to 2500 kPa.

BB. Scale Range for Steam Piping: 0 to 600 psi and 0 to 4000 kPa.

3.8 FLOWMETER SCHEDULE

A. Flowmeters for Chilled-Water Piping: Turbine type.

B. Flowmeters for Condenser-Water Piping: Turbine type.

C. Flowmeters for Heating, Hot-Water Piping: Turbine type.

D. Flowmeters for Steam and Steam-Condensate Piping: Turbine type.

3.9 THERMAL-ENERGY METER SCHEDULE

A. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine type.

B. Thermal-Energy Meters for Condenser-Water Piping: Impeller-turbine type.

C. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.

D. Thermal-Energy Meters for Steam and Steam-Condensate Piping: Impeller-turbine type.

END OF SECTION

SECTION 23 05 23.10

– GENERAL DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Angle Valves.
2. Globe valves.
3. Ball valves.
4. Butterfly valves.
5. Check valves.
6. Gate valves.
7. Chainwheels.

1.2 DEFINITIONS

A. CWP: Cold working pressure.

B. SWP: Steam working pressure.

C. EPDM: Ethylene propylene copolymer rubber.

D. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

E. NRS: Non-rising stem.

F. OS&Y: Outside screw and yoke.

G. RS: Rising stem

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle and globe valves closed to prevent rattling.
4. Set ball valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.
7. Set gate valves closed to prevent rattling.
8. Set plug valves open to minimize exposure of functional surfaces.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher-than-ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
   3. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

   1. ASME B1.20.1 for threads for threaded-end valves.
   2. ASME B16.1 for flanges on iron valves.
   3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   4. ASME B16.18 for solder joint.
   5. ASME B31.1 for power piping valves.
   6. ASME B31.9 for building services piping valves.

C. Refer to HVAC valve schedule articles for applications of valves.

D. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

E. Valve Sizes: Same as upstream piping unless otherwise indicated.

F. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 4 and larger.
   2. Handlever: For quarter-turn valves smaller than NPS 4.
   3. Chainwheel: Device for attachment to gear, stem, or other actuator of size and with chain for mounting height, according to "Valve Installation" Article.
   4. Valve Actuator Types: Wrench. Furnish Owner with one wrench for every 10 plug valves, for each size square plug-valve head

G. Valves in Insulated Piping:

   1. Include 2-inch stem extensions.
   2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
   3. Memory stops that are fully adjustable after insulation is applied.

H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Bronze Angle Valves, Class 125:
   1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron or bronze.

B. Bronze Angle Valves, Class 150:
1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron or bronze.

2.3 BRONZE GLOBE VALVES

A. Bronze Globe Valves, Class 125:
1. Description:

a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Material: ASTM B62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem and Disc: Bronze.
f. Packing: Asbestos free.
g. Handwheel: Malleable iron or bronze.

B. Bronze Globe Valves, Class 150:
1. Description:

a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig.
c. Body Material: ASTM B62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron or bronze.

2.4 IRON GLOBE VALVES

A. Iron Globe Valves, Class 125:
1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 200 psig.
c. Body Material: ASTM A126, gray iron with bolted bonnet.
d. Ends: Flanged.

e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.
g. Operator: Handwheel or chainwheel.

B. Iron Globe Valves, Class 250:
1. Description:

a. Standard: MSS SP-85, Type I.
b. CWP Rating: 500 psig.
c. Body Material: ASTM A126, gray iron with bolted bonnet.
d. Ends: Flanged.
e. Trim: Bronze.
f. Packing and Gasket: Asbestos free.
g. Operator: Handwheel or chainwheel.

2.5 BRASS BALL VALVES

A. Brass Ball Valves, One-Piece:
1. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Forged brass.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Threaded Ends:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

C. Brass Ball Valves, Two-Piece with Full Port and Brass Trim, Press Ends:
1. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: Two piece.
d. Body Material: Forged brass.
e. Ends: Press.
f. Seats: PTFE or RPTFE.
g. Stem: Brass.
h. Ball: Chrome-plated brass.
i. Port: Full.
j. O-Ring Seal: Buna-N or EPDM.

D. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Threaded Ends:
   1. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Ends: Threaded.
      g. Seats: PTFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.

E. Brass Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim, Press Ends:
   1. Description:
      a. Standard: MSS SP-110.
      b. CWP Rating: Minimum 200 psig.
      c. Body Design: Two piece.
      d. Body Material: Forged brass.
      e. Ends: Press.
      f. Press Ends Connections Rating: Minimum 200 psig.
      g. Seats: PTFE or RPTFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Full.
      k. O-Ring Seal: Buna-N or EPDM.

F. Brass Ball Valves, Two-Piece with Regular Port and Brass Trim:
   1. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Forged brass.
      f. Ends: Threaded.
      g. Seats: PTFE.
      h. Stem: Brass.
      i. Ball: Chrome-plated brass.
      j. Port: Regular.

G. Brass Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
   1. Description:
      a. Standard: MSS SP-110.
      b. SWP Rating: 150 psig.
      c. CWP Rating: 600 psig.
      d. Body Design: Two piece.
      e. Body Material: Brass or bronze.
      f. Ends: Threaded.
      g. Seats: PTFE.
      h. Stem: Stainless steel.
      i. Ball: Stainless steel, vented.
      j. Port: Regular.

H. Brass Ball Valves, Three-Piece with Full Port and Brass Trim:
   1. Description:
      a. Standard: MSS SP-110.

b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Brass.
i. Ball: Chrome-plated brass.
j. Port: Full.

I. Brass Ball Valves, Three-Piece with Full Port and Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Forged brass.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

2.6 BRONZE BALL VALVES

A. Bronze Ball Valves, One-Piece with Bronze Trim:
1. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 400 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Bronze.
h. Ball: Chrome-plated brass.
i. Port: Reduced.

B. Bronze Ball Valves, One-Piece with Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. CWP Rating: 600 psig.
c. Body Design: One piece.
d. Body Material: Bronze.
e. Ends: Threaded.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Reduced.

C. Bronze Ball Valves, Two-Piece with Full Port and Bronze or Brass Trim, Threaded Ends:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.

e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Full.

D. Bronze Ball Valves, Two-Piece with Full Port and Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

E. Bronze Ball Valves, Two-Piece with Regular Port and Bronze or Brass Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.
i. Ball: Chrome-plated brass.
j. Port: Regular.

F. Bronze Ball Valves, Two-Piece with Regular Port and Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

G. Bronze Ball Valves, Three-Piece with Full Port and Bronze or Brass Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Bronze.

i. Ball: Chrome-plated brass.
j. Port: Full.

H. Bronze Ball Valves, Three-Piece with Full Port Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Bronze.
f. Ends: Threaded.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Full.

I. Bronze Ball Valves, Three-Piece with Regular Port, and Stainless-Steel Trim:
1. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig.
c. CWP Rating: 600 psig.
d. Body Design: Three piece.
e. Body Material: Bronze.
f. Ends: Threaded and solder.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel, vented.
j. Port: Regular.

2.7 STEEL BALL VALVES

A. Steel Ball Valves with Full Port and Stainless-Steel Trim, Class 150:
1. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 285 psig.
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

B. Steel Ball Valves with Full Port and Stainless-Steel Trim, Class 300:
1. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 720 psig.
c. Body Design: Split body.
d. Body Material: Carbon steel, ASTM A216, Type WCB.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel, vented.
i. Port: Full.

2.8 IRON BALL VALVES

A. Iron Ball Valves, Class 125:
1. Description:
a. Standard: MSS SP-72.
b. CWP Rating: 200 psig.
c. Body Design: Split body.
d. Body Material: ASTM A126, gray iron.
e. Ends: Flanged.
f. Seats: PTFE.
g. Stem: Stainless steel.
h. Ball: Stainless steel.
i. Port: Full.

2.9 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. Iron, Single-Flange Butterfly Valves with Aluminum-Bronze Disc:
1. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Aluminum bronze.

B. Iron, Single-Flange Butterfly Valves with Ductile-Iron Disc:
1. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Nickel-plated or -coated ductile iron.

C. Iron, Single-Flange Butterfly Valves with Stainless-Steel Disc:
1. Description:
a. Standard: MSS SP-67, Type I.
b. CWP Rating: 200 psig.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: ASTM A126, cast iron or ASTM A536, ductile iron.
e. Seat: EPDM or NBR.
f. Stem: One- or two-piece stainless steel.
g. Disc: Stainless steel.

2.10 DUCTILE-IRON, GROOVED-END BUTTERFLY VALVES

A. Iron, Grooved-End Butterfly Valves, 175 CWP:
1. Description:

a. Standard: MSS SP-67, Type I.
b. CWP Rating: 175 psig.
c. Body Material: Coated, ductile iron.
d. Stem: Two-piece stainless steel.
e. Disc: Coated, ductile iron.
f. Seal: EPDM.

B. Iron, Grooved-End Butterfly Valves, 300 CWP:
1. Description:
a. Standard: MSS SP-67, Type I.
b. NPS 8 and Smaller CWP Rating: 300 psig.
c. NPS 10 and Larger CWP Rating: 200 psig.
d. Body Material: Coated, ductile iron.
e. Stem: Two-piece stainless steel.
f. Disc: Coated, ductile iron.
g. Seal: EPDM.

2.11 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Single-Flange, High-Performance Butterfly Valves, Class 150:
1. Description:
a. Standard: MSS SP-68.
b. CWP Rating: 285 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

B. Single-Flange, High-Performance Butterfly Valves, Class 300:
1. Description:
a. Standard: MSS SP-68.
b. CWP Rating: 720 psig at 100 deg F.
c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
d. Body Material: Carbon steel, cast iron, or ductile iron.
e. Seat: Reinforced PTFE or metal.
f. Stem: Stainless steel; offset from seat plane.
g. Disc: Carbon steel.
h. Service: Bidirectional.

2.12 BRONZE LIFT CHECK VALVES

A. Bronze Lift Check Valves with Bronze Disc, Class 125:
1. Description:
a. Standard: MSS SP-80, Type 1.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B61 or ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Bronze Lift Check Valves with Nonmetallic Disc, Class 125:
1. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig.
c. Body Design: Vertical flow.
d. Body Material: ASTM B61 or ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: NBR or PTFE.

2.13 BRONZE SWING CHECK VALVES

A. Bronze Swing Check Valves with Bronze Disc, Class 125:
1. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

B. Bronze Swing Check Valves with Nonmetallic Disc, Class 125:
1. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: PTFE.

C. Bronze Swing Check Valves with Bronze Disc, Class 150:
1. Description:
a. Standard: MSS SP-80, Type 3.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: Bronze.

D. Bronze Swing Check Valves with Nonmetallic Disc, Class 150:
1. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B62, bronze.
e. Ends: Threaded.
f. Disc: PTFE.

2.14 IRON SWING CHECK VALVES

A. Iron Swing Check Valves with Metal Seats, Class 125:
1. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

B. Iron Swing Check Valves with Nonmetallic-to-Metal Seats, Class 125:
1. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Composition.
h. Seat Ring: Bronze.
i. Disc Holder: Bronze.
j. Disc: PTFE.
k. Gasket: Asbestos free.

C. Iron Swing Check Valves with Metal Seats, Class 250:
1. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
c. NPS 14 to NPS 24, CWP Rating: 300 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.15 IRON SWING CHECK VALVES WITH CLOSURE CONTROL

A. Iron Swing Check Valves with Lever- and Spring-Closure Control, Class 125:
1. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and spring.

B. Iron Swing Check Valves with Lever and Weight-Closure Control, Class 125:
1. Description:
a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.

h. Gasket: Asbestos free.
i. Closure Control: Factory-installed, exterior lever and weight.

2.16 IRON, GROOVED-END SWING CHECK VALVES

A. Iron, Grooved-End Swing Check Valves, 300 CWP:
1. Description:
a. CWP Rating: 300 psig.
b. Body Material: ASTM A536, ductile iron.
c. Seal: EPDM.
d. Disc: Spring operated, ductile iron or stainless steel.

2.17 IRON, CENTER-GUIDED CHECK VALVES

A. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 125:
1. Description:
a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A126, gray iron.
e. Style: Compact wafer.
f. Seat: Bronze.

B. Iron, Globe, Center-Guided Check Valves with Metal Seat, Class 125:
1. Description:
a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Material: ASTM A126, gray iron.
e. Style: Globe, spring loaded.
f. Ends: Flanged.
g. Seat: Bronze.

C. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 150:
1. Description:
a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
e. Style: Compact wafer.
f. Seat: Bronze.

D. Iron, Globe, Center-Guided Check Valves with Metal Seat, Class 150:
1. Description:
a. Standard: MSS SP-125.
b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
c. NPS 14 to NPS 24, CWP Rating: 250 psig.
d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
e. Style: Globe, spring loaded.
f. Ends: Flanged.
g. Seat: Bronze.

E. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 250:

1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
    c. NPS 14 to NPS 24, CWP Rating: 300 psig.
    d. Body Material: ASTM A126, gray iron.
    e. Style: Compact wafer, spring loaded.
    f. Seat: Bronze.

F. Iron, Globe, Center-Guided Check Valves with Metal Seat, Class 250:
1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
    c. NPS 14 to NPS 24, CWP Rating: 300 psig.
    d. Body Material: ASTM A126, gray iron.
    e. Style: Globe, spring loaded.
    f. Ends: Flanged.
    g. Seat: Bronze.

G. Iron, Compact-Wafer, Center-Guided Check Valves with Metal Seat, Class 300:
1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
    c. NPS 14 to NPS 24, CWP Rating: 400 psig.
    d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
    e. Style: Compact wafer, spring loaded.
    f. Seat: Bronze.

H. Iron, Globe, Center-Guided Check Valves with Metal Seat, Class 300:
1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
    c. NPS 14 to NPS 24, CWP Rating: 400 psig.
    d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
    e. Style: Globe, spring loaded.
    f. Ends: Flanged.
    g. Seat: Bronze.

I. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 125:
1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Material: ASTM A126, gray iron.
    e. Style: Compact wafer.
    f. Seat: EPDM or NBR.

J. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 125:
1. Description:
    a. Standard: MSS SP-125.
    b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
    c. NPS 14 to NPS 24, CWP Rating: 150 psig.
    d. Body Material: ASTM A126, gray iron.
    e. Style: Globe, spring loaded.
    f. Ends: Flanged.
    g. Seat: EPDM or NBR.

K. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 150:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      e. Style: Compact wafer.
      f. Seat:EPDM or NBR.

L. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 150:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      e. Style: Globe, spring loaded.
      f. Ends: Flanged.
      g. Seat: EPDM or NBR.

M. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 250:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A126, gray iron.
      e. Style: Compact wafer, spring loaded.
      f. Seat: EPDM or NBR.

N. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 250:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Material: ASTM A126, gray iron.
      e. Style: Globe, spring loaded.
      f. Ends: Flanged.
      g. Seat: EPDM or NBR.

O. Iron, Compact-Wafer, Center-Guided Check Valves with Resilient Seat, Class 300:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 400 psig.
      d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      e. Style: Compact wafer, spring loaded.
      f. Seat: EPDM or NBR.

P. Iron, Globe, Center-Guided Check Valves with Resilient Seat, Class 300:
   1. Description:
      a. Standard: MSS SP-125.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 400 psig.
      d. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      e. Style: Globe, spring loaded.
      f. Ends: Flanged.
      g. Seat: EPDM or NBR.

2.18 IRON, PLATE-TYPE CHECK VALVES

A. Iron, Dual-Plate Check Valves with Metal Seat, Class 125:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: Bronze.

B. Iron, Dual-Plate Check Valves with Metal Seat, Class 150:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      f. Seat: Bronze.

C. Iron, Dual-Plate Check Valves with Metal Seat, Class 250:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: Bronze.

D. Iron, Dual-Plate Check Valves with Metal Seat, Class 300:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 400 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      f. Seat: Bronze.

E. Iron, Single-Plate Check Valves with Resilient Seat, Class 125:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Wafer, spring-loaded plate.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: EPDM or NBR.

F. Iron, Dual-Plate Check Valves with Resilient Seat, Class 125:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
      c. NPS 14 to NPS 24, CWP Rating: 150 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: EPDM or NBR.

G. Iron, Dual-Plate Check Valves with Resilient Seat, Class 150:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 300 psig.
      c. NPS 14 to NPS 24, CWP Rating: 250 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      f. Seat: EPDM or NBR.

H. Iron, Wafer, Single-Plate Check Valves with Resilient Seat, Class 250:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Design: Wafer, spring-loaded plate.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: EPDM or NBR.

I. Iron, Dual-Plate Check Valves with Resilient Seat, Class 250:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 400 psig.
      c. NPS 14 to NPS 24, CWP Rating: 300 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A126, gray iron.
      f. Seat: EPDM or NBR.

J. Iron, Dual-Plate Check Valves with Resilient Seat, Class 300:
   1. Description:
      a. Standard: API 594.
      b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
      c. NPS 14 to NPS 24, CWP Rating: 400 psig.
      d. Body Design: Wafer, spring-loaded plates.
      e. Body Material: ASTM A395/A395M or ASTM A536, ductile iron.
      f. Seat: EPDM or NBR.

2.19 CHAINWHEELS

A. Description: Valve actuation assembly with sprocket rim, chain guides, chain and attachment brackets for mounting chainwheels directly to handwheels.

   1. Sprocket Rim with Chain Guides: Bronze, of type and size required for valve.
   2. Chain: Brass, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install chainwheels on operators for valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

G. Install valve tags. Comply with requirements in Division 23 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

   1. Throttling Service except Steam: Globe or angle valves.
   2. Throttling Service, Steam: Globe or angle valves.

B. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.

C. Select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 150 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 150.
5. Bronze gate valves, RS Class 150, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 250 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 125.
   a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 150.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 200 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 150 CWP, and EPDM or NBR seat.
6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
   a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
   b. Iron swing check valves with metal seats, Class 250.
   c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
   d. Iron, single-plate check valves with resilient seat, Class 125.
   e. Iron, dual-plate check valves with metal seat, Class 300.
   f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 250.

3.6 CONDENSER-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 150 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 150.
5. Bronze gate valves, RS Class 150, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 250 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 125.
   a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 150.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 200 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 150 CWP, and EPDM or NBR seat.
6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
   a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
   b. Iron swing check valves with metal seats, Class 250.
   c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
   d. Iron, single-plate check valves with resilient seat, Class 250.
   e. Iron, dual-plate check valves with metal seat, Class 300.
   f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 250.

3.7 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 150 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 150.
5. Bronze gate valves, RS Class 150, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 250 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 125.
   a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 150.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 200 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 150 CWP, and EPDM or NBR seat.
6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
   a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
   b. Iron swing check valves with metal seats, Class 250.
   c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
   d. Iron, single-plate check valves with resilient seat, Class 125.
   e. Iron, dual-plate check valves with metal seat, Class 300.
   f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 250.

3.8 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 150 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 150.
5. Bronze gate valves, RS Class 150, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 250 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 125.
   a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 150.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 200 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 150 CWP, and EPDM or NBR seat.
6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
   a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
   b. Iron swing check valves with metal seats, Class 250.
   c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
   d. Iron, single-plate check valves with resilient seat, Class 125.
   e. Iron, dual-plate check valves with metal seat, Class 300.
   f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 250.

3.9 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 300 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 300.
5. Bronze gate valves, RS Class 300, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 300 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 300.
   a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 300.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 300 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 300 CWP, and EPDM or NBR seat.

6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
    a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
    b. Iron swing check valves with metal seats, Class 300.
    c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
    d. Iron, single-plate check valves with resilient seat, Class 300.
    e. Iron, dual-plate check valves with metal seat, Class 300.
    f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 300.

3.10 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
1. Valves may be provided with solder-joint ends instead of threaded ends.
2. Bronze angle or globe valves, Class 150 bronze disc, with soldered or threaded ends.
3. Brass or bronze ball valves, three piece, with bronze or stainless-steel trim, full port, threaded or solder ends.
4. Bronze swing check valves with bronze disc, Class 150.
5. Bronze gate valves, RS Class 150, with soldered or threaded ends.

B. Pipe NPS 2-1/2 and Larger:
1. Iron globe valves, Class 250 with flanged ends. Pipe NPS 2 and Smaller: Retain subparagraph below if solder-joint valve ends are permitted for this application.

2. Iron ball valves, Class 125.
    a. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
3. Steel ball valves, Class 150.
4. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: Stainless-steel disc, 200 CWP, and EPDM or NBR seat.
5. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: Stainless-steel disc, 150 CWP, and EPDM or NBR seat.
6. Iron, Grooved-End Butterfly Valves, NPS 2-1/2 to NPS 12: 300 CWP.
7. High-Performance Butterfly Valves: Single flange, Class 300.
8. Iron swing check valves with lever and spring closure control.
    a. NPS 3 to NPS 12: Iron, grooved-end swing check valves, 300 CWP.
    b. Iron swing check valves with metal seats, Class 250.
    c. Iron, compact-wafer or globe, center-guided check valves metal seat, Class 300.
    d. Iron, single-plate check valves with resilient seat, Class 125.
    e. Iron, dual-plate check valves with metal seat, Class 300.
    f. Iron, dual-plate check valves with resilient seat, Class 300.
9. Iron gate valves, OS&Y,Class 250.

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Requirements:

1. Division 05 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
3. Division 23 "Vibration and Seismic Controls for HVAC" for vibration isolation devices.
4. Division 23 "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: Fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Include design calculations for designing trapeze hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Structural-Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code, Section IX.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design trapeze pipe hangers and equipment supports.

B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

2.2 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized, hot-dip galvanized, or electro-galvanized.
3. Nonmetallic Coatings: Plastic coated, or epoxy powder-coated.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel stainless steel <Insert material>.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe and Tube Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-plated steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-58, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.4 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, factory-fabricated steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.
3. Flammability: ASTM D635, ASTM E84, and UL 94.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.

    a. Flammability: ASTM D635, ASTM E84, and UL 94.

2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.5 PLASTIC PIPE HANGERS

A. Description: Similar to MSS SP-58, Types 1 through 58, factory-fabricated steel pipe hanger except hanger is made of plastic.

B. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Flammability: ASTM D635, ASTM E84, and UL 94.

2.6 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:
1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon-steel channel with inturned lips.
4. Channel Width: Selected for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Galvanized.
8. Paint Coating: Green epoxy, acrylic, or urethane.

9. Plastic Coating: PVC.

B. Non-MFMA Manufacturer Metal Framing Systems:
1. Description: Shop- or field-fabricated, pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
3. Channels: Continuous slotted carbon- channel with inturned lips.
4. Channel Width: Select for applicable load criteria.
5. Channel Nuts: Formed or stamped nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
7. Metallic Coating: Hot-dip galvanized.
8. Paint Coating: Green epoxy, acrylic, or urethane.
9. Plastic Coating: PVC.

2.7 FIBERGLASS STRUT SYSTEMS

A. Description: Structural-grade, factory-formed, glass-fiber-resin channels and angles for supporting multiple parallel pipes.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channels: Continuous slotted fiberglass-reinforced plastic channel with inturned lips.
3. Channel Width: Selected for applicable load criteria.
4. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
5. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
6. Rated Strength: Selected to suit applicable load criteria.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.8 THERMAL-HANGER SHIELD INSERTS

A. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psi or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psi minimum compressive strength and vapor barrier.

B. Insulation-Insert Material for Hot Piping: Water-repellent-treated, ASTM C533, Type I calcium silicate with 100-psi or ASTM C552, Type II cellular glass with 100-psi minimum compressive strength.

C. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

D. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.9 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

B. Mechanical-Expansion Anchors: Insert-wedge-type anchors for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Indoor Applications: stainless-steel.
   2. Outdoor Applications: Stainless steel.

2.10 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand:
   1. Description: Single base unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Hardware: Galvanized steel or polycarbonate.
   4. Accessories: Protection pads.

C. Low-Profile, Single Base, Single-Pipe Stand:
   1. Description: Single base with vertical and horizontal members, and pipe support, for roof installation without membrane protection.
   2. Base: Single, vulcanized rubber, molded polypropylene, or polycarbonate.
   3. Vertical Members: Two, stainless-steel, continuous-thread 1/2-inch rods.
   4. Horizontal Member: Adjustable horizontal, stainless-steel pipe support channels.
   5. Pipe Supports: Roller, Strut clamps, Clevis hanger, or Swivel hanger.
   6. Hardware: Stainless steel.
   7. Accessories: Protection pads.
   8. Height: 12 inches above roof.

D. High-Profile, Single Base, Single-Pipe Stand:
   1. Description: Single base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   2. Base: Single vulcanized rubber or molded polypropylene.
   3. Vertical Members: Two, stainless-steel, continuous-thread 1/2-inch rods.
   4. Horizontal Member: One, adjustable height, stainless-steel pipe support slotted channel or plate.
   5. Pipe Supports: Roller,Clevis hanger, or Swivel hanger.
   6. Hardware: Stainless steel.
   7. Accessories: Protection pads, 1/2-inch continuous-thread stainless-steel rod.
   8. Height: 36 inches above roof.

E. High-Profile, Multiple-Pipe Stand:
   1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   2. Bases: Two or more; vulcanized rubber or molded polypropylene.

3. Vertical Members: Two or more,stainless-steel channels.
4. Horizontal Members: One or more, adjustable height, stainless-steel pipe support.
5. Pipe Supports: Roller,Strut clamps,Clevis hanger, or Swivel hanger.
6. Hardware: Stainless steel.
7. Accessories: Protection pads, 1/2-inch continuous-thread rod.
8. Height: 36 inches above roof.

F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.11 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.12 MATERIALS

A. Aluminum: ASTM B221.

B. Carbon Steel: ASTM A1011/A1011M.

C. Structural Steel: ASTM A36/A36M, carbon-steel plates, shapes, and bars; galvanized.

D. Stainless Steel: ASTM A240/A240M.

E. Threaded Rods: Continuously threaded. Zinc-plated or galvanized steel for indoor applications and stainless steel for outdoor applications. Mating nuts and washers of similar materials as rods.

F. Grout: ASTM C1107/C1107M, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

3.2 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-58. Install hangers and attachments as required to properly support piping from building structure.

D. Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled strut systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

G. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 "Roof Accessories" for curbs.

H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

O. Insulated Piping:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.

    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
    b. NPS 4: 12 inches long and 0.06 inch thick.
    c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
    d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
    e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 "Exterior Painting, "Interior Painting", and "High-Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780/A780M.

3.7 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is unnecessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is unnecessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:

a. Light (MSS Type 31): 750 lb.
b. Medium (MSS Type 32): 1500 lb.
c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

P. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 48.13

VIBRATION CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Pipe-riser resilient supports.
9. Resilient pipe guides.
10. Air-spring isolators.
11. Restrained-air-spring isolators.
12. Elastomeric hangers.
13. Spring hangers.
14. Vibration isolation equipment bases.
15. Restrained isolation roof-curb rails.

B. Related Requirements:

1. Division 21000 "Vibration Controls for Fire Suppression" for devices for fire-suppression equipment and systems.
2. Division 22000 "Vibration Controls for Plumbing" for devices for plumbing equipment and systems.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.

B. Shop Drawings:

1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For each vibration isolation device.

1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.

B. Qualification Data: For testing agency.

C. Welding certificates.

D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads:
1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
2. Size: Factory or field cut to match requirements of supported equipment.
3. Pad Material: Oil and water resistant with elastomeric properties.
4. Surface Pattern: Ribbed or Waffle pattern.
5. Infused nonwoven cotton or synthetic fibers.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric.

a. Surface Pattern: Ribbed or Waffle pattern.
b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts:
1. Mounting Plates:

a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.

2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts:
1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

a. Housing: Cast-ductile iron or welded steel.
b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 OPEN-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators:
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

2.5 HOUSED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators in Two-Part Telescoping Housing:
1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
5. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators.

a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Top housing with attachment and leveling bolt, threaded mounting holes and internal leveling device, or elastomeric pad as recommended for the application by the manufacturer.

2.6 RESTRAINED-SPRING ISOLATORS

A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
   1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

      a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
      b. Top plate with threaded mounting holes elastomeric pad as recommended by the manufacture for the application.
      c. Internal leveling bolt that acts as blocking during installation.

   2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
   3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.7 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing:
   1. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with non-adjustable snubbers to limit vertical movement.

      a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
      b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.

   2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.8 PIPE-RISER RESILIENT SUPPORT

A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch-thick neoprene.

   1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
   2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

2.9 RESILIENT PIPE GUIDES

A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene.

1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.10 AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows:
1. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
2. Maximum Natural Frequency: 3 Hz.
3. Operating Pressure Range: 25 to 100 psig.
4. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
5. Tank valves.

2.11 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint:
1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.

a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
b. Top plate with threaded mounting holes or elastomeric pad as recommended by the manufacture for the application.
c. Internal leveling bolt that acts as blocking during installation.

2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
8. Maximum Natural Frequency: 3 Hz.
9. Operating Pressure Range: 25 to 100 psig.
10. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
11. Tank valves.

2.12 ELASTOMERIC HANGERS

A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:

1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.13 SPRING HANGERS

A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

2.14 VIBRATION ISOLATION EQUIPMENT BASES

A. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

B. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

    a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Concrete Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A36/A36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.15 RESTRAINED ISOLATION ROOF-CURB RAILS

A. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment.

B. Upper Frame: Upper frame shall provide continuous and captive support for equipment.

C. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials and shall be insulated with a minimum of 2 inches of rigid glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

D. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

E. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 VIBRATION CONTROL DEVICE INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 0 "Cast-in-Place Concrete."

B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

3.3 AIR-SPRING ISOLATORS INSTALLATION

A. Independent Isolator Installation:

1. Install tank valve into each air isolator.
2. Inflate each isolator to height and pressure as recommended by the manufacture for the application.

B. Pressure-Regulated Isolator Installation:

1. Coordinate the constant pressure-regulated air supply to air springs with the requirements for piping and connections specified in Division 22000 "General-Service Compressed-Air Piping."
2. Connect all pressure regulators to a single dry, filtered constant air supply.
3. Inflate isolators to height and/or as recommended by the manufacture for the application.

3.4 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 0 "Cast-in-Place Concrete."

END OF SECTION

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Valve tags.

1.2 ACTION SUBMITTAL

A. Product Data: For each type of product indicated.

B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch Stainless steel, 0.025-inch Aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows :

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.
b. Dual-duct systems.
c. Variable-air-volume systems.
d. Multizone systems.
e. Induction-unit systems.

2. Balancing Hydronic Piping Systems:

a. Constant-flow hydronic systems.
b. Variable-flow hydronic systems.
c. Primary-secondary hydronic systems.

3. Balancing steam systems.
4. Testing, Adjusting, and Balancing Equipment:

a. Heat exchangers.
b. Motors.
c. Chillers.
d. Cooling towers.
e. Condensing units.
f. Boilers.
g. Heat-transfer coils.

5. Testing, adjusting, and balancing existing systems and equipment.
6. Sound tests.
7. Vibration tests.
8. Duct leakage tests.
9. Control system verification.

1.2 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. BAS: Building automation systems.

C. NEBB: National Environmental Balancing Bureau.

D. TAB: Testing, adjusting, and balancing.

E. TABB: Testing, Adjusting, and Balancing Bureau.

F. TAB Specialist: An independent entity meeting qualifications to perform TAB work.

G. TDH: Total dynamic head.

1.3 PREINSTALLATION MEETINGS

A. TAB Conference: If requested by the Owner, conduct a TAB conference at Project site after approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Provide a minimum of 14 days' advance notice of scheduled meeting time and location.

1. Minimum Agenda Items:

a. The Contract Documents examination report.
b. The TAB plan.
c. Needs for coordination and cooperation of trades and subcontractors.
d. Proposed procedures for documentation and communication flow.

1.4 ACTION SUBMITTALS

A. Sustainable Design Submittals:

1. TAB Report: Documentation indicating that Work complies with ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB specialist and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 60 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. System Readiness Checklists: Within 60 days of Contractor's Notice to Proceed, submit system readiness checklists as specified in "Preparation" Article.

E. Examination Report: Submit a summary report of the examination review required in "Examination" Article.

F. Certified TAB reports.

G. Sample report forms.

H. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.

3. Application.
4. Dates of use.
5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC.
2. TAB Technician: Employee of the TAB specialist and certified by AABC as a TAB technician.

B. TAB Specialists Qualifications: Certified by NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB specialist and certified by NEBB or TABB.
2. TAB Technician: Employee of the TAB specialist and certified by NEBB or TABB as a TAB technician.

C. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

1.7 FIELD CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

PART 2 - SYSTEMS

2.1 INCLUDED SYSTEMS

A. The equipment and system descriptions listed in this section may not all be used on this project. Refer to the drawings for the specific systems included. Where there is a conflict between the drawing schedules and specifications, the drawings shall take precedent.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems designs that may preclude proper TAB of systems and equipment.

B. Examine installed systems for balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are applicable for intended purpose and are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and verify that bearings are greased, belts are aligned and tight, filters are clean, and equipment with functioning controls is ready for operation.

J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens have been replaced by permanent screens with indicated perforations.

L. Examine control valves for proper installation for their intended function of throttling, diverting, or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes the following:

1. Equipment and systems to be tested.
2. Strategies and step-by-step procedures for balancing the systems.
3. Instrumentation to be used.
4. Sample forms with specific identification for all equipment.

B. Perform system-readiness checks of HVAC systems and equipment to verify system readiness for TAB work. Include, at a minimum, the following:

1. Airside:

a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
b. Duct systems are complete with terminals installed.
c. Volume, smoke, and fire dampers are open and functional.
d. Clean filters are installed.
e. Fans are operating, free of vibration, and rotating in correct direction.
f. Variable-frequency controllers' startup is complete and safeties are verified.
g. Automatic temperature-control systems are operational.
h. Ceilings are installed.
i. Windows and doors are installed.
j. Suitable access to balancing devices and equipment is provided.

2. Hydronics:

a. Verify leakage and pressure tests on water distribution systems have been satisfactorily completed.
b. Piping is complete with terminals installed.
c. Water treatment is complete.
d. Systems are flushed, filled, and air purged.
e. Strainers are pulled and cleaned.
f. Control valves are functioning per the sequence of operation.
g. Shutoff and balance valves have been verified to be 100 percent open.
h. Pumps are started and proper rotation is verified.
i. Pump gage connections are installed directly at pump inlet and outlet flanges or in discharge and suction pipe prior to valves or strainers.
j. Variable-frequency controllers' startup is complete and safeties are verified.
k. Suitable access to balancing devices and equipment is provided.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in “AABC's "National Standards for Total System Balance or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 23 33 00 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 23 07 13 "Duct Insulation," Section 23 07 16 "HVAC Equipment Insulation," and Section 23 07 19 "HVAC Piping Insulation."

C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IPd) and metric (SI) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Cross-check the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23000 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.6 PROCEDURES FOR DUAL-DUCT SYSTEMS

A. Adjust the dual-duct systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge. On systems with separate hot-deck and cold-deck fans, verify the location of the sensor on each deck.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit's hot deck and cold deck for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for full cooling. Some controllers require starting with minimum set point. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factors as required for design cold-deck maximum airflow and hot-deck minimum airflow. Record calibration factors.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for full heating.
    e. Measure airflow and adjust calibration factors as required for design cold-deck minimum airflow and hot-deck maximum airflow. Record calibration factors. If no minimum calibration is available, note any deviation from design airflow.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
    b. Set terminals for maximum airflow. If system design includes diversity (cooling coil or fan), adjust terminals for maximum and minimum airflow so that connected total matches cooling coil or fan selection and simulates actual load in the building. In systems with separate hot-deck and cold-deck fans, diversity consideration applies to each individual fan.
    c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
    d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
    e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure the fan(s) static pressures as follows:

    a. Measure static pressure directly at the fan outlet or through the flexible connection.
    b. Measure static pressure directly at the fan inlet or through the flexible connection.
    c. Measure static pressure across each component that makes up the air-handling system.
    d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan(s) while operating at maximum return airflow and minimum outdoor airflow.

    a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
    b. Verify that all terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

    a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
    b. Re-measure and confirm that total airflow is within design.
    c. Re-measure final fan operating data, rpms, volts, amps and static profile.
    d. Mark final settings.
    e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
    f. Verify tracking between supply and return fans.

10. Record final fan-performance data.

3.7 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Adjust the variable-air-volume systems as follows:

1. Verify that the system static pressure sensor is located two-thirds of the distance down the duct from the fan discharge.
2. Verify that the system is under static pressure control.
3. Select the terminal unit that is most critical to the supply-fan airflow. Measure inlet static pressure, and adjust system static pressure control set point so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
4. Calibrate and balance each terminal unit for maximum and minimum design airflow as follows:

    a. Adjust controls so that terminal is calling for maximum airflow. Some controllers require starting with minimum airflow. Verify calibration procedure for specific project.
    b. Measure airflow and adjust calibration factor as required for design maximum airflow. Record calibration factor.
    c. When maximum airflow is correct, balance the air outlets downstream from terminal units.
    d. Adjust controls so that terminal is calling for minimum airflow.
    e. Measure airflow and adjust calibration factor as required for design minimum airflow. Record calibration factor. If no minimum calibration is available, note any deviation from design airflow.
    f. When in full cooling or full heating, ensure that there is no mixing of hot-deck and cold-deck airstreams unless so designed.
    g. On constant volume terminals, in critical areas where room pressure is to be maintained, verify that the airflow remains constant over the full range of full cooling to full heating. Note any deviation from design airflow or room pressure.

5. After terminals have been calibrated and balanced, test and adjust system for total airflow. Adjust fans to deliver total design airflows within the maximum allowable fan speed listed by fan manufacturer.

    a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.

b. Set terminals for maximum airflow. If system design includes diversity, adjust terminals for maximum and minimum airflow so that connected total matches fan selection and simulates actual load in the building.
c. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
d. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
e. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

6. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report any artificial loading of filters at the time static pressures are measured.

7. Set final return and outside airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.

a. Balance the return-air ducts and inlets the same as described for constant-volume air systems.
b. Verify that terminal units are meeting design airflow under system maximum flow.

8. Re-measure the inlet static pressure at the most critical terminal unit and adjust the system static pressure set point to the most energy-efficient set point to maintain the optimum system static pressure. Record set point and give to controls contractor.
9. Verify final system conditions as follows:

a. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
b. Re-measure and confirm that total airflow is within design.
c. Re-measure final fan operating data, rpms, volts, amps, and static profile.
d. Mark final settings.
e. Test system in economizer mode. Verify proper operation and adjust if necessary. Measure and record all operating data.
f. Verify tracking between supply and return fans.

3.8 PROCEDURES FOR MULTIZONE SYSTEMS

A. Position the unit's automatic zone dampers for maximum flow through the cooling coil.

B. The procedures for multizone systems will utilize the zone balancing dampers to achieve the indicated airflow within the zone.

C. After balancing, place the unit's automatic zone dampers for maximum heating flow. Retest zone airflows and record any variances.

D. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air and relief-air dampers for proper position that simulates minimum outdoor air conditions.
b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

E. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

F. Adjust air inlets and outlets for each space to indicated airflows.

1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
2. Measure inlets and outlets airflow.
3. Adjust each inlet and outlet for specified airflow.
4. Re-measure each inlet and outlet after they have been adjusted.

G. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.9 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

C. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Set outside-air, return-air, and relief-air dampers for proper position that simulates minimum outdoor-air conditions.
b. Where duct conditions allow, measure airflow by Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses to obtain total airflow.
c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.
d. If a reliable Pitot-tube traverse or coil traverse is not possible, measure airflow at terminals and calculate the total airflow.

2. Measure fan static pressures as follows:

a. Measure static pressure directly at the fan outlet or through the flexible connection.
b. Measure static pressure directly at the fan inlet or through the flexible connection.
c. Measure static pressure across each component that makes up the air-handling system.
d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
4. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
5. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload occurs. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

D. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.

1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

E. Balance airflow to each induction unit by measuring the nozzle pressure and comparing it to the manufacturer's published data for nozzle pressure versus cfm. Adjust the unit's inlet damper to achieve the required nozzle pressure for design cfm.

F. Verify final system conditions.

1. Re-measure and confirm that minimum outdoor, return, and relief airflows are within design. Readjust to match design if necessary.
2. Re-measure and confirm that total airflow is within design.
3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
4. Mark all final settings.
5. Test system in economizer mode. Verify proper operation and adjust if necessary.
6. Measure and record all operating data.
7. Record final fan-performance data.

3.10 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare test reports for pumps, coils, and heat exchangers. Obtain approved submittals and manufacturer-recommended testing procedures. Crosscheck the summation of required coil and heat exchanger flow rates with pump design flow rate.

B. Prepare schematic diagrams of systems' "as-built" piping layouts.

C. In addition to requirements in "Preparation" Article, prepare hydronic systems for testing and balancing as follows:

1. Check liquid level in expansion tank.
2. Check highest vent for adequate pressure.
3. Check flow-control valves for proper position.
4. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
5. Verify that motor starters are equipped with properly sized thermal protection.
6. Check that air has been purged from the system.

3.11 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

A. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

    a. Position valves for full flow through coils.
    b. Measure flow by main flow meter, if installed.
    c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

    a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
    b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
    c. Convert pressure to head and correct for differences in gage heights.
    d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow, and verify that the pump has the intended impeller size.
    e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

B. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

C. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

D. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

E. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

F. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

G. Verify that memory stops have been set.

3.12 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals, and proceed as specified above for hydronic systems.

B. Adjust the variable-flow hydronic system as follows:

1. Verify that the differential-pressure sensor is located as indicated.
2. Determine whether there is diversity in the system.

C. For systems with no diversity:

1. Adjust pumps to deliver total design gpm.

a. Measure total water flow.

1) Position valves for full flow through coils.
2) Measure flow by main flow meter, if installed.

3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

b. Measure pump TDH as follows:

1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
3) Convert pressure to head and correct for differences in gage heights.
4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

2. Adjust flow-measuring devices installed in mains and branches to design water flows.

a. Measure flow in main and branch pipes.
b. Adjust main and branch balance valves for design flow.
c. Re-measure each main and branch after all have been adjusted.

3. Adjust flow-measuring devices installed at terminals for each space to design water flows.

a. Measure flow at terminals.
b. Adjust each terminal to design flow.
c. Re-measure each terminal after it is adjusted.
d. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
e. Perform temperature tests after flows have been balanced.

4. For systems with pressure-independent valves at terminals:

a. Measure differential pressure and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

5. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

6. Prior to verifying final system conditions, determine the system differential-pressure set point.
7. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
8. Mark final settings and verify that all memory stops have been set.

9. Verify final system conditions as follows:

    a. Re-measure and confirm that total water flow is within design.
    b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
    c. Mark final settings.

10. Verify that memory stops have been set.

D. For systems with diversity:

1. Determine diversity factor.
2. Simulate system diversity by closing required number of control valves, as approved by the design engineer.
3. Adjust pumps to deliver total design gpm.

    a. Measure total water flow.

        1) Position valves for full flow through coils.
        2) Measure flow by main flow meter, if installed.
        3) If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

    b. Measure pump TDH as follows:

        1) Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
        2) Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
        3) Convert pressure to head and correct for differences in gage heights.
        4) Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
        5) With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

    c. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

4. Adjust flow-measuring devices installed in mains and branches to design water flows.

    a. Measure flow in main and branch pipes.
    b. Adjust main and branch balance valves for design flow.
    c. Re-measure each main and branch after all have been adjusted.

5. Adjust flow-measuring devices installed at terminals for each space to design water flows.

    a. Measure flow at terminals.
    b. Adjust each terminal to design flow.
    c. Re-measure each terminal after it is adjusted.
    d. Position control valves to bypass the coil, and adjust the bypass valve to maintain design flow.
    e. Perform temperature tests after flows have been balanced.

6. For systems with pressure-independent valves at terminals:

a. Measure differential pressure, and verify that it is within manufacturer's specified range.
b. Perform temperature tests after flows have been verified.

7. For systems without pressure-independent valves or flow-measuring devices at terminals:

a. Measure and balance coils by either coil pressure drop or temperature method.
b. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

8. Open control valves that were shut. Close a sufficient number of control valves that were previously open to maintain diversity, and balance terminals that were just opened.
9. Prior to verifying final system conditions, determine system differential-pressure set point.
10. If the pump discharge valve was used to set total system flow with variable-frequency controller at 60 Hz, at completion open discharge valve 100 percent and allow variable-frequency controller to control system differential-pressure set point. Record pump data under both conditions.
11. Mark final settings and verify that memory stops have been set.
12. Verify final system conditions as follows:

a. Re-measure and confirm that total water flow is within design.
b. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
c. Mark final settings.

13. Verify that memory stops have been set.

3.13 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

A. Balance the primary circuit flow first.

B. Balance the secondary circuits after the primary circuits are complete.

C. Adjust pumps to deliver total design gpm.

1. Measure total water flow.

a. Position valves for full flow through coils.
b. Measure flow by main flow meter, if installed.
c. If main flow meter is not installed, determine flow by pump TDH or exchanger pressure drop.

2. Measure pump TDH as follows:

a. Measure discharge pressure directly at the pump outlet flange or in discharge pipe prior to any valves.
b. Measure inlet pressure directly at the pump inlet flange or in suction pipe prior to any valves or strainers.
c. Convert pressure to head and correct for differences in gage heights.
d. Verify pump impeller size by measuring the TDH with the discharge valve closed. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
e. With valves open, read pump TDH. Adjust pump discharge valve until design water flow is achieved.

3. Monitor motor performance during procedures and do not operate motor in an overloaded condition.

D. Adjust flow-measuring devices installed in mains and branches to design water flows.

1. Measure flow in main and branch pipes.
2. Adjust main and branch balance valves for design flow.
3. Re-measure each main and branch after all have been adjusted.

E. Adjust flow-measuring devices installed at terminals for each space to design water flows.

1. Measure flow at terminals.
2. Adjust each terminal to design flow.
3. Re-measure each terminal after it is adjusted.
4. Position control valves to bypass the coil and adjust the bypass valve to maintain design flow.
5. Perform temperature tests after flows have been balanced.

F. For systems with pressure-independent valves at terminals:

1. Measure differential pressure and verify that it is within manufacturer's specified range.
2. Perform temperature tests after flows have been verified.

G. For systems without pressure-independent valves or flow-measuring devices at terminals:

1. Measure and balance coils by either coil pressure drop or temperature method.
2. If balanced by coil pressure drop, perform temperature tests after flows have been verified.

H. Verify final system conditions as follows:

1. Re-measure and confirm that total water flow is within design.
2. Re-measure final pumps' operating data, TDH, volts, amps, and static profile.
3. Mark final settings.

I. Verify that memory stops have been set.

3.14 PROCEDURES FOR STEAM SYSTEMS

A. Measure and record upstream and downstream pressure of each piece of equipment.

B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.

C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.

D. Check settings and operation of each safety valve. Record settings.

E. Verify the operation of each steam trap.

3.15 PROCEDURES FOR HEAT EXCHANGERS

A. Adjust water flow to within specified tolerances.

B. Measure inlet and outlet water temperatures.

C. Measure inlet steam pressure.

D. Check settings and operation of safety and relief valves. Record settings.

3.16 PROCEDURES FOR MOTORS

A. Motors 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Phase and hertz.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter size and thermal-protection-element rating.
8. Service factor and frame size.

B. Motors Driven by Variable-Frequency Controllers: Test manual bypass of controller to prove proper operation.

3.17 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator and condenser to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. For water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
6. Capacity: Calculate in tons of cooling.
7. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.18 PROCEDURES FOR COOLING TOWERS

A. Balance total condenser-water flows to towers. Measure and record the following data:

1. Condenser-water flow to each cell of the cooling tower.
2. Entering- and leaving-water temperatures.
3. Wet- and dry-bulb temperatures of entering air.
4. Wet- and dry-bulb temperatures of leaving air.
5. Condenser-water flow rate recirculating through the cooling tower.
6. Cooling-tower spray pump discharge pressure.
7. Condenser-water flow through bypass.

8. Fan and motor operating data.

3.19 PROCEDURES FOR CONDENSING UNITS

A. Verify proper rotation of fans.

B. Measure entering- and leaving-air temperatures.

C. Record fan and motor operating data.

3.20 PROCEDURES FOR BOILERS

A. Hydronic Boilers:

1. Measure and record entering- and leaving-water temperatures.
2. Measure and record water flow.
3. Record relief valve pressure setting.

B. Steam Boilers:

1. Measure and record entering-water temperature.
2. Measure and record feed water flow.
3. Measure and record leaving-steam pressure and temperature.
4. Record relief valve pressure setting.

3.21 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop for major (more than 20 gpm) equipment coils, excluding unitary equipment such as reheat coils, unit heaters, and fan-coil units.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each steam coil:

1. Dry-bulb temperature of entering and leaving air.
2. Airflow.
3. Inlet steam pressure.

D. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.

3.22 SOUND TESTS

A. After the systems are balanced and construction is Substantially Complete, measure and record sound levels at least one representative location for every air handling system .

B. Instrumentation:

1. The sound-testing meter shall be a portable, general-purpose testing meter consisting of a microphone, processing unit, and readout.
2. The sound-testing meter shall be capable of showing fluctuations at minimum and maximum levels, and measuring the equivalent continuous sound pressure level (LEQ).
3. The sound-testing meter must be capable of using 1/3 octave band filters to measure mid-frequencies from 31.5 Hz to 8000 Hz.
4. The accuracy of the sound-testing meter shall be plus or minus one decibel.

C. Test Procedures:

1. Perform test at quietest background noise period. Note cause of unpreventable sound that affects test outcome.
2. Equipment should be operating at design values.
3. Calibrate the sound-testing meter prior to taking measurements.
4. Use a microphone suitable for the type of noise levels measured that is compatible with meter. Provide a windshield for outside or in-duct measurements.
5. Record a set of background measurements in dBA and sound pressure levels in the eight un-weighted octave bands 31.5 Hz to 4000 Hz (RC] with the equipment off.
6. Take sound readings in dBA and sound pressure levels in the eight un-weighted octave bands 31.5 Hz to 4000 Hz with the equipment operating.
7. Take readings no closer than 36 inches from a wall or from the operating equipment and approximately 60 inches from the floor, with the meter held or mounted on a tripod.
8. For outdoor measurements, move sound-testing meter slowly and scan area that has the most exposure to noise source being tested. Use A-weighted scale for this type of reading.

D. Reporting:

1. Report shall record the following:

a. Location.
b. System tested.
c. dBA reading.
d. Sound pressure level in each octave band with equipment on and off.

2. Plot sound pressure levels on NC worksheet with equipment on and off.

3.23 VIBRATION TESTS

A. After systems are balanced and construction is Substantially Complete, measure and record

3.24 DUCT LEAKAGE TESTS

A. Witness the duct pressure testing performed by Installer.

B. Verify that proper test methods are used and that leakage rates are within specified tolerances.

C. Report deficiencies observed.

3.25 CONTROLS VERIFICATION

A. In conjunction with system balancing, perform the following:

1. Verify temperature control system is operating within the design limitations.
2. Confirm that the sequences of operation are in compliance with Contract Documents.
3. Verify that controllers are calibrated and function as intended.
4. Verify that controller set points are as indicated.
5. Verify the operation of lockout or interlock systems.
6. Verify the operation of valve and damper actuators.
7. Verify that controlled devices are properly installed and connected to correct controller.
8. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
9. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.26 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.

1. Measure and record the operating speed, airflow, and static pressure of each fan.
2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
3. Check the refrigerant charge.
4. Check the condition of filters.
5. Check the condition of coils.
6. Check the operation of the drain pan and condensate-drain trap.
7. Check bearings and other lubricated parts for proper lubrication.
8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.

B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:

1. New filters are installed.
2. Coils are clean and fins combed.
3. Drain pans are clean.
4. Fans are clean.
5. Bearings and other parts are properly lubricated.
6. Deficiencies noted in the preconstruction report are corrected.

C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.

1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.
2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the airflow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

3.27 TOLERANCES

A. Set HVAC system's airflow rates and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.
4. Cooling-Water Flow Rate: Plus or minus 10 percent.

B. Maintaining pressure relationships as designed shall have priority over the tolerances specified above.

3.28 PROGRESS REPORTING

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems balancing devices. Recommend changes and additions to systems balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.

B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.29 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.
3. Certify validity and accuracy of field data.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.

2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance; do not include Shop Drawings and Product Data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB specialist.
3. Project name.
4. Project location.
5. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of TAB supervisor who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

12. Nomenclature sheets for each item of equipment.
13. Data for terminal units, including manufacturer's name, type, size, and fittings.
14. Notes to explain why certain final data in the body of reports vary from indicated values.
15. Test conditions for fans and pump performance forms including the following:

    a. Settings for outdoor-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Face and bypass damper settings at coils.
    e. Fan drive settings including settings and percentage of maximum pitch diameter.
    f. Inlet vane settings for variable-air-volume systems.
    g. Settings for supply-air, static-pressure controller.
    h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water and steam flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches, and bore.
i. Center-to-center dimensions of sheave and amount of adjustments in inches.
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:

a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches, and bore.
f. Center-to-center dimensions of sheave and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Filter static-pressure differential in inches wg.
f. Preheat-coil static-pressure differential in inches wg.
g. Cooling-coil static-pressure differential in inches wg.
h. Heating-coil static-pressure differential in inches wg.
i. Outdoor airflow in cfm.
j. Return airflow in cfm.
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch o.c.
f. Make and model number.
g. Face area in sq. ft..
h. Tube size in NPS.
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.

b. Average face velocity in fpm.
c. Air pressure drop in inches wg.
d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
e. Return-air, wet- and dry-bulb temperatures in deg F.
f. Entering-air, wet- and dry-bulb temperatures in deg F.
g. Leaving-air, wet- and dry-bulb temperatures in deg F.
h. Water flow rate in gpm.
i. Water pressure differential in feet of head or psig.
j. Entering-water temperature in deg F.
k. Leaving-water temperature in deg F.
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig.
n. Refrigerant suction temperature in deg F.
o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

a. System identification.
b. Location.
c. Make and type.
d. Model number and unit size.
e. Manufacturer's serial number.
f. Fuel type in input data.
g. Output capacity in Btu/h.
h. Ignition type.
i. Burner-control types.
j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches, and bore.
n. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm.
b. Entering-air temperature in deg F.
c. Leaving-air temperature in deg F.
d. Air temperature differential in deg F.
e. Entering-air static pressure in inches wg.
f. Leaving-air static pressure in inches wg.
g. Air static-pressure differential in inches wg.
h. Low-fire fuel input in Btu/h.
i. High-fire fuel input in Btu/h.
j. Manifold pressure in psig.
k. High-temperature-limit setting in deg F.
l. Operating set point in Btu/h.
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h.

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:

    a. System identification.
    b. Location.
    c. Coil identification.
    d. Capacity in Btu/h.
    e. Number of stages.
    f. Connected volts, phase, and hertz.
    g. Rated amperage.
    h. Airflow rate in cfm.
    i. Face area in sq. ft..
    j. Minimum face velocity in fpm.

2. Test Data (Indicated and Actual Values):

    a. Heat output in Btu/h.
    b. Airflow rate in cfm.
    c. Air velocity in fpm.
    d. Entering-air temperature in deg F.
    e. Leaving-air temperature in deg F.
    f. Voltage at each connection.
    g. Amperage for each phase.

I. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches, and bore.
    h. Center-to-center dimensions of sheave and amount of adjustments in inches.

2. Motor Data:

    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches, and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

    a. Total airflow rate in cfm.
    b. Total system static pressure in inches wg.
    c. Fan rpm.
    d. Discharge static pressure in inches wg.
    e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Air-Terminal-Device Reports:

1. Unit Data:

a. System and air-handling unit identification.
b. Location and zone.
c. Apparatus used for test.
d. Area served.
e. Make.
f. Number from system diagram.
g. Type and model number.
h. Size.
i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Air velocity in fpm.
c. Preliminary airflow rate as needed in cfm.
d. Preliminary velocity as needed in fpm.
e. Final airflow rate in cfm.
f. Final velocity in fpm.
g. Space temperature in deg F.

L. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

a. Airflow rate in cfm.
b. Entering-water temperature in deg F.

c. Leaving-water temperature in deg F.
d. Water pressure drop in feet of head or psig.
e. Entering-air temperature in deg F.
f. Leaving-air temperature in deg F.

M. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm.
g. Water pressure differential in feet of head or psig.
h. Required net positive suction head in feet of head or psig.
i. Pump rpm.
j. Impeller diameter in inches.
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):

a. Static head in feet of head or psig.
b. Pump shutoff pressure in feet of head or psig.
c. Actual impeller size in inches.
d. Full-open flow rate in gpm.
e. Full-open pressure in feet of head or psig.
f. Final discharge pressure in feet of head or psig.
g. Final suction pressure in feet of head or psig.
h. Final total pressure in feet of head or psig.
i. Final water flow rate in gpm.
j. Voltage at each connection.
k. Amperage for each phase.

N. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.30 VERIFICATION OF TAB REPORT

A. The TAB specialist's test and balance engineer shall conduct the inspection in the presence of Engineer (and commissioning authority where applicable).

B. Engineer (and commissioning authority where applicable) shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

C. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

D. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

E. If TAB work fails, proceed as follows:

1. TAB specialists shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB specialist to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB specialist's final payment.

F. Prepare test and inspection reports.

3.31 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

SECTION 23 07 13

DUCT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following duct services:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

B. Related Sections:

1. Division 23 "HVAC Piping Insulation."
2. Division 23 "Metal Ducts" for duct liners.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Ductwork Insulation Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Friendly Feel Duct Wrap.

d. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; Commercial Board.

b. Johns Manville; 800 Series Spin-Glas.

c. Knauf Insulation; Insulation Board.

d. Owens Corning; Fiberglas 700 Series.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.

b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

b. Eagle Bridges - Marathon Industries; 225.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.

d. Mon-Eco Industries, Inc.; 22-25.

D. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.

b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.

c. P.I.C. Plastics, Inc.; Welding Adhesive.

d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.

b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.

b. Eagle Bridges - Marathon Industries; 550.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.

d. Mon-Eco Industries, Inc.; 55-50.

e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

b. Eagle Bridges - Marathon Industries; 405.

c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.

d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system. Color as selected by Architect].

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.

b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.

c. RPR Products, Inc.; Insul-Mate.

2. Sheet and roll stock ready for shop or field sizing.
3. Finish and thickness are indicated in field-applied jacket schedules.
4. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
5. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.

c. Compac Corporation; 104 and 105.

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.

c. Compac Corporation; 120.

d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.3 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 "Penetration Firestopping."

3.4 INSTALLATION OF MINERAL-FIBER INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface.

Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.6 FINISHES

A. Insulation with ASJ or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 "Exterior Painting" and Division 09 "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

C. Do not field paint aluminum or stainless-steel jackets.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.8 DUCT INSULATION SCHEDULE, GENERAL

A. Refer to schedules on drawings for material and thickness application to duct systems.

B. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
7. Outdoor, concealed supply and return.
8. Outdoor, exposed supply and return.

C. Items Not Insulated:

1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1-2007.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

END OF SECTION

SECTION 23 07 16

HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Chilled-water pumps.
   2. Heating, hot-water pumps.
   3. Expansion/compression tanks.
   4. Air separators.

B. Related Sections:

   1. Division 23 "Duct Insulation."
   2. Division 23 "HVAC Piping Insulation."

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail removable insulation at equipment connections.
   4. Detail application of field-applied jackets.
   5. Detail application at linkages of control devices.
   6. Detail field application for each equipment type.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Pittsburgh Corning Corporation; Foamglas.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Aeroflex USA, Inc.; Aerocel.
b. Armacell LLC; AP Armaflex.
c. K-Flex USA; Insul-Sheet and K-FLEX LS.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; SoftTouch Duct Wrap.
b. Johns Manville; Microlite.
c. Knauf Insulation; Friendly Feel Duct Wrap.
d. Manson Insulation Inc.; Alley Wrap.
e. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x

deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. CertainTeed Corp.; CrimpWrap.
    b. Johns Manville; MicroFlex.
    c. Knauf Insulation; Pipe and Tank Insulation.
    d. Manson Insulation Inc.; AK Flex.
    e. Owens Corning; Fiberglas Pipe and Tank Insulation.
    f. .

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Aeroflex USA, Inc.; Aeroseal.
    b. Armacell LLC; Armaflex 520 Adhesive.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
    d. K-Flex USA; R-373 Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    b. Eagle Bridges - Marathon Industries; 225.
    c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
    d. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.

b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H .B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Eagle Bridges - Marathon Industries; 550.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
d. Mon-Eco Industries, Inc.; 55-50.
e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
d. Mon-Eco Industries, Inc.; 44-05.
e. Pittsburgh Corning Corporation; Pittseal 444.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
b. Eagle Bridges - Marathon Industries; 405.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Johns Manville; Zeston.
    b. P.I.C. Plastics, Inc.; FG Series.
    c. Proto Corporation; LoSmoke.
    d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

1. Products: Subject to compliance with requirements, provide one of the following:

    a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    c. RPR Products, Inc.; Insul-Mate.
2. Finish and thickness are indicated in field-applied jacket schedules.
3. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
4. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
5. Factory-Fabricated Fitting Covers:

    a. Same material, finish, and thickness as jacket.
    b. Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    c. Tee covers.
    d. Flange and union covers.
    e. End caps.
    f. Beveled collars.
    g. Valve covers.
    h. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Polyguard Products, Inc.; Alumaguard 60.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 428 AWF ASJ.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
c. Compac Corporation; 104 and 105.
d. <Insert manufacturer's name; product name or designation>.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Aluminum Bands: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

B. Insulation Pins and Hangers:

1. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
2) GEMCO; Perforated Base.
3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Aluminum, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

2.9 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

    a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

4. Manholes.
5. Handholes.
6. Cleanouts.

3.3 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.4 FIELD-APPLIED JACKET INSTALLATION

A. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.5 FINISHES

A. Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09"Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.7 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chilled-water pump insulation shall be one of the following:

1. Cellular Glass: 3 inches thick.
2. Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

D. Heating-Hot-Water Pump Insulation: Mineral-Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.

E. Chilled-water expansion/compression tank insulation shall be one of the following:

1. Cellular Glass: 1-1/2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

F. Heating-Hot-Water Expansion/Compression Tank Insulation: Mineral-Fiber Pipe and Tank: 1 inch thick.

G. Chilled-water air-separator insulation shall be one of the following:

1. Cellular Glass: 2 inches thick.
2. Flexible Elastomeric: 1 inch thick.
3. Mineral-Fiber Pipe and Tank: 1 inch thick.

H. Heating-Hot-Water Air-Separator Insulation: Mineral-Fiber Pipe and Tank: 2 inches thick.

3.8 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.

D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. PVC: 20 mils thick.

END OF SECTION

SECTION 23 07 19

HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping, indoors.
2. Chilled-water and brine piping, indoors and outdoors.
3. Heating hot-water piping, indoors.
4. Steam and steam condensate piping, indoors.
5. Refrigerant suction and hot-gas piping, indoors and outdoors.

B. Related Sections:

1. Division 23 "Duct Insulation."
2. Division 23 "HVAC Equipment Insulation."
3. Division 23 "Underground Hydronic Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail removable insulation at piping specialties.
6. Detail application of field-applied jackets.
7. Detail application at linkages of control devices.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Piping Insulation Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be used without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

B. If retaining more than one type of insulation in this article, indicate where each type applies in insulation system schedules.

C. Products shall not contain asbestos, lead, mercury, or mercury compounds.

D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

G. Calcium Silicate:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Industrial Insulation Group (IIG); Thermo-12 Gold.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000-Degree Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
b. Eagle Bridges - Marathon Industries; 290.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
d. Mon-Eco Industries, Inc.; 22-30.
e. Vimasco Corporation; 760.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
d. K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.

d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
b. Eagle Bridges - Marathon Industries; 225.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Corning Corporation; 739, Dow Silicone.
b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

4. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.6 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.

   a. Sheet and roll stock ready for shop or field sizing.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper 3-mil-thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
   e. Factory-Fabricated Fitting Covers:

      1) Same material, finish, and thickness as jacket.
      2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      3) Tee covers.
      4) Flange and union covers.
      5) End caps.
      6) Beveled collars.
      7) Valve covers.
      8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

E. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. Pittsburgh Corning Corporation; Pittwrap.
   b. Polyguard Products, Inc.; Insulrap No Torch 125.

2.7 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABI, Ideal Tape Division; 370 White PVC tape.
    b. Compac Corporation; 130.
    c. Venture Tape; 1506 CW NS.
2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ABI, Ideal Tape Division; 488 AWF.
    b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    c. Compac Corporation; 120.
    d. Venture Tape; 3520 CW.

2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

    a. ITW Insulation Systems; Gerrard Strapping and Seals.
    b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation,

install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
4. Seal jacket to wall flashing with flashing sealant.

D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

1. Comply with requirements in Division 07 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.10 FINISHES

A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 "Exterior Painting" and "Interior Painting."

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.11 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.12 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.13 PIPING INSULATION SCHEDULE

A. Refer to drawings for schedule.

END OF SECTION

SECTION 23 09 23

DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Products Installed But Not Supplied Under This Section:
   1. Thermostats with standalone units.

1.2 RELATED WORK SPECIFIED ELESEWHERE

A. Products Not Furnished or Installed But Integrated with the Work of This Section:
   1. Smoke detectors (through alarm relay contacts).

B. Work Required Under Other Divisions Related to This Section:
   1. Power wiring to line side of motor starters, disconnects or variable frequency drives.
   2. Provision and wiring of smoke detectors and other devices relating to fire alarm system.
   3. Campus LAN (Ethernet) connection adjacent to JACE network management controller.
   4. Electrical submeters provided and installed by Electrical Contractor. Submeters to be provided with BACnet ms/tp communication.
   5. Solar Panel System and associated power meters
   6. Television display of Solar Panel System savings. Controls contractor to provide custom graphic appropriate for public display of Solar Panel system power data.

1.3 RELATED SECTIONS

A. Section 23 05 00 - Common Work Results for HVAC.

1.4 SYSTEM DESCRIPTION

A. Scope: Furnish all labor, materials and equipment necessary for a complete and operating Building Management System (BMS), utilizing Direct Digital Controls as shown on the drawings and as described herein. Drawings are diagrammatic only. All controllers furnished in this section shall communicate on a peer-to-peer BACnet protocol bus.
   1. System architecture shall fully support a multi-vendor environment and be able to integrate third party systems via protocols including, as a minimum, LonTalk, BACnet and MODBUS.

2. System architecture shall provide secure Web access using any of the current versions of Microsoft Internet Explorer, Mozilla Firefox, or Google Chrome browsers from any computer on the owner's LAN.
3. Any control vendor that shall provide additional BMS server software shall be unacceptable.
4. The BMS server or Master Controller shall host all graphic files for the control system.
5. Provide all hardware, software, programming tools and documentation necessary to modify the system, accommodate system expansion, and facilitate changes in operation on site. Modification includes addition and deletion of devices, circuits, and changes to system operation and custom label changes for devices and circuits. The system structure and software shall place no limit on the type or extent of software modifications on-site.
6. Owner shall receive all Administrator level login and passwords for engineering toolset at first training session. The Owner shall have full licensing and full access rights for all network management, operating system server, engineering and programming software required for the ongoing maintenance and operation of the BMS.
7. All JACE hardware licenses and certificates shall be stored on local MicroSD memory card employing encrypted "safe boot" technology.

B. All products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided on request, with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
1. Federal Communications Commission (FCC), Rules and Regulations, Volume II - July 1986 Part 15 Class A Radio Frequency Devices.
2. FCC, Part 15, Subpart B, Class B
3. FCC, Part 15, Subpart C
4. FCC, Part 15, Subpart J, Class A Computing Devices.
5. UL 504 - Industrial Control Equipment.
6. UL 506 - Specialty Transformers.
7. UL 910 - Test Method for Fire and Smoke Characteristics of Electrical and Optical-Fiber Cables Used in Air-Handling Spaces.
8. UL 916 - Energy Management Systems All.
9. UL 1449 - Transient Voltage Suppression.
10. Standard Test for Flame Propagation Height of Electrical and Optical - Fiber Cables Installed Vertically in Shafts.
11. EIA/ANSI 232-E - Interface Between Data Technical Equipment and Data Circuit Terminal Equipment Employing Serial Binary Data Interchange.
12. EIA 455 - Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Connecting and Terminating Devices.
13. IEEE C62.41- Surge Voltages in Low-Voltage AC Power Circuits.
14. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
    a. NEMA 250 - Enclosures for Electrical Equipment.
15. NEMA ICS 1 - Industrial Controls and Systems.

16. NEMA ST 1 - Specialty Transformers.
17. NCSBC Compliance, Energy: Performance of control system shall meet or surpass the requirements of ASHRAE/IESNA 90.1-1999.
18. CE 61326.
19. C-Tick.
20. cUL.

1.5 SPECIFICATIONS NOMECLATURE

A. Acronyms used in this specification are as follows:
1. Actuator: Control device that opens or closes valve or damper in response to control signal.
2. AI: Analog Input.
3. AO: Analog Output.
4. Analog: Continuously variable state over stated range of values.
5. BMS: Building Management System.
6. DDC: Direct Digital Control.
7. Discrete: Binary or digital state.
8. DI: Discrete Input.
9. DO: Discrete Output.
10. FC: Fail Closed position of control device or actuator. Device moves to closed position on loss of control signal or energy source.
11. FO: Fail open (position of control device or actuator). Device moves to open position on loss of control signal or energy source.
12. GUI: Graphical User Interface.
13. HVAC: Heating, Ventilating and Air Conditioning.
14. IDC: Interoperable Digital Controller.
15. ILC: Interoperable Lon Controller.
16. LAN: Local Area Network.
17. Modulating: Movement of a control device through an entire range of values, proportional to an infinitely variable input value.
18. Motorized: Control device with actuator.
19. NAC: Network Area Controller.
20. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.
21. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.
22. OSS: Operating System Server, host for system graphics, alarms, trends, etc.
23. Operator: Same as actuator.
24. PC: Personal Computer.
25. Peer-to-Peer: Mode of communication between controllers in which each device connected to network has equal status and each shares its database values with all other devices connected to network.
26. P: Proportional control; control mode with continuous linear relationship between observed input signal and final controlled output element.

27. PI: Proportional-Integral control, control mode with continuous proportional output plus additional change in output based on both amount and duration of change in controller variable (reset control).
28. PICS: BACnet Product Interoperability Compliance Statement.
29. PID: Proportional-Integral-Derivative control, control mode with continuous correction of final controller output element versus input signal based on proportional error, its time history (reset) and rate at which it's changing (derivative).
30. Point: Analog or discrete instrument with addressable database value.
31. WAN: Wide Area Network.

1.6 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Catalog Information
   2. Detailed Product Information / Data Sheets
   3. Installation and/or Maintenance Instructions

C. Submit documentation of contractor qualifications if requested by the A-E.

D. Five copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers' catalog data sheets and installation instructions. Submit in printed electronic format. Samples of written Controller Checkout Sheets and Performance Verification Procedures for applications similar in scope shall be included for approval.

E. Shop drawings shall also contain complete wiring and schematic diagrams, sequences of operation, control system bus layout and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.

F. Upon completion of the work, provide 5 complete sets of ' as-built' drawings and other project-specific documentation in 3-ring hard-backed binders and on digital media.

G. Any deviations from these specifications or the work indicated on the drawings shall be clearly identified in the Submittals.

1.7 QUALITY ASSURANCE

A. The Control System Contractor shall have a full service DDC office within 50 miles of the job site. This office shall be staffed with applications engineers, software engineers and field technicians. This office shall maintain parts inventory and shall have all testing and diagnostic equipment necessary to support this work, as well as staff trained in the use of this equipment.

B. Single Source Responsibility of Supplier: The Control System Contractor shall be responsible for the complete installation and proper operation of the control system. The Control System Contractor shall exclusively be in the regular and customary business of design, installation and service of computerized building management systems similar in size and complexity to the system specified.

C. Equipment and Materials: Equipment and materials shall be cataloged products of manufacturers regularly engaged in the production and installation of HVAC control systems. Products shall be manufacturer's latest standard design and have been tested and proven in actual use.

1.8 CLOSEOUT SUBMITTALS

A. Maintain integrity of shipping cartons for each piece of equipment and control device through shipping, storage and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.9 MAINTENANCE MATERIAL SUBMITTALS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers and structural and architectural features.

1.10 QUALITY ASSURANCE

A. Ensure that products of this section are supplied to affected trades in time to prevent interruption of construction progress.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. KMC Controls as provided by Harrison Energy Partners
   2. JCI Controls as provided by Building Technologies & Solutions
   3. Siemens Controls as provided by Powers of Arkansas
   4. Alerton Controls as provided by Northwest Controls
   5. Trane Controls as provided by Trane Commercial

B. Substitutions: Engineer Approval Required

2.2 GENERAL

A. The Building Management System (BMS) shall be comprised of a network of interoperable, stand-alone digital controllers, a network area controller, graphics and programming and other control devices for a complete system as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the overall BMS.

2.3 OPEN, INTEROPERABLE, INTERGRATED ARCHITECTURE

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system.

B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment shall be via BACnet ms/tp or IP.

C. All components and controllers supplied under this contract shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data shall not be acceptable.

D. The supplied system shall incorporate the ability to access all data using HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
   1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
   2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.Retain one of two “Delegated Design” paragraphs below if Contractor is required to assume responsibility for design.

2.4 BAS SERVER HARDWARE

A. Minimum Computer Configuration (Hardware Independent).

1. Central Server. Owner shall provide a dedicated BAS server with configuration that includes the following components as a minimum:
2. Processor: Intel Xeon CPU E5-2640 x64 (or better), compatible with dual- and quad-core processors.
3. Memory: 2 GB or more recommended for large systems
4. Hard Drive: 256 GB minimum, more recommended depending on archiving requirements.
5. Display: Video card and monitor capable of displaying 1024 x 768 pixel resolution or greater.
6. Network Support: Ethernet adapter (10/100 Mb with RJ-45 connector).
7. Connectivity: Full-time high-speed ISP connection recommended for remote site access (i.e. T1, ADSL, cable modem).

B. Standard Client: The thin-client Web Browser BAS GUI shall be Microsoft Internet Explorer (10.0 or later) running on Microsoft 7+. No special software shall be required to be installed on the PCs used to access the BAS via a web browser.

2.5 SYSTEM NETWORK CONTOLLER (SNC)

A. These controllers are designed to manage communications between the programmable equipment controllers, application specific controllers and advanced unitary controllers which are connected to its communications trunks, manage communications between itself and other system network controllers , and perform control and operating strategies for the system based on information from any controller connected to the BAS.

B. The controllers shall be fully programmable to meet the unique requirements of the facility it shall control.

C. The controllers shall be capable of peer-to-peer communications with other SNC's and with any OWS connected to the BAS, whether the OWS is directly connected, connected via cellular modem or connected via the Internet.

D. The communication protocols utilized for peer-to-peer communications between SNC's will be Niagara 4 Fox, BACnet TCP/IP and SNMP. Use of a proprietary communication protocol for peer-to-peer communications between SNC's is not allowed.

E. The SNC shall employ a device count capacity license model that supports expansion capabilities.

F. The SNC shall be enabled to support and shall be licensed with the following Open protocol drivers (client and server) by default:
1. BACnet
2. Lon
3. MODBUS
4. SNMP

5. KNX

G. The SNC shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization
   6. Integration of LonWorks, BACnet, and MODBUS controller data.
   7. Network management functions for all SNC, PEC and ASC based devices.

H. The SNC shall provide the following hardware features as a minimum:
   1. Two 10/100 Mbps Ethernet ports.
   2. Two Isolated RS-485 ports with biasing switches.
   3. 1 GB RAM
   4. 4 GB Flash Total Storage / 2 GB User Storage
   5. Wi-Fi (Client or WAP)
   6. USB Flash Drive
   7. High Speed Field Bus Expansion
   8. -20-60 degreesC Ambient Operating Temperature
   9. Integrated 24 VAC/DC Global Power Supply
   10. MicroSD Memory Card Employing Encrypted Safe Boot Technology

I. The SNC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

J. The SNC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.

K. The SNC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via cellular modem, or wide-area network.
   1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
      a. Alarm
      b. Return to Normal
      c. To default
   2. Alarms shall be annunciated in any of the following manners as defined by the user:
      a. Screen message text.
      b. Email of complete alarm message to multiple recipients.
      c. Pagers via paging services that initiate a page on receipt of email message.
      d. Graphics with flashing alarm object(s).
   3. The following shall be recorded by the SNC for each alarm (at a minimum):
      a. Time and date.
      b. Equipment (air handler #, access way, etc.).
      c. Acknowledge time, date, and user who issued acknowledgement.

L. Programming software and all controller "Setup Wizards" shall be embedded into the SNC.

M. The SNC shall support the following security functions.
   1. Module code signing to verify the author of programming tool and confirm that the code has not been altered or corrupted.
   2. Role-Based Access Control (RBAC) for managing user roles and permissions.
   3. Require users to use strong credentials.
   4. Data in Motion and Sensitive Data at Rest be encrypted.
   5. LDAP and Kerberos integration of access management.

N. The SNC shall support the following data modeling structures to utilize Search; Hierarchy; Template; and Permission functionality:
   1. Metadata: Descriptive tags to define the structure of properties.
   2. Tagging: Process to apply metadata to components
   3. Tag Dictionary

O. The SNC shall employ template functionality. Templates are a containerized set of configured data tags, graphics, histories, alarms... that are set to be deployed as a unit based upon manufacturer's controller and relationships. All lower level communicating controllers (PEC, AUC, AVAV, VFD.) shall have an associated template file for reuse on future project additions.

2.6 PROGRAMMABLE EQUIPMENT CONTROLLER (PEC)

A. HVAC control shall be accomplished using BACnet based devices where the application has a BTL Listed PICS defined. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara 4 Framework, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

B. All PECs shall be application programmable and shall at all times maintain their certification. All control sequences within or programmed into the PEC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained.

C. The PEC shall provide LED indication of communication and controller performance to the technician, without cover removal.

D. The PEC shall not require any external configuration tool or programming tool. All configuration and programming tasks shall be accomplished and accessible from within the Niagara 4 environment.

E. The following integral and remote Inputs/Outputs shall be supported per each PEC:
   1. Digital inputs
   2. Analog inputs (configurable as 0-10V, 0-10,000 ohm or, 20K NTC).
   3. Analog outputs.

4. Digital outputs, configurable as maintained or floating motor control outputs.
5. One integral power supply for auxiliary devices.
6. If a 20 Vdc 65-mA power supply terminal is not integral to the PEC, provide at each PEC a separate, fully isolated, enclosed, current limited and regulated UL listed auxiliary power supply for power to auxiliary devices.

F. Each PEC shall have expansion ability to support additional I/O requirements through the use of remote input/output modules.

G. PEC Controllers shall support at minimum the following control techniques:
1. General-purpose control loops that can incorporate Demand Limit Control strategies, Set point reset, adaptive intelligent recovery, and time of day bypass.
2. General-purpose, non-linear control loops.
3. Start/stop Loops.
4. If/Then/Else logic loops.
5. Math Function loops (MIN, MAX, AVG, SUM, SUB, SQRT, MUL, DIV, ENTHALPY).

2.7 OTHER CONTROL SYSTEM HARWARE

A. Wall Mount Room Temperature sensors: Room temperature sensors will be provided with HVAC equipment package. Each room temperature sensor shall provide temperature indication to the factory, digital controller, provide the capability for a software-limited occupant set point adjustment and limited operation override capability. Remote adjustment of room set points and limits of set points shall be adjustable from the BMS.

B. Humidity sensors shall be thin-film capacitive type sensor with on-board nonvolatile memory, accuracy to plus or minus two percent (2%) at 10 to 95% RH, 12 - 30 VDC input voltage, analog output (0 - 10 VDC or 4 - 20mA output). Operating range shall be 0 to 100% RH and 32 to 122 degrees F.

C. Carbon Dioxide Sensors (CO2): Sensors shall utilize Non-dispersive infrared technology. Sensor range shall be 0 - 2000 PPM. Accuracy shall be plus or minus three percent (3%) or 40 PPM, whichever is greater. Response shall be less than two minutes. Input voltage shall be 20 to 30 VAC or DC. Output shall be 0 - 10 VDC.

D. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

E. Differential Analog (duct) Static Pressure Transmitters Provide a pressure transmitter with integral capacitance type sensing and solid-state circuitry. Accuracy shall be plus or minus 1% of full range; range shall be selected for the specific application. Provide zero and span adjustment capability. Device shall have integral static pickup tube.

F. Differential Air Pressure Switches: Provide SPDT type, UL-approved, and selected for the appropriate operating range where applied. Switches shall have adjustable set points and barbed pressure tips.

G. Temperature Control Panels: Furnish temperature control panels of code gauge steel with hinged doors for each DDC controller. A complete set of ' as-built' control drawings (relating to the controls within that panel) shall be furnished within each control panel.

H. Pipe and Duct Temperature sensing elements: 20,000-ohm thermistor temperature sensors with and accuracy of ±1% accuracy. Their range shall be -5 to 250 degrees F (-20 to 121 degrees C). Limited range sensors shall be acceptable provided they are capable of sensing the range expected for the point at the specified accuracy. Thermal wells with heat conductive gel shall be included.

I. Low Air Temperature Sensors: Provide SPST type switch, with 15 to 55 degrees F (-9 to 13 degrees C), range, vapor-charged temperature sensor. Honeywell model L482A, or approved equivalent.

J. Variable Frequency Drives: The variable frequency drives (VFD) for this project shall be provided factory installed with the HVAC equipment.

K. Relays: Start/stop relay model shall provide either momentary or maintained switching action as appropriate for the motor being started. All relays shall be plugged in, interchangeable, mounted on a sub base and wired to numbered terminals strips. Relays installed in panels shall all be DPDT with indicating lamp. Relays installed outside of controlled devices shall be enclosed in a NEMA enclosure suitable for the location. Relays shall be labeled with UR symbol. RIB-style relays are acceptable for remote enable/disable.

L. Control Power Transformers: Provide step-down transformers for all DDC controllers and devices as required. Transformers shall be sized for the load, but shall be sized for 50 watts, minimum. Transformers shall be UL listed Class 2 type, for 120 VAC/24 VAC operation.

M. Line voltage protection: All DDC system control panels that are powered by 120 VAC circuits shall be provided with surge protection. This protection is in addition to any internal protection provided by the manufacturer. The protection shall meet UL, ULC 1449, IEEE C62.41B. A grounding conductor, (minimum 12 AWG), shall be brought to each control panel.

2.8 BAS SERVER & WEB BROWSER GUI - SYSTEM OVERVIEW

A. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.

B. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems.

C. The BAS server software shall support at least the following server platforms (Windows 7, 8.1, Server 12). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.

D. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:
   1. Trending.
   2. Scheduling.
   3. Electrical demand limiting.
   4. Duty Cycling.
   5. Downloading Memory to field devices.
   6. Real time 'live' Graphic Programs.
   7. Tree Navigation.
   8. Parameter change of operators.
   9. Set point adjustments.
   10. Alarm / event information.
   11. Configuration of operators.
   12. Execution of global commands.
   13. Add, delete, and modify graphics and displayed data.

E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
   1. Server Software, Database and Web Browser Graphical User Interface.
   2. 1 Year Software Maintenance license.
   3. Embedded System Configuration Utilities for future modifications to the system and controllers.
   4. Embedded Graphical Programming Tools.
   5. Embedded Direct Digital Control software.
   6. Embedded Application Software.

F. BAS Server Database: The BAS server software shall utilize a Java Database Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.

G. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
   1. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to

the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.

2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

2.9 WEB BROWSER GRAPHICAL USER INTERFACE

A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.

B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.

C. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.

1. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
2. Groups View shall display Scheduled Groups and custom reports.
3. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).

D. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.

2. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
3. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
4. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
5. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
6. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
7. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
8. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
9. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.

E. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
1. Display Size: The GUI workstation software shall graphically display in a minimum of 1024 by 768 pixels 24 bit True Color.
2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
3. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
4. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    a. Each piece of equipment monitored or controlled including each terminal unit.
    b. Each Building
    c. Each floor and zone controlled

F. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.

1. Schedules: Schedules shall comply with the LonWorks and BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
    a. Types of schedule shall be Normal, Holiday or Override.
    b. A specific date.
    c. A range of dates.
    d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
    e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

G. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:

1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
    a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
    b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.

c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
d. Write Property: The write property reporting action updates a property value in a hardware module.
e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
f. Run External Program: The Run External Program reporting action launches specified program in response to an event.

H. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
7. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

I. Security Access: Systems that are accessedfrom the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.

a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
b. Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.

2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.10 GRAPHICAL PROGRAMING

A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.

B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.

C. Graphic Sequence: The clarity of the graphic sequence shall be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming shall be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.

D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:

1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.

2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
10. Live Graphical Programs: The Graphic Programming software shall support a ' live' mode, where all input/output data, calculated data and set points shall be displayed in a ' live' real-time mode.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPERATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 GENERAL

A. Install system and materials in accordance with manufacturer's instructions, and as detailed on the project drawing set.

B. Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Control System Contractor in accordance with these specifications.

C. Equipment furnished by the Mechanical Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by the Control System Contractor.

D. All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

3.4 WIRING

A. All electrical control wiring to the control panels shall be the responsibility of the Control System Contractor.

B. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All control wiring shall be installed in raceways.

C. Excess wire shall not be looped or coiled in the controller cabinet.

D. Incorporate electrical noise suppression techniques in relay control circuits.

E. There shall be no drilling on the controller cabinet after the controls are mounted inside.

F. Careful stripping of wire while inside the cabinet is required to ensure that no wire strand fragments land on circuit boards.

G. Use manufacturer-specified wire for all network connections.

H. Use approved optical isolation and lightning protection when penetrating building envelope.

I. Read installation instructions carefully. Any unavoidable deviations shall be approved by owner's rep prior to installation.

3.5 ACCEPTANCE TESTING

A. Upon completion of the installation, the Control System Contractor shall load all system software and start-up the system. The Control System Contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational

checks to insure that the system is functioning in full accordance with these specifications.

B. The Control System Contractor shall perform tests to verify proper performance of components, routines and points. Repeat tests until proper performance results. This testing shall include a point-by-point log to validate 100% of the input and output points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when the Control System Contractor has performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.6 OPERATOR TRAINING

A. During system commissioning and at such time acceptable performance of the Control System hardware and software has been established, the Control System Contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction shall be done during normal working hours and shall be performed by a competent representative familiar with the system hardware, software and accessories.

B. The Control System Contractor shall provide 8 total hours of comprehensive training for system orientation, product maintenance, and troubleshooting, The training shall start after final commissioning.

3.7 WARRANTY PERIOD SERVICES

A. Equipment, materials and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the BMS due to faulty materials, methods of installation or workmanship shall be promptly repaired or replaced by the Control System Contractor at no expense to the Owner.

C. Maintenance of Control Hardware: The Control System Contractor shall inspect, repair, replace, adjust, and calibrate, as required, the controllers, control devices and associated peripheral units during the warranty period. The Control System Contractor shall then furnish a report describing the status of the equipment, problem areas (if any) noticed during service work, and description of the corrective actions taken. The report shall clearly certify that all hardware is functioning correctly.

D. Service Period: Calls for service by the Owner shall be honored within 24 hours and are not to be considered as part of routine maintenance.

E. Service Documentation: A copy of the service report associated with each owner-initiated service call shall be provided to the owner.

3.8 WARRANTY ACCESS

A. The Owner shall grant to the Control System Contractor reasonable access to the BMS during the warranty period. Remote access to the BMS (for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period) will be allowed.

3.9 See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:

A. See Division 1 for requirements. O&M manuals shall include the following elements, as a minimum:
   1. As-built control drawings for all equipment.
   2. As-built Network Communications Diagram.
   3. General description and specifications for all components.
   4. Completed Performance Verification sheets.
   5. Completed Controller Checkout/Calibration Sheets.

3.10 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 23 23 00

REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.2 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-134a:

1. Suction Lines for Air-Conditioning Applications: 115 psig.
2. Suction Lines for Heat-Pump Applications: 225 psig.
3. Hot-Gas and Liquid Lines: 225 psig.

B. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig.
2. Suction Lines for Heat-Pump Applications: 380 psig.
3. Hot-Gas and Liquid Lines: 380 psig.

C. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig.
2. Suction Lines for Heat-Pump Applications: 535 psig.
3. Hot-Gas and Liquid Lines: 535 psig.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop based on manufacturer's test data.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

A. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

B. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.7 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing Filler Metals: AWS A5.8.

F. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
2. End Connections: Socket ends.
3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch-long assembly.
4. Pressure Rating: Factory test at minimum 500 psig.
5. Maximum Operating Temperature: 250 deg F.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-Gas and Liquid Lines, and Suction Lines: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Division 23 "Identification for HVAC Piping and Equipment."

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 "Sleeves and Sleeve Seals for HVAC Piping."

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 "Sleeves and Sleeve Seals for HVAC Piping."

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 "Escutcheons for HVAC Piping."

3.3 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

B. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.

2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.

3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.

5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.

7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.

8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.

9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Support multifloor vertical runs at least at each floor.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping and specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.

    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.6 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

3.7 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Rectangular ducts and fittings.
2. Round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

B. Related Sections:

1. Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. The product descriptions listed in the section may not all be used on this project. Refer to the Ductwork Material Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be used without pre-approval from the Engineer. Where there is a conflict between the drawing schedule and specifications, the drawing schedule shall take precedent.

2.2 RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support

intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 ROUND AND FLAT OVAL DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

    a. Lindab Inc.

    b. McGill AirFlow LLC.

    c. SEMCO Incorporated.

    d. Sheet Metal Connectors, Inc.

    e. Spiral Manufacturing Co., Inc.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger Than 90 inches in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and

Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.

2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   a. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Inner Duct: Minimum 0.028-inch perforated galvanized sheet steel having 3/32-inch-diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60.
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.6 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation; Insulation Group.
b. Johns Manville.
c. Knauf Insulation.
d. Owens Corning.

2. Maximum Thermal Conductivity:
a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant

coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

C. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.8 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

M. In congested areas (with respect to other building components / services), coordinate the installed duct connection to its air device so as to provide the designed air flow without any restrictions.

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT

A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

B. Install fire-rated access panel assemblies at each change in direction and at maximum intervals of 20 feet in horizontal ducts, and at every floor for vertical ducts, or as indicated on Drawings. Locate access panel on top or sides of duct a minimum of 1-1/2 inches from bottom of duct.

C. Do not penetrate fire-rated assemblies except as allowed by applicable building codes and authorities having jurisdiction.

3.4 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.6 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 START UP

A. Air Balance: Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC."

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems

3.9 DUCT SCHEDULE

A. Use the following duct types unless otherwise specified on the plans. Fabricate ducts with galvanized sheet steel except as otherwise indicated.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Constant-Volume Air-Handling Units:

    a. Pressure Class: Positive 2-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Variable-Air-Volume Air-Handling Units:
    a. Pressure Class: Positive 6-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

4. Ducts Connected to Equipment Not Listed Above:

    a. Pressure Class: Positive 4-inch wg.
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

    a. Pressure Class: Positive or negative 2-inch wg.
    b. Minimum SMACNA Seal Class: A .
    c. SMACNA Leakage Class for Rectangular: 12.
    d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 4-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1-2007, Class 1 and 2) Air:

a. Pressure Class: Negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Commercial Kitchen Hoods: Comply with NFPA 96. Refer to plan schedules for type.

a. Double Wall, Factory-Built Grease Duct:
1) Captiveaire Models DW-2R, 3R and 3Z: double wall, factory built grease duct to be ETL listed to UL-1978 and UL-2221 for venting air and grease vapors from commercial cooking operation and listed for a continuous internal temperature of 500 degrees F and intermittent temperatures of 2000 degrees F.
2) The duct sections shall be constructed of an inner duct wall and an outer wall with insulation in between. The inner duct wall shall be constructed of .036 inch thick, 430 type stainless steel. The outer wall shall be constructed of stainless steel at a minimum of .024 inch thickness. The duct shall include layers of Super Wool 607 Plus insulation between the inner and outer wall. Grease duct joints shall be held together by means of formed V clamps and sealed with 3M Fire Barrier 2000+. The duct wall assembly shall be tested and listed at ¾" or zero inch clearance, according to classifications.

b. Field Built:
1) Exposed to View: Type 304, stainless-steel sheet, No. 4 finish.
2) Concealed: Carbon-steel sheet.
3) Welded seams and joints.
4) Pressure Class: Positive or negative 4-inch wg.
5) Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
6) SMACNA Leakage Class: 3.

4. Ducts Connected to Dishwasher Hoods:

a. Type 304, stainless-steel sheet.
b. Exposed to View: No. 4 finish.
c. Concealed: No. 2D finish.
d. Welded seams and flanged joints with watertight EPDM gaskets.
e. Pressure Class: Positive or negative 3-inch wg.
f. Minimum SMACNA Seal Class: Welded

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 12.
d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 6.
d. SMACNA Leakage Class for Round and Flat Oval: 6.

3. Ducts Connected to Equipment Not Listed Above:

a. Pressure Class: Positive or negative 2-inch wg.
b. Minimum SMACNA Seal Class: A.
c. SMACNA Leakage Class for Rectangular: 3.
d. SMACNA Leakage Class for Round and Flat Oval: 3.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.

2. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.
b. Not Exposed to Airstream: Galvanized.

3. Aluminum Ducts: Aluminum.

G. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch thick, only where noted otherwise on drawings.
2. Return Air Ducts: Fibrous glass, Type I, 1 inch thick, only where noted otherwise on drawings.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."

a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.

1) Radius-to Diameter Ratio: 1.5.

b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

I. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: Spin in.

2. Round: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

a. Velocity 1000 fpm or Lower: 90-degree tap.
b. Velocity 1000 to 1500 fpm: Conical tap.
c. Velocity 1500 fpm or Higher: 45-degree lateral.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
   a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections, from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling radiation dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Flexible connectors.
16. Duct security bars.
17. Duct accessory hardware.

B. Related Requirements:

1. Division 23 "Flexible Ducts" for insulated and non-insulated flexible ducts.
2. Division 23 "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
3. Division 28 "Addressable Fire-Alarm Systems" "Conventional Fire-Alarm Systems" for duct-mounted fire and smoke detectors.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Sustainable Design Submittals:

C. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

a. Special fittings.
b. Manual volume damper installations.
c. Control-damper installations.
d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
e. Duct security bars.
f. Wiring Diagrams: For power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

B. Source quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.

1. Galvanized Coating Designation: G90.
2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and finish for exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

D. Extruded Aluminum: Comply with ASTM B221, Alloy 6063, Temper T6.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.3 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Description: Gravity balanced.

B. Maximum Air Velocity: 2000 fpm.

C. Maximum System Pressure: 3-inch wg.

D. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

E. Blades: Multiple single-piece blades, maximum 6-inch width, 0.050-inch-thick aluminum sheet with sealed edges.

F. Blade Action: Parallel.

G. Blade Seals: Neoprene, mechanically locked.

H. Blade Axles:

1. Material: Aluminum.
2. Diameter: 0.20 inch.

I. Tie Bars and Brackets: Aluminum.

J. Return Spring: Adjustable tension.

K. Bearings: synthetic pivot bushings.

L. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.
2. Counterweights and spring-assist kits for vertical airflow installations.
3. Electric actuators.
4. Chain pulls.
5. Screen Mounting: Front mounted in sleeve.

    a. Sleeve Thickness: 20 gauge minimum.
    b. Sleeve Length: 6 inches minimum.

6. Screen Mounting: Rear mounted.
7. Screen Material: Aluminum.
8. Screen Type: Bird.
9. 90-degree stops.

2.4 BAROMETRIC RELIEF DAMPERS

A. Suitable for horizontal or vertical mounting.

B. Maximum Air Velocity: 2000 fpm.

C. Maximum System Pressure: 3-inch wg.

D. Frame: Hat-shaped, 0.063-inch-thick extruded aluminum, with welded corners or mechanically attached and mounting flange.

E. Blades:

1. Multiple, 0.050-inch-thick aluminum sheet.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.

F. Blade Seals: Neoprene.

G. Blade Axles: Stainless steel.

H. Tie Bars and Brackets:

1. Material: Aluminum.
2. Rattle free with 90-degree stop.

I. Return Spring: Adjustable tension.

J. Bearings: Synthetic.

K. Accessories:

1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.5 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
1. Standard leakage rating, with linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames:

a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.

4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Galvanized-steel, 0.064 inch thick.

5. Blade Axles: Galvanized steel or Nonferrous metal.
6. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Galvanized steel.

B. Standard, Aluminum, Manual Volume Dampers:
1. Standard leakage rating, with linkage outside airstream.
2. Suitable for horizontal or vertical applications.
3. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
4. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.
    d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
    e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

5. Blade Axles: Galvanized steel or Nonferrous metal.
6. Bearings:

    a. Molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

7. Tie Bars and Brackets: Aluminum.

C. Low-Leakage, Steel, Manual Volume Dampers:
1. Comply with AMCA 500-D testing for damper rating.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:

    a. Hat shaped.
    b. 0.094-inch-thick, galvanized sheet steel.
    c. Mitered and welded corners.
    d. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

    a. Multiple or single blade.
    b. Parallel- or opposed-blade design.
    c. Stiffen damper blades for stability.

d. Galvanized, roll-formed steel, 0.064 inch thick.

6. Blade Axles: Galvanized steel or Nonferrous metal.
7. Bearings:

a. Molded synthetic.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

D. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Comply with AMCA 500-D testing for damper rating.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:

a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.

6. Blade Axles: Galvanized steel or Nonferrous metal.
7. Bearings:

a. Molded synthetic.
b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Aluminum.
11. Accessories:

a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Jackshaft:

1. Size: 1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.6 CONTROL DAMPERS

A. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

B. Frames:

1. Hat shaped.
2. 0.094-inch-thick, galvanized sheet steel.
3. Mitered and welded corners.

C. Blades:

1. Multiple blade with maximum blade width of 6 inches.
2. Opposed-blade design.
3. Aluminum.
4. 0.0747-inch-thick dual skin.
5. Blade Edging: Closed-cell neoprene.
6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

D. Blade Axles: 1/2-inch-diameter; galvanized steel or nonferrous metal; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.

1. Operating Temperature Range: From minus 40 to plus 200 deg F.

E. Bearings:

1. Molded synthetic.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.7 FIRE DAMPERS

A. Type: Static and dynamic; rated and labeled according to UL 555 by an NRTL.

B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed galvanized steel; with mitered and interlocking corners; gauge in accordance with UL listing.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel; gauge in accordance with UL listing.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, galvanized sheet steel; gauge in accordance with UL listing.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Heat-Responsive Device: Replaceable, 165 deg F or 212 deg F rated, fusible links based on the application.

2.8 CEILING RADIATION DAMPERS

A. General Requirements:

1. Labeled according to UL 555C by an NRTL.
2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

B. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

C. Blades: Galvanized sheet steel with refractory insulation.

D. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

E. Fire Rating: 1, 2, or 3 hour(s) based on the application.

2.9 SMOKE DAMPERS

A. General Requirements: Label according to UL 555S by an NRTL.

B. Smoke Detector: Integral, factory wired for single-point connection. If required, Duct mounted smoke detectors to be provided by fire alarm contractor.

C. Frame: Hat-shaped, galvanized sheet steel, with welded corners and mounting flange; gauge in accordance with UL listing.

D. Blades: Roll-formed, horizontal, interlocking or overlapping, galvanized sheet steel; gauge in accordance with UL listing.

E. Leakage: Class II.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.

H. Damper Motors: two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

J. Accessories:

1. Auxiliary switches for signaling.
2. Test and reset switches, damper mounted.

2.10 COMBINATION FIRE AND SMOKE DAMPERS

A. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

B. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

C. Fire Rating: 1-1/2 and 3 hours.

D. Frame: Hat-shaped, galvanized sheet steel, with welded corners and mounting flange; gauge in accordance with UL listing.

E. Heat-Responsive Device: Replaceable, 165 deg F or 212 deg F rated, fusible links.

F. Smoke Detector: Integral, factory wired for single-point connection. If required, Duct mounted smoke detectors to be provided by fire alarm contractor.

G. Blades: Roll-formed, horizontal, interlocking or overlapping, galvanized sheet steel; gauge in accordance with UL listing.

H. Leakage: Class II.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.

K. Master control panel for use in dynamic smoke-management systems.

L. Damper Motors: two-position action.

M. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

N. Accessories:

1. Auxiliary switches for signaling.
2. Test and reset switches, damper mounted.

2.11 CORRIDOR DAMPERS

A. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-hour or 1-1/2-hour rating by an NRTL.

B. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

C. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

D. Frame: Hat-shaped, galvanized sheet steel, with welded corners and mounting flange; gauge in accordance with UL listing.

E. Blades: Roll-formed, horizontal, interlocking, galvanized sheet steel; gauge in accordance with UL listing.

F. Mounting Sleeve: Factory-installed, galvanized sheet steel; length to suit wall or floor application; gauge in accordance with UL listing.

G. Damper Motors: Modulating action.

H. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 "Direct Digital Control (DDC) System for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

2.12 FLANGE CONNECTORS

A. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

B. Material: Galvanized steel.

C. Gauge and Shape: Match connecting ductwork.

2.13 DUCT SILENCERS

A. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

B. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

C. Rectangular Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel, 0.034 inch thick.

D. Round Silencer Outer Casing: ASTM A653/A653M, G90, galvanized sheet steel.

1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: 0.034 inch thick.
2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: 0.040 inch thick.
3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: 0.05 inch thick.
4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: 0.064 inch thick.

E. Inner Casing and Baffles: ASTM A653/A653M, G90 galvanized sheet metal, 0.034 inch thick, and with 1/8-inch-diameter perforations.

F. Special Construction:

1. Suitable for outdoor use.
2. High transmission loss to achieve STC 45.

G. Connection Sizes: Match connecting ductwork unless otherwise indicated.

H. Principal Sound-Absorbing Mechanism:

1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
2. Dissipative type with fill material.

a. Fill Material: Inert and Moisture-proof nonfibrous material.
b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.

3. Lining: Mylar.

I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.

1. Joints: continuously welded.
2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
3. Reinforcement: Cross or trapeze angles for rigid suspension.

J. Accessories:

1. Integral 3-hour fire damper with access door. Access door to be high transmission loss to match silencer.
2. Factory-installed end caps to prevent contamination during shipping.
3. Removable splitters.
4. Airflow measuring devices.

K. Source Quality Control: Test according to ASTM E477.

1. Testing of mockups to be witnessed by Architect.
2. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.14 TURNING VANES

A. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

B. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

D. Vane Construction: Double wall.

2.15 REMOTE DAMPER OPERATORS

A. Description: Cable system designed for remote manual damper adjustment.

B. Tubing: Aluminum.

C. Cable: Stainless steel.

D. Wall-Box Mounting: Recessed.

E. Wall-Box Cover-Plate Material: Steel.

2.16 DUCT-MOUNTED ACCESS DOORS

A. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."

1. Door:

    a. Double wall, rectangular.
    b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    c. Vision panel.
    d. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.
    e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:

    a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
    b. Access Doors up to 18 Inches Square: Two hinges and two sash locks.
    c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

B. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 3.0- to 8.0-inch wg.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.17 DUCT ACCESS PANEL ASSEMBLIES

A. Labeled according to UL 1978 by an NRTL.

B. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

C. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

D. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

E. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.18 FLEXIBLE CONNECTORS

A. Materials: Flame-retardant or noncombustible fabrics.

B. Coatings and Adhesives: Comply with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

E. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd..
2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F.

F. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.

1. Minimum Weight: 16 oz./sq. yd..
2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

G. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.

1. Minimum Weight: 14 oz./sq. yd..
2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F.

H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.19 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

1. Install steel volume dampers in steel ducts.
2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire and smoke dampers according to UL listing.

H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch-diameter steel bars, 6 inches o.c. in each direction

in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

I. Connect ducts to duct silencers rigidly.

J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.
2. Upstream from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
7. At each change in direction and at maximum 50-foot spacing.
8. Upstream from turning vanes.
9. Upstream or downstream from duct silencers.
10. Control devices requiring inspection.
11. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.
3. Head and Hand Access: 18 by 10 inches.
4. Head and Shoulders Access: 21 by 14 inches.
5. Body Access: 25 by 14 inches.
6. Body plus Ladder Access: 25 by 17 inches.

M. Label access doors according to Division 23 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Install duct test holes where required for testing and balancing purposes.

Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION

SECTION 23 33 46

FLEXIBLE DUCTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-insulated flexible ducts.
2. Insulated flexible ducts.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Shop Drawings: For flexible ducts.

1. Include plans showing locations and mounting and attachment details.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from installers of the items involved.

PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

C. Comply with the Air Diffusion Council's "ADC Flexible Air Duct Test Code FD 72-R1."

D. Comply with ASTM E96/E96M, "Test Methods for Water Vapor Transmission of Materials."

2.2 NON-INSULATED FLEXIBLE DUCTS

A. Non-Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.

B. Non-Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.

C. Non-Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

D. Non-Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.

E. Non-Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 100 to plus 435 deg F.

2.3 INSULATED FLEXIBLE DUCTS

A. Insulated, Flexible Duct: UL 181, Class 1, two-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 10 to plus 160 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

B. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

D. Insulated, Flexible Duct: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
2. Maximum Air Velocity: 4000 fpm.
3. Temperature Range: Minus 20 to plus 210 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

E. Insulated, Flexible Duct: UL 181, Class 0, interlocking spiral of aluminum foil; fibrous-glass insulation; aluminized vapor-barrier film.

1. Pressure Rating: 8-inch wg positive or negative.
2. Maximum Air Velocity: 5000 fpm.
3. Temperature Range: Minus 20 to plus 250 deg F.
4. Insulation R-Value: Comply with ASHRAE/IES 90.1.

2.4 FLEXIBLE DUCT CONNECTORS

A. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

B. Non-Clamp Connectors: Liquid adhesive plus tape.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install flexible ducts according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install in indoor applications only. Flexible ductwork should not be exposed to UV lighting.

C. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

D. Connect flexible ducts to metal ducts with draw bands.

E. Install duct test holes where required for testing and balancing purposes.

F. Installation:

1. Install ducts fully extended.

2. Do not bend ducts across sharp corners.
3. Bends of flexible ducting shall not exceed a minimum of one duct diameter.
4. Avoid contact with metal fixtures, water lines, pipes, or conduits.
5. Install flexible ducts in a direct line, without sags, twists, or turns.

G. Supporting Flexible Ducts:

1. Suspend flexible ducts with bands 1-1/2 inches wide or wider and spaced a maximum of 48 inches apart. Maximum centerline sag between supports shall not exceed 1/2 inch per 12 inches.
2. Install extra supports at bends placed approximately one duct diameter from center line of the bend.
3. Ducts may rest on ceiling joists or truss supports. Spacing between supports shall not exceed the maximum spacing per manufacturer's written installation instructions.
4. Vertically installed ducts shall be stabilized by support straps at a maximum of 72 inches o.c.

END OF SECTION

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backward-inclined centrifugal fans, including airfoil and curved blade fans.
2. Forward-curved centrifugal fans.
3. Square in-line centrifugal fans.
4. Tubular in-line centrifugal fans.
5. Plenum fans.
6. Plug fans.
7. Utility set fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Sustainable Design Submittals:

D. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Fan room layout and relationships between components and adjacent structural and mechanical elements, drawn to scale, and coordinated with each other, using input from installers of the items involved.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity, and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For centrifugal fans to include in normal operation, emergency operation, and maintenance manuals with replacement parts listing.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 PERFORMANCE REQUIREMENTS

A. Unusual Service Conditions

1. Base fan-performance ratings on performance scheduled on the plans.

B. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design vibration isolators and supports.

C. Seismic Performance: Centrifugal fans shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

D. Capacities and Characteristics on performance scheduled on the plans

1. Vibration Isolators:

a. Type: Restrained spring.
b. Static Deflection: 1 inch.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
2. Factory-installed and -wired disconnect switch.

B. Housings:

1. Housing Material: See schedule.
2. Housing Coating: See schedule.
3. Housing Assembly: Sideplates continuously welded.
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing is field rotatable to any of eight discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI or DWDI construction with a precision-spun curved inlet flange and a backplate fastened to shaft with setscrews. Wheels shall be statically and dynamically balanced, and nonoverloading.
2. Wheel and Blade Material: See schedule.

3. Wheel and Blade Coating: See schedule.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.
5. Backward-Inclined Airfoil Blades:

a. Aerodynamic design.
b. Heavy backplate.

c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

6. Backward-Inclined Curved Blades:

a. Curved design.
b. Heavy backplate.
c. Single-thickness blades continuously welded at tip flange and backplate.

D. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

a. Self-aligning, pillow-block-type ball bearings.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
b. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch pulleys for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without

short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: Totally enclosed, fan cooled.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.4 FORWARD-CURVED CENTRIFUGAL FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, centrifugal fans, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Housings:

1. Housing Material: See schedule.
2. Housing Coating: See schedule .
3. Housing Assembly: Sideplates continuously welded.
4. Formed panels to make curved-scroll housings with shaped cutoff.
5. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
6. Horizontally split, bolted-flange housing.
7. Spun inlet cone with flange.
8. Outlet flange.
9. Discharge Arrangement: Fan scroll housing field rotatable to any of eight discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI or DWDI construction with a curved inlet flange, and a backplate fastened to shaft with setscrews.
2. Wheel and Blade Material: See schedule.

3. Wheel and Blade Coating: See schedule.
4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with setscrews.

5. Forward-Curved Wheels:

    a. Black-enameled or galvanized-steel construction with inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow.
    b. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with setscrews.

D. Shafts:

1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

E. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

    a. Self-aligning, pillow-block-type roller bearings.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

    a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    b. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
    c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

    a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
    d. Extended Lubrication Lines: Extend lines to accessible location.

F. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size:
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

G. Motor Enclosure: Totally enclosed, fan cooled.

H. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Scroll Drain Connection: NPS 1 steel pipe coupling welded to low point of fan scroll.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
5. Inlet Screens: Grid screen of same material as housing.
6. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
9. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.5 SQUARE IN-LINE CENTRIFUGAL FANS

A. Description: Square in-line centrifugal fans.

B. Housing:

1. Housing Material: See schedule.
2. Housing Coating: See schedule.
3. Housing Construction: Side panels shall be easily removable for service. Include inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosures around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum airfoil blades welded to aluminum hub.

F. Motor Enclosure: Totally enclosed, fan cooled.

G. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.
7. Side Discharge: Flange connector and attachment hardware to provide right-angle discharge on side of unit.

2.6 TUBULAR IN-LINE CENTRIFUGAL FANS

A. Description: Tubular in-line centrifugal fans.

B. Housing:

1. Housing Material: See schedule.
2. Housing Coating: See schedule.
3. Housing Construction: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

C. Direct-Drive Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

D. Belt-Driven Units: Motor mounted on adjustable base, with adjustable sheaves, enclosure around belts within fan housing, and lubricating tubes from fan bearings extended to outside of fan housing.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Motor Enclosure: Totally enclosed, fan cooled.

G. Accessories:

1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
2. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
3. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
4. Companion Flanges: For inlet and outlet duct connections.
5. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.
6. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

2.7 PLENUM FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: See schedule.
3. Wheel and Blade Coating: See schedule.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

C. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum-rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

D. Bearings:

1. Prelubricated and Sealed Shaft Bearings:

    a. Self-aligning, pillow-block-type ball bearings.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.

2. Grease-Lubricated Shaft Bearings, Tapered Roller:

    a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    b. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
    c. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

    a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
    d. Extended Lubrication Lines: Extend lines to accessible location.

E. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

F. Motor Enclosure: Totally enclosed, fan cooled.

G. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.

2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
7. Piezometer Ring: Piezometer ring mounted at fan inlet cone for airflow measurement.

2.8 PLUG FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans, consisting of wheel, fan shaft, bearings, motor, drive assembly, and support structure.
2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
3. Factory-installed and -wired disconnect switch.

B. Wheels:

1. Wheel Configuration: SWSI construction with curved inlet flange and heavy backplate; fastened to shaft with setscrews.
2. Wheel and Blade Material: See schedule.
3. Wheel and Blade Coating: See schedule.
4. Backward-Inclined Airfoil Blades: Hollow, die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

C. Shafts:

1. Statically and dynamically balanced, and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

D. Bearings:

1. Prelubricated and Sealed Shaft Bearings:
    a. Self-aligning, pillow-block-type ball bearings.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
    c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
2. Grease-Lubricated Shaft Bearings, Tapered Roller:
    a. Self-aligning, pillow-block-type, tapered roller bearings with double-locking collars and two-piece, cast-iron housing.
    b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.

c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours.
d. Extended Lubrication Lines: Extend lines to accessible location.

3. Grease-Lubricated Shaft Bearings, Ball or Roller:

a. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
b. Ball-Bearing Rating Life: ABMA 9, L(10) at 120,000 hours.
c. Roller-Bearing Rating Life: ABMA 11, L(10) at 120,000 hours .
d. Extended Lubrication Lines: Extend lines to accessible location.

E. Belt Drives:

1. Factory mounted, with adjustable alignment and belt tensioning.
2. Service Factor Based on Fan Motor Size.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with larger motors.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146 inch- thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
7. Motor Mount: Adjustable for belt tensioning.

F. Motor Enclosure: Totally enclosed, fan cooled.

G. Accessories:

1. Inlet Safety Screen: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
2. Safety Enclosure: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
3. Belt Guard: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards." Diamond mesh wire screen is welded to steel angle frame or equivalent, prime coated.
4. Inlet Companion Flange: Rolled flanges for duct connections of same material as housing.
5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
6. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

2.9 UTILITY SET FANS

A. Description:

1. Factory-fabricated, -assembled, -tested, and -finished, centrifugal fan utility vent sets, consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.

B. Housings:

1. Housing Material: See schedule.
2. Housing Coating: See schedule.
3. Formed panels to make curved-scroll housings with shaped cutoff.
4. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
5. Discharge Arrangement: Fan scroll housing field rotatable to any of eight discharge positions. Provide fan with discharge positioned in proper direction to minimize connected duct turns.

C. Wheels:

1. Wheel Configuration: SWSI, with hub keyed to shaft.
2. Wheel and Blade Materials: See schedule.

3. Wheel and Blade Coating: See schedule.
4. Backward-Inclined Airfoil Blades:

    a. Aerodynamic design.
    b. Heavy backplate.
    c. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.

5. Backward-Inclined Curved Blades:

    a. Curved design.
    b. Heavy backplate.
    c. Single-thickness blades continuously welded at tip flange and backplate.

6. Backward-Inclined Flat Blades:

    a. Flat design.
    b. Heavy backplate.
    c. Single-thickness blades continuously welded at tip flange and backplate.

7. Forward-Curved Blades:

    a. Curved design.
    b. Heavy backplate.
    c. Single-thickness blades continuously welded or riveted at tip flange and backplate.

D. Shafts:

1. Turned, ground, and polished steel; keyed to wheel hub. First critical speed at least 1.4 times maximum class speed.

E. Bearings:

1. Heavy-duty regreasable ball or roller type in a cast iron pillowblock housing.
2. Ball-Bearing Rating Life: ABMA 9, L(50) of 200,000 hours.
3. Roller-Bearing Rating Life: ABMA 11, L(50) of 200,000 hours.
4. Extend grease fitting to accessible location outside of unit.

F. Belt Drive:

1. Factory mounted, with final alignment and belt adjustment made after installation.
2. Service Factor Based on Fan Motor Size.
3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with motors larger than 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
6. Belt Guards: Comply with OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards," 0.146 inch- thick, 3/4-inch diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short-circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.

G. Motor Enclosure: Totally enclosed, fan cooled.

H. Accessories:

1. Inlet and Outlet: Flanged.
2. Companion Flanges: Rolled flanges for duct connections of same material as housing.
3. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades, with felt edges in steel frame installed on fan discharge.
4. Access Door: Gasketed door in scroll with latch-type handles.
5. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
6. Inlet Screens: Removable wire mesh.
7. Outlet Screens: Removable wire mesh.
8. Belt Guard: OSHA-compliant, completely enclosed shaft and drive components.
9. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
10. Drain Connections: NPS 3/4 threaded coupling drain connection installed at lowest point of housing.
11. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
12. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around, and to, shaft, channel frame, and sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.
13. Grease Collection Trough and Receiver: For restaurant exhaust application.
14. Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

2.10 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

2.11 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Compliance: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

C. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

E. Operating Limits: Classify fans according to AMCA 99.

PART 3 - EXECUTION

3.1 INSTALLATION OF CENTRIFUGAL HVAC FANS

A. Install centrifugal fans level and plumb.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

D. Equipment Mounting:

1. Install floor- or roof-mounted centrifugal fans on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
2. Support duct-mounted and other hanging centrifugal fans directly from the building structure, using suitable hanging systems as specified in Division 23 "Hangers and Supports for HVAC Piping and Equipment."
3. Comply with requirements for vibration isolation and seismic-control devices specified in Division 23 "Vibration and Seismic Controls for HVAC."
4. Comply with requirements for vibration isolation devices specified in Division 23 "Vibration Controls for HVAC."

E. Curb Support, Field Built-Up: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," detail "Equipment Support Curb," number "SPF-9" (page 1409) and detail "Equipment Support Curb," number "SPF-9S" (page 1410). Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.

F. Curb Support, Prefabricated: Rail-type wood support provided by fan manufacturer.

G. Unit Support: Install centrifugal fans level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.

H. Isolation Curb Support: Install centrifugal fans on isolation curbs, and install flexible duct connectors and vibration-isolationand seismic-control devices.

1. Comply with requirements in Division 23 "Air Duct Accessories" for flexible duct connectors.
2. Comply with requirements in Division 23 "Vibration and Seismic Controls for HVAC" "Vibration Controls for HVAC" for vibration-isolation and seismic-control devices.

I. Install units with clearances for service and maintenance.

J. Label fans according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

D. Install heat tracing on all drain piping subject to freezing temperature and as indicated on Drawings. Furnish and install heat tracing according to Division 23 "Heat Tracing for HVAC Piping."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
6. Adjust belt tension.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. See Division 23 "Testing, Adjusting, and Balancing For HVAC" for testing, adjusting, and balancing procedures.
11. Remove and replace malfunctioning units and retest as specified above.

F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Axial roof ventilators.
2. Ceiling-mounted ventilators.
3. Centrifugal ventilators - roof downblast.
4. Centrifugal ventilators - roof upblast and sidewall.
5. Sidewall propeller fans.
6. Upblast propeller roof exhaust fans.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes for fans.
2. Rated capacities, operating characteristics, and furnished specialties and accessories.
3. Certified fan performance curves with system operating conditions indicated.
4. Certified fan sound-power ratings.
5. Motor ratings and electrical characteristics, plus motor and electrical accessories.
6. Material thickness and finishes, including color charts.
7. Dampers, including housings, linkages, and operators.
8. Prefabricated roof curbs.
9. Fan speed controllers.

B. Shop Drawings:

1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints.

C. Delegated-Design Submittal: For unit hangars and supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale, showing the items described in this Section and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC power ventilators to include in normal and emergency operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Belts: One set(s) for each belt-driven unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design vibration isolationand seismic restraints, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: HVAC power ventilators shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.3 AXIAL ROOF VENTILATORS

A. Housing: Heavy-gauge, removable, spun-aluminum dome top and outlet baffle; square, one-piece, hinged, aluminum base.

B. Fan Wheel: Aluminum hub and blades.

C. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.

D. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
4. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
5. Stack hood with built-in backdraft dampers.
6. Extended lubrication lines.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing with mounting flange. Coordinate with architectural roof plan for cant requirements.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Pitch Mounting: Manufacture curb for roof slope.
5. Metal Liner: Galvanized steel.
6. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 CEILING-MOUNTED VENTILATORS

A. Housing: Steel, lined with acoustical insulation.

B. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel removable for service.

C. Back-draft damper: Integral.

D. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew or spring retainer attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
4. Motion Sensor: Motion detector with adjustable shutoff timer.
5. Ceiling Radiation Damper: Fire-rated assembly with ceramic blanket, stainless steel springs, and fusible link.
6. Filter: Washable aluminum to fit between fan and grille.
7. Isolation: Rubber-in-shear vibration isolators.
8. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.5 CENTRIFUGAL VENTILATORS - ROOF DOWNBLAST

A. Housing: Downblast; removable spun aluminum; square, one-piece aluminum base with venturi inlet cone.

B. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

C. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

D. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.

E. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing with mounting flange. Coordinate with architectural roof plan for cant requirements.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Pitch Mounting: Manufacture curb for roof slope.
6. Metal Liner: Galvanized steel.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.6 CENTRIFUGAL VENTILATORS - ROOF UPBLAST OR SIDEWALL

A. Configuration: Centrifugal roof upblast or sidewall ventilator.

B. Housing: Removable spun aluminum; square, one-piece aluminum base with venturi inlet cone.

1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Provide grease collector on fans serving Type I Grease Hoods.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
3. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings; minimum ABMA9, L(10) of 100,000 hours.
4. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
5. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
6. Fan and motor isolated from exhaust airstream.

E. Accessories:

1. Variable-Frequency Motor Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Spark-resistant, all-aluminum wheel construction.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Wall Mount Adapter: Attach wall-mounted fan to wall.
9. Restaurant Kitchen Exhaust: UL 762 listed for grease-laden air exhaust.

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing with mounting flange. Coordinate with architectural roof plan for cant requirements.

G. Prefabricated Kitchen Exhaust Roof Curbs: Galvanized steel; mitered and welded corners; ventilation openings on all sides to ventilate curb interstitial space. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing with mounting flange. Coordinate with architectural roof plan for cant requirements.
2. Overall Height: 12 inches.
3. Sound Curb: Curb with sound-absorbing insulation and galvanized metal liner.
4. Hinged sub-base to provide access to damper or as cleanout for grease applications.
5. Pitch Mounting: Manufacture curb for roof slope.
6. Metal Liner: Galvanized steel.
7. Mounting Pedestal: Galvanized steel with removable access panel.
8. Vented Curb: For kitchen exhaust; 12-inch-high galvanized steel; unlined, with louvered vents in vertical sides.
9. NFPA 96 code requirements for commercial cooking operations.
10. Kitchen Hood Exhaust: UL 762 listed for grease-laden air.

2.7 SIDEWALL PROPELLER FANS

A. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

B. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

C. Fan Wheel: Replaceable, extruded-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Fan Drive: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.

E. Fan Drive:

1. Belt drive.
2. Resiliently mounted to housing.
3. Statically and dynamically balanced.
4. Selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
5. Extend grease fitting to accessible location outside of unit.
6. Service Factor Based on Fan Motor Size: 1.4.
7. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
8. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.

a. Ball-Bearing Rating Life: ABMA 9, L(10) of 100,000 hours.

9. Pulleys: Cast iron with split, tapered bushing; dynamically balanced at factory.

10. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
11. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
12. Belt Guards: Fabricate of steel for motors mounted on outside of fan cabinet.

F. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
4. Motor-Side Back Guard: Galvanized steel, complying with OSHA specifications, removable for maintenance.
5. Wall Sleeve: Galvanized steel to match fan and accessory size.
6. Weathershield Hood: Galvanized steel to match fan and accessory size.
7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

2.8 UPBLAST PROPELLER ROOF EXHAUST FANS

A. Configuration: Upblast propeller ventilator.

B. Wind Band, Fan Housing, and Base: Reinforced and braced galvanized steel, containing galvanized-steel butterfly dampers and rain trough, motor and drive assembly, and fan wheel.

1. Damper Rods: Steel with bronze bearings.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
3.

C. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

D. Belt Drives:

1. Resiliently mounted to housing.
2. Weatherproof housing of same material as fan housing.
3. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
4. Shaft Bearings: Prelubricated and sealed, self-aligning, pillow-block-type ball bearings.
5. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
6. Motor Pulleys: Adjustable pitch for use with motors through 5 hp. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions. Provide fixed pitch for use with motors larger than 5 hp.
7. Motor Mount: On outside of fan cabinet, adjustable base for belt tensioning.

E. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
3. Inspection Door: Hinged.

4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.
6. Extended Lubrication Lines.
7. Kitchen Hood Exhaust: UL 762 listed for grease-laden air exhaust**.**

F. Prefabricated Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch-thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

1. Configuration: Self-flashing with mounting flange. Coordinate with architectural roof plan for cant requirements.

2.9 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2.10 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. AMCA Certification: Fans shall comply with AMCA 11 and bear the AMCA-Certified Ratings Seal.

C. Fan Sound Ratings: Comply with AMCA 311, and label fans with the AMCA-Certified Ratings Seal. Sound ratings shall comply with AMCA 301. The fans shall be tested according to AMCA 300.

D. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. The fans shall be tested for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

E. Operating Limits: Classify according to AMCA 99.

F. UL Standards: Power ventilators shall comply with UL 705. Power ventilators for use for restaurant kitchen exhaust shall also comply with UL 762.

PART 3 - EXECUTION

3.1 INSTALLATION OF HVAC POWER VENTILATORS

A. Install power ventilators level and plumb.

B. Equipment Mounting:

1. Install power ventilators on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic-control devices specified in Division 23 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Division 23 "Vibration Controls for HVAC."

C. Secure roof-mounted fans to roof curbs with zinc-plated hardware. See Division 07 "Roof Accessories" for installation of roof curbs.

D. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch. Vibration-control devices are specified in Division 23 "Vibration and Seismic Controls for HVAC."

F. Install units with clearances for service and maintenance.

G. Label units according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

3.2 DUCTWORK CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 "Air Duct Accessories."

3.3 ELECTRICAL CONNECTIONS

A. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.4 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 "Control-Voltage Electrical Power Cables."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.

E. Tests and Inspections:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that there is adequate maintenance and access space.
4. Verify that cleaning and adjusting are complete.
5. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
6. Adjust belt tension.
7. Adjust damper linkages for proper damper operation.
8. Verify lubrication for bearings and other moving parts.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
10. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
11. Shut unit down and reconnect automatic temperature-control operators.
12. Remove and replace malfunctioning units and retest as specified above.

F. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

G. Prepare test and inspection reports.

3.6 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

E. Lubricate bearings.

3.7 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

END OF SECTION

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modulating, single-duct air terminal units.
2. Parallel, fan-powered air terminal units.
3. Series, fan-powered air terminal units.
4. Diffuser-type air terminal units.
5. Balancing terminal units.
6. Pressure control terminal units.
7. Critical environment control valve.
8. Underfloor air distribution terminal units.
9. Underfloor air distribution floor induction units.
10. Exhaust single-duct terminal units.
11. Casing liner.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of air terminal unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings: For air terminal units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
4. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

D. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Include design calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

a. Instructions for resetting minimum and maximum air volumes.
b. Instructions for adjusting software set points.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Powered-Unit Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."

C. ASHRAE Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

2.3 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections, one size larger than inlet size.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

E. Attenuator Section: 0.034-inch steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

F. Multioutlet Attenuator Section: With four 10-inch- diameter collars, each with locking butterfly balancing damper.

G. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

H. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. SCR controlled.
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
4. Nickel chrome 80/20 heating elements.
5. Airflow switch for proof of airflow.
6. Fan interlock contacts.

7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
8. Mercury contactors.
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

I. Control devices shall be compatible with temperature controls system specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

1. Electric Damper Actuator: 24 V, powered open, spring return.
2. Electronic Damper Actuator: 24 V, powered open, spring return.
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
6. Terminal Unit Controller: Pressure-independent, variable-air-volume (VAV) controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

7. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

J. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. System-powered, wall-mounted thermostat.

K. Control Sequences:

1. Occupied:

    a. On a call for cooling, airflow will increase as the damper opens towards maximum setting to satisfy set point.
    b. On a call for less cooling, airflow will decrease as the damper closes towards minimum setting to satisfy set point.
    c. On a call for heating, after terminal unit has reached minimum airflow set point, hydronic heating coil valve will modulate toward open or electric-resistance heating coil will sequence control to satisfy set point.

2. Unoccupied:

    a. Damper closes to minimum setting.

2.4 PARALLEL FAN-POWERED AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly and fan in parallel arrangement inside unit casing with control components inside a protective metal shroud. Low-profile design.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal, located at plenum air inlet.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

D. Velocity Sensors: Multipoint array with velocity sensors.

E. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."
2. Type: Electronically commutated motor.
3. Fan-Motor Assembly Isolation: Rubber isolators.

4. Efficiency: Premium efficient.
5. Motor Speed: Multispeed.

a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

6. Electrical Characteristics:
a. Refer to plan schedules.

F. Filters:

1. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.
2. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
3. Material: Polyurethane foam, MERV 3 .
4. Material: Glass fiber treated with adhesive, MERV 5.
5. Material: Pleated cotton-polyester media, MERV 7.
6. Thickness: 2 inches.

G. Attenuator Section: 0.034-inch galvanized steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

1. Location: Plenum air inlet.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. Location: Plenum air inlet.
2. SCR controlled.
3. Access door interlocked disconnect switch.
4. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
5. Nickel chrome 80/20 heating elements.
6. Airflow switch for proof of airflow.
7. Fan interlock contacts.
8. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
9. Mercury contactors.
10. Pneumatic-electric switches and relays.
11. Magnetic contactor for each step of control (for three-phase coils).

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

L. Control devices shall be compatible with temperature controls system specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

1. Electric Damper Actuator: 24 V, powered open, spring return.
2. Electronic Damper Actuator: 24 V, powered open, spring return.
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
6. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

M. Control Sequence:

1. Occupied (Primary Airflow On):

a. Operate as throttling control for cooling.
b. As cooling requirement decreases, control valve throttles toward minimum airflow.
c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is energized.

2. Unoccupied (Primary Airflow Off):

a. When pressure at primary inlet is zero or less, fan is de-energized.
b. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve will be energized.

2.5 SERIES FAN-POWERED AIR TERMINAL UNITS

A. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud for installation above a ceiling and within a raised access floor.

1. Designed for quiet operation.
2. Low-profile design.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Air Inlets: Round stub connections or S-slip and drive connections for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
5. Fan: Forward-curved centrifugal.
6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

D. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.

E. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."
2. Type: Electronically commutated motor.
3. Fan-Motor Assembly Isolation: Rubber isolators.

4. Efficiency: Premium efficient.
5. Motor Speed: Multispeed.

    a. Speed Control: Infinitely adjustable with pneumatic-electric and electronic controls.

6. Electrical Characteristics:
    a. Refer to plan Schedules

F. Filters:

1. Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.
2. Minimum Efficiency Reporting Value: According to ASHRAE 52.2.
3. Material: Polyurethane foam; MERV 3.
4. Material: Glass fiber treated with adhesive; MERV 5.
5. Material: Pleated cotton-polyester media MERV 7.
6. Thickness: 2 inches.

G. Attenuator Section: 0.034-inch galvanized steel sheet.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air-terminal units scheduled on Drawings.

I. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. SCR controlled.
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).
4. Nickel chrome 80/20 heating elements.
5. Airflow switch for proof of airflow.
6. Fan interlock contacts.
7. Fuses in terminal box for overcurrent protection (for coils more than 48 A).
8. Mercury contactors.
9. Pneumatic-electric switches and relays.
10. Magnetic contactor for each step of control (for three-phase coils).

J. Factory-Mounted and -Wired Controls: Electrical components mounted in control box with removable cover. Incorporate single-point electrical connection to power source.

1. Control Transformer: Factory mounted for control voltage on electric and electronic control units with terminal strip in control box for field wiring of thermostat and power source.
2. Wiring Terminations: Fan and controls to terminal strip. Terminal lugs to match quantities, sizes, and materials of branch-circuit conductors. Enclose terminal lugs in terminal box that is sized according to NFPA 70.
3. Disconnect Switch: Factory-mounted, fuse type.

K. Control Panel Enclosure: NEMA 250, Type 1, with access panel sealed from airflow and mounted on side of unit.

L. Control devices shall be compatible with temperature controls system specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

1. Electric Damper Actuator: 24 V, powered open, spring return.
2. Electronic Damper Actuator: 24 V, powered open, spring return.
3. Electric Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.
4. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
5. Electronic Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
6. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Division 23 "Instrumentation and Control for HVAC."

M. Control Sequence:

1. Occupied (Primary Airflow On):

    a. Operate as throttling control for cooling.
    b. As cooling requirement decreases, control valve throttles toward minimum airflow.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2. Unoccupied (Primary Airflow Off):

    a. When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
    b. When pressure at primary inlet is zero or less, fan is de-energized.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2.6 DIFFUSER-TYPE AIR TERMINAL UNITS

A. Configuration: Volume-damper, diffuser, controller assembly and electric heater and wall-mounted thermostat with master-slave capability.

B. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

C. Diffuser: Galvanized steel with white baked-enamel finish.

D. Control Sequence: Diffusion dampers open and close to regulate airflow into the room in response to room temperature. The dampers are mechanically actuated by internal, factory-set thermal element thermostats with limited field adjustment.

2.7 BALANCING TERMINAL UNITS

A. Configuration: Manually operated volume-damper assembly with locking mechanism inside unit casing with multipoint, center-averaging velocity sensors for installation above a ceiling.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Leakage: Maximum 2 percent of nominal airflow at 3-inch wg static pressure.
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.

D. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

2.8 PRESSURE CONTROL TERMINAL UNITS

A. Configuration: Volume damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
2. Air Inlet: Round stub connection for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to diverting damper and other parts requiring service, adjustment, or maintenance; with airtight gasket.
5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Diverter Assembly: Aluminum blade, with nylon-fitted pivot points.

D. Multioutlet Attenuator Section: With four 10-inch- diameter collars, each with locking butterfly balancing damper.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.

E. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat. Control devices shall be compatible with temperature controls specified in Division 23 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

1. Static pressure tap for field installation.
2. Adjustable control module.

F. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

G. Control Sequence:

1. Under the control of a static pressure sensor, damper opens or closes to maintain static pressure downstream branch duct.

2.9 CRITICAL ENVIRONMENT CONTROL VALVE

A. Configuration: Venturi valve assembly inside an externally insulated unit casing with control components inside a protective metal shroud.

B. Casing:

1. Type 316 stainless steel, 0.0375 inch, with continuously welded seams.
2. Heresite-coated aluminum.
3. Galvanized steel.
4. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.

C. Sensors: Multipoint, Type 316 stainless steel, removable.

D. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

E. Electric-Resistance Heating Coils: Nickel-chromium heating wire, free of expansion noise and hum, mounted in ceramic inserts in a galvanized-steel housing; with primary automatic, and secondary manual, reset thermal cutouts. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware. Provide electric-resistance heating coils for air terminal units scheduled on Drawings.

1. SCR controlled.
2. Access door interlocked disconnect switch.
3. Downstream air temperature sensor with local connection to override discharge-air temperature to not exceed a maximum temperature set point (adjustable).

F. Control Sequence:

1. Occupied (Primary Airflow On):

    a. Operate as throttling control for cooling.
    b. As cooling requirement decreases, control valve throttles toward minimum airflow.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2. Unoccupied (Primary Airflow Off):

    a. When externally initiated, begin the morning warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
    b. When pressure at primary inlet is zero or less, fan is de-energized.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2.10 UNDERFLOOR AIR DISTRIBUTION TERMINAL UNITS

A. Configuration: Volume-damper assembly and fan in series arrangement inside unit casing with control components inside a protective metal shroud within a raised access floor. Designed for pressurized floor cavity supply and ducted air supply.

B. Casing: 0.040-inch- thick galvanized steel, single wall.

1. Integral floor discharge diffusers.
2. Mixing damper.
3. VAV throttling damper.
4. Leveling feet.
5. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.
6. Air Outlet: S-slip and drive connections.
7. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket and quarter-turn latches.
8. Fan: Forward-curved centrifugal in double blower configuration.
9. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Volume Damper: Galvanized steel with flow-sensing ring and peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

D. Velocity Sensors: Multipoint array with velocity sensors in air inlets and air outlets.

E. Motor:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."
2. Type: Electronically commutated motor.
3. Fan-Motor Assembly Isolation: Rubber isolators.

4. Efficiency: Premium efficient.

5. Motor Speed: Multispeed.
6. Electrical Characteristics:
    a. Refer to plan schedules.

F. Controller Type: Terminal Unit Controller.

G. Accessories:

1. Inlet filter.
2. Disconnect switch.
3. Transformers.
4. Airflow switch.

H. Control Sequence:

1. Occupied (Primary Airflow On):

    a. Operate as throttling control for cooling.
    b. As cooling requirement decreases, control valve throttles toward minimum airflow.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2. Unoccupied (Primary Airflow Off):

    a. When externally initiated, begin the morning-warm-up/cool-down function. Damper drives to the fully open position without regard for the preset maximum.
    b. When pressure at primary inlet is zero or less, fan is de-energized.
    c. As heating requirement increases, fan energizes to draw in warm plenum air and electric heat modulates under SCR control or the hot-water coil valve is opened.

2.11 UNDERFLOOR AIR DISTRIBUTION FLOOR INDUCTION UNITS

A. Configuration: Raised-access floor-mounting units with ducted primary air and hydronic coil(s). Air is discharged to space through nozzles. Design includes secondary air induced from served space.

B. Casing: 0.040-inch- thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum with interior painted black.

1. Provide air mixing chamber.
2. Provide casing space for control valves and actuators.
3. Casing to have adjustable feet.

C. Hydronic Heating Coils: Two rows. Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

1. Coils to be painted black.

2.12 EXHAUST SINGLE-DUCT TERMINAL

A. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

B. Casing: 0.040-inch- thick galvanized steel, single wall. Casing includes removable aluminum linear grille and plenum.

1. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
2. Air Outlet: S-slip and drive connections, one size larger than inlet size.
3. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

C. Regulator Assembly: System-air-powered bellows section incorporating polypropylene bellows for volume regulation and thermostatic control. Bellows shall operate at temperatures from zero to 140 deg F, shall be impervious to moisture and fungus, shall be suitable for 10-inch wg static pressure, and shall be factory tested for leaks.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 6-inch wg inlet static pressure.
2. Damper Position: Normally open.

E. Attenuator Section: 0.034-inch galvanized steel sheet.

1. Casing Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.

F. Multioutlet Attenuator Section: With four 10-inch- diameter collars, each with locking butterfly balancing damper.

1. Attenuator Section Liner: Comply with requirements in "Casing Liner" Article for flexible elastomeric duct liner.

G. Electric Controls: Damper actuator and thermostat.

1. Damper Actuator: 24 V, powered open, spring return.
2. Thermostat: Wall-mounted electronic type with clock display, temperature display in Fahrenheit and Celsius, and space temperature set point.

H. Electronic Controls: Bidirectional damper operator and microprocessor-based thermostat with integral airflow transducer and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered open, spring return.
2. Velocity Controller: Factory calibrated and field adjustable to minimum and maximum air volumes; shall maintain constant airflow dictated by thermostat within 5 percent of set point while compensating for inlet static-pressure variations up to 4-inch wg; and shall have a multipoint velocity sensor at air inlet.
3. Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.

I. Direct Digital Controls: Single-package unitary controller and actuator specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

J. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23 "Direct Digital Control (DDC) System for HVAC" and shall have the following features:

1. Damper Actuator: 24 V, powered open, spring return.
2. Terminal Unit Controller: Pressure-independent, VAV controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:

    a. Occupied and unoccupied operating mode.
    b. Remote reset of airflow or temperature set points.
    c. Adjusting and monitoring with portable terminal.
    d. Communication with temperature-control system specified in Division 23 "Direct Digital Control (DDC) System for HVAC."

3. Pressure Sensor: Duct mounted with pressure set-point adjustment and access for connection of portable operator terminal.

K. Controls:

1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg inlet static pressure.
2. System-powered, wall-mounted thermostat.

L. Control Sequence:

1. Damper blade opens or closes to maintain differential pressure set point in response to upstream and downstream differential pressure sensors.

2.13 CASING LINER

A. Casing Liner: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Minimum Thickness: 1 inch.

    a. Maximum Thermal Conductivity:

        1) Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
        2) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.

2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Casing Liner: Flexible elastomeric duct liner fabricated of preformed, cellular, closed-cell, sheet materials complying with ASTM C534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.

1. Minimum Thickness: 3/4 inch.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.14 SOURCE QUALITY CONTROL

A. Factory Tests: Test assembled air terminal units according to AHRI 880.

1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Division 23 "Hangers and Supports for HVAC Piping and Equipment."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.2 SEISMIC-RESTRAINT-DEVICE INSTALLATION

A. Install hangers and braces designed to support the air terminal units and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7. Comply with requirements for seismic-restraint devices in Division 23 "Vibration and Seismic Controls for HVAC."

B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install cable restraints on air terminal units that are suspended with vibration isolators.

E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.

F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.

G. Drilling for and Setting Anchors:

1. Identify position of reinforcing steel and other embedded items before drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Install heavy-duty sleeve anchors with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.3 TERMINAL UNIT INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Install wall-mounted thermostats.

3.4 PIPING CONNECTIONS

A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.

B. Hot-Water Piping: Comply with requirements in Division 23 "Hydronic Piping" and Hydronic Piping Specialties," and connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

3.5 DUCTWORK CONNECTIONS

A. Comply with requirements in Division 23 "Metal Ducts" and "Nonmetal Ducts" for connecting ducts to air terminal units.

B. Make connections to air terminal units with flexible connectors complying with requirements in Division 23 "Air Duct Accessories."

3.6 ELECTRICAL CONNECTIONS

A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.

B. Connect wiring in accordance with Division 26 "Low-Voltage Electrical Power Conductors and Cables."

C. Ground equipment in accordance with Division 26 "Grounding and Bonding for Electrical Systems."

D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Division 26 "Identification for Electrical Systems."
2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

3.7 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring in accordance with Division 26 "Control-Voltage Electrical Power Cables."

3.8 IDENTIFICATION

A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

3.9 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Air terminal unit will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.10 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
3. Verify that controls and control enclosure are accessible.
4. Verify that control connections are complete.
5. Verify that nameplate and identification tag are visible.
6. Verify that controls respond to inputs as specified.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION

SECTION 23 37 13.13

AIR DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Round ceiling diffusers.
2. Rectangular and square ceiling diffusers.
3. Perforated diffusers.
4. Louver face diffusers.
5. Linear bar diffusers.
6. Linear slot diffusers.
7. Ceiling-integral continuous slot diffusers.
8. Light troffer diffusers.
9. Round induction underfloor air-distribution diffusers.
10. Linear underfloor air-distribution diffuser plenums.
11. High-capacity drum louver diffusers.
12. High-capacity, modular-core supply grille diffusers.
13. Adjustable blade face registers and grilles.
14. Fixed face registers and grilles.
15. Linear bar grilles.

B. Related Requirements:

1. Division 23 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers and grilles.
2. Division 23 "Security Registers and Grilles" for security registers and security grilles.
3. Division 23 “Fabric Air-Diffusion Devices" for continuous tubular diffusers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser Register and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples: For each exposed product and for each color and texture specified. Actual size of smallest diffuser, register and grille indicated.

C. Samples for Initial Selection: For diffusers, register and grille with factory-applied color finishes. Actual size of smallest diffuser, register and grille indicated.

D. Samples for Verification: For diffusers, register and grilles, in manufacturer's standard sizes to verify color selected. Actual size of smallest diffuser, register and grille indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 ROUND CEILING DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Mounting: Duct connection.

D. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.2 RECTANGULAR AND SQUARE CEILING DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.3 PERFORATED DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Pattern Controller: Adjustable with louvered pattern modules at inlet.

D. Accessories:

1. Equalizing grid.
2. Plaster ring.
3. Safety chain.
4. Wire guard.
5. Sectorizing baffles.
6. Operating rod extension.

2.4 LOUVER FACE DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Accessories:

1. Square to round neck adaptor.
2. Adjustable pattern vanes.
3. Throw reducing vanes.
4. Equalizing grid.
5. Plaster ring.
6. Safety chain.
7. Wire guard.
8. Sectorizing baffles.
9. Operating rod extension.

2.5 LINEAR BAR DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

C. Accessories:

1. Plaster frame

2. Directional vanes

3. Alignment pins

4. Core clips

5. Blank-off strips.

2.6 LINEAR SLOT DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

2.7 CEILING-INTEGRAL CONTINUOUS DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Straight and curved sections as required to accommodate layout.

C. Mitered tees and corners.

D. Other Features:

1. Painted interior.
2. Blank-offs.

2.8 LIGHT TROFFER DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Devices shall be specifically designed for variable-air-volume flows.

2.9 ROUND INDUCTION UNDERFLOOR AIR-DISTRIBUTION DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Airflow Principle: Swirl-pattern induction.

C. Material: Plastic, high impact, and resistant to cart and foot traffic.

D. Components:

1. Diffuser core.
2. Flow regulator.
3. Dirt and liquid catch pan.
4. Spacer flange.
5. Gasketed, underfloor compression ring.

2.10 LINEAR UNDERFLOOR AIR-DISTRIBUTION DIFFUSER PLENUMS

A. Refer to plan schedules for specific requirements.

B. Components:

1. Aluminum diffuser core.
2. Diffuser frame.
3. Plenum, 0.034-inch steel.

2.11 HIGH-CAPACITY DRUM LOUVER DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Airflow Principle: Extended distance for high airflow rates.

C. Gasket between drum and border.

D. Body: Drum shaped; adjustable vertically.

E. Blades: Individually adjustable horizontally.

F. Accessories:

1. Opposed-blade steel damper.
2. Duct-mounting collars with countersunk screw holes.

2.12 HIGH-CAPACITY, MODULAR-CORE SUPPLY GRILLE DIFFUSERS

A. Refer to plan schedules for specific requirements.

B. Throw: Extended distance for airflow rates.

C. Blades:

1. Airfoil, individually adjustable horizontally.
2. Double deflection.
3. Set in modules.

D. Modules: Removable; rotatable.

E. Accessory: Opposed-blade steel damper.

2.13 REGISTERS

A. Refer to plan schedules for specific requirements.

2.14 GRILLES

A. Refer to plan schedules for specific requirements.

2.15 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, register and grilles are installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install diffusers, register and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, register and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, register and grille to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

SECTION 23 37 23

HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Hooded ventilators.
3. Goosenecks.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product. For louvered-penthouse ventilators specified to bear AMCA seal, include printed catalog pages, showing specified models with appropriate AMCA Certified Ratings Seals.

B. Sustainable Design Submittals:

C. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.
2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

D. Samples: For each exposed product and for each color and texture specified.

E. Samples for Initial Selection: For units with factory-applied color finishes.

F. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

G. Delegated-Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

B. Seismic Qualification Data: Certificates for ventilators, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.5 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design ventilators.

B. Structural Performance: Ventilators shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of ventilator components, noise or metal fatigue caused by ventilator blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
2. Wind Loads: Determine loads based on a uniform pressure of 30 lbf/sq. ft., acting inward or outward.
3. Snow Load: Unit to withstand a minimum of 20- lbf/sq. ft. snow load.

C. Seismic Performance: Ventilators, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
2. Component Importance Factor: 1.0.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.

E. ASHRAE 62.1 Compliance: Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-up."

F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range):

a. Ambient: 120 deg F.
b. Material Surfaces: 180 deg F.

G. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

H. Capacities and Characteristics:
1. Maximum Air Pressure Drop: Not more than 0.10- inch wg static pressure drop.

2.3 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.4 LOUVERED-PENTHOUSE VENTILATORS

A. Description: Multitier rectangular louvered penthouse for intake or relief air.

B. Source Limitations: Obtain louvered-penthouse ventilators from single manufacturer.

C. Construction:

1. Material: All-welded assembly with 6-inch-deep louvers, mitered corners, and aluminum sheet roof.

2. Frame and Blade Material: Extruded aluminum, of thickness required to comply with structural performance requirements, but not less than 0.080 inch for frames and 0.080 inchfor blades with condensate deflectors.
3. Frame and Blade Material: Galvanized-steel sheet, of thickness required to comply with structural performance requirements, but not less than 0.052 inchfor frames and 0.064 inchfor blades with condensate deflectors.
4. Insulation: Mineral-fiber insulation and vapor barrier.
5. Wind-Driven Rain Performance: Not less than 99 percent effectiveness when subjected to a rainfall rate of 3 inches per hour and a wind speed of 29 mph at a free-area intake velocity of 500 fpm.
6. AMCA Seal: Mark units with the AMCA Certified Ratings Seal.
7. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.
8. Bird Screening: Aluminum, 1/2-inch-square mesh or flattened, expanded aluminum, 3/4-inch-diamond mesh wire.
9. Insect Screening: Aluminum, 18-by-16 mesh wire.
10. Galvanized-Steel Sheet Finish:

    a. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
    b. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
    c. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

        1) Color and Gloss: As selected by Architect from manufacturer's full range.

D. Dampers:

1. Location: Inside louver face or Curb damper tray.
2. Control: Motorized.
3. Tray: Provide damper tray or shelf with opening 3 inches less than interior curb dimensions indicated.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches.

2.5 HOODED VENTILATORS

A. Description: Hooded round penthouse for intake or relief air.

B. Source Limitations: Obtain hooded ventilators from single manufacturer.

C. Construction:

1. Material: Galvanized steel, of thickness required to comply with structural performance requirements, but not less than 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.
2. Material: Aluminum, of thickness required to comply with structural performance requirements, but not less than 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.
3. Insulation: Mineral-fiber insulation and vapor barrier.
4. Bird Screening: Aluminum, 1/2-inch-square mesh or flattened, expanded aluminum, 3/4-inch diamond mesh wire.
5. Insect Screening: Aluminum, 18-by-16 mesh wire.

D. Galvanized-Steel Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.
2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

    a. Color and Gloss: As selected by Architect from manufacturer's full range.

E. Dampers:

1. Location: Curb damper tray.
2. Control: Motorized.
3. Tray: Provide damper tray or shelf with opening 3 inches less than interior curb dimensions indicated.

F. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches.

2.6 GOOSENECKS

A. Factory or shop fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 6-5; with a minimum of 0.052-inch-thick, galvanized-steel sheet.

B. Bird Screening: Aluminum, 1/2-inch-square mesh, 0.063-inch wire.

C. Insect Screening: Aluminum, 18-by-16 mesh, 0.012-inch.

D. Galvanized-Steel Sheet Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.
3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

    a. Color and Gloss: As selected by Architect from manufacturer's full range.

E. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.
2. Overall Height: 12 inches.

2.7 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A666, Type 304, with No. 6 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware, that comply with the wind and seismic fastening requirements. Use concealed anchorages where possible. Refer to Division 07 "Roof Accessories."

C. Install goosenecks on curb base where throat size exceeds 9 by 9 inches.

D. Install gravity ventilators with clearances for service and maintenance.

E. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Division 07 "Joint Sealants" for sealants applied during installation.

G. Label gravity ventilators according to requirements specified in Division 23 "Identification for HVAC Piping and Equipment."

H. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

I. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

J. Refer to Division 07 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in Division 23 "Metal Ducts" and & “Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.3 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION

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PACKAGED, LARGE-CAPACITY, AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes packaged, large-capacity, air conditioning units with the following components:

1. Casings.
2. Fans, drives, and motors.
3. Rotary heat exchanger.
4. Coils.
5. Refrigerant circuit components.
6. Air filtration.
7. Gas furnaces.
8. UV germicidal irradiation section.
9. Sound-attenuator section.
10. Dampers.
11. Electrical power connections.
12. Controls.
13. Roof curbs.
14. Accessories.

1.2 DEFINITIONS

A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, large-capacity, rooftop air-conditioning units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

1.3 ACTION SUBMITTALS

A. Product Data: For each RTU.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:

    a. Include certified fan-performance curves with system operating conditions indicated.
    b. Include certified fan-sound power ratings.
    c. Include fan construction and accessories.
    d. Include motor ratings, electrical characteristics, and motor accessories.

6. Include certified coil-performance ratings with system operating conditions indicated.

7. Include filters with performance characteristics.
8. Include gas furnaces with performance characteristics.
9. Include factory selection calculations for each antimicrobial ultraviolet lamp installation.
10. Include dampers, including housings, linkages, and operators.

B. Sustainable Design Submittals:

C. Shop Drawings: For each packaged, large-capacity, rooftop air-conditioning units.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

D. Delegated-Design Submittal: For RTU supports indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
3. Wind- and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Sample Warranty: For manufacturer's warranty.

C. Seismic Qualification Data: Certificates, for RTUs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
4. Restraint of internal components.

D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Division 23 "Vibration and Seismic Controls for HVAC."

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control reports.

F. System startup reports.

G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: Two set(s) of filters for each unit. One set for initial start up, final set installed after CofO. Use MERV 8 unless specifically called out on equipment schedule.

1.7 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of packaged unit that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 5 year(s) from date of Substantial Completion. Entire unit total parts, labor, and refrigerant, non prorated.
2. Warranty Period for Heat Exchangers: Manufacturer's standard, but not less than 10 years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of RTUs and components.

C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

D. ASHRAE 15 Compliance: For refrigeration system safety.

E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

F. UL Compliance: Comply with UL 1995.

G. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 "Quality Requirements," to design mounting and restraints for RTUs, including comprehensive engineering analysis.

1. Design RTU supports to comply with wind and seismic performance requirements.

H. Wind-Restraint Performance:

1. Basic Wind Speed: ASCE/7-05 Wind Speed..
2. Minimum 10 lb/sq. ft. multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

I. Seismic Performance: RTUs shall withstand the effects of earthquake motions determined according to ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified" and the unit will be fully operational after the seismic event.
2. Component Importance Factor: 1.5.

2.2 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.3 UNIT CASINGS

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Double-Wall Construction:

1. Outside Casing Wall: Galvanized steel, minimum 18 gauge thick with manufacturer's standard finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
2. Inside Casing Wall: G90-coated galvanized steel, 0.034 inch thick.
3. Floor Plate: G90 galvanized steel, minimum 18 gauge thick.
4. Casing Insulation:

a. Materials: Injected polyurethane foam insulation.
b. Casing Panel R-Value: Minimum 11.0.
c. Insulation Thickness: 2 inches.
d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roof of unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Static-Pressure Classifications:

E. Panels and Doors:

1. Panels:

    a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

2. Access Doors:

    a. Hinges: A minimum of two hinges or stainless steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
    b. Gasket: Neoprene, applied around entire perimeters of panel frames.
    c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components. Dimensions to be at least 18 inches wide by full height of unit casing up to a maximum height of 60 inches.

3. Locations and Applications:

    a. Fan Section: Doors and inspection and access panels.
    b. Access Section: Doors.
    c. Coil Section: Inspection and access panels.
    d. Damper Section: Doors.
    e. Filter Section: Doors large enough to allow periodic removal and installation of filters.
    f. Mixing Section: Doors.

4. Service Light: LED vaporproof fixture with switched junction box located inside adjacent to door.

    a. Locations: Each section accessed with door.

F. Condensate Drain Pans:

1. Location: Each type of cooling coil.
2. Construction:
    a. Double-wall, galvanized-steel or noncorrosive polymer sheet with space between walls filled with foam insulation and moisture-tight seal.

3. Drain Connection:

    a. Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
    b. Minimum Connection Size: NPS 1.

4. Slope: Minimum 0.125-in./ft. slope, to comply with ASHRAE 62.1, in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
5. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
6. Width: Entire width of water producing device.
7. Depth: A minimum of 2 inches deep.
8. Pan-Top Surface Coating for Galvanized-Steel Drain Pans: Asphaltic waterproofing compound.
9. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

2.4 FANS, DRIVES, AND MOTORS

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Supply-Air Fans: Centrifugal, rated according to AMCA 210; galvanized or painted steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway.

2. Shaft Bearings:

a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours according to ABMA 9.

3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

4. Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; steel or aluminum hub swaged to backplate and fastened to shaft with setscrews.
5. Mounting: For internal vibration isolation and seismic control. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 2 inch.
6. Shaft Lubrication Lines: Extended to a location outside the casing.
7. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

C. Drives, Direct: Factory-mounted, direct drive.

D. Variable Frequency Drives: Provide factory installed, commissioned, and tested VFD inside RTU.

E. Drives, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.

1. Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.
2. Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.
3. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.146-inch- thick, diamond-mesh wire screen, welded to steel angle frame; prime coated.

F. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed or ECM motors.

G. Relief-Air Fan: Forward curved, shaft mounted on permanently lubricated motor.

H. Motors:
1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Enclosure Type: Open, dripproof or Totally enclosed, fan cooled.

3. Efficiency: Premium efficient as defined in NEMA MG 1.
4. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; fixed pitch for use with motors larger than 5 hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
5. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.5 COILS

A. General Requirements for Coils:

1. Comply with AHRI 410.
2. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
3. Coils shall not act as structural component of unit.

B. Refrigerant Coils:

1. Tubes: Copper.
2. Fins:

a. Material: Aluminum.
b. Fin Spacing: Maximum 12 fins per inch.

3. Fin and Tube Joints: Mechanical bond.
4. Frames: Galvanized steel.
5. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

a. Working Pressure: Minimum 300 psig.

C. Outdoor-Air Refrigerant Coil:

1. Tubes: Copper.
2. Fins:

a. Material: Aluminum.
b. Fin Spacing: Maximum 12 fins per inch.

3. Fin and Tube Joints: Mechanical bond.
4. Headers: Seamless-copper headers with brazed connections.
5. Frames: Galvanized steel.
6. Ratings: Designed, tested, and rated according to ASHRAE 33 and AHRI 410.

a. Working Pressure: Minimum 300 psig.

2.6 REFRIGERANT CIRCUIT COMPONENTS

A. Number of Refrigerant Circuits: Two.

B. Compressor: Hermetic,scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:

1. Refrigerant: R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas reheat solenoid valve modulating with a replaceable magnetic coil.
11. Hot-gas bypass solenoid valve with a replaceable magnetic coil.
12. Four-way reversing valve with a replaceable magnetic coil, thermostatic expansion valves with bypass check valves, and a suction line accumulator.

2.7 AIR FILTRATION

A. Panel Filters:

1. Description: Pleated factory-fabricated, self-supported, disposable air filters with holding frames. MERV 8 minimum unless otherwise specified.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

B. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

1. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.8 GAS FURNACES

A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47/CSA 2.3 and NFPA 54.

B. CSA Approval: Designed and certified by and bearing label of CSA.

C. Burners: Stainless steel.

1. Rated Minimum Turndown Ratio: 30 to 1.
2. Fuel: Natural gas.
3. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
4. Gas Control Valve: Modulating.
5. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.
6. High-Altitude Kit: For Project elevations more than 2000 feet above sea level.

D. Heat-Exchanger and Drain Pan: Stainless steel.

E. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve with vertical extension.

F. Safety Controls:

1. Gas Manifold: Safety switches and controls complying with ANSI standards.

2.9 ANTIMICROBIAL ULTRAVIOLET LAMP SYSTEM (ONLY IF SCHEDULED ON DRAWINGS)

A. Description:

1. UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
2. Factory installed and preengineered.

B. Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted.

C. Lamps: High output, hot cathode.

D. Lamp-Holder Construction:

1. UV- and moisture-resistant materials and designed to connect the lamp to the plug.
2. Adjustable positioning.

E. Lamp-Clamp Construction:

1. UV- and moisture-resistant materials, water-tight connection.
2. Adjustable positioning.

F. Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.

G. Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution.

H. Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.

I. Power Supply: UL-listed, single-point electrical connection with service disconnect.

J. Power Density: Minimum of 15 W/sq. ft.

2.10 DAMPERS

A. Dampers: Comply with requirements in Division 23 "Control Dampers."

B. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg

C. Barometric relief dampers.

D. Damper Operators: Comply with requirements in Division 23 "Control Dampers."

E. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 "Common Motor Requirements for HVAC Equipment."
    b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
    c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.

4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:

    a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
    c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
    d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
    e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
    f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.

8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
10. Power Requirements (Two-Position Spring Return): 24 V dc.
11. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
12. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
13. Temperature Rating: Minus 22 to plus 122 deg F.
14. Run Time: 12 seconds open, 5 seconds closed.

2.11 ELECTRICAL POWER CONNECTIONS

A. RTU shall have a single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.

2.12 CONTROLS

A. DDC Controller:

1. Controller shall have volatile-memory backup.
2. Safety Control Operation:

    a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    b. Firestats: Stop fan and close outdoor-air damper if air greater than 130 deg F enters unit. Provide additional contacts for alarm interface to fire alarm control panel.
    c. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Division 28 "Addressable Fire-Alarm Systems."
    d. Low-Discharge Temperature: Stop fan and close outdoor-air damper if supply air temperature is less than 40 deg F.
    e. Defrost Control for Condenser Coil: Pressure differential switch to initiate defrost sequence.

3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
4. Unoccupied Period:

    a. Heating Setback: Plus 10 deg F.
    b. Cooling Setback: Minus 10 deg F.
    c. Override Operation: Two hours.

5. Supply Fan Operation:

    a. Occupied Periods: Run fan continuously.
    b. Unoccupied Periods: Cycle fan to maintain setback temperature.

6. Refrigerant Circuit Operation:

    a. Occupied Periods: Cycle or stage compressors, and operate hot-gas bypass to match compressor output to cooling load to maintain room temperature and humidity. Cycle condenser fans to maintain maximum hot-gas pressure. Operate low-ambient control kit to maintain minimum hot-gas pressure.

b. Unoccupied Periods: Compressors off.
c. Switch reversing valve for heating or cooling mode on air-to-air heat pump.

7. Hot-Gas Reheat-Coil Operation (Only if scheduled on drawings)

a. Occupied Periods: Humidistat opens hot-gas valve to provide hot-gas reheat, and cycles compressor.
b. Unoccupied Periods: Reheat not required.

8. Gas Furnace Operation:

a. Occupied Periods: Modulate burner to maintain room temperature.
b. Unoccupied Periods: Cycle burner to maintain setback temperature.

9. Economizer Outdoor-Air Damper Operation:

a. Morning warm up and cool down cycles.
b. Occupied Periods: Open to 10 percent fixed minimum intake, and maximum 100 percent of the fan capacity. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use outdoor-air temperature to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
c. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
d. Outdoor-Airflow Monitor: Accuracy maximum plus or minus 5 percent within 15 and 100 percent of total outdoor air. Monitor microprocessor shall adjust for temperature, and output shall range from 2- to 10-V dc.

10. Carbon Dioxide Sensor Operation:

a. Occupied Periods: Reset minimum outdoor-air ratio down to minimum 10 percent to maintain maximum 1400-ppm concentration.
b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.

B. Interface Requirements for HVAC Instrumentation and Control System:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
3. Provide BACnet compatible interface for central HVAC control workstation for the following:

a. Adjusting set points.
b. Monitoring supply fan start, stop, and operation.
c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
d. Monitoring occupied and unoccupied operations.
e. Monitoring constant and variable motor loads.
f. Monitoring variable-frequency drive operation.
g. Monitoring cooling load.
h. Monitoring economizer cycles.
i. Monitoring air-distribution static pressure and ventilation air volume.

2.13 ROOF CURBS

A. Roof curbs with vibration isolators and wind or seismic restraints are specified in Division 23 "Vibration and Seismic Controls for HVAC."

B. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Division 23 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

C. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

a. Materials: ASTM C1071, Type I or II.
b. Thickness: 1 inch.

2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

a. Liner Adhesive: Comply with ASTM C916, Type I.
b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
d. Liner Adhesive: Comply with ASTM C916, Type I.

D. Curb Dimensions: Height of 14 inches.

2.14 ACCESSORIES

A. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.

B. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.

C. Low-ambient kit using variable-speed condenser fans for operation down to 35 deg F.

D. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

E. Remote potentiometer to adjust minimum economizer damper position.

F. Return-air bypass damper.

G. Factory- or field-installed demand-controlled ventilation.

H. Safeties:

1. Smoke detector.
2. Condensate overflow switch.
3. Phase-loss reversal protection.
4. High and low pressure control.
5. Gas furnace airflow-proving switch.

I. Coil guards of painted, galvanized-steel wire.

J. Hail guards of galvanized steel, painted to match casing.

K. Concentric diffuser with white louvers and polished aluminum return grilles, insulated diffuser box with mounting flanges, and interior transition.

L. Vertical vent extensions to increase the separation between the outdoor-air intake and the flue-gas outlet.

M. Door switches to disable heating or reset set point when open.

N. Outdoor air intake weather hood with moisture eliminator.

O. Service Lights and Switch: Factory installed in fan section with weatherproof cover. Factory wire lights to a single-point field connection.

2.15 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.
2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.
2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

E. Comply with Division 23 "Coatings for HVAC" for corrosion-resistant coating.

F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.

1. Standards:

a. ASTM B117 for salt spray.
b. ASTM D2794 for minimum impact resistance of 100 in-lb.
c. ASTM B3359 for cross-hatch adhesion of 5B.

2. Application: Immersion.
3. Thickness: 1 mil.
4. Gloss: Minimum gloss of 60 on a 60-degree meter.

2.16 SOURCE QUALITY CONTROL

A. AHRI Compliance:

1. Comply with AHRI 340/360 for testing and rating energy efficiencies for RTUs.
2. Comply with AHRI 210/240 for testing and rating energy efficiencies for RTUs
3. Comply with AHRI 270 for testing and rating sound performance for RTUs.
4. Comply with AHRI 1060 for testing and rating performance for air-to-air exchanger.

B. AMCA Compliance:

1. Comply with AMCA 11 and bear the AMCA-Certified Ratings Seal for air and sound performance according to AMCA 211 and AMCA 311.
2. Damper leakage tested in accordance with AMCA 500-D.
3. Operating Limits: Classify according to AMCA 99.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "NRCA Roofing Manual: Membrane Roof Systems." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07 "Roof Accessories." Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment provided.

1. Install normal-weight, 3000-psi, compressive strength (28-day) concrete mix inside roof curb, 4 inches thick. Concrete, formwork, and reinforcement are specified with concrete.

B. Unit Support: Install unit level on structural curbs. Coordinate wall penetrations and flashing with wall construction. Secure RTUs to structural support with anchor bolts.

C. Equipment Mounting:

1. Install RTUs on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Division 23 "Vibration and Seismic Controls for HVAC."
3. Comply with requirements for vibration isolation devices specified in Division 23 "Vibration Controls for HVAC."

3.3 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to RTU, allow space for service and maintenance.

C. Connect piping to unit mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or roof drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. Gas Piping: Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

F. Hot- and Chilled-Water Piping: Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

G. Refrigerant Piping: Install shutoff valve and union or flange at each supply and return connection.

3.4 DUCT CONNECTIONS

A. Comply with duct installation requirements specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
3. Connect supply ducts to RTUs with flexible duct connectors specified in Division 23 "Air Duct Accessories."
4. Install return-air duct continuously through roof structure.

3.5 ELECTRICAL CONNECTIONS

A. Connect electrical wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs.
2. Nameplate shall be laminated acrylic or melamine plastic signs as layers of black with engraved white letters at least 1/2 inch high.
3. Locate nameplate where easily visible.

3.6 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

3.7 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions.

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean furnace flue and inspect for construction debris.
11. Connect and purge gas line.
12. Remove packing from vibration isolators.
13. Inspect operation of barometric relief dampers.
14. Verify lubrication on fan and motor bearings.
15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
16. Adjust fan belts to proper alignment and tension.
17. Start unit according to manufacturer's written instructions.

    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.

18. Inspect and record performance of interlocks and protective devices; verify sequences.
19. Operate unit for an initial period as recommended or required by manufacturer.
20. Perform the following operations for both minimum and maximum firing. Adjust burner for peak efficiency.

    a. Measure gas pressure on manifold.
    b. Inspect operation of power vents.
    c. Measure combustion-air temperature at inlet to combustion chamber.
    d. Measure flue-gas temperature at furnace discharge.
    e. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    f. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

21. Calibrate thermostats.
22. Adjust and inspect high-temperature limits.
23. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
24. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F above return-air temperature:

    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.

c. Outdoor-air, dry-bulb temperature.
d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

25. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
26. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.
    b. Return-air volume.
    c. Relief-air volume.
    d. Outdoor-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

28. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:

    a. High-temperature limit on gas-fired heat exchanger.
    b. Low-temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.

29. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.8 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Division 23 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.9 CLEANING

A. After completing system installation and testing, adjusting, and balancing RTUs and air-distribution systems and after completing startup service, clean RTUs internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. RTU will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs.

END OF SECTION

SECTION 23 81 26

– MINI SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes split-system air-conditioning and heat-pump units consisting of separate air handlers and condensing unit components.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Sustainable Design Submittals:

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - " Procedures," and Section 7 - "Construction and System Start-up."

C. ASHRAE/IES Compliance: Applicable requirements in ASHRAE/IES 90.1.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: 5 year(s) from date of Substantial Completion.
b. For Parts: 5 year(s) from date of Substantial Completion.
c. For Labor: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The equipment descriptions listed in the section may not all be used on this project. Refer to the Equipment Schedules on the drawings for the specific application for each product or material. Products not shown on the schedule for the specific application may not be substituted without pre-approval from the Engineer. Where there is a conflict between the drawing schedules and specifications, the drawing schedules shall take precedent.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.

2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:

    a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 "Common Motor Requirements for HVAC Equipment."
    b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    c. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: Permanent, cleanable.
10. Condensate Drain Pans:

    a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

        1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
        2) Depth: A minimum of 2 inches deep.

    b. Single-wall, galvanized-steel sheet.
    c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

        1) Minimum Connection Size: NPS 1.

    d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
    e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Floor or Ceiling Mounted, Air Handler Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect.
    a. Insulation: Faced, glass-fiber duct liner.
    b. Drain Pans: Galvanized steel, with connection for drain; insulated. Provide overflow switch to disable compressor (fan continues to operate).

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.

4. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
5. Fan: Direct drive, centrifugal
6. Fan Motors:
   a. Multitapped, multispeed with internal thermal protection and permanent lubrication.

7. Air Filtration Section:

   a. General Requirements for Air Filtration Section:

      1) Comply with NFPA 90A.
      2) Minimum MERV according to ASHRAE 52.2.
      3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from at least one side.

   b. Disposable Panel Filters:

      1) Factory-fabricated, pleated media, flat-panel type.
      2) Thickness: 1 inches.
      3) MERV according to ASHRAE 52.2: 6.0
      4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
      5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

C. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.
2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
4. Fan: Direct drive, centrifugal.
5. Fan Motors:
   a. Multitapped, multispeed with internal thermal protection and permanent lubrication.
   b. Enclosure Type: Totally enclosed, fan cooled.
   c. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
   d. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
   e. Mount unit-mounted disconnect switches on exterior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
7. Condensate Drain Pans:

   a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 1 inch deep.

b. Single-wall, galvanized-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.
2) Minimum MERV according to ASHRAE 52.2.
3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Filters:

1) Factory-fabricated, pleated media, disposable.
2) Thickness: 1 inch.
3) MERV according to ASHRAE 52.2: 6.0
4) Media: Interlaced glass fibers sprayed with nonflammable adhesive.
5) Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.

2.3 INDOOR UNITS (6 TONS OR MORE)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
5. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.
6. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
7. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Division 23 "Common Motor Requirements for HVAC Equipment."
b. Multitapped, multispeed with internal thermal protection and permanent lubrication.

c. Three-phase, permanently lubricated, ball-bearing motors with built-in thermal-overload protection.
d. Wiring Terminations: Connect motor to chassis wiring with plug connection.

8. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
9. Filters: 2 inch thick, in fiberboard frames.
10. Condensate Drain Pans:

a. Fabricated with one two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
2) Depth: A minimum of 2 inches deep.

b. Single-wall, galvanized-steel sheet.
c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

1) Minimum Connection Size: NPS 1.

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.
e. Units with stacked coils shall have an intermediate drain pan to collect condensate from top coil.

B. Variable-Frequency Controllers:

1. Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, three-phase induction motor by adjusting output voltage and frequency.
2. Output Rating: Three-phase; 6 to 120 Hz, with voltage proportional to frequency throughout voltage range.
3. Unit Operating Requirements:
   a. Input-frequency tolerance of 06/11 Hz, plus or minus 6 percent.
   b. Minimum Efficiency: 96 percent at 60 Hz, full load.
   c. Minimum Displacement Primary-Side Power Factor: 96 percent.
   d. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   e. Starting Torque: 100 percent of rated torque or as indicated.
   f. Speed Regulation: Plus or minus 1 percent.

4. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
5. Internal Adjustability Capabilities:

a. Minimum Speed: 5 to 25 percent of maximum rpm.
b. Maximum Speed: 80 to 100 percent of maximum rpm.
c. Acceleration: 2 seconds to a minimum of 22 seconds.
d. Deceleration: 2 seconds to a minimum of 22 seconds.
e. Current Limit: 50 percent to a minimum of 110 percent of maximum rating.

6. Self-Protection and Reliability Features:

a. Input transient protection by means of surge protection devices (SPDs).
b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
c. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
d. Instantaneous line-to-line and line-to-ground overcurrent trips.
e. Loss-of-phase protection.
f. Reverse-phase protection.
g. Short-circuit protection.
h. Motor overtemperature fault.

7. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads, spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
8. Power-Interruption Protection: Prevents motor from re-energizing after a power interruption until motor has stopped.
9. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
10. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back, based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
11. Door-mounted, digital status lights shall indicate the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.

12. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual-speed-control potentiometer and elapsed-time meter.
13. Meters or digital readout devices and selector switch, mounted flush in controller door and connected, to indicate the following controller parameters:

a. Output frequency (Hertz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percent).
f. Fault or alarming status (code).
g. Proportional-integral-derivative feedback signal (percent).
h. DC-link voltage (volts dc).
i. Set-point frequency (Hertz).
j. Motor output voltage (volts).

14. Control Signal Interface:

a. Electric Input Signal Interface: A minimum of two analog inputs (0 to 10 V or 0/4-20 mA) and six programmable digital inputs.
b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:

1) 0 to 10-V dc.

2) 0-20 or 4-20 mA.
3) Potentiometer using up/down digital inputs.
4) Fixed frequencies using digital inputs.
5) RS485.
6) Keypad display for local hand operation.

c. Output signal interface with a minimum of one analog output signal (0/4-20 mA), which can be programmed to any of the following:

1) Output frequency (Hertz).
2) Output current (load).
3) DC-link voltage (volts dc).
4) Motor torque (percent).
5) Motor speed (rpm).
6) Set-point frequency (Hertz).

d. Remote indication interface with a minimum of two dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

1) Motor running.
2) Set-point speed reached.
3) Fault and warning indication (overtemperature or overcurrent).
4) High- or low-speed limits reached.

15. Communications: BACnet interface allows VFC to be used with an external system. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.
16. Integral Disconnecting Means: NEMA AB 1, instantaneous-trip circuit breaker with lockable handle.
17. Accessories:

a. Devices shall be factory installed in controller enclosure unless otherwise indicated.
b. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
c. Standard Displays:

1) Output frequency (Hertz).
2) Set-point frequency (Hertz).
3) Motor current (amperes).
4) DC-link voltage (volts dc).
5) Motor torque (percent).
6) Motor speed (rpm).
7) Motor output voltage (volts).

2.4 OUTDOOR UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll.
    b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.5 OUTDOOR UNITS (6 TONS OR MORE)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

    a. Compressor Type: Scroll, Minimum 2 stage control
    b. Compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    c. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.
4. Fan: Aluminum-propeller type, directly connected to motor.
5. Motor: Permanently lubricated, with integral thermal-overload protection.
6. Low Ambient Kit: Permits operation down to 45 deg F.
7. Mounting Base: Polyethylene.

2.6 ACCESSORIES

A. Thermostat: Low voltage with subbase functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.

2. 2H2C control with heat pump option
3. 4 events per day
4. Auto changeover
5. Liquid-crystal display indicating temperature, set-point temperature, time setting, operating mode, and fan speed.
6. Fan-speed selection including auto setting.
7. 7-day programmability

B. Automatic-reset timer to prevent rapid cycling of compressor.

C. Wireless remote for mini-split units.

D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

E. Drain Hose: For condensate. Copper, fully insulated to prevent condensation

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install condensate pump for all wall and ceiling cassette units where gravity drain is not possible. Use pump equivalent to Little Giant VCL-24ULS. Gravity drain inside the wall to a concealed place, then use condensate pump. Do not expose condensate pump in plain sight.

C. Install air handler components using manufacturer's standard mounting devices securely fastened to building structure. If installed in concealed spaces, suspend the unit using 2” spring isolation to prevent vibration from transmitting from unit to structure. Provide flexible duct connections between equipment and rigid ductwork.

D. Install roof-mounted, compressor-condenser components on manufactured equipment supports equivalent to RPS ER-4.

E. Equipment Mounting:

1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s) or polyethylene base.
2. Comply with requirements for vibration isolation and seismic control devices.

F. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

A. Use manufacturer’s recommendations for all piping, trim, and specialties.

B. Install external filter/dryer at all conventional condensing units (not installed on mini-split units).

C. Insulate all refrigerant piping suction lines using elastomeric 1” insulation.

D. Sleeve all refrigerant lines that are run underground using PVC with long-radius elbows and sealed water tight at both ends. Exposed refrigerant lines should be concealed and protected using a line-set cover equivalent to MRCOOL Lineguard.

E. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

F. Duct Connections: Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION

SECTION 23 82 39.19

WALL AND CEILING UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Sustainable Design Submittals:

C. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

D. Samples: For each exposed product and for each color and texture specified.

1.3 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 DESCRIPTION

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 CABINET

A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's custom color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.4 COIL

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection. Provide integral circuit breaker for overcurrent protection.

2.5 FAN AND MOTOR

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 "Common Motor Requirements for HVAC Equipment."

2.6 CONTROLS

A. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.7 CAPACITIES AND CHARACTERISTICS

A. See scheduled requirements on plans.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Metal-clad cable, Type MC, rated 600 V or less.
3. Armored cable, Type AC, rated 600 V or less.
4. Connectors, splices, and terminations rated 600 V and less.

1.2 DEFINITIONS

A. RoHS: Restriction of Hazardous Substances.

B. VFC: Variable-frequency controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Product Schedule: Indicate type, use, location, and termination locations.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer's authorized service representative.

B. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B496 for stranded conductors.

D. Conductor Insulation:

1. Type NM: Comply with UL 83 and UL 719.
2. Type RHH and Type RHW-2: Comply with UL 44.
3. Type USE-2 and Type SE: Comply with UL 854.
4. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
5. Type THHN and Type THWN-2: Comply with UL 83.
6. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
7. Type UF: Comply with UL 83 and UL 493.
8. Type XHHW-2: Comply with UL 44.

E. Shield:

1. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, dual spirally wrapped copper tape shields and three bare symmetrically applied ground wires, and sunlight- and oil-resistant outer PVC jacket.

2.2 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. Comply with UL 1569.
3. RoHS compliant.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors.

2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation:

1. Type TFN/THHN/THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

G. Armor: Aluminum, interlocked.

H. Jacket: PVC applied over armor.

2.3 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Comply with UL 4.
4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

1. Single circuit and multicircuit with color-coded conductors.
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

G. Armor: Aluminum, interlocked.

2.4 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

C. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

D. MC cable shall not be used for home runs unless approved prior to bid in writing by the EOR. Contractor shall notify the EOR in writing their intent to use MC cable for any application in the building prior to bidding.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN/THWN-2, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

G. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

H. Branch Circuits in Cable Tray: Type THHN/THWN-2, single conductors in raceway.

I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

J. VFC Output Circuits: Type XHHW-2 in metal conduit.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

D. Comply with requirements in Section 28 31 11 "Digital, Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

C. All conductor insulation shall be continuously colored to match phase types according to NFPA standards.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 07 84 13 "Penetration Firestopping."

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.

2. Perform each of the following visual and electrical tests:

a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
b. Test bolted connections for high resistance using one of the following:

1) A low-resistance ohmmeter.
2) Calibrated torque wrench.
3) Thermographic survey.

c. Inspect compression-applied connectors for correct cable match and indentation.
d. Inspect for correct identification.
e. Inspect cable jacket and condition.
f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
g. Continuity test on each conductor and cable.
h. Uniform resistance of parallel conductors.

3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

B. Cables will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Sustainable Design Submittals:

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency and testing agency's field supervisor.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Certified by NETA.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.

E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.

F. Conduit Hubs: Mechanical type, terminal with threaded hub.

G. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.

H. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.

I. Straps: Solid copper, copper lugs. Rated for 600 A.

J. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.

K. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Grounding Conductors: Green-colored insulation with continuous yellow stripe.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.
3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Armored and metal-clad cable runs.
8. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Installbonding jumper to bond across flexible duct connections to achieve continuity.

D. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 1 ohm(s).

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Aluminum slotted support systems.
3. Nonmetallic slotted support systems.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Delegated-Design Submittal: For hangers and supports for electrical systems.

1. Include design calculations and details of hangers.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Stainless steel, Type 304.
3. Channel Width: Selected for applicable load criteria.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Material: 6063-T5 aluminum alloy.
3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width: Selected for applicable load criteria.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Width: Selected for applicable load criteria.
3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
5. Rated Strength: Selected to suit applicable load criteria.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: Stainless-steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325.
6. Toggle Bolts: Stainless-steel springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 05 50 00 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA 101
3. NECA 102.
4. NECA 105.
5. NECA 111.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceways and Boxes for Electrical Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, according to NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that comply with seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions based on manufacturer’s recommendations, but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Engage a licensed structural engineer to design concrete bases for pad mounted electrical equipment. Provide signed and sealed drawings for equipment pads.

C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Comply with architect’s requirements for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Surface raceways.
6. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid steel conduit.

C. IMC: Intermediate metal conduit.

1.3 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:
1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. GRC: Comply with ANSI C80.1 and UL 6.
3. ARC: Comply with ANSI C80.5 and UL 6A.

4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.

    a. Comply with NEMA RN 1.
    b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings:
1. Comply with NEMA FB 1 and UL 514B.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:

    a. Material: Steel.
    b. Type: Setscrew.

6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:
1. Listing and Labeling: Nonmetallic conduit shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Fiberglass:

    a. Comply with NEMA TC 14.
    b. Comply with UL 2515 for aboveground raceways.
    c. Comply with UL 2420 for belowground raceways.

3. ENT: Comply with NEMA TC 13 and UL 1653.
4. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
5. LFNC: Comply with UL 1660.
6. Rigid HDPE: Comply with UL 651A.
7. RTRC: Comply with UL 2515A and NEMA TC 14.

B. Nonmetallic Fittings:
1. Fittings, General: Listed and labeled for type of conduit, location, and use.
2. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

a. Fittings for LFNC: Comply with UL 514B.

3. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 3R unless otherwise indicated, and sized according to NFPA 70.

1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Wireway Covers: Hinged type unless otherwise indicated.

D. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.5 SURFACE RACEWAYS

A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

E. Metal Floor Boxes:
   1. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.

G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.

   1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.

J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

L. Gangable boxes are allowed.

M. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.

   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
   2. Nonmetallic Enclosures: Fiberglass.
   3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

N. Cabinets:

   1. NEMA 250, Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.
   6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Raceway Size: 3/4-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use setscrew, steel fittings. Comply with NEMA FB 2.10.
4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

D. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for hangers and supports.

B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits.

Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

C. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

D. Do not fasten conduits onto the bottom side of a metal deck roof.

E. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

F. Complete raceway installation before starting conductor installation.

G. Arrange stub-ups so curved portions of bends are not visible above finished slab.

H. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.

I. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

J. Support conduit within 12 inches of enclosures to which attached.

K. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC before rising above floor.

L. Stub-Ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

M. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.

O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

U. Surface Raceways:

1. Install surface raceway with a minimum 2-inch radius control at bend points.
2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.

W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Conduit extending into pressurized duct and equipment.
5. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
6. Where otherwise required by NFPA 70.

X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

Y. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.

c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 36 inches of flexible conduit for recessed and semi-recessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

AA. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

BB. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

DD. Locate boxes so that cover or plate will not span different building finishes.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 31 20 00 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 31 20 00 "Earth Moving."

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 31 20 00 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground Warning Tape: Comply with requirements in Section 26 05 53 "Identification for Electrical Systems."

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

3.6 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
2. Rigid nonmetallic duct.
3. Flexible nonmetallic duct.
4. Duct accessories.
5. Precast concrete handholes.
6. Polymer concrete handholes and boxes with polymer concrete cover.
7. Fiberglass handholes and boxes with polymer concrete cover.
8. Fiberglass handholes and boxes.
9. High-density plastic boxes.
10. Precast manholes.
11. Cast-in-place manholes.
12. Utility structure accessories.

1.2 DEFINITIONS

A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.

B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

C. Duct Bank:

1. Two or more ducts installed in parallel, with or without additional casing materials.
2. Multiple duct banks.

D. GRC: Galvanized rigid (steel) conduit.

E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for manholes, handholes, boxes, and other utility structures.
4. Include underground-line warning tape.
5. Include warning planks.

B. Sustainable Design Submittals:

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.

B. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.

C. Source quality-control reports.

D. Field quality-control reports.

1.5 MAINTENANCE MATERIALS SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.

1.7 FIELD CONDITIONS

A. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

A. GRC: Comply with ANSI C80.1 and UL 6.

B. Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

C. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 DUCT ACCESSORIES

A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.

B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 26 05 53 "Identification for Electrical Systems."

2.4 PRECAST CONCRETE HANDHOLES AND BOXES

A. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

B. Comply with ASTM C858 for design and manufacturing processes.

C. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.

D. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

E. Cover Legend: Molded lettering, "ELECTRIC." as indicated for each service.

F. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

G. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.

1. Extension shall provide increased depth of 12 inches.
2. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.

H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

I. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Center window location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
4. Knockout panels shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches thick.

J. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of handholes to facilitate racking of cable.

K. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC."

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 FIBERGLASS HANDHOLES AND BOXES WITH POLYMER CONCRETE FRAME AND COVER

A. Description: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC."

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.7 FIBERGLASS HANDHOLES AND BOXES

A. Description: Molded of fiberglass-reinforced polyester resin, with covers made of reinforced concrete.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC."

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.8 HIGH-DENSITY PLASTIC BOXES

A. Description: Injection molded of HDPE or copolymer-polypropylene. Cover shall be made of polymer concrete.

B. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.

C. Color: Gray.

D. Configuration: Units shall be designed for flush burial and have integral closed bottom unless otherwise indicated.

E. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.

F. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

G. Cover Legend: Molded lettering, "ELECTRIC."

H. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.

I. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.

J. Handholes 12 inches wide by 24 inches long and larger shall have factory-installed inserts for cable racks and pulling-in irons.

2.9 PRECAST MANHOLES

A. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Comply with ASTM C858.

C. Structural Design Loading: Comply with requirements in "Underground Enclosure Application" Article.

D. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

1. Center window location.

2. Knockout panels shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
3. Knockout panel opening shall have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
4. Knockout panel shall be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
5. Knockout panels shall be 1-1/2 to 2 inches thick.

E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

1. Type and size shall match fittings to duct to be terminated.
2. Fittings shall align with elevations of approaching duct and be located near interior corners of manholes to facilitate racking of cable.

F. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

G. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.10 CAST-IN-PLACE MANHOLES

A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for duct entrance and sleeve for ground rod.

B. Materials: Comply with ASTM C858 and with Section 03 30 00 "Cast-in-Place Concrete."

C. Structural Design Loading: As specified in "Underground Enclosure Application" Article.

2.11 UTILITY STRUCTURE ACCESSORIES

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 29 inches.

a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.

2. Cover Legend: Cast in. Selected to suit system.

a. Legend: "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
b. Legend: "ELECTRIC-HV" for duct systems with medium-voltage cables.

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

    a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used.
    b. Seal joints watertight using preformed plastic or rubber complying with ASTM C990. Install sealing material according to sealant manufacturers' written instructions.

C. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling Eyes in Nonconcrete Walls: Eyebolt with reinforced fastening, 1-1/4-inch-diameter eye, rated 2500-lbf minimum tension.

F. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

H. Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with 1/2-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.

J. Cable Rack Assembly: Steel, hot-rolled galvanized, except insulators.

1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form a continuous unit; 1-1/2 inches in width by nominal 24 inches long; punched with 14 hook holes on 1-1/2-inch centers for cable-arm attachment.
2. Arms: 1-1/2 inches wide, lengths ranging from 3 inches with 450-lb minimum capacity to 18 inches with 250-lb minimum capacity. Arms shall have slots along full length for cable ties and be arranged for secure mounting in horizontal position at any vertical location on stanchions.
3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

K. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.

1. Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.

2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

L. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

M. Fixed Manhole Ladders: Arranged for attachment to wall and floor of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.

N. Portable Manhole Ladders: UL-listed, heavy-duty fiberglass specifically designed for portable use for access to electrical manholes. Minimum length equal to distance from deepest manhole floor to grade plus 36 inches. One required.

O. Cover Hooks: Heavy duty, designed for lifts 60 lbf and greater. Two required.

2.12 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C1037.

B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
3. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

C. Clear and grub vegetation to be removed, and protect vegetation to remain.

3.2 UNDERGROUND DUCT APPLICATION

A. Duct for Electrical Feeders 600 V and Less: Type EPC-80-PVC RNC, direct-buried unless otherwise indicated.

B. Duct for Electrical Branch Circuits: Type EPC-80-PVC RNC, direct-buried unless otherwise indicated.

C. Bored Underground Duct: Type EPEC-80-HDPE unless otherwise indicated.

D. Underground Ducts Crossing Paved Paths and Driveways: Type EPC-40 PVC RNC, encased in reinforced concrete.

E. Stub-ups: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, H-10 structural load rating.
2. Cover design load shall not exceed the design load of the handhole or box.

B. Manholes: cast-in-place concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

A. Refer to civil engineer drawings for earthwork details and specifications.

3.5 DUCT AND DUCT-BANK INSTALLATION

A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

B. Install duct according to NEMA TCB 2.

C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.

D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations unless otherwise indicated.

1. Duct shall have maximum of two 90 degree bends or the total of all bends shall be no more 180 degrees between pull points.

E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.

F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell, without reducing duct slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
3. Grout end bells into structure walls from both sides to provide watertight entrances.

H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.

I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 26 05 44 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.

K. Pulling Cord: Install 200-lbf-test nylon cord in empty ducts.

L. Concrete-Encased Ducts and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 31 20 00 "Earth Moving" for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.

4. Depth: Install so top of duct envelope is at least 24 inches below finished grade in areas not subject to deliberate traffic, and at least 30 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
7. Minimum Space between Duct: 3 inches between edge of duct and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and communications ducts.
8. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
9. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and no less than 3 inches from conduit side to edge of slab.

10. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
11. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
12. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
13. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

    a. Start at one end and finish at the other, allowing for expansion and contraction of duct as its temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written instructions, or use other specific measures to prevent expansion-contraction damage.
    b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing-rod dowels extending a minimum of 18 inches into concrete on both sides of joint near corners of envelope.

14. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 03 30 00 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.

M. Direct-Buried Duct and Duct Bank:

1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 31 20 00 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches in nominal diameter.
2. Width: Excavate trench 12 inches wider than duct on each side.
3. Width: Excavate trench 3 inches wider than duct on each side.
4. Depth: Install top of duct at least 36 inches below finished grade unless otherwise indicated.
5. Set elevation of bottom of duct bank below frost line.
6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 feet of duct. Place spacers within 24 inches of duct ends. Stagger spacers approximately 6 inches between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
8. Install duct with a minimum of 3 inches between ducts for like services and 6 inches between power and communications duct.
9. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
10. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.

    a. Couple RNC duct to GRC with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
    b. Stub-ups to Outdoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and minimum 3 inches from conduit side to edge of slab.

    c. Stub-ups to Indoor Equipment: Extend concrete-encased GRC horizontally a minimum of 60 inches from edge of wall. Install insulated grounding bushings on terminations at equipment.

        1) Stub-ups shall be flush with finished floor and no less than 3 inches from conduit side to edge of slab.

11. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of

run and complete backfilling with normal compaction. Comply with requirements in Section 31 20 00 "Earth Moving" for installation of backfill materials.

a. Place minimum 3 inches of sand as a bed for duct. Place sand to a minimum of 6 inches above top level of duct.
b. Place minimum 6 inches of engineered fill above concrete encasement of duct.

N. Warning Planks: Bury warning planks approximately 12 inches above direct-buried duct, placing them 24 inches o.c. Align planks along the width and along the centerline of duct or duct bank. Provide an additional plank for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional planks 12 inches apart, horizontally.

O. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 26 05 53 "Identification for Electrical Systems" no less than 12 inches above all concrete-encased duct and duct banks and approximately 12 inches below grade. Align tape parallel to and within 3 inches of centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Cast-in-Place Manhole Installation:

1. Finish interior surfaces with a smooth-troweled finish.
2. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inches thick, arranged as indicated.
3. Comply with requirements in Section 03 30 00 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line, below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After duct has been connected and grouted, and before backfilling, waterproof joints and connections, and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days.

G. Damp proofing: Apply damp proofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. Damp proofing materials and installation are specified in Section 07 11 13 "Bituminous Damp proofing." After ducts are connected and grouted, and before backfilling, dampproof joints and connections, and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.

H. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.

I. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.

J. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch above finished grade.

D. Install handholes and boxes with bottom below frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.

F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and

with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.

1. Concrete: 3000 psi, 28-day strength, complying with Section 03 30 00 "Cast-in-Place Concrete," with a troweled finish.
2. Dimensions: 10 inches wide by 12 inches deep.

3.8 GROUNDING

A. Ground underground ducts and utility structures according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum 12-inch-long mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

3.10 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump.

1. Sweep floor, removing dirt and debris.
2. Remove foreign material.

END OF SECTION

SECTION 26 05 44

SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 07 84 13 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.

D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5000-psi, 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Color and legend requirements for raceways, conductors, and warning labels and signs.
2. Labels.
3. Bands and tubes.
4. Tapes and stencils.
5. Tags.
6. Signs.
7. Cable ties.
8. Paint for identification.
9. Fasteners for labels and signs.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 70.

B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

C. Comply with ANSI Z535.4 for safety signs and labels.

D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

A. Raceways and Cables Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.

1. Color shall be continuous colored insulation.
2. Colors for 208/120-V Circuits:

a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.
b. Phase B: Orange.
c. Phase C: Yellow.

4. Color for Neutral: White.
5. Color for Equipment Grounds: Green.

C. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

D. Warning labels and signs shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

E. Equipment Identification Labels:

1. Black letters on a white field.

2.3 LABELS

A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.

B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.

C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, vinyl flexible label with acrylic pressure-sensitive adhesive.

1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.

D. Self-Adhesive Labels: Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
1. Minimum Nominal Size:

a. 1-1/2 by 6 inches for raceway and conductors.
b. 3-1/2 by 5 inches for equipment.
c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.

B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

2.5 TAPES AND STENCILS

A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.

C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and are 12 inches wide. Stop stripes at legends.

D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

E. Underground-Line Warning Tape:
1. Tape:

a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
b. Printing on tape shall be permanent and shall not be damaged by burial operations.
c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.

2. Color and Printing:

a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".

c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".

3. Tag: Type II:

a. Multilayer laminate, consisting of high-density polyethylene scrim coated with pigmented polyolefin; bright colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
b. Width: 3 inches.
c. Thickness: 12 mils.
d. Weight: 36.1 lb/1000 sq. ft..
e. Tensile according to ASTM D882: 400 lbf and 11,500 psi.

F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.6 TAGS

A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.

B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.023 inch thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.

2.7 SIGNS

A. Baked-Enamel Signs:
1. Preprinted aluminum signs, high-intensity reflective, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 7 by 10 inches.

B. Metal-Backed Butyrate Signs:
1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
2. 1/4-inch grommets in corners for mounting.
3. Nominal Size: 10 by 14 inches.

C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
2. Thickness:

a. For signs up to 20 sq. in., minimum 1/16 inch thick.
b. For signs larger than 20 sq. in., 1/8 inch thick.
c. Engraved legend with black letters on white face.
d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 12,000 psi.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black.

C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 Deg F according to ASTM D638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 INSTALLATION

A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Verify identity of each item before installing identification products.

D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.

E. Apply identification devices to surfaces that require finish after completing finish work.

F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.

G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

H. System Identification for Raceways and Cables over 600 V: Identification shall completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.

I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

K. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

L. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:

1. "EMERGENCY POWER."
2. "POWER."
3. "UPS."

M. Vinyl Wraparound Labels:

1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.

N. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.

O. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.

P. Self-Adhesive Labels:

1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.

2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.

Q. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.

R. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.

S. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.

T. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.

1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.

U. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

V. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.

W. Underground Line Warning Tape:

1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
2. Limit use of underground-line warning tape to direct-buried cables.
3. Install underground-line warning tape for direct-buried cables and cables in raceways.

X. Metal Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using plenum-rated cable ties.

Y. Nonmetallic Preprinted Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using plenum-rated cable ties.

Z. Write-on Tags:

1. Place in a location with high visibility and accessibility.
2. Secure using plenum-rated cable ties.

AA. Baked-Enamel Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.

BB. Metal-Backed Butyrate Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

CC. Laminated Acrylic or Melamine Plastic Signs:

1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.

DD. Cable Ties: General purpose, for attaching tags, except as listed below:

1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.

3.3 IDENTIFICATION SCHEDULE

A. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment. Install access doors or panels to provide view of identifying devices.

B. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, pull points, and locations of high visibility. Identify by system and circuit designation.

C. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits, More Than 15 A and 100 V to Ground: Identify with self-adhesive raceway labels.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 10-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

2. Label shall include circuit number and panel of origin.

D. Accessible Fittings for Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive labels containing the wiring system legend and system voltage. System legends shall be as follows:
1. "POWER."

E. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify the phase.

1. Locate identification at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with the conductor or cable designation, origin, and destination.

G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide self-adhesive labels with the conductor designation.

H. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

I. Auxiliary Electrical Systems Conductor Identification: Marker tape that is uniform and consistent with system used by manufacturer for factory-installed connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.

J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.

K. Workspace Indication: Apply floor marking tape to finished surfaces. Show working clearances in the direction of access to live parts. Workspace shall comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

L. Instructional Signs: Self-adhesive labels, including the color code for grounded and ungrounded conductors.

M. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels.

1. Apply to exterior of door, cover, or other access.
2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:

a. Power-transfer switches.
b. Controls with external control power connections.

N. Arc Flash Warning Labeling: Self-adhesive labels.

O. Operating Instruction Signs: Self-adhesive labels.

P. Emergency Operating Instruction Signs: Self-adhesive labels with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

Q. Equipment Identification Labels:

1. Indoor Equipment: Self-adhesive label.
2. Outdoor Equipment: Laminated acrylic or melamine sign.
3. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be in the form of a self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Enclosed switches.
e. Enclosed circuit breakers.
f. Enclosed controllers.
g. Variable-speed controllers.
h. Contactors.
i. Remote-controlled switches, dimmer modules, and control devices.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Time switches.
2. Photoelectric switches.
3. Indoor occupancy and vacancy sensors.
4. Switchbox-mounted occupancy sensors.
5. Lighting contactors.

B. Related Requirements:

1. Section 26 27 26 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Show installation details for the following:

a. Occupancy sensors.
b. Vacancy sensors.

2. Interconnection diagrams showing field-installed wiring.
3. Include diagrams for power, signal, and control wiring.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

1.5 WARRANTY

A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Faulty operation of lighting control devices.

2. Warranty Period: Two year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 ELECTRONIC TIME SWITCHES

A. Electronic Time Switches: Solid state, programmable, with alphanumeric display; complying with UL 917.

1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
2. Programs: Eight on-off set points on a 24-hour schedule and an annual holiday schedule that overrides the weekly operation on holidays.
3. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
4. Astronomic Time: All channels.
5. Automatic daylight savings time changeover.
6. Battery Backup: Not less than seven days reserve, to maintain schedules and time clock.

2.2 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Requirements for Sensors:

1. Wall and Ceiling-mounted, solid-state indoor vacancy sensors.
2. Dual technology.
3. Integrated power pack.
4. Hardwired connection to switch and lighting control system.
5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
6. Operation:

   a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
8. Power: Line voltage.

9. Power Pack: Dry contacts rated for 20-A LED load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
10. Mounting:

    a. Sensor: Suitable for mounting in any position on a standard outlet box.
    b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
12. Bypass Switch: Override the "on" function in case of sensor failure.
13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.

B. Dual-Technology Type: Wall and Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch-high ceiling.
4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted48 inches above finished floor.

2.3 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS using hardwired connection.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24 (only for projects in CA).
2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA LED load at 277 V, and 800-W incandescent.

2.4 LIGHTING CONTACTORS

A. Description: Electrically operated and mechanically held, combination-type lighting contactors with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less THD of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

2.5 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.

B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SENSOR INSTALLATION

A. Comply with NECA 1.

B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression systems, and partition assemblies.

C. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.3 CONTACTOR INSTALLATION

A. Comply with NECA 1.

B. Mount electrically held lighting contactors with elastomeric isolator pads to eliminate structure-borne vibration unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.4 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method: Comply with Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 1/2 inch.

C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.5 IDENTIFICATION

A. Identify components and power and control wiring according to Section 26 05 53 "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections :

1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Lighting control devices will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

3.8 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Distribution dry-type transformers rated 600 V and less, with capacities up to 1500 kVA.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.

B. Shop Drawings:

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
3. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Source quality-control reports.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Accredited by NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each transformer type from single source from single manufacturer.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Transformers Rated 15 kVA and Larger: Comply with NEMA TP 1 energy-efficiency levels as verified by testing according to NEMA TP 2.

D. Cores: Electrical grade, non-aging silicon steel with high permeability and low hysteresis losses.

E. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.
2. Coil Material: Copper.

F. Encapsulation: Transformers smaller than 30 kVA shall have core and coils completely resin encapsulated.

G. Shipping Restraints: Paint or otherwise color code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

2.3 DISTRIBUTION TRANSFORMERS

A. Comply with NFPA 70, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated.

1. NEMA 250, Type 3R: Core and coil shall be encapsulated within resin compound utilizing a vacuum pressure impregnation process to seal out moisture and air.
2. KVA Ratings: Based on convection cooling only and not relying on auxiliary fans.

D. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

E. Taps for Transformers 3 kVA and Smaller: One 5 percent tap above normal full capacity.

F. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

G. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.

H. Insulation Class, Smaller than 30 kVA: 185 deg C, UL-component-recognized insulation system with a maximum of 115-deg C rise above 40-deg C ambient temperature.

I. Insulation Class, 30 kVA and Larger: 220 deg C, UL-component-recognized insulation system with a maximum of 150-deg C rise above 40-deg C ambient temperature.

J. Electrostatic Shielding: Each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.

1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Section 26 05 53 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.

1. Resistance measurements of all windings at the rated voltage connections and at all tap connections.
2. Ratio tests at the rated voltage connections and at all tap connections.
3. Phase relation and polarity tests at the rated voltage connections.
4. No load losses, and excitation current and rated voltage at the rated voltage connections.
5. Impedance and load losses at rated current and rated frequency at the rated voltage connections.
6. Applied and induced tensile tests.
7. Regulation and efficiency at rated load and voltage.
8. Insulation Resistance Tests:

a. High-voltage to ground.
b. Low-voltage to ground.
c. High-voltage to low-voltage.

9. Temperature tests.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install transformers level and plumb on a concrete base with vibration-dampening supports. Locate transformers away from corners and not parallel to adjacent wall surface.

B. Construct concrete bases according to Section 03 30 00 "Cast-in-Place Concrete" or Section 03 30 53 "Miscellaneous Cast-in-Place Concrete" and anchor floor-mounted transformers according to manufacturer's written instructions and requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems."

1. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

C. Secure transformer to concrete base according to manufacturer's written instructions.

D. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.

E. Remove shipping bolts, blocking, and wedges.

3.3 CONNECTIONS

A. Ground equipment according to Section 26 05 26 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.

C. Remove and replace units that do not pass tests or inspections and retest as specified above.

D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.

1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
2. Perform two follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.
3. Prepare a certified report identifying transformer checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.

E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. ATS: Acceptance testing specification.

B. GFCI: Ground-fault circuit interrupter.

C. GFEP: Ground-fault equipment protection.

D. HID: High-intensity discharge.

E. MCCB: Molded-case circuit breaker.

F. SPD: Surge protective device.

G. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of panelboard.

1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details.
2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.

3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
4. Detail bus configuration, current, and voltage ratings.
5. Short-circuit current rating of panelboards and overcurrent protective devices.
6. Include evidence of NRTL listing for SPD as installed in panelboard.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.10 FIELD CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

a. Ambient Temperature: Not exceeding minus 22 deg F to plus 104 deg F.
b. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.11 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

1. SPD Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARD COMMON REQUIREMENTS

A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

E. Enclosures: Flush and Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
b. Outdoor Locations: NEMA 250, Type 3R.

c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

2. Height: 84 inches maximum.
3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
4. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.
5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
6. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
7. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
b. Back Boxes: Same finish as panels and trim.

F. Incoming Mains:

1. Location: Convertible between top and bottom.
2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.

G. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

a. Plating shall run entire length of bus.
b. Bus shall be fully rated the entire length.

2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.

H. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Terminations shall allow use of 75 deg C rated conductors without derating.
3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
4. Main and Neutral Lugs: Compression type, with a lug on the neutral bar for each pole in the panelboard.
5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

I. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

1. Percentage of Future Space Capacity: 20 percent.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 POWER PANELBOARDS

A. Panelboards: NEMA PB 1, distribution type.

B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches high, provide two latches, keyed alike.

C. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

C. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

D. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers:

a. Inverse time-current element for low-level overloads.
b. Instantaneous magnetic trip element for short circuits.
c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic Trip Circuit Breakers:

a. RMS sensing.
b. Field-replaceable rating plug or electronic trip.
c. Digital display of settings, trip targets, and indicated metering displays.
d. Multi-button keypad to access programmable functions and monitored data.
e. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
f. Integral test jack for connection to portable test set or laptop computer.
g. Field-Adjustable Settings:

1) Instantaneous trip.
2) Long- and short-time pickup levels.
3) Long and short time adjustments.
4) Ground-fault pickup level, time delay, and I squared T response.

4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
6. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Subfeed Circuit Breakers: Vertically mounted.
9. MCCB Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Breaker handle indicates tripped status.
c. UL listed for reverse connection without restrictive line or load ratings.
d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
g. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
h. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
i. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.
j. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.

k. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
l. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
m. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.6 IDENTIFICATION

A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.

B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.

C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.

1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.

B. Receive, inspect, handle, and store panelboards according to NECA 407.

C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.

D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Comply with NECA 1.

C. Install panelboards and accessories according to NECA 407.

D. Equipment Mounting:

1. Install panelboards on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 03 30 00 "Cast-in-Place Concrete."
2. Attach panelboard to the vertical finished or structural surface behind the panelboard.
3. Comply with requirements for seismic control devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

F. Comply with mounting and anchoring requirements specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

G. Mount top of trim 90 inches above finished floor unless otherwise indicated.

H. Mount panelboard cabinet plumb and rigid without distortion of box.

I. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

J. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.

K. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.
2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.

L. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.

M. Install filler plates in unused spaces.

N. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

O. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

P. Mount spare fuse cabinet in accessible location.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

E. Install warning signs complying with requirements in Section 26 05 53 "Identification for Electrical Systems" identifying source of remote circuit.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Perform optional tests. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Perform the following infrared scan tests and inspections and prepare reports:

    a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
    c. Instruments and Equipment:

1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Section 26 05 73 "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Straight-blade convenience and tamper-resistant receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. SPD receptacles.
5. Twist-locking receptacles.
6. Cord and plug sets.
7. Toggle switches.
8. Decorator-style convenience.
9. Wall switch sensor light switches with dual technology sensors.
10. Wall switch sensor light switches with passive infrared sensors.
11. Wall switch sensor light switches with ultrasonic sensors.
12. Digital timer light switches.
13. Wall-box dimmers.
14. Wall plates.
15. Floor service outlets.
16. Poke-through assemblies.

1.3 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

B. BAS: Building automation system.

C. EMI: Electromagnetic interference.

D. GFCI: Ground-fault circuit interrupter.

E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

F. RFI: Radio-frequency interference.

G. SPD: Surge protective device.

H. UTP: Unshielded twisted pair.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

D. Devices for Owner-Furnished Equipment:

1. Receptacles: Match plug configurations.
2. Cord and Plug Sets: Match equipment requirements.

E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

B. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
   1. Description: Labeled and complying with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 USB CHARGER DEVICES

A. Tamper-Resistant, USB Charger Receptacles: 12 V dc, 2.0 A, USB Type A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1310, and FS W-C-596.
   1. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
   2. USB Receptacles: Quad, Type A.
   3. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.4 GFCI RECEPTACLES

A. General Description:

   1. 125 V, 20 A, straight blade, feed-through type, self-test type.
   2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
   3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles:
   1. All 15A and 20A, 125V and 250V non-locking receptacles shall be listed as “Weather Resistant” type in Damp and wet locations.

C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:

2.5 SPD RECEPTACLES

A. General Description: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 1449, and FS W-C-596, with integral SPD in line to ground, line to neutral, and neutral to ground.

   1. 125 V, 20 A, straight-blade type.
   2. SPD Components: Multiple metal-oxide varistors; with a nominal clamp-level rating of 400 V and minimum single transient pulse energy dissipation of 240 J, according to IEEE C62.41.2 and IEEE C62.45.
   3. Active SPD Indication: Visual and audible, with light visible in face of device to indicate device is "active" or "no longer in service."

B. Duplex SPD Convenience Receptacles:

2.6 TWIST-LOCKING RECEPTACLES

A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

B. Twist-Lock, Isolated-Ground, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
   1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.7 CORD AND PLUG SETS

A. Description:

   1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
   3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.8 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

C. Key-Operated Switches: 120/277 V, 20 A.
   1. Description: Single pole, with factory-supplied key in lieu of switch handle.

D. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

2.9 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.

   1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

E. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.10 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Color determined by architect.
3. Material for Finished Spaces: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
4. Material for Unfinished Spaces: Galvanized steel.
5. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.11 POKE-THROUGH ASSEMBLIES

A. Description:

1. Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly.
2. Comply with UL 514 scrub water exclusion requirements.
3. Service-Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
4. Size: Selected to fit nominal 4-inch cored holes in floor and matched to floor thickness.
5. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
6. Closure Plug: Arranged to close unused 4-inch cored openings and reestablish fire rating of floor.
7. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, four-pair cables.

2.12 WALL MOUNTED TV LOCATIONS

A. Where wall mounted TVs are indication in the plans provide the following:

1. All-in-one power and AV recessed box similar to Legrand Evolution Series.
2. Box shall include one duplex outlet, one coax cable, and one CAT6 cable.
3. Provide all accessories for a complete finish.
4. Boxes shall have a white finish

2.13 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
2. Wiring Devices Connected to Emergency Power System: Red.
3. SPD Devices: Blue.
4. Isolated-Ground Receptacles: Orange.

B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

A. Comply with Section 26 05 53 "Identification for Electrical Systems."

B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

A. Test Instruments: Use instruments that comply with UL 1436.

B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

C. Perform the following tests and inspections:
1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

D. Tests for Convenience Receptacles:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

E. Test straight-blade convenience outlets in patient-care areas for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz..

F. Wiring device will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 26 51 19

LED INTERIOR LIGHTING

PART 1 - PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes the following:
   1. Materials.
   2. Finishes.
   3. Luminaire support.

B. Related Requirements:

   1. Section 26 09 23"Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. LED: Light-emitting diode.

F. Lumen: Measured output of lamp and luminaire, or both.

G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

   1. Arrange in order of luminaire designation.
   2. Include data on features, accessories, and finishes.
   3. Include physical description and dimensions of luminaires.
   4. Include emergency lighting units, including batteries and chargers.
   5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.

6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.

    a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

B. Product Schedule: For luminaires and lamps.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Product Certificates: For each type of luminaire.

D. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Provide luminaires from a single manufacturer for each luminaire type.

C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
   1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Standards:

   1. ENERGY STAR certified.
   2. California Title 24 compliant.
   3. UL Listing: Listed for installed environment.
   4. Recessed luminaires shall comply with NEMA LE 4.
   5. User Replaceable Lamps:

      a. Bulb shape complying with ANSI C78.79.
      b. Lamp base complying with ANSI C81.61 or IEC 60061-1.

C. CRI of minimum of 80. CCT as specified on drawings.

D. Rated lamp life of 50,000 hours to L90.

E. Lamps dimmable from 100 percent to 0 percent of maximum light output.

F. Internal driver.

G. Nominal Operating Voltage: as indicated on drawings.

   1. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

H. Housings:

1. Extruded-aluminum housing and heat sink.
2. Powder-coat finish.

2.2 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE SUPPORT

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.

D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.
2. Do not attach luminaires directly to gypsum board.

G. Ceiling-Mounted Luminaire Support:

1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
2. Ceiling mount with pendant mount
3. Ceiling mount with hook mount.

H. Suspended Luminaire Support:

1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

I. Ceiling-Grid-Mounted Luminaires:

1. Secure to any required outlet box.
2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

J. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 26 56 19

LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.

B. Related Requirements:

1. Section 26 09 23"Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of luminaire.

1. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 IES LM-80.

    a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
    b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

C. Delegated-Design Submittal: For luminaire supports.

1. Include design calculations for luminaire supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing laboratory providing photometric data for luminaires.

B. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

C. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

D. Source quality-control reports.

E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.

1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

E. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: 5 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. UL Compliance: Comply with UL 1598 and listed for wet location.

C. Lamp base complying with ANSI C81.61 or IEC 60061-1.

D. Bulb shape complying with ANSI C79.1.

E. CRI of 80. CCT as specified on drawings.

F. L70 lamp life of 50,000 hours.

G. Lamps dimmable from 100 percent to 0 percent of maximum light output.

H. Internal driver.

I. Nominal Operating Voltage: as indicated on drawings.

J. Lamp Rating: Lamp marked for outdoor use and in enclosed locations.

K. Source Limitations: Obtain luminaires from single source from a single manufacturer.

L. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE-MOUNTED PHOTOELECTRIC RELAYS

A. Comply with UL 773 or UL 773A.

B. Contact Relays: Factory mounted, single throw, designed to fail in the on position, and factory set to turn light unit on at 1.5 to 3 fc and off at 4.5 to 10 fc with 15-second minimum time delay.

1. Relay with locking-type receptacle shall comply with ANSI C136.10.
2. Adjustable window slide for adjusting on-off set points.

2.3 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Sheet Metal Components: Corrosion-resistant aluminum. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

D. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
2. Glass: Annealed crystal glass unless otherwise indicated.
3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

G. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
2. Provide filter/breather for enclosed luminaires.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

a. "USE ONLY" and include specific lamp type.
b. Lamp diameter, shape, size, wattage and coating.
c. CCT and CRI for all luminaires.

2.4 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20 requirements; and seal aluminum surfaces with clear, hard-coat wax.
3. Class I, Clear-Anodic Finish: AA-M32C22A41 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
4. Class I, Color-Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: Medium satin; Chemical Finish: Etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker), complying with AAMA 611.

    a. Color: Verify with Architect.

D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.

2.5 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, and canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Install luminaires at height and aiming angle as indicated on Drawings.

I. Coordinate layout and installation of luminaires with other construction.

J. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.

K. Comply with requirements in Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" and Section 26 05 33 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 BOLLARD LUMINAIRE INSTALLATION:

A. Align units for optimum directional alignment of light distribution.

1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 03 30 00 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 26 05 33 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

    a. IES LM-5.
    b. IES LM-50.
    c. IES LM-52.
    d. IES LM-64.
    e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Grounding conductors.
2. Grounding connectors.
3. Grounding busbars.
4. Grounding rods.
5. Grounding labeling.

1.2 DEFINITIONS

A. BCT: Bonding conductor for telecommunications.

B. TGB: Telecommunications grounding busbar.

C. TMGB: Telecommunications main grounding busbar.

D. Service Provider: The operator of a service that provides telecommunications transmission delivered over access provider facilities.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For communications equipment room signal reference grid. Include plans, elevations, sections, details, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing as-built locations of grounding and bonding infrastructure, including the following:

1. Ground rods.
2. Ground and roof rings.
3. BCT, TMGB, TGBs, and routing of their bonding conductors.

B. Qualification Data: For Installer, installation supervisor, and field inspector.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:

a. Result of the ground-resistance test, measured at the point of BCT connection.
b. Result of the bonding-resistance test at each TGB and its nearest grounding electrode.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Installation Supervision: Installation shall be under the direct supervision of ITS Technician, who shall be present at all times when Work of this Section is performed at Project site.
2. Field Inspector: Currently registered by BICSI as Technician to perform the on-site inspection.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

C. Comply with TIA-607-B.

2.2 CONDUCTORS

A. Comply with UL 486A-486B.

B. Insulated Conductors: Stranded copper wire, green or green with yellow stripe insulation, insulated for 600 V, and complying with UL 83.

1. Ground wire for custom-length equipment ground jumpers shall be No. 6 AWG, 19-strand, UL-listed, Type THHN wire.
2. Cable Tray Equipment Grounding Wire: No. 6 AWG.
a. Use No. 4 AWG if cable tray contains electrical power conductors per NFPA 70, Article 392.

C. Cable Tray Grounding Jumper:

1. Not smaller than No. 6 AWG and not longer than 12 inches. If jumper is a wire, it shall have a crimped grounding lug with two holes and long barrel for two crimps. If jumper is a

flexible braid, it shall have a one-hole ferrule. Attach with grounding screw or connector provided by cable tray manufacturer.

D. Bare Copper Conductors:

1. Solid Conductors: ASTM B3.
2. Stranded Conductors: ASTM B8.
3. Tinned Conductors: ASTM B33.
4. Bonding Cable: 28 kcmils, 14 strands of No. 17 AWG conductor, and 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Tinned-copper tape, braided conductors terminated with two-hole copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.3 CONNECTORS

A. Irreversible connectors listed for the purpose. Listed by an NRTL as complying with NFPA 70 for specific types, sizes, and combinations of conductors and other items connected. Comply with UL 486A-486B.

B. Compression Wire Connectors: Crimp-and-compress connectors that bond to the conductor when the connector is compressed around the conductor. Comply with UL 467.

1. Electroplated tinned copper, C and H shaped.

C. Signal Reference Grid Connectors: Combination of compression wire connectors, access floor grounding clamps, bronze U-bolt grounding clamps, and copper split-bolt connectors, designed for the purpose.

D. Busbar Connectors: Cast silicon bronze, solderless compression or exothermic-type, mechanical connector; with a long barrel and two holes spaced on 5/8- or 1-inch centers for a two-bolt connection to the busbar.

E. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.4 GROUNDING BUSBARS

A. TMGB: Predrilled, wall-mounted, rectangular bars of hard-drawn solid copper, 1/4 by 4 inches in cross section, length shall be 16 inches minimum or as indicated on Drawings. The busbar shall be NRTL listed for use as TMGB and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.
2. Mounting Hardware: Stand-off brackets that provide a 4-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

B. TGB: Predrilled rectangular bars of hard-drawn solid copper, 1/4 by 2 inches in cross section, length shall be 12 inches minimum or as indicated on Drawings. The busbar shall be for wall mounting, shall be NRTL listed as complying with UL 467, and shall comply with TIA-607-B.

1. Predrilling shall be with holes for use with lugs specified in this Section.

2. Mounting Hardware: Stand-off brackets that provide at least a 2-inch clearance to access the rear of the busbar. Brackets and bolts shall be stainless steel.
3. Stand-off insulators for mounting shall be Lexan or PVC. Comply with UL 891 for use in 600-V switchboards, impulse tested at 5000 V.

C. Rack and Cabinet Grounding Busbars: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-B. Predrilling shall be with holes for use with lugs specified in this Section.

1. Cabinet-Mounted Busbar: Terminal block, with stainless-steel or copper-plated hardware for attachment to the cabinet.
2. Rack-Mounted Horizontal Busbar: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical Busbar: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to the rack.

2.5 GROUND RODS

A. Ground Rods: Copper-clad steel; 5/8 by 96 inches in diameter.

2.6 IDENTIFICATION

A. Comply with requirements for identification products in Division 27 "Identification for Communications Systems."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the ac grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of the electrical system.

B. Inspect the test results of the ac grounding system measured at the point of BCT connection.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with connection of the BCT only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Bonding shall include the ac utility power service entrance, the communications cable entrance, and the grounding electrode system. The bonding of these elements shall form a loop so that each element is connected to at least two others.

B. Comply with NECA 1.

C. Comply with TIA-607-B.

3.3 APPLICATION

A. Conductors: Install solid conductor for No. 8 AWG and smaller and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

1. The bonding conductors between the TGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.
2. The bonding conductors between the TMGB and structural steel of steel-frame buildings shall not be smaller than No. 6 AWG.

B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 2 AWG minimum.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

D. Conductor Support:

1. Secure grounding and bonding conductors at intervals of not less than 36 inches.

E. Grounding and Bonding Conductors:

1. Install in the straightest and shortest route between the origination and termination point, and no longer than required. The bend radius shall not be smaller than eight times the diameter of the conductor. No one bend may exceed 90 degrees.
2. Install without splices.
3. Support at not more than 36-inch intervals.
4. Install grounding and bonding conductors in 3/4-inch PVC conduit until conduit enters a telecommunications room. The grounding and bonding conductor pathway through a plenum shall be in EMT. Conductors shall not be installed in EMT unless otherwise indicated.

    a. If a grounding and bonding conductor is installed in ferrous metallic conduit, bond the conductor to the conduit using a grounding bushing that complies with requirements in Division 27 "Pathways for Communications Systems," and bond both ends of the conduit to a TGB.

3.4 GROUNDING ELECTRODE SYSTEM

A. The BCT between the TMGB and the ac service equipment ground shall not be smaller than No. 3/0 AWG.

3.5 GROUNDING BUSBARS

A. Indicate locations of grounding busbars on Drawings. Install busbars horizontally, on insulated spacers 2 inches minimum from wall, 12 inches above finished floor unless otherwise indicated.

B. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.6 CONNECTIONS

A. Bond metallic equipment in a telecommunications equipment room to the grounding busbar in that room, using equipment grounding conductors not smaller than No. 6 AWG.

B. Stacking of conductors under a single bolt is not permitted when connecting to busbars.

C. Assemble the wire connector to the conductor, complying with manufacturer's written instructions and as follows:

1. Use crimping tool and the die specific to the connector.
2. Pretwist the conductor.
3. Apply an antioxidant compound to all bolted and compression connections.

D. Primary Protector: Bond to the TMGB with insulated bonding conductor.

E. Interconnections: Interconnect all TGBs with the TMGB with the telecommunications backbone conductor. If more than one TMGB is installed, interconnect TMGBs using the grounding equalizer conductor. The telecommunications backbone conductor and grounding equalizer conductor size shall not be less than 2 kcmils/linear foot of conductor length, up to a maximum size of No. 3/0 AWG unless otherwise indicated.

F. Telecommunications Enclosures and Equipment Racks: Bond metallic components of enclosures to the telecommunications bonding and grounding system. Install top-mounted or vertically mounted rack grounding busbar unless the enclosure and rack are manufactured with the busbar. Bond the equipment grounding busbar to the TGB No. 2 AWG bonding conductors.

G. Structural Steel: Where the structural steel of a steel frame building is readily accessible within the room or space, bond each TGB and TMGB to the vertical steel of the building frame.

H. Electrical Power Panelboards: Where an electrical panelboard for telecommunications equipment is located in the same room or space, bond each TGB to the ground bar of the panelboard.

I. Shielded Cable: Bond the shield of shielded cable to the TGB in communications rooms and spaces. Comply with TIA-568-C.1 and TIA-568-C.2 when grounding shielded balanced twisted-pair cables.

J. Rack- and Cabinet-Mounted Equipment: Bond powered equipment chassis to the cabinet or rack grounding bar. Power connection shall comply with NFPA 70; the equipment grounding conductor in the power cord of cord- and plug-connected equipment shall be considered as a supplement to bonding requirements in this Section.

K. Access Floors: Bond all metal parts of access floors to the TGB.

L. Equipment Room Signal Reference Grid: For equipment rooms with a raised floor, provide a low-impedance path between telecommunications cabinets, equipment racks, and the reference grid, using No. 6 AWG bonding conductors.

1. Install the conductors in grid pattern on 4-foot centers, allowing bonding of one pedestal from each access floor tile.
2. Bond the TGB of the equipment room to the reference grid at two or more locations.
3. Bond all conduits and piping entering the equipment room to the TGB at the perimeter of the room.

3.7 IDENTIFICATION

A. Labels shall be preprinted or computer-printed type.

1. Label TMGB(s) with "fs-TMGB," where "fs" is the telecommunications space identifier for the space containing the TMGB.
2. Label TGB(s) with "fs-TGB," where "fs" is the telecommunications space identifier for the space containing the TGB.
3. Label the BCT and each telecommunications backbone conductor at its attachment point: "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
2. Test the bonding connections of the system using an ac earth ground-resistance tester, taking two-point bonding measurements in each telecommunications equipment room containing a TMGB and a TGB and using the process recommended by BICSI TDMM. Conduct tests with the facility in operation.

    a. Measure the resistance between the busbar and the nearest available grounding electrode. The maximum acceptable value of this bonding resistance is 100 milliohms.

3. Test for ground loop currents using a digital clamp-on ammeter, with a full-scale of not more than 10 A, displaying current in increments of 0.01 A at an accuracy of plus/minus 2.0 percent.

    a. With the grounding infrastructure completed and the communications system electronics operating, measure the current in every conductor connected to the TMGB and in each TGB. Maximum acceptable ac current level is 1 A.

D. Excessive Ground Resistance: If resistance to ground at the BCT exceeds 5 ohms, notify Engineer promptly and include recommendations to reduce ground resistance.

E. Grounding system will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 27 05 28

PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Optical-fiber-cable pathways and fittings.
4. Metal wireways and auxiliary gutters.
5. Nonmetallic wireways and auxiliary gutters.
6. Metallic surface pathways.
7. Nonmetallic surface pathways.
8. Tele-power poles.
9. Hooks.
10. Boxes, enclosures, and cabinets.

1.2 DEFINITIONS

A. ARC: Aluminum rigid conduit.

B. GRC: Galvanized rigid conduit.

C. IMC: Intermediate metal conduit.

D. RTRC: Reinforced thermosetting resin conduit.

1.3 ACTION SUBMITTALS

A. Product data for the following:

1. Surface pathways
2. Wireways and fittings.
3. Tele-power poles.
4. Boxes, enclosures, and cabinets.
5. Underground handholes and boxes.

B. Sustainable Design Submittals:

C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of pathway groups with common supports.
2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
3. Underground ducts, piping, and structures in location of underground enclosures and handholes.

B. Qualification Data: For professional engineer.

C. Source quality-control reports.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-D.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. ARC: Comply with ANSI C80.5 and UL 6A.

E. IMC: Comply with ANSI C80.6 and UL 1242.

F. PVC-Coated Steel Conduit: PVC-coated GRC.

1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch, minimum.

G. EMT: Comply with ANSI C80.3 and UL 797.

H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
2. Fittings for EMT:

a. Material: Die cast.
b. Type: Compression.

3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Description: Nonmetallic raceway of circular section with manufacturer-fabricated fittings.

B. General Requirements for Nonmetallic Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

C. RNC: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. Rigid HDPE: Comply with UL 651A.

E. Continuous HDPE: Comply with UL 651A.

F. RTRC: Comply with UL 2515A and NEMA TC 14.

G. Fittings: Comply with NEMA TC 3; match to conduit or tubing type and material.

H. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

A. Description: Comply with UL 2024; flexible-type pathway with a circular cross section, approved for plenum, riser, or general-use installation unless otherwise indicated.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.

B. General Requirements for Metal Wireways and Auxiliary Gutters:

1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
3. Comply with TIA-569-D.

C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Hinged type unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.

2.5 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

A. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.

B. General Requirements for Nonmetallic Wireways and Auxiliary Gutters:

1. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
2. Comply with TIA-569-D.

C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.

D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.6 SURFACE METAL PATHWAYS

A. Description: Galvanized steel with snap-on covers, complying with UL 5.

B. Finish: Prime coated, ready for field painting.

C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

D. Comply with TIA-569-D.

2.7 SURFACE NONMETALLIC PATHWAYS:

A. Description: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC.

B. Finish: Texture and color selected by Architect from manufacturer's standard colors.

C. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.8 TELE-POWER POLES:

A. Description: Prefabricated, finished metal pole with prewired power and communications outlets.

B. Material: Aluminum with clear anodized finish.

C. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

E. Comply with TIA-569-D.

2.9 HOOKS

A. Description: Prefabricated sheet metal cable supports for telecommunications cable.

B. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

C. Comply with TIA-569-D.

D. Galvanized steel.

E. J shape.

2.10 BOXES, ENCLOSURES, AND CABINETS

A. Description: Enclosures for communications.

B. General Requirements for Boxes, Enclosures, and Cabinets:

1. Comply with TIA-569-D.
2. Boxes, enclosures, and cabinets installed in wet locations shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for use in wet locations.
3. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
4. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
5. Gangable boxes are prohibited.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Metal Floor Boxes:

1. Material: Cast metal or sheet metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Nonmetallic Floor Boxes: Nonadjustable, rectangular.

1. Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures:

a. Material: Plastic.

3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.11 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.

1. Tests of materials shall be performed by an independent testing agency.
2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

A. Outdoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed Conduit: RNC, Type EPC-80-PVC.
2. Concealed Conduit, Aboveground: RNC, Type EPC-40-PVC.
3. Underground Conduit: RNC, Type EPC-80-PVC], direct buried.
4. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.

B. Indoors: Apply pathway products as specified below unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:

    a. Loading dock.
    b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    c. Mechanical rooms.
    d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Damp or Wet Locations: GRC.
6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
7. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
8. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway.
9. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.

C. Minimum Pathway Size: 3/4-inch trade size for copper and aluminum cables, and 1 inch for optical-fiber cables.

D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
3. EMT: Use compression, cast-metal fittings. Comply with NEMA FB 2.10.

E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.

F. Install surface pathways only where indicated on Drawings.

G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

A. Comply with the following standards for installation requirements except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.

C. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

D. Comply with requirements in Division 27 "Hangers and Supports for Communications Systems" for hangers and supports.

E. Comply with requirements in Division 27 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.

F. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.

G. Complete pathway installation before starting conductor installation.

H. Arrange stub-ups so curved portions of bends are not visible above finished slab.

I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.

J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

K. Support conduit within 12 inches of enclosures to which attached.

L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
3. Arrange pathways to keep a minimum of 2 inches of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from nonmetallic conduit and fittings to GRC and fittings before rising above floor.

M. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for pathways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

N. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.

O. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.

P. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.

Q. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.

S. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.

T. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.

U. Surface Pathways:

1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
2. Install surface pathway with a minimum 2-inch radius control at bend points.
3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.

V. Pathways for Optical-Fiber and Communications Cable: Install pathways, metal and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

W. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.

X. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service pathway enters a building or structure.
3. Where otherwise required by NFPA 70.

Y. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.

Z. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT that is located where environmental

temperature change may exceed 100 deg F, and that has straight-run length that exceeds 100 feet.

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:

    a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    d. Attics: 135 deg F temperature change.

3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

AA. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches of slack. The lowest point of the cables shall be no less than 6 inches adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet o.c.
5. Provide a hook at each change in direction.

BB. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

CC. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

DD. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

GG. Set metal floor boxes level and flush with finished floor surface.

HH. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Division 27 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Division 01 "Penetration Firestopping."

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 27 05 29

HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems for communication raceways.
2. Aluminum slotted support systems for communication raceways.
3. Nonmetallic slotted support systems for communication raceways.
4. Conduit and cable support devices.
5. Support for conductors in vertical conduit.
6. Structural steel for fabricated supports and restraints.
7. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
8. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

a. Slotted support systems, hardware, and accessories.
b. Clamps.
c. Hangers.
d. Sockets.
e. Eye nuts.
f. Fasteners.
g. Anchors.
h. Saddles.
i. Brackets.

2. Include rated capacities and furnished specialties and accessories.

B. Shop Drawings: For fabrication and installation details for communications hangers and support systems.

1. Trapeze hangers. Include product data for components.
2. Steel slotted-channel systems.
3. Aluminum slotted-channel systems.
4. Nonmetallic slotted-channel systems.
5. Equipment supports.
6. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

C. Delegated-Design Submittal: For hangers and supports for communications systems.

1. Include design calculations and details of trapeze hangers.
2. Include design calculations for seismic restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Suspended ceiling components.
2. Ductwork, piping, fittings, and supports.
3. Structural members to which hangers and supports will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:

a. Luminaires.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Projectors.

B. Seismic Qualification Data: Certificates, for hangers and supports for communications equipment and systems, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Welding certificates.

1.4 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M.
2. AWS D1.2/D1.2M.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design hanger and support system.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame Rating: Class 1.
2. Self-extinguishing according to ASTM D635.

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: **Galvanized steel**.
3. Channel Width: **Selected for applicable load criteria**.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

B. Aluminum Slotted Support Systems: Extruded aluminum channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Material: 6063-T6 aluminum alloy.
3. Fittings and Accessories Material: 5052-H32 aluminum alloy.
4. Channel Width: **Selected for applicable load criteria**.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
8. Channel Dimensions: Selected for applicable load criteria.

C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Channel Width: **Selected for applicable load criteria**.
3. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.
4. Fitting and Accessory Materials: Same as those for channels and angles**, except metal items may be stainless steel**.
5. Rated Strength: Selected to suit applicable load criteria.
6. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Conduit and Cable Support Devices: **Steel** clamps, hangers, and associated fittings, designed for types and sizes of raceway or cable to be supported.

E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored communications conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces

as required to suit individual conductors or cables supported. Body shall be made of malleable iron.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

2. Mechanical-Expansion Anchors: Insert-wedge-type **zinc-coated steel** for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M,Grade A325.
6. Toggle Bolts: **All-steel** springhead type.
7. Hanger Rods: Threaded steel.

2.3 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 5 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:

1. NECA 1.
2. NECA/BICSI 568.
3. TIA-569-D.
4. NECA 101.
5. NECA 102.
6. NECA 105.
7. NECA 111.

B. Comply with requirements in Section 07 84 13 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.

C. Comply with requirements for pathways specified in Section 27 05 28 "Pathways for Communications Systems."

D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMTs, IMCs, and RMCs as **required by** NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least **25** percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with **single-bolt conduit clamps, using spring friction action for retention in support channel**.

F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Raceway Support Methods: In addition to methods described in NECA 1, **EMT IMC and RMC** may be supported by openings through structure members, according to NFPA 70.

B. Strength of Support Assemblies: Where not indicated, select sizes of components, so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten communications items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Use approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Use expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated-driven threaded studs, provided with lock washers and nuts, may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: **Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69**.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate **by means that comply with seismic-restraint strength and anchorage requirements**.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 5 "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor communications materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in **Section 09 91 13 "Exterior Painting" Section 09 91 23 "Interior Painting" and Section 09 96 00 "High-Performance Coatings"** for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas, and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION

SECTION 27 05 36
CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:
   1. Ladder cable tray.
   2. Wire-mesh cable tray.
   3. Cable tray accessories.
   4. Warning signs.

B. Related Requirements:

1.03 ACTION SUBMITTALS

A. Product Data: For each type of cable tray.
   1. Include data indicating dimensions and finishes for each type of cable tray indicated.

B. Shop Drawings: For each type of cable tray.
   1. Show fabrication and installation details of cable trays, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, and fittings.
   2. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to sides of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 40 00 "Quality Requirements," to design cable tray supports and seismic bracing.

B. Seismic Performance: Cable trays and supports shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
   1. The term "withstand" means "the cable trays will remain in place without separation of any parts when subjected to the seismic forces specified."

2. Component Importance Factor: 1.5.

C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes in cable tray installed outdoors.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2.02 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
1. Source Limitations: Obtain cable trays and components from single manufacturer.

B. Structural Performance: See articles for individual cable tray types for specific values for the following parameters:
1. Uniform Load Distribution: Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
2. Concentrated Load: A load applied at midpoint of span and centerline of tray.
3. Load and Safety Factors: Applicable to both side rails and rung capacities.

2.03 LADDER CABLE TRAY

A. Description:
1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 24 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 6 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 6 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:
1. Steel:
a. Straight Section and Fitting Side Rails and Rungs: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
d. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
1) Hardware: Galvanized, ASTM B 633.
e. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A 653/A 653M, G90 (Z275).

1) Hardware: Galvanized, ASTM B 633.

f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
   1) Hardware: Galvanized, ASTM B 633.

g. Finish: Epoxy-resin paint.
   1) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
   2) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.

h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.

i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

2.04 WIRE-MESH CABLE TRAY

A. Description:
1. Configuration: Galvanized- steel wire mesh, complying with NEMA VE 1.
2. Width: 24 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 6 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Structural Performance: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 400-lb concentrated load, when tested according to NEMA VE 1.
6. Splicing Assemblies: Bolted type using serrated flange locknuts.
7. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

B. Materials and Finishes:
1. Steel:
   a. Straight Sections and Fittings: Steel complies with the minimum mechanical properties of ASTM A 1011/A 1011M, SS, Grade 33.
   b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
   c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
   d. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
      1) Hardware: Galvanized, ASTM B 633.
   e. Finish: Hot-dipped galvanized after fabrication, complying with ASTM A 653/A 653M, G90 (Z275).
      1) Hardware: Galvanized, ASTM B 633.
   f. Finish: Electrogalvanized after fabrication, complying with ASTM B 633.
      1) Hardware: Galvanized, ASTM B 633.
   g. Finish: Epoxy-resin paint.
      1) Powder-Coat Enamel: Cable tray manufacturer's recommended primer and corrosion-inhibiting treatment, with factory-applied powder-coat paint.
      2) Epoxy-Resin Prime Coat: Cold-curing epoxy primer, MPI# 101.
      3) Epoxy-Resin Topcoat: Epoxy, cold-cured gloss, MPI# 77.
      4) Hardware: Chromium-zinc plated, ASTM F 1136.
   h. Finish: Factory-standard primer, ready for field painting, with chromium-zinc-plated hardware according to ASTM F 1136.
   i. Finish: Black oxide finish for support accessories and miscellaneous hardware according to ASTM D 769.

C. Materials: Aluminum alloy 6063-T6 according to ANSI H35.1/H 35.1M for extruded components, and Alloy 5052-H32 or Alloy 6061-T6 according to ANSI H35.1/H 35.1M for fabricated parts.

D. Hardware: Chromium-zinc-plated steel, ASTM F 1136.

E. Hardware for Aluminum Cable Tray Used Outdoors: Stainless steel, Type 316, ASTM F 593 and ASTM F 594.

2.05 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.06 WARNING SIGNS

A. Lettering: 1-1/2-inch high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 26 05 53 "Identification for Electrical Systems."

2.07 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA VE 1.

PART 3 - EXECUTION

3.01 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible for cable installation and all splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays.

E. Join aluminum cable tray with splice plates; use four square neck-carriage bolts and locknuts.

F. Fasten cable tray supports to building structure and install seismic restraints.

G. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb. Comply with requirements in Section 26 05 29 "Hangers and Supports for Electrical Systems." Comply with seismic-restraint details according to Section 26 05 48.16 "Seismic Controls for Electrical Systems."

H. Place supports so that spans do not exceed maximum spans on schedules and provide clearances shown on Drawings. Install intermediate supports when cable weight exceeds the load-carrying capacity of the tray rungs.

I. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

J. Support bus assembly to prevent twisting from eccentric loading.

K. Install center-hung supports for single-rail trays designed for 60 versus 40 percent eccentric loading condition, with a safety factor of 3.

L. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

M. Support wire-basket cable trays with center support hanger or trapeze hangers or wall brackets.

N. Support center support hangers or trapeze hangers for wire-basket trays with 3/8-inch diameter rods.

O. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

P. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA VE 2. Space connectors and set gaps according to applicable standard.

Q. Make changes in direction and elevation using manufacturer's recommended fittings.

R. Make cable tray connections using manufacturer's recommended fittings.

S. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

T. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

U. Install cable trays with enough workspace to permit access for installing cables.

V. Install barriers to separate cables of different systems, such as power, communications, and data processing; or of different insulation levels, such as 600, 5000, and 15 000 V.

W. Install permanent covers, if used, after installing cable. Install cover clamps according to NEMA VE 2.

X. Clamp covers on cable trays installed outdoors with heavy-duty clamps.

Y. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.02 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 27 05 26 "Grounding and Bonding for Communications Systems."

B. Cable trays shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with single-conductor power conductors shall be bonded together with a grounding conductor run in the tray along with the power conductors and bonded to the tray at 72-inch intervals. The grounding conductor shall be sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors," and Article 392, "Cable Trays."

D. When using epoxy- or powder-coat painted cable trays as a grounding conductor, completely remove coating at all splice contact points or ground connector attachment. After completing splice-to-grounding bolt attachment, repair the coated surfaces with coating materials recommended by cable tray manufacturer.

E. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.03 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket. Install cable ties with a tool that includes an automatic pressure-limiting device.

C. Fasten cables on vertical runs to cable trays every 18 inches.

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches.

E. Tie MI cables down every 36 inches where required to provide a 2-hour fire rating and every 72 inches elsewhere.

F. In existing construction, remove inactive or dead cables from cable trays.

3.04 CONNECTIONS

A. Remove paint from all connection points before making connections. Repair paint after the connections are completed.

B. Connect pathways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.06 PROTECTION

A. Protect installed cable trays and cables.
1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction. Temporary protection for cables and cable tray can be constructed of wood or metal materials and shall remain in place until the risk of damage is over.
2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

SECTION 27 10 00
STRUCTURED CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. ANSI/NFPA-70, National Electric Code

1.2 SUMMARY

A. Section Includes:

B.

1. Backboards.
2. Backbone Cabling.
3. Horizontal Cabling.
4. Entrance protection.
5. Boxes, enclosures, and cabinets.
6. Power strips.
7. Uninterruptible Power Supply.
8. 19-inch freestanding and wall-mounted equipment cabinets.
9. Ladder cable tray.

C. Related Requirements:

D.

1. Section 27 05 00 "Common Work Results for Communications" for Cable Trays and Accessories, Grounding and Bonding, Identification, Pathways and Firestopping.
2. BICSI, Telecommunications Distribution Methods Manual, current edition.
3. BICSI, Information Transport Systems Installation Methods Manual, current edition.
4. BICSI, Customer-Owned Outside Plant Design Reference Manual, current edition.

1.3 DEFINITIONS

A. Access Provider: An operator that provides a circuit path or facility between the service provider and user. An access provider can also be a service provider.

B. BICSI: Building Industry Consulting Service International.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. F/FTP: Overall foil screened cable with foil screened twisted pair.

F. FTP: Shielded twisted pair.

G. F/UTP: Overall foil screened cable with unscreened twisted pair.

H. IDC: Insulation displacement connector.

I. Jack: Also, commonly called an "outlet," it is the fixed, female connector.

J. LAN: Local area network.

K. Plug: Also, commonly called a "connector," it is the removable, male telecommunications connector.

L. PBB: Primary bus bar.

M. RCDD: Registered communications distribution designer.

N. Service Provider: The operator of a telecommunications transmission service delivered through access provider facilities.

O. SBB: Secondary bus bar.

P. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

Q. S/FTP: Overall braid screened cable with foil screened twisted pair.

R. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

S. S/UTP: Overall braid screened cable with unscreened twisted pairs.

T. UTP: Unscreened (unshielded) twisted pair.

1.4 BACKBONE CABLING SUBSYTEM DESCRIPTION

A. Copper backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Copper backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of the copper backbone cabling.

C. Optical fiber backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

D. Coaxial cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

E. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of the backbone cabling.

1.5 HORIZONTAL CABLING SUBSYSTEM DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

B. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

C. Coaxial horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568.0-D requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

D. A work area is approximately 100 sq. ft. and includes the components that extend from the equipment outlets to the station equipment.

E. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

1.6 ACTION SUBMITTALS

A. Reference Div. 27 0500 for all requirements.

1.7 INFORMATIONAL SUBMITTALS

A. Reference Div. 27 0500 for all requirements.

1.8 CLOSEOUT SUBMITTALS

A. Reference Div. 27 0500 for all requirements.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling installer must have personnel certified by BICSI on staff.

B.

1. Layout Responsibility: Preparation of Shop Drawings shall be under direct supervision of RCDD.
2. Installation Supervision: Installation shall be under direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as RCDD to perform the on-site inspection.

1.10 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1.
   2. Patch-Panel Units: 6 of each type.
   3. Plugs: 12 of each type.
   4. Jacks: 12 of each type.
   5. Cassettes: 6 of each type at every point of fiber termination.

1.11 DELIVERY, STORAGE AND HANDLING

A. Test and inspect cables upon receipt.
   1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Equipment shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B.

1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

C. General Performance: Backbone cabling system shall comply with transmission standards in TIA-568-C.2, when tested according to test procedures of this standard, and the requirements of TIA-568.4-D.

D. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
   1. Flame-Spread Index: 25 or less.
   2. Smoke-Developed Index: 50 or less.

E. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

F. Grounding: Comply with TIA-607-C.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches.

B. Backboard Paint: Pre-painted.

2.3 GENERAL CABLE CHARACTERSITICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.
   2. Communications, Riser Rated: Type CMR in listed riser communications raceway.
   3. Communications, Riser Rated: Type CMR in metallic conduit installed according to NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

B. CATV Cable: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:
   1.
   2. CATV Riser Rated: Type CATVR complying with UL 1666 installed in riser raceways or cable routing assemblies.
   3. CATV Cable: CATVR installed in general purpose, riser, or plenum communications raceways or cable routing assemblies in fireproof riser shafts with firestops at each penetration.

2.4 COPPER BACKBONE CABLING

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

2.5 HIGH-COUNT CATEGORY 3 TWISTED PAIR CABLE

A. Description: 25 or 50 pair, balanced-twisted pair cable, certified to meet transmission characteristics of Category 3 cable at frequencies up to 16MHz.

B. Standard: Comply with ICEA S-90-661, NEMA WC 63.1, and TIA-568-C.2 for Category 3 cables.

C. Conductors: 100-ohm, 24 AWG solid copper.

D. Cable Rating: Plenum.

E. Jacket: Gray thermoplastic and overall metallic shield.

2.6 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

C. General Requirements for Cable Connecting Hardware:
   1. Twisted pair cable hardware shall meet the performance requirements of Category 5e, Category 6 or Category 6a.
   2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
   3. Cables shall be terminated with connecting hardware of same category or higher.
   4. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer or from same manufacturer as twisted pair cable, from single source.

D. Connecting Blocks: 110-style IDC for Category 3. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

E. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
   1. Number of Terminals per Field: One for each conductor in assigned cables.

F. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
   1. Features:
      a. Universal T568A and T568B wiring labels.
      b. Labeling areas adjacent to conductors.
      c. Replaceable connectors.
      d. 24 or 48 ports.
   2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
   3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

G. Plugs and Plug Assemblies:
   1. Male; eight position (8P8C); color-coded modular telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
   2. Standard: Comply with TIA-568-C.2.
   3. Marked to indicate transmission performance.

H. Jacks and Jack Assemblies:
   1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair 100-ohm unshielded or shielded twisted pair cable.
   2. Designed to snap-in to a patch panel or faceplate.
   3. Standard: Comply with TIA-568-C.2.
   4. Marked to indicate transmission performance.

I. Patch Cords: Factory-made, four-pair cables in 12-inch lengths; terminated with an eight-position modular plug at each end.
   1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
   2. Patch cords shall have color-coded boots for circuit identification.

J. Faceplates:
   1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
   2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
   3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."

4. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work-area cords.
    a. Flush-mount jacks, positioning the cord at a 45-degree angle.

K. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.7 COAXIAL CABLE

A. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Belden
2. Commscope
3. Superior Essex
4. General Cable
5. Approved equivalent
6. RG-6/U: UL Type CMR
    a. No. 16 AWG, solid, copper-covered steel conductor.
    b. Riser rated.
    c. Gas-injected, foam-PE insulation.
    d. Shielded with 100 percent aluminum tape and 60 percent aluminum braid.
    e. Double shielded with 100 percent aluminum foil shield and 60 percent aluminum braided outer shield.
    f. Jacketed with black PVC or PE.
    g. Suitable for indoor installations.

2.8 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Belden.
2. Commscope
3. Superior Essex
4. General Cable
5. Approved equivalent

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

D. Patch Cords: Factory-made cables in 36-inch or 48-inch lengths; terminated with modular Type BNC connector at each end.

E. Faceplates:
1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."

3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
   a. Flush-mounted jacks, positioning the cord at a 90-degree angle.
4. Legend:
   a. Machine printed, in the field, using adhesive-tape label.
   b. Snap-in, clear-label covers and machine-printed paper inserts.

2.9 FIBER OPTIC BACKBONE CABLING

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

2.10 850 NANOMETER LASER-OPTIMIZED, 50/125 MICROMETER, MULTIMODE OPTICAL FIBER CABLE (OM3)

A. Description: Multimode, 50/125-micrometer, 24, 48 and 96-fiber, nonconductive, tight buffer, optical fiber cable.

B. Standards:
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-492AAAC for detailed specifications.

C. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

D. Minimum Overfilled Modal Bandwidth-length Product: 1500 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

E. Minimum Effective Modal Bandwidth-length Product: 2000 MHz-km at 850 nm.

F. Jacket:
   1. Jacket Color: Aqua.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

G. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Riser Rated, Nonconductive: Type OFNR or Type OFNP, complying with UL 1666.
   2. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
   3. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces.".

2.11 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

B. Standards:
   1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.

2. Comply with TIA-568.3-D.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, dual-fiber cables in 1-meter lengths.

E. Connector Type: Type LC complying with TIA-604-10-B, connectors.

F. Plugs and Plug Assemblies:
   1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
   2. Insertion loss not more than 0.75 dB.
   3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:
   1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
   2. Insertion loss not more than 0.75 dB.
   3. Marked to indicate transmission performance.
   4. Designed to snap-in to a patch panel or faceplate.

2.12 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal bisector tape, certified to meet transmission characteristics of Category 6 cable at frequencies up to 300MHz.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand..

C. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

D. Conductors: 100-ohm, 23 AWG solid copper.

E. Shielding/Screening: Unshielded twisted pairs (UTP).

F. Cable Rating: Riser.

G. Jacket: Thermoplastic. Refer to sheet ITS0.00 for cable sheath color code.

2.13 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

C. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

D. Source Limitations: Obtain twisted pair cable hardware from single source from single manufacturer. or from same manufacturer as twisted pair cable, from single source.

E. Connecting Blocks:
1.
2. 110-style IDC for Category 6.
3. Provide blocks for the number of cables terminated on the block, plus 25 percent spare, integral with connector bodies, including plugs and jacks where indicated.

F. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
1. Number of Terminals per Field: One for each conductor in assigned cables.

G. Patch Panel: Modular panels housing numbered jack units with IDC-type connectors at each jack location for permanent termination of pair groups of installed cables.
1. Features:
   a. Universal T568A and T568B wiring labels.
   b. Labeling areas adjacent to conductors.
   c. Replaceable connectors.
   d. 24 or 48 ports.
2. Construction: 16-gauge steel and mountable on 19-inch equipment racks.
3. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

H. Patch Cords: Factory-made, four-pair cables in 12-inch lengths; terminated with an eight-position modular plug at each end.
1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

I. Plugs and Plug Assemblies:
1. Male; eight position; color-coded modular telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Standard: Comply with TIA-568-C.2.
3. Marked to indicate transmission performance.

J. Jacks and Jack Assemblies:
1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.
4. Marked to indicate transmission performance.

K. Faceplate:
1. Four port, vertical single gang faceplates designed to mount to single gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

L. Legend:
1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.14 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. SYSTIMAX Solutions; a CommScope Inc. brand.

B. Description: MUTOAs shall meet the requirements of "Twisted Pair Cable Hardware" Article.
1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:
a. One for each four-pair unshielded or shielded twisted-pair group of indicated cables, plus 25 percent spare positions.
3. Mounting: Wall.
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA-568-C.1.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.15 COMMUNICATIONS COAXIAL HORIZONTAL CABLING

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard, and the requirements of TIA-568-C.4.

B. Description: Coaxial cable with a 75-ohm characteristic impedance designed for broadband data transmission.

C. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Belden CDT Networking Division/NORDX.
2. Coleman Cable, Inc.
3. CommScope, Inc.
4. Approved equivalent.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 13, and with NFPA 70, "Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits" and "Communications Circuits" articles. Types are as follows:
1. RG-6/U: UL Type CMR.
a. No. 16 AWG, solid, copper-covered steel conductor.
b. Riser rated.
c. Gas-injected, foam-PE insulation.
d. Shielded with 100 percent aluminum tape and 60 percent aluminum braid.
e. Double shielded with 100 percent aluminum foil shield and 60 percent aluminum braided outer shield.
f. Jacketed with black PVC.
g. Suitable for indoor installations.

2.16 COAXIAL CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate coaxial cable with a 75-ohm characteristic impedance.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Emerson Network Power Connectivity Solutions.
   2. Leviton Manufacturing Co., Inc.
   3. The Siemon Co.
   4. Belden.

C. Coaxial-Cable Connectors: Type BNC, 75 ohms.

D. Jacks and Jack Assemblies: Modular, color-coded, with female Type BNC connectors.

E. Patch Cords: Factory-made cables in 36-inch or 48-inch lengths; terminated with a male Type BNC connector at each end.

F. Faceplates:
   1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
   2. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
   3. For use with snap-in jacks accommodating any combination of twisted pair, optical-fiber, and coaxial work area cords.
      a. Flush-mounted jacks, positioning the cord at a 90-degree angle from faceplate surface.
   4. Legend:
      a. Machine printed, in the field, using adhesive-tape label.
      b. Snap-in, clear-label covers and machine-printed paper inserts.

2.17 OPTICAL FIBER HORIZONTAL CABLING

A. Optical fiber horizontal cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C and the equipment outlet, otherwise known as "Cabling Subsystem 1" in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
   1. TIA-568.1-D requires that a minimum of two equipment outlets be installed for each work area.
   2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the equipment outlet.
   3. Bridged taps and splices shall not be installed in the horizontal cabling.

2.18 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568.1-D, when tested according to test procedures of this standard.

2.19 50/125-MICROMETER, MULTIMODE, OPTICAL FIBER CABLE (OM3)

A. Description: Multimode OM3, 50/125-micrometer, 2-fiber, nonconductive, tight buffer, optical fiber cable.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. Belden CDT Networking Division/NORDX.
   2. Berk-Tek Leviton; a Nexans/Leviton alliance.
   3. Corning Cable Systems.

C. Standards:
   1. Comply with ICEA S-83-596 for mechanical properties.
   2. Comply with TIA-568-C.3 for performance specifications.
   3. Comply with TIA-492AAAB for detailed specifications.

D. Conductive cable shall be aluminum armored type.

E. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.

F. Minimum Overfilled Modal Bandwidth-length Product: 200 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

G. Jacket:
   1. Jacket Color: Orange.
   2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-D.
   3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

H. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
   1. Riser Rated, Nonconductive: Type OFNR or Type OFNP, complying with UL 1666.
   2. Riser Rated, Nonconductive: Type OFNP or Type OFNR in listed riser or plenum communications raceway.
   3. Riser Rated, Nonconductive: Type OFNP, or Type OFNR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."

2.20 OPTICAL FIBER CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
   1. SYSTIMAX Solutions; a CommScope Inc. brand.

B. Standards:
   1. Comply with Fiber Optic Connector Intermateability Standard (FOCIS) specifications of the TIA-604 series.
   2. Comply with TIA-568-C.3.

C. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Cords: Factory-made, single-fiber cables in 36-inch lengths.

E. Connector Type: Type LC complying with TIA-604-10-B, connectors.

F. Plugs and Plug Assemblies:
1. Male; color-coded modular telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.

G. Jacks and Jack Assemblies:
1. Female; quick-connect, simplex and duplex; fixed telecommunications connector designed for termination of a single optical fiber cable.
2. Insertion loss not more than 0.75 dB.
3. Marked to indicate transmission performance.
4. Designed to snap-in to a patch panel or faceplate.

H. Faceplate:
1. Four -port, vertical single-gang faceplates designed to mount to single-gang wall boxes.
2. Plastic Faceplate: High-impact plastic. Coordinate color with Section 26 27 26 "Wiring Devices."
3. Metal Faceplate: Stainless steel, complying with requirements in Section 26 27 26 "Wiring Devices."
4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
   a.
   b. Flush mounting jacks, positioning the cord at a 45-degree angle.

2.21 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568.0-D.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

2.22 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels specified in Section 06 10 00 “Rough Carpentry.”

B. Backboard Paint: Pre-painted.

2.23 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hoffman; a brand of Pentair Equipment Protection.
2. Hubbell Incorporated.
3. MonoSystems, Inc.

4. O-Z/Gedney; a brand of Emerson Industrial Automation.
5. Wiremold / Legrand.
6. <Insert manufacturer's name>.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets shall be listed and labeled for intended location and use.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, Type FD, aluminum, with gasketed cover.

E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.

J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic.
3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

K. Cabinets:
1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.24 POWER STRIPS

A. Comply with requirements in Section 27 05 00 "Common Work Results for Communications" for Grounding and Bonding of Communications Systems.

B. Power Strips: Comply with UL 1363.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Rack mounting, with detachable or integral flanges.
3. Height: 1 RU.
4. Housing: Metal.
5. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
6. Front-facing receptacles.
7. LED indicator lights for power and protection status.

8. LED indicator lights for reverse polarity and open outlet ground.
9. Circuit Breaker and Thermal Fusing: When protection is lost, circuit opens and cannot be reset.
10. Circuit Breaker and Thermal Fusing: Unit continues to supply power if protection is lost.
11. Close-coupled, direct plug-in line cord.
12. Rocker-type on-off switch, illuminated when in on position.
13. Surge Protection: UL 1449, Type 3.
    a. Maximum Surge Current, Line to Neutral: 27 kA.
    b. Protection modes shall be line to neutral, line to ground, and neutral to ground.
    c. UL 1449 Voltage Protection Rating for line to neutral and line to ground shall be 600 V and 500 V for neutral to ground.

2.25 UNINTERRUPTIBLE POWER SUPPLY

A. Comply with requirements in Section 27 05 00 "Common Work Results for Communications."

B. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. APC.

C. UPS: Verify rack load with owner for properly sized supply.

D.
1. Rack mounted, 3 kVA.
2. Height: 2RU.
3. Housing: Metal.
4. NEMA L5-30P input connection.
5. Rear-facing receptacles.
6. 120V nominal output voltage.
7. 50/60Hz output frequency.
8. Output connections:
    a. Six (6) NEMA 5-15R, battery backup.
    b. Two (2) NEMA 5-20R, battery backup.

2.26 19-INCH EQUIPMENT RACKS

A. Description: Two and four-post racks with threaded rails designed for mounting telecommunications equipment. Width is compatible with EIA/ECIA 310-E, 19-inch equipment mounting with an opening of 17.72-inches between rails.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1.
2. Chatsworth Products, Inc.

C. General Requirements:
1. Frames: Modular units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Material: Aluminum.
3. Finish: Manufacturer's standard, baked-polyester powder coat.
4. Color: Black.

D. Floor-Mounted Racks:

E.
1. Overall Height: 84 inches.
2. Overall Depth:
   a. Two-Post: 18 inches.
   b. Four-Post: 35 inches.
3. Two-Post Upright Mounting Channel Depth: 6 inches.
4. Two-Post Load Rating: 1000 lb.
5. Four-Post Load Rating: 1000 lb.
6. Number of Rack Units per Rack: 45.
   a. Numbering: Every rack unit, on interior of rack.
7. Threads: 12-24.
8. Vertical and horizontal cable management channels, top and bottom cable troughs and grounding studs.
9. Base shall have a minimum of four mounting holes for permanent attachment to floor.
10. Top shall have provisions for attaching to cable tray or ceiling.
11. Self-leveling.

F. Wall-Mounted Racks:

G.
1. Height: 22 inches.
2. Depth: 29 inches.
3. Load Rating: Minimum 150 lb.
4. Number of Rack Units per Rack: 22.
5. Threads: 12-24.
6. Wall Attachment: Four mounting holes.
7. Equipment Access: Integral swing.

2.27 LADDER CABLE TRAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products, Inc.
   a. OnTrac wire mesh cable tray, shaped.

B. Description:
1. Configuration: Two longitudinal side rails with transverse rungs swaged or welded to side rails, complying with NEMA VE 1.
2. Width: 24 inches unless otherwise indicated on Drawings.
3. Minimum Usable Load Depth: 6 inches.
4. Straight Section Lengths: 10 feet, except where shorter lengths are required to facilitate tray assembly.
5. Rung Spacing: 9 inches o.c.
6. Radius-Fitting Rung Spacing: 9 inches at center of tray's width.
7. Minimum Cable-Bearing Surface for Rungs: 7/8-inch width with radius edges.
8. No portion of the rungs shall protrude below the bottom plane of side rails.
9. Structural Performance of Each Rung: Capable of supporting a maximum cable load, with a safety factor of 1.5, plus a 200-lb concentrated load, when tested according to NEMA VE 1.
10. Fitting Minimum Radius: 24 inches.
11. Splicing Assemblies: Bolted type using serrated flange locknuts.
12. Splice-Plate Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

C. Materials and Finishes:

1. Steel:
    a. Straight Section and Fitting Side Rails and Rungs: Rectangular steel tubing.
    b. Steel Tray Splice Plates: ASTM A 1011/A 1011M, HSLAS, Grade 50, Class 1.
    c. Fasteners: Steel complies with the minimum mechanical properties of ASTM A 510/A 510M, Grade 1008.
    d. Finish: Hot-dip galvanized after fabrication, complying with ASTM A123/A123 M, Class B2.
        1) Hardware: Chromium-zinc plated, ASTM F 1136.

2.28 GROUNDING

A. Comply with requirements in Section 27 05 00 "Common Work Results for Communications " for grounding conductors and connectors.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Chatsworth Products, Inc.
2. Ortronics, Inc.
3. Panduit Corp.
4. Approved equivalent.

C. Rack and Cabinet SBBs: Rectangular bars of hard-drawn solid copper, accepting conductors ranging from No. 14 to No. 2/0 AWG, NRTL listed as complying with UL 467, and complying with TIA-607-C. Predrilling shall be with holes for use with lugs specified in this Section.
1. Cabinet-Mounted SBB: Terminal block, with stainless-steel or copper-plated hardware for attachment to cabinet.
2. Rack-Mounted Horizontal SBB: Designed for mounting in 19- or 23-inch equipment racks. Include a copper splice bar for transitioning to an adjoining rack, and stainless-steel or copper-plated hardware for attachment to the rack.
3. Rack-Mounted Vertical SBB: 72 or 36 inches long, with stainless-steel or copper-plated hardware for attachment to rack.

2.29 LABELING

A. Comply with TIA-606-C and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Comply with requirements in Section 27 05 00 "Common Work Results for Communications Systems" for materials and installation requirements for underground, buried or aerial pathways.

3.2 INSTALLATION PRACTICES

A. Comply with NECA 1, NECA 301, and NECA/BICSI 568.

B. Comply with BICSI's "Telecommunications Distribution Methods Manual" for layout of communications equipment spaces.

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual" for installation of equipment in communications equipment spaces.

D. Coordinate layout and installation of communications equipment in racks and in room. Coordinate service entrance configuration with service provider.
   1. Comply with TIA-568-C.1 and TIA-568-C.3.
   2. Comply with BICSI ITSIMM, Ch. 6, "Cable Termination Practices."
   3. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
   4. Meet jointly with systems providers, equipment suppliers, and Owner to exchange information and agree on details of equipment configurations and installation interfaces.
   5. Record agreements reached in meetings and distribute them to other participants.
   6. Adjust configurations and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize configurations and space requirements of communications equipment.
   7. Adjust configurations and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in equipment room.
   8. Install 110-style IDC termination hardware unless otherwise indicated.
   9. Do not untwist twisted pair cables more than 1/2 inch from the point of termination to maintain cable geometry.
   10. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   11. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   12. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
   13. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section Use lacing bars and distribution spools.
   14. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
   15. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   16. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
   17. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.

H. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

I. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

J. Backboards:
1. Install from 6 inches to 8 feet, 6 inches above finished floor. If plywood is fire rated, ensure that fire-rating stamp is visible after installation.
2. Paint all sides of backboard with two coats of paint, leaving fire rating stamp visible.
3. Comply with requirements for backboard installation in BICSI's "Information Technology Systems Installation Methods Manual" and TIA-569-D.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections with the assistance of a factory-authorized service representative.

E. Tests and Inspections:
1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect copper cabling connections for compliance with TIA-568-C.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
4. Copper Cable Tests
    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
5. Optical Fiber Cable Tests:
    a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.1. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:
        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in one direction according to TIA-526-14-B, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than those calculated according to equation in TIA-568-C.1.

F. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

G. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

H. End-to-end cabling will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.

3.4 SLEEVE AND SLEEVE SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 27 05 00 "Common Work Results for Communications" for pathways and cabling."

3.5 FIRESTOPPING

A. Comply with requirements in Section 07 84 00 "Penetration Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

C. Comply with BICSI's "Information Technology Systems Installation Methods Manual," "Firestopping Practices" Ch.

3.6 IDENTIFICATION

A. Comply with requirements in Section 27 05 00 "Common Work Results for Communications Systems" for Identification

END OF SECTION

SECTION 27 41 16

INTEGRATED AUDIO-VIDEO EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. Provide and install complete and Integrated Audio-Video systems per specifications listed herein.

B. Documents: Provisions of General Conditions, Supplementary Conditions, and the sections included under Procurement & Contract Requirements are included as part of this section as though bound herein.

1.2 SUMMARY

A. The Contractor shall provide all materials, equipment, labor and all other incidental materials and appliances necessary, as described herein and in the drawings, to provide complete turn-key and functional systems, regardless of any materials and/or equipment not listed or described in this specification and/or supplementary drawings.

B. Contractor shall provide system optimization services and shall complete an internal system commissioning. A commissioning plan shall be submitted in writing to the Owner and or Owner's representative for approval. Notify the customer and or Owner's representative two weeks prior to the start of commissioning to allow for Owner representation to be present during all testing and commissioning. Final testing and commissioning shall be completed by customer's representative.

C. General elements of the work shall consist of but not limited to following major items:

1. All equipment shall be installed per the manufacturer's installation instructions.
2. Any deviation from the manufacturer's installation instructions shall be requested prior to the work being done.
3. Any unapproved deviations will be corrected at the installer's sole expense
4. Procure all permits and licenses required to complete this installation.
5. Attend job construction and progress meetings.
6. Provide audio mixers, distribution amplifiers, equalizers, amplifiers and other audio signal processing equipment.
7. Provide loudspeaker and speaker mounting hardware.
8. Provide equipment racks, cabinets and/or mobile carts.
9. Fabricate custom panels and face plates.
10. Provide cables, connectors and wiring.
11. Provide microphone(s), microphone stand(s)
12. Verify conditions and dimensions at the job site prior to installation.
13. Submittal preparation and processing
14. Perform installation according to contract documents.
15. Perform initial testing, programming and adjustments with written reports.
16. Demonstrate system for final adjustments and approval.
17. Preparation of Operational and Maintenance manuals and Project Record (as-built) documents

18. Providing training for Owner
19. Providing warranty service
20. Remove all job specific created debris to approved collection points.

1.3 RELATED SECTIONS

A. The general provisions of the Contract and the requirements of work specified in these sections:
   1. Section 26 05 33 Raceways and Boxes
   2. Section 26 27 26 Wiring Devices
   3. Section 27 05 00 Common Work Results for Communications
   4. Section 27 10 00 Structured Cabling

1.4 REFERENCES

A. Specifications, Standards and Codes: All work shall be in accordance with the current editions of the following:

   1. ANSI T1.404 (DS3) and CATV Applications.
   2. ANSI S4.48-1992
   3. ANSI X3T9.5 TPPMD.
   4. American Society of Testing and Materials (ASTM).
   5. Building Industry Consulting Service International (BICSI) Telecommunications Distribution Methods Manual.
   6. Federal Communications Systems (FCC).
   7. Institute of Electrical and Electronics Engineers (IEEE).
   8. National Electrical Code (NEC) (Latest revision and pertinent addendums).
   9. National Electrical Manufacturer's Association (NEMA).
   10. National Fire Protection Association (NFPA) Publications (Latest revisions and pertinent addendums).
   11. "Basic Principles for suspended Loud Speaker Systems", Technical Notes Volume 1, Number 19, JBL Professional or latest edition.
   12. "Handbook for Riggers" 1977 Revised Edition, Newberry, W.G., Calgary, Alberta Canada.
   13. Underwriters Laboratory (UL)
   14. Americans with Disabilities Act (ADA)
   15. In the event of a conflict between documents referenced herein and the contents of this specification, the contents of this specification shall be considered the superseding document except for the NFPA publications, which shall have precedence.

1.5 IT COORDINATION

A. Where connection between components or control features are accomplished over the Owner's LAN, Contractor shall coordinate with the Owners IT department for IP addresses, firewall access, and other issues pertaining to successful integration.

1.6 GENERAL REQUIREMENTS

A. This section covers the general requirements for the installation of the Integrated Audio-Video system by the Contractor.

1. In the installation of this work, the Contractor shall comply in every way with the requirements of customer standards, local and state laws and ordinances, the National Board of Fire Underwriters, and the National Electrical Code. If, in the opinion of the Contractor, there is anything in the plans or specifications that will not strictly comply with the above laws, ordinances, and rules, the matter shall be referred to the attention of customer's representatives for a decision before proceeding with that part of the work. No change in the plans or in the Specifications shall be made without full consent in writing by the customer representative's engineer.
2. The Contractor shall obtain the customer's permission before proceeding with any work necessitating cutting into or through any part of building structures such as girders, beams, concrete or tile floors, partition ceilings.
3. The Contractor shall be responsible for and repair all damage to building due to carelessness of workers, and exercise reasonable care to avoid any damage to customer property. The Contractor will report to the customer representatives any damage to the building which may exist or may occur during the occupancy of the quarters.
4. Contractor shall provide components, wire, connectors, materials, parts, equipment and labor necessary for the complete installation of the system, in full accordance with the recommendations of the equipment manufacturers and the requirements, specifications and all applicable codes.
5. The Contractor shall be responsible for installation of proper grounding and bonding.
6. The Contractor shall take necessary steps to ensure that required firefighting apparatus is accessible always. Flammable materials shall be kept in suitable places outside the building.
7. The Contractor shall install the materials in accordance with the manufacturer's specifications.
8. Equipment shall be held firmly in place with manufacturer's recommendation and/or EIA standard types of mounting hardware. All equipment shall be installed so as to provide reasonable safety to the operator.
9. The Contractor shall promptly correct all defects for which the Contractor is responsible.
10. The Contractor shall insure that all records and reports, City relations, engineering, metering, inspections, testing, quality or service standards and safety measures comply with standards applicable for the State where the work is being performed.
11. The Contractor shall coordinate all work with the customer's assignee or as will be designated at a future date.
12. The Contractor shall remove all excess material and debris and return to original state of cleanliness. The Contractor shall maintain a work area free of debris, trash, empty cable reels, scrap wire, etc., and dispose of such items daily.
13. Upon completion of installation and prior to acceptance, all equipment shall be thoroughly cleaned and made free from extraneous bits of soldier, wire, etc. by the Contractor. Contractor shall cleanup work area and remove ALL waste and trash. Debris resulting from the installation shall be removed from all areas and disposed of by the Contractor.
14. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
15. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
16. An appropriate installation schedule shall be developed by the Contractor and will be subject to approval by the customer's representatives. The construction schedule should include at least one installation supervisor, or lead technician, for on-site management of the project.
17. Prior to starting the installation, the assigned installation supervisor, or lead technician, shall participate in a walk-through of the project location with customer's engineers to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
18. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.

19. It shall be the responsibility of the installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
20. The Contractor shall not roll or store cable reels without an appropriate underlay.
21. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.
22. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.
23. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
24. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
25. All wiring, materials, and equipment must be listed and labeled by a nationally recognized testing laboratory.
26. All equipment proposed by the Contractor must be new and unused. Equipment refers to all hardware, software, equipment, cabling, materials and incidentals etc.

1.7 SUBMITTALS

A. Successful Contractor will submit a single electronic PDF copy of the submittal package within 20 days of written notification to proceed or other written documentation from the Architect or General Contractor. Documents will be organized into the following sections:

B. General

1. Provide submittals in accordance with Owner's approved construction schedule. Submittals shall consist of a cover page, table of contents (TOC), product data, prequalification certificate, shop drawings and warranty documents.
2. Partial submittals shall not be acceptable without prior approval by Owner.
3. The contract shall not be relieved from any contract-required responsibility by the Owner's approval of submittals.
4. Nothing in the specification shall relieve respondents of system package design responsibility, including, but not limited to, all equipment furnished under this contract. The successful respondent is, in all cases, solely responsible for the performance of the delivered system, and for furnishing complete system documentation for each and every part of the system.
5. No portion of the work shall commence, or equipment ordered until the Owner has approved the submittals.
6. All work to be performed in accordance with approved submittals.
7. Submit a detailed completion schedule with the submittals.
8. Provide submittals in accordance with Division 1 requirements and Owners approved construction schedule.
9. Submittals shall not be combined with additional scope awarded.

C. Pre-Installation Submittals: Contractor shall supply the following for review within 20 business days of contract award.

1. Configuration file for audio digital signal processors (DSP), drafted in DSP manufacturer’s provided software.
2. Processor power required of DSP shall not exceed 95% total processing capacity.

a. If processing power required exceeds available processing power, Contractor shall immediately notify Owner during pre-installation phase.

3. Copy of manufacturer configuration software, or link to manufacturer website download page for accessing configuration software.
   a. Version: Submitted software shall be identical version used to create DSP configuration.
4. Layouts of physical and virtual user controls in graphical format. This shall include:
   a. Engraved buttons and overlays
   b. Machine-printed adhesive labels
   c. Graphical user interfaces for touch panels or web interfaces.

D. Submittal Requirements

1. Cover Page and Section 1 ─ Information, Pricing and Material
   a. Cover sheet containing the Company Name and/or logo, Title of submittal package, client name, and Contractor work address with a point of contact (POC) and phone number.
2. Table of Contents (TOC)
   a. Listing, in order, of all submittal documents.
3. Section 2 ─ Product Data
   a. Manufacturer's catalog information showing dimensions, colors, and configurations.
   b. Submittals will include all items called for in PART 2 – PRODUCTS of this document and the manufacturers cut sheets for each item listed in the specifications and the bill of materials.
   c. In cases of multiple product numbers on a single cut sheet, the Contractor will identify the proper part number with an arrow, check mark or highlight.
4. Section 3 ─ Pre-Qualification Certificate
   a. Contractor will submit the following documents with project proposal:
      1) A letter of approval from the manufacturer indicating completion of pre-qualification requirements.
      2) Training certificates for design, engineering and installation of the proposed products.
5. Section 4 ─ Warranty Documentation
   a. Warranty will be for one year from final acceptance of the final product.
   b. Complete documentation regarding the manufacturer's warranty will be submitted as part of the proposal. This will include, but is not limited to, a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
6. Section 5 – Record Drawings
   a. Contractor shall provide record drawings for the submittal package that will be used throughout the inspection process and into substantial completion / final acceptance. Drawings will contain the Contractors own title block on the edge of the drawing and will include the company name, address, phone number and date of the final drawings. Use of any part of the Architect title block is not acceptable at any time.
   b. The drawings shall include the following information:
      1) All shown drop locations shall be labeled in accordance with the specifications.
      2) Provide the audio-visual equipment rack elevation details demonstrating the locations of the equipment, power raceways and thermal management.
      3) All overhead rigging and installation details
      4) Required wood blocking details with dimensions.
7. Any and all changes to the scope of work during the project shall be included in the drawings upon completion of system(s) installation and will be used as part of the

substantial completion process. Reference the section on close out documentation for additional information on the substantial completion process.

1.8 QUALITY ASSURANCE

A. The Contractor is bound by the intent of these specifications to provide a complete and functional Integrated Audio-Video as described herein which meets or exceeds all standard currently established for such systems, regardless of any errors or omissions.

1. ICS control functionality, verification of presets, volume controls, mute controls, etc.
2. Stable operation, completely free of feedbacks and distortion throughout entire range of available ICS controls.
3. Correct routing of all signals to intended destination.
4. Unity gain structure.
5. Output transducer (speaker protection processing functionality).
6. AEC functionality
7. Provide measurement test results per ANSI/InfoComm 1m-2009 ACU.
8. Outdoor sound system measurements shall be provided at a minimum of one measurement per 50 seats. Measurements shall be performed using pink noise test signal at a volume congruent with nominal system operation. Measurements shall indicate
    a. Site plan map of seating areas and test locations.
    b. Frequency response from 40Hz-16kHz in 1/3 octave resolution.
    c. SPL (A weighted) of the test signal as measured form each location.
    d. Weather condition at time of test; including temperature, humidity and average wind speeds.
9. Loudspeaker performance shall exhibit frequency response of +/-3dB from 40Hz to 8kHz throughout 70% of the home grand stand seating area, and +/-6dB throughout remaining seats.
10. Visitor grandstands shall exhibit frequency response of +/-3dB from 250Hz to 8kHz throughout 70% of the visitor seating area, and +/-6dB throughout remaining seating area.

B. Provide all necessary labor, materials, tools, transportation, services, ancillary items and coordination to furnish the Owner a complete turnkey system as described herein.

C. The Owner's representative will make regular progress inspections. The Contractor shall make their job supervisor available to assist during these visits.

D. The Contractor shall thoroughly familiarize themselves with: the complete construction documents, to have visited all sites affecting the proposed work, studied bid package information and all necessary details of the complete set of drawings and specifications and to have included in the proposal an amount to cover all work.

E. The Contractor shall keep a complete set of drawings, specification, reviewed submittals and progress markups on the job site at all times. These documents shall be made available during Owner's representative site progress visits. Changes made during installation shall be noted on the project markup set.

F. Submission of bids shall be deemed evidence of Contractor’s knowledge, review and examination of the construction documents.

G. Provide a competent supervisor and supporting technical personnel with a minimum of AVIXA CTS certification and is acceptable to the general Contractor, Owner and consultant during

installation. Notify the Owner's representative in writing prior to any project supervisor replacement.

H. In the event of a conflict between documents referenced herein and the contents of this specification, the contents of this specification shall be considered the superseding document except for the NFPA publications, which shall have precedence.

1.9 PROJECT EXPERIENCE AND PERFORMANCE REQUIREMENTS

A. The work performed under this Section shall be performed by an experienced A/V Contractor, primarily engaged in the business of A/V system installations.

B. The Contractor shall show proof, as part of the bid, that he has been in the A/V system installation business for a period of not less than 3 years and has successfully, completed projects of similar size and scope.

C. The Contractor will provide proof that it supports a well-trained maintenance force in the area local to the project.

D. The Contractor must maintain a fully staffed installation and service facility equipped with appropriate test equipment for repair of systems such as those specified herein.

E. E. Provide a competent supervisor and supporting technical personnel with a minimum of AVIXA CTS certification and is acceptable to the General Contractor, Owner and Consultant during installation. Notify the Owner's representative in writing prior to any project supervisor replacement.

F. F. The contractor shall be, or have direct relations through their subcontractors, an approved manufacturer's representative for all products they furnish and install.

G. References:

1. The Contractor shall submit the names, addresses and telephone numbers of the operating personnel who can be contacted regarding previous installed systems.
2. Submitting incomplete or inaccurate reference information can be a reason to disqualify bidding Contractor.

1.10 COOPERATION AND COORDINATION

A. Cooperate and coordinate as required with other Contractors who are responsible for work not included in this section.

B. Provide all information as required or requested by the Owner, architect, consultant or general Contractor for the project to be completed to the satisfaction of the Owner.

C. Notify general Contractor in a timely manner of system design or installation conflicts, which affect the intended use, or performance of the system.

D. Attend job construction and progress meetings that the Owner deems necessary.

1.11 QUALIFICATIONS

A. Manufacturer

1. Manufacturer will have a minimum of ten (10) years' experience in the manufacture of sound system products.
2. Maintain a 24-hour toll free telephone assistance line or online presence for customer and installer support.

B. Contractor

1. The Contractor selected to provide the installation of this system will be certified by the manufacturing company in all aspects of design, installation and testing of the products described herein.
2. The Contractor will utilize the authorized manufacturer components in provisioning this Project.
3. Contractor will have a minimum of three (3) years of recent experience with the proposed manufacturers' products.
4. Contractor will have a minimum of five (5) years' experience with the design, installation and project management of local sound systems.
5. Contractor will be in compliance with all federal, state and local statutes regarding qualifications of firms.
6. The Contractor will be experienced in all aspects of this work and will be required to demonstrate direct experience on recent systems of similar type and size.
7. The Contractor will have personnel who are adequately trained in the usage of such tools and equipment.
8. The Contractor must have previously established offices located within 75 miles of the project location as the starting point.
9. The customer reserves the right to reject bid of any bidder who has previously failed to perform properly, or complete on time, contracts of a similar nature.

1.12 BID

A. Contractor will be required to provide the following documents with the bid response.

1. Training certificates for design, engineering and installation of the proposed product types.
2. Contractor will provide a list of all current installations that will be ongoing during the course of this project, and the manpower requirements for each of those installations.
3. The preferred Contractor will have a minimum of (3) three references. Contractors providing a reference with an invalid phone number will be considered as an incomplete response and may be disqualified.
4. Contractor will provide a sample of the warranty that would be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues.
5. Contractor will submit a resume of qualification with the Contractor's bid proposal indicating the following:
    a. A technical resume of experience for the Contractor's Project Manager and on-site installation supervisor (Project Foreman) who will be assigned to this project. The project manager should have a minimum of 5 years' experience on projects of similar size and design. The Project Foreman will have a minimum of 3 years related project experience working crews of 4 or more personnel.
    b. A list of technical product training attended by the Contractor's personnel that will install the system.

c. Any sub-Contractor, who will assist this section Contractor in performance of this work, will have the same training and certification as the Contractor. The use of Subcontractors is not prohibited for this project.

1.13 DELIVERY STORAGE AND HANDLING

A. Comply with requirements of Section 01 66 00 – Product Storage and Handling Requirements.

B. Deliver, Storage and Protection

1. Contractor shall verify all site conditions are suitable for delivery of product.
2. Deliver products in manufacturer's original, unopened, undamaged containers with labels intact.
3. Contractor shall provide all equipment and materials necessary for the delivery of materials safely and securely on site.

1.14 PROJECT CONDITIONS

A. Project Environmental Requirements.

B. Comply with requirements of referenced standards and recommendations of material manufacturers for environmental conditions before, during, and after installation.

PART 2 - PRODUCTS

2.1 PRODUCT SPECIFICATIONS

A. Hardware: Contractor shall supply equipment, accessories, cables, and connectors necessary for system to operate according to stated functional requirements, whether said products are listed.

B. Software: Contractor shall utilize Manufacturers official current version of configuration software. Special exemption may be obtained from Owner if current version contains known issues. In such event, the version immediately preceding shall be utilized.

C. Control Interfaces: Shall be labeled or configured with graphical user interface as appropriate.

D. Power Supplies: As required, Contractor shall provide necessary power supplies for amplifies requiring DC voltage to power Ethernet card when forced in standby mode.

2.2 GENERAL

A. Unless otherwise provided in the specifications, reference to any equipment, material, article, or patented process, by trade name, make or catalog number, shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. If the respondent wished to make a substitution to the specifications, the respondent shall furnish to the Engineer the name of the manufacturer, the model number, and other identifying data and information necessary to aid the Engineer in evaluating the substitution, and such substitution shall be subject to the Engineer's approval. Substitutions shall be approved only if determined by the Engineer to be equivalent to that specified. A proposal containing a substitution is subject to

disqualification if the customer’s representative does not approve the substitution. Quantities of products should be verified with drawings and any discrepancies reported to the Owner's representative in writing for resolution.

B. Unapproved product substitutions which have been provided and/or installed will be replaced with the specified products at Contractor’s sole expense.

C. Furnish all accessories items necessary to integrate each piece of equipment into the system including rack mounts and other mounting devices, special connectors and interfaces.

D. Coordinate with architect the finish of all exposed items to blend with adjacent architectural elements of the building.

E. Major components of the system such as DSP, power amplifiers, mixer-preamplifiers, and tuners, shall have a device, whether internal or external, which provides protection against voltage spikes and current surges originating from commercial power sources.

2.3 PAGING

A. The Paging System shall be a VoIP all-call system. The system shall be low voltage throughout.

1. PAGING LOUDSPEAKERS
   a. Acceptable Manufacture: Valcom
   b. Acceptable Model: V-1020C
   c. Acceptable Model: 1030C
2. PAGING POWER SUPPLY
   a. Acceptable Manufacture: Valcom
   b. Acceptable Model: VP-2164
   c. Acceptable Model: VP-624B
3. PAGE ADAPTER
   a. Acceptable Manufacture: Valcom
   b. Acceptable Model: VIP-801A

2.4 SOUND MASKING

A. The Sound Masking system shall be a 70V plenum space system.

1. LOUDSPEAKERS
   a. Acceptable Manufacture: AtlasIED
   b. Acceptable Model: M1000
2. WHITE NOISE GENERATOR
   a. Acceptable Manufacture: AtlasIED
   b. Acceptable Model: GPN1200K
3. GRAPHIC EQUALIZER
   a. Acceptable Manufacture: AtlasIED
   b. Acceptable Model: EQM131
4. AMPLIFIER
   a. Acceptable Manufacture: AtlasIED
   b. Acceptable Model: CP400
5. Attenuator Panels
   a. Acceptable Manufacture: AtlasIED
   b. Acceptable Model: AT-35RM, ATPLATE-052

2.5 CONFERENCE / TRAINING ROOMS

A. The Conference / Training Rooms shall vary in functionality based upon the functional drawings and AV plans.

1. EQUIPMENT RACK
    a. Acceptable Manufacture: Middle Atlantic
    b. Acceptable Model: SRSR-4-16
    c. Provide with the following accessories:
        1) Middle Atlantic PD-915C-20
        2) Middle Atlantic SB series Blank Panels
        3) Middle Atlantic UMS1-11.5 Rack Shelves
        4) Middle Atlantic Cable Management
2. WIRELESS MICROPHONE SYSTEM
    a. Provide remote antenna(s) for proper coverage and reception of wireless microphone transmitters.
    b. Contractor to confirm available local RF frequencies prior to purchasing to be certain that correct frequency bands will be installed for the areas surrounding the project.
    c. Acceptable Manufacture: Shure
    d. Acceptable Model: ULXD4, ULXD2/B87A, ULXD1, MX150
3. DIGITAL SIGNAL PROCESSOR (DSP)
    a. Fire Alarm remote relay cabling provided by Fire Alarm Contractor.
    b. Acceptable Manufacture: ClearOne
    c. Acceptable Model: Converge Pro2
4. AMPLIFIER
    a. Acceptable Manufacture: QSC
    b. Acceptable Model: SPA2-60, SPA4-60
5. LOUDSPEAKER (SS)
    a. Acceptable Manufacture: QSC
    b. Acceptable Model: AD-C6D
6. VOLUME CONTROL (VC)
    a. Acceptable Manufacture: AtlasIED
    b. Acceptable Model: AT10D
7. DISPLAYS
    a. Acceptable Manufacture: LG
    b. Acceptable Model: UK6300 Series
8. HDMI SWITCH
    a. Acceptable Manufacture: Extron
    b. Acceptable Model: SW2 HD 4K
9. WIRELESS MOUSE AND KEYBOARD
    a. Acceptable Manufacture: Logitech
    b. Acceptable Model: MX800
10. USB EXTENDER
    a. Acceptable Manufacture: VDO360
    b. Acceptable Model: VUSBEX
11. CONTROL SYSTEM
    a. Acceptable Manufacture: FSR
    b. Acceptable Model: FLEX-LT200
12. CAMERAS
    a. Acceptable Manufacture: VDO360
    b. Acceptable Model: VPTZH-05
13. CAMERA MOUNT
    a. Acceptable Manufacture: VDO360
    b. Acceptable Model: VMOUNT-01
    c. Acceptable Manufacture: Vaddio

d. Acceptable Model: 535-2000-291

14. BEAMFORMING MICROPHONE ARRAY
    a. Acceptable Manufacture: ClearOne
    b. Acceptable Model: 910-3200-201
15. LINE COMBINERS
    a. Acceptable Manufacture: RDL
    b. Acceptable Model: TX-LC2
16. AUDIO D/A
    a. Acceptable Manufacture: Gefen
    b. Acceptable Model: GTV-DIFAUD-2-AAUD
17. HDMI DISTRIBUTION AMPLIFIER
    a. Acceptable Manufacture: EXTRON
    b. Acceptable Model: DA2 HD 4K
18. EQUIPMENT WALL MOUNTS
    a. Acceptable Manufacture: HIDEit
    b. Acceptable Model: As Needed

2.6 WIRE AND CABLE

A. Minimum Specifications

1. All wire and cable shall be: UL approved, meet all national, state and local codes, and manufacturers recommendations for connected components for its intended application.
2. Plenum Insulation shall be rated for a minimum of 300 volts and satisfy the Underwriters Laboratories (UL) listed fire rated cable insulation requirements in plenum areas.
3. Cable runs shall be continuous runs. Mid-span cable splicing is not acceptable.
4. Any pulling compound or lubricant used in cable installation shall not deteriorate the conductor or the insulation.
5. Conductors shall be 100% copper.
6. Measure and record home-run impedance and include in as built documentation.
7. All cabling shall have machine generated labels self-laminating or wrap around. Handwritten labels shall not be accepted.
8. Under carpet wiring and flat wiring shall not be used.
9. Manufacturers recommended cabling supersedes wire specified below.
10. Contractor responsible for verifying all plenum rated spaces prior to installation. Provide Plenum rated cable as required.

B. Acceptable Manufacturers:

a. Extron XTP DTP 24 – XTP, DTP cable
b. Extron XTP DTP 24/P – XTP, DTP cable
c. DM-CBL-NP-SP500
d. DM-CBL-P-SP500
e. West Penn 254246F - UTP cable.
f. West Penn 25227B – Full range speakers / home run 70V cable
g. West Penn 25225B – Speaker to speaker cabling.
h. West Penn HA210 – Low frequency cabling.
i. West Penn 25291B – Mic and line level cable.
j. Non-Plenum cabling acceptable for wire installed in conduit.
k. Or approved equivalent.

C. JACKS, CONNECTORS AND WALLPLATES

1. All plate-mounted connectors shall be ground isolated from the mounting plate.

2. All custom A/V panels shall be minimum 1/8" brushed aluminum with engraved paint filled legends.
3. All connectors shall be as follows:
    a. Microphone input jacks - 3 pin female XLR with gold contacts
    b. Monitor jack – ¼: phono female receptacle
    c. Powered monitor jack – male 3 pin XLR with gold contacts
    d. Audio output jacks - 3 pin male XLR with gold contacts
    e. Cable end connectors - 3 pin XLR
    f. 3.5mm mini-jack connectors

D. OTHER REQUIREMENTS

1. All materials and equipment proposed by the Contractor shall be new and unused. Equipment refers to all hardware, cabling, materials and incidentals, etc.
2. All equipment shall be installed per the manufacturer's instructions.
3. System shall be complete.

PART 3 - EXECUTION

3.1 INSTALLATION

A. This Section includes installation requirements of the Integrated Audio-Video. If you have any questions regarding the intent or application of any feature, submit these questions to the principal contact for this project, as indicated in Division 00. This section covers the general requirements for the installation of the equipment by the Contractor.

1. All work shall be done in a thorough and conscientious manner according to industry standards and shall be subject to inspection and acceptance.
2. The Contractor shall be certain that all installation work areas are secure and made safe in accordance with Occupational Safety and Health Administration (OSHA) regulations.
3. An appropriate construction schedule shall be developed by the Contractor and will be subject to approval by the customer's representatives. The construction schedule is should include at least one installation supervisor, or lead technician, for on-site management of the project.
4. Prior to starting the installation, the assigned installation supervisor, or lead technician, shall participate in a "walk-through" of the project location with the customer's representatives to review the installation documentation, verify that all construction necessary for the installation has been completed, and verify all installation methods and cable routes.
5. The Contractor shall be responsible for completing a standardized report form addressing the weekly progress of the installation schedule.
6. The Contractor shall maintain conductor polarity identification at the main equipment room, backbone, and horizontal connections in accordance with industry practices.
7. The Contractor shall provide any necessary screws, anchors, clamps, tie wraps, distribution rings, miscellaneous grounding and support hardware, etc., necessary to facilitate the installation of the system.
8. The Contractor shall be responsible for labeling all cable, distribution frames, and outlet locations, according to industry standards.
9. It shall be the responsibility of the installation Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
10. The Contractor shall not roll or store cable reels without an appropriate underlay.
11. The Contractor shall not place any distribution cabling alongside power lines, or share the same conduit, channel or sleeve with electrical apparatus.

12. The Contractor shall insure that the maximum pulling tensions of the specified distribution cables are not exceeded at any time during the placement facilities. Failure to follow the appropriate guidelines may require the Contractor to provide additional material and labor necessary to properly rectify the situation. This shall also apply to any and all damages sustained to the cables by the installation Contractor during the implementation.
13. The Contractor shall plug conduits where cabling has been installed by the installation Contractor in the equipment rooms, backbone and other cable entrance locations with re-enterable duct seal of flame retardant putty.
14. Materials shall be consistent throughout the building. Where two or more units of the same class of equipment are required, these units shall be the product of a single manufacturer and shall be the same product with the same material, model, and manufacturer number.
15. Wiring, materials, and equipment will be delivered and stored in a clean dry space. They will be properly packaged in factory fabricated type containers and protected from damaging fumes, construction debris and traffic until job completion.
16. The wiring, materials, and equipment furnished for this request shall be essentially the standard product of the manufacturer.
17. All installation techniques and fixtures shall result in ease of maintenance and ready access to all components for testing measurements. All external screws, nuts, and locking washers shall be stainless steel. No self-tapping screws shall be used unless specifically approved by the customer's representatives. All parts shall be made of corrosion resistant material, such as plastic, anodized aluminum or brass. All materials used in installation shall be resistant to fungus growth and moisture deterioration. An inert dielectric material shall separate dissimilar metals apt to corrode through electrolysis under the environmental operating conditions specified.
18. The Contractor will submit for approval, a detailed description of the procedures and equipment included for the complete operational installation.

B. Wiring Plan Requirements

1. Distribution of the cabling will be accomplished through cable trays, conduit raceways, ducts, core-holes, extended columns, false half columns and plenums. Cabling shall be run at right angles from cable trays. Horizontal cable segments will be placed in cable trays and with cable exits/entrances supported by distribution rings or J Hooks. Cable may not rest on ceiling tile, be supported on existing ducting nor interlaced with existing cable.
2. The Contractor shall be responsible for providing an approved ground at all equipment locations. The Contractor shall also be responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, and frameworks. All grounds shall consist of minimum 12 AWG copper wire or larger as required by code and shall be supplied from an approved building ground and bonded to the main electrical ground.
3. Observe proper circuit and loudspeaker wiring polarity. Properly and clearly label connections and wires as to function and polarity. No cables will be wired with polarity reversal between connectors, at either end. Take care when wiring microphone cables to ensure that constant polarity is maintained.

C. Identification, Labeling and Documentation

1. The Contractor shall label all termination devices, panels, enclosures and equipment rooms. The Contractor will mark each unit with permanently attached, self-laminating markings that will not impair the equipment or present a hazard to maintenance personnel.
2. Place wire identification numbers on each end of all conductors. Install markers to be readable from left to right or top to bottom. Wire numbers shall be computer printed. Hand written labels are not acceptable.

3. Mark all spare conductors and coiled neatly located at the bottom of the equipment rack.

3.2 TESTING REQUIREMENTS

A. The Contractor shall perform sample tests in the presence of the customer's representatives. Performing the testing procedures specified herein assures that the equipment and interconnection meets the performance characteristics specified. If testing indicates that the performance characteristics are not met, the test shall be declared a failure. The communication equipment and interconnection cabling shall be modified and/or repaired accordingly. The failed test and any other test that may be affected by the modification and/or repair shall be rerun. After all components have been installed, the integrity of the equipment and interconnection cabling shall be verified.

B. If system test fails because of any component(s) in the system, the failed component(s) shall be corrected or substituted with other components and the tests shall be repeated. If a component has been modified because of the system test failure, a report shall be prepared and delivered to customer's representatives prior to retesting. The Contractor shall prepare and submit all test procedures and data forms for the post installation and system test to the customer's representatives.

C. The test report shall contain the description of all tests performed, the results obtained, and any required adjustments or modifications necessary because of testing and installation. This report shall reflect the as-built communication equipment and interconnection cabling. An authorized representative of the Contractor shall sign the test report. At least three copies of the test report shall be sent to the customer's representatives.

D. The test procedures shall have the customer's representative's approval before the tests.

E. Contractor shall demonstrate to the customer's representatives that the equipment operates as specified and that the tests meet performance requirements.

F. The Contractor shall insure that the equipment is in first-class working condition and free of short circuits, ground loops, parasitic oscillations, excessive hum, RF interference, or instability of any form.

G. The Contractor shall test each operational component and adjust for equal sound levels at a given volume setting and replace defective items.

H. Contractor shall ensure that all loudspeaker and distributed audio systems described herein are balanced and optimized for maximum quality sound and coverage of listening areas.

3.3 TRAINING

A. System training shall be provided for the operator/user and technical staff.

1. Operator/user training shall consist of two, one-hour sessions. The training time is calculated solely on onsite training activity and does not include Contractor traveling time.
2. Technical operation and maintenance training session shall consist of two two-hour sessions. The training time is calculated solely on onsite training activity and does not include Contractor traveling time.

B. Complete operation and maintenance manuals and preliminary as-built drawings shall be delivered to the Owner one week prior to training sessions.

C. Operator/user training shall minimally consist of:

1. Provide printed reference material for each trainee that documents and explains in layman's terms:
2. System block diagram
3. Normal day-to-day operation
4. Operator selectable features
5. Provide a hands-on training with Q & A session

D. Technical Operations and Maintenance training shall consist of:

1. The technical explanation shall be sufficiently thorough that staff personnel shall be able to make any programming changes required, analyze malfunctions and make equipment substitutions or bypasses necessary to maintain system operation except for the malfunctioning equipment or circuits.
2. Provide printed reference material for each trainee that documents and explains in technical terms:
   a. System block diagram with technical features
   b. Technical operation, adjustments and programming
   c. System features and programming
3. Review of as-built drawings.
4. Provide a hands-on training with Q & A session.

E. Contractor will provide a complete and comprehensive list of the maintenance schedule for all installed and/or provided equipment. The list shall be provided in both printed and Adobe Acrobat formats.

3.4 ACCEPTANCE OF SYSTEMS

A. Specifications set forth for construction of the system have been devised to insure system compatibility and performance. Compliance to these specifications will be determined during periodic observances of construction. Repeated failure to comply with the specification will be considered before the initial acceptance phase of the plant commences.

B. Prior to Contractor performed final testing, deliver preliminary as-build documents to Owner for use in conducting testing observation.

C. Project Record Documentation

1. Upon completion of final engineering and incorporation of the Architect review comments, Contractor will provide to the Architect for its records the following close out documentation:
   a. Record or As Build Drawings which shall include but not limited to:
      1) Functional block diagrams for each Integrated Audio-Video System
      2) All Integrated Audio-Video or Audio-Visual junction box locations
      3) Audio Visual equipment rack locations
      4) Rack elevations
         a) Rack elevations shall show all components as installed under this contract.
         b) Contractor will label each component describing the component. (Examples: Cafeteria Amplifier or Gymnasium DSP etc).
      5) Floor plan drawings with device locations and associated assigned item number.
      6) Mounting detail for equipment and hardware.

7) Schedule of all devices with associated panel termination, zoning, power circuits, etc.
8) Corrected product submittal information

b. A complete inventory list of installed products shall include:
1) Manufacture Name
2) Model Number
3) Serial Number
4) Room number and/or description of installed location

c. Operation and Maintenance Manuals shall include
1) Include detailed procedures for system operation that begin with startup procedures and continue through system shut down referenced in section 3.3 Training.
2) List of manufacture recommended maintenance and intervals with manufacture support contact information.

D. Drawings will contain the Contractors own title block on the edge of the drawing and will include the company name, address, phone number and date of the final drawings.

2. Use of any part of the Architect title block is not acceptable at any time.

E. Drawing documentation will be in the following format:

1. Two (2) electronic copies, one per flash drive shall be provided.
a. Drawings will be in both CAD (DWG) and PDF format and the Contractor will include all files on each drive.
b. File transfer is acceptable.
2. Drawings shall be provided to the architect two weeks prior to the final testing and commissioning of the system. Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.
3. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Drawings rejected for any reason will delay the final acceptance process until resolved.

F. Testing Results

1. In addition to the project record drawings, the Contractor shall provide the testing information for all audio-visual cabling.
a. Test results shall be provided to the architect two weeks prior to expected final acceptance of the system(s). Coordinate with the Owner during the pre-construction meeting for low voltage Contractors to schedule this delivery date.
b. The drawings will be reviewed on site with the architect and the Owner prior to the final acceptance process. Test results rejected for any reason will delay the final acceptance process until resolved.

G. Once accepted by the architect and Owner all documentation / program code becomes the property of the Owner

H. Within ten days receipt of the final acceptance notice, the Owner's representatives shall schedule and perform the final inspection. When the work is found acceptable under the contract documents and the contract is fully performed, declare the project complete.

3.5 WARRANTY

A. The Contractor shall warrant and guarantee all work against defects in material, equipment or workmanship for one (1) year from the date of substantial completion of the entire project.

B. Upon receipt of written notice, Contractor shall remedy defects within thirty (30) days or the Owner shall correct the defects and the Contractor, or its surety shall be liable for expenses.

END OF SECTION

SECTION 27 51 23.20
COMMERCIAL INTERCOMMUNICATIONS AND PROGRAM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes intercommunications and program systems with the following components:
1. Master stations.
2. Speaker-microphone stations.
3. Video-speaker-microphone stations.
4. Call-switch unit.
5. All-call amplifier.
6. Intercommunication amplifier.
7. Loudspeakers/speaker microphones.
8. Conductors and cables.
9. Raceways.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For intercommunications and program systems.
1. Include plans, elevations, sections, and attachment details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include scaled drawings for master station and speaker-microphone station that detail built-in equipment.
4. Include diagrams for power, signal, and control wiring.
a. Identify terminals to facilitate installation, operation, and maintenance.
b. Single-line diagram showing interconnection of components.
c. Cabling diagram showing cable routing.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:
1. Reflected ceiling plans, drawn to scale, on which ceiling-mounted items including luminaires, diffusers, grilles, speakers, sprinklers, access panels, and special moldings are shown and coordinated with each other, using input from installers of the items involved.
2. Elevation drawings, drawn to scale, on which wall-mounted items including luminaires, intercommunications components, windows, doors, access panels, wall finishes, trims, piping, and conduit are shown and coordinated with each other, using input from installers of the items involved.

B. Qualification Data: For Installer and testing agency.

C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For intercommunications and program systems to include in operation and maintenance manuals.
   1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:
      a. A record of Owner's equipment-programming option decisions.
      b. Plans, drawn to scale, indicating location, designation, and connection of intercommunications system components.

B. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On USB media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified agency, with the experience and capability to conduct testing indicated.
   1. Testing Agency's Field Supervisor: Certified by NICET as Audio Systems Level II Technician.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted speaker microphones with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Equipment: Modular, using solid-state components, fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power supplied at 110 to 130 V, 60 Hz without requirement of any external power conditioning equipment.

B. Expansion Capability: Increase number of stations in the future by 25 percent above those indicated without adding any internal or external components or main backbone cable conductors.

C. Integration: Coordinate features and select components to form an integrated system. Match components and interconnections for optimum performance of specified functions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

2.2 FUNCTIONAL DESCRIPTION OF MANUALLY SWITCHED SYSTEMS

A. Master Station:
1. Communicating selectively with other master and speaker-microphone stations by actuation of selector switches.
2. Communicating with all other stations by actuation of a single all-call switch.
3. Communicating with individual stations in privacy.
4. Include other master-station connections in a multiple-station conference call.
5. Access separate paging speakers or groups of paging speakers by actuation of selector switches.
6. Conversation override by a designated master station.
7. Visual monitoring of CCTV camera viewing area of video-speaker-microphone stations.
8. Remote door lock and access control function.

B. Speaker-Microphone Station:
1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations shall have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Hands-free communication.
3. Calling master station by actuation of call switch.
4. Returns a busy signal to indicate that master station is already in use.
5. Free of noise and distortion during operation and when in standby mode.
6. Embedded HID or Weigand-formatted, proximity-type, access control card reader.
7. Remote door lock and access control function, controlled by master station.

C. Video-Speaker-Microphone Station:
1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations shall have a privacy switch to prevent another station from listening and to permit incoming calls. Illuminated signal to indicate video monitoring.
2. Color CCD video camera and illumination LED for low-light conditions.
3. Embedded HID or Weigand-formatted, proximity-type, access control card reader.
4. Remote door lock and access control function, controlled by master station.
5. Hands-free communication.
6. Calling master station by actuation of call switch.
7. Returns a busy signal to indicate that station is already in use.
8. Free of noise and distortion during operation and when in standby mode.

2.3 FUNCTIONAL DESCRIPTION OF MICROPROCESSOR-SWITCHED SYSTEMS

A. Master Station:
1. Communicating selectively with other master and speaker-microphone stations by dialing station's number on a 12-digit keypad.
2. Communicating simultaneously with all other stations by dialing a designated number on a 12-digit keypad.
3. Communicating with individual stations in privacy.
4. Include other master-station connections in a multiple-station conference call.
5. Access separate paging speakers or groups of paging speakers by dialing designated numbers on a 12-digit keypad.
6. Override any conversation by a designated master station.
7. Display selected station.

8. Video monitoring of all call stations on actuation of call switch.
9. Remote door lock and access control function.

B. Speaker-Microphone Station:
1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls.
2. Hands-free communication.
3. Calling master station by actuation of call switch.
4. Return a busy signal to indicate that station is already in use.
5. Free of noise and distortion during operation and when in standby mode.
6. Embedded HID or Weigand-formatted, proximity-type, access control card reader.

C. Video-Speaker-Microphone Station:
1. Remote Monitoring: Initiated without a warning tone signal at monitored station. Designated speaker-microphone stations have a privacy switch to prevent another station from listening and to permit incoming calls. Illuminated signal to indicate video monitoring.
2. Color CCD video camera and illumination LED for low-light conditions.
3. Embedded HID or Weigand-formatted, proximity-type, access control card reader.
4. Remote door lock and access control function, controlled by master station.
5. Hands-free communication.
6. Calling master station by actuation of call switch.
7. Returns a busy signal to indicate that station is already in use.
8. Free of noise and distortion during operation and when in standby mode.

2.4 MASTER STATION FOR MANUALLY SWITCHED SYSTEMS

A. Station-Selector and Talk-Listen Switches: Heavy-duty type with gold-plated contacts rated for five million operations.

B. Volume Control: Regulates incoming-call volume.

C. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.

D. Tone Annunciation: Momentary audible tone signal announces incoming calls.

E. Speaker Microphone: Transmits and receives calls.

F. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

G. Color LCD video screen for monitoring of CCD cameras integral to call stations.

H. Equipment Cabinet: Comply with ECA/EIA-310-E. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and auxiliary equipment.

2.5 MASTER STATION FOR MICROPROCESSOR-SWITCHED SYSTEMS

A. 12-Digit Keypad Selector: Transmits calls to other stations and initiates commands for programming and operation.

B. Volume Control: Regulates incoming-call volume.

C. LED Annunciation: Identifies calling stations and stations in use. LED remains on until call is answered.

D. Tone Annunciation: Momentary audible tone signal announces incoming calls.

E. Color LCD video screen for monitoring of CCD cameras integral to call stations.

F. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

G. Reset Control: Cancels call and resets system for next call.

H. Equipment Cabinet: Comply with ECA/EIA-310-E. Lockable, ventilated metal cabinet houses terminal strips, power supplies, amplifiers, system volume control, and other switching and control devices required for conversation channels and control functions.

2.6 SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Back Box: Two-gang galvanized steel with 2-1/2-inch minimum depth.

D. Speaker: 3 inches, 2.3 oz. minimum; permanent magnet.

E. Tone Annunciation: Recurring momentary tone indicates incoming calls.

F. Call Switch: Mount on faceplate. Permits calls to master station.

G. Privacy Switch: Mount on faceplate. When in on position, switch prevents transmission of sound from remote station to system; when in off position, without further switch manipulation, response can be made to incoming calls.

H. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.7 VIDEO-SPEAKER-MICROPHONE STATIONS

A. Mounting: Flush unless otherwise indicated, and suitable for mounting conditions indicated.

B. Faceplate: Stainless steel or anodized aluminum with tamperproof mounting screws.

C. Back Box: Custom size provided by manufacturer for flush mounting of station device.

D. Wide-angle camera with digital pan-tilt-zoom functions and automatic light adjustment to compensate for varying ambient light levels. Camera lens shall provide a minimum viewing angle of 170 degrees horizontal and 100 degrees vertical.

E. LED Lamp: Indicates video activation and provides illumination during low-light conditions.

F. Speaker: 3 inches, 2.3 oz. minimum; permanent magnet.

G. Tone Annunciation: Recurring momentary tone indicates incoming calls.

H. Call Switch: Mount on faceplate. Permits calls to master station.

2.8 CALL-SWITCH UNIT

A. Enclosure: Single-gang box with stainless-steel faceplate.

B. Call Switch: Momentary contact signals system that a call has been placed.

C. Privacy Switch: Prevents transmission of sound signals from station to system.

D. Volume Control: Operated by screwdriver blade through a hole in faceplate to adjust output level of associated speaker.

E. Handset with Hook Switch: Telephone type with 18-inch- long, permanently coiled cord. Arrange to disconnect speaker when handset is lifted.

2.9 ALL-CALL AMPLIFIER

A. Output Power: 70-V balanced line. 80 percent of the sum of wattage settings of connected for each station and speaker connected in all-call mode of operation, plus an allowance for future stations.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to quantity of stations connected in all-call mode of operation.

C. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 12,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Compatible with master stations and central equipment so amplifier delivers full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.10 INTERCOMMUNICATION AMPLIFIER

A. Minimum Output Power: 2 W; adequate for all functions.

B. Total Harmonic Distortion: Less than 5 percent at rated output power with load equivalent to one station connected to output terminals.

C. Minimum Signal-to-Noise Ratio: 45 dB, at rated output.

D. Frequency Response: Within plus or minus 3 dB from 70 to 10,000 Hz.

E. Output Regulation: Maintains output level within 2 dB from full to no load.

F. Input Sensitivity: Matched to input circuit and to provide full-rated output with sound-pressure level of less than 10 dynes/sq. cm impinging on master stations, speaker microphones, or handset transmitters.

G. Amplifier Protection: Prevents damage from shorted or open output.

2.11 CONE-TYPE LOUDSPEAKERS

A. Minimum Axial Sensitivity: 91 dB at 3 feet, with 1-W input.

B. Frequency Response: Within plus or minus 3 dB from 70 to 15,000 Hz.

C. Minimum Dispersion Angle: 100 degrees.

D. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

E. Enclosures: Steel housings or back boxes, acoustically dampened, with front face of at least 0.0478-inch steel and whole assembly rust proofed and factory primed; complete with mounting assembly and suitable for surface ceiling, flush ceiling, pendant, or wall mounting; with relief of back pressure.

F. Baffle: For flush speakers, minimum thickness of 0.032-inch aluminum.

G. Vandal-Proof, High-Strength Baffle: For flush or surface-mounted speakers, self-aging cast aluminum with tensile strength of 44,000 psi, 0.025-inch minimum thickness; countersunk heat-treated alloy mounting screws; and textured white epoxy finish.

H. Size: 8 inches with 1-inch voice coil and minimum 5-oz. ceramic magnet.

2.12 HORN-TYPE LOUDSPEAKERS

A. Speakers shall be all-metal, weatherproof construction; complete with universal mounting brackets.

B. Frequency Response: Within plus or minus 3 dB from 275 to 14,000 Hz.

C. Minimum Power Rating of Driver: 15 W, continuous.

D. Minimum Dispersion Angle: 110 degrees.

E. Line Transformer: Maximum insertion loss of 0.5 dB, power rating equal to speaker's, and at least four level taps.

2.13 HORN-TYPE EXPLOSION-PROOF LOUDSPEAKERS

A. Speakers shall be all-metal construction; complete with universal mounting brackets.

B. Units in Hazardous (Classified) Locations: Listed and labeled for environment in which they are located.

C. Frequency Response: Within plus or minus 3 dB from 300 to 12,000 Hz.

D. Minimum Power Rating of Driver: 30 W, continuous.

E. Minimum Dispersion Angle: 95 degrees.

F. Line Transformer: Internally mounted and factory installed, power rating equal to speaker's, and at least four level taps.

2.14 CONDUCTORS AND CABLES

A. Conductors: Jacketed, twisted pair and twisted multipair, untinned solid copper. Sizes as recommended by system manufacturer, but no smaller than No. 22 AWG.

B. Insulation: Thermoplastic, not less than 1/32 inch thick.

C. Shielding: For speaker-microphone leads and elsewhere where recommended by manufacturer; No. 34 AWG, tinned, soft-copper strands formed into a braid or equivalent foil.
   1. Minimum Shielding Coverage on Conductors: 60 percent.

D. Plenum Cable: Listed and labeled for plenum installation.

2.15 RACEWAYS

A. Intercommunication and Program System Raceways and Boxes: Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

B. Intercommunication and Program System Raceways and Boxes: Same as required for electrical branch circuits specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

C. Intercommunication and Program System Raceways and Boxes:
   1. Raceways: EMT
   2. Boxes:
      a. NEMA 250
   3. Faceplates:
      a. Stainless steel

D. Outlet boxes shall be not less than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

E. Flexible metal conduit is prohibited.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.

2. Comply with requirements for raceways and boxes specified in Section 26 05 33 "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.2 INSTALLATION OF RACEWAYS

A. Comply with requirements in Section 26 05 33 "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

B. Install manufactured conduit sweeps and long-radius elbows whenever possible.

3.3 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements:
1. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at outlets and terminals.
2. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
3. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
5. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used.

C. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunication spaces with terminating hardware and interconnection equipment.
2. Suspend cable not in a wireway or pathway a minimum of 8 inches above ceiling by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or be in contact with pipes, ducts, or other potentially damaging items.

D. Separation of Wires: Separate speaker-microphone, line-level, speaker-level, video, and power wiring runs. Install in separate raceways or, where exposed or in same enclosure, separate conductors at least 12 inches apart for speaker microphones and adjacent parallel power and telephone wiring. Separate other intercommunication equipment conductors as recommended by equipment manufacturer.

3.4 INSTALLATION

A. Match input and output impedances and signal levels at signal interfaces. Provide matching networks where required.

B. Identification of Conductors and Cables: Color-code conductors and apply wire and cable marking tape to designate wires and cables so they identify media in coordination with system wiring diagrams.

C. Weatherproof Equipment: For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

D. Speaker-Line Matching Transformer Connections: Make initial connections using tap settings indicated on Drawings.

E. Connect wiring according to Section "Low-Voltage Electrical Power Conductors and Cables."

F. Mounting of Stations: Surface mount at 54 inches above finished floor to center of station unless otherwise indicated.

3.5 GROUNDING

A. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes.

3.6 SYSTEM PROGRAMMING

A. Programming: Fully brief Owner on available programming options. Record Owner's decisions and set up initial system program. Prepare a written record of decisions, implementation methodology, and final results.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Schedule tests with at least seven days' advance notice.
   2. After installing intercommunications and program systems and after electrical circuitry has been energized, test for compliance with requirements.
   3. Operational Test: Test originating station-to-station, all-call, video display, and page messages at each intercommunication station. Verify proper routing and volume levels and that system is free of noise and distortion. Test each available message path from each station on system.

4. Frequency Response Test: Determine frequency response of two transmission paths, including all-call and paging, by transmitting and recording audio tones. Minimum acceptable performance is within 3 dB from 150 to 2500 Hz.
5. Signal-to-Noise Ratio Test: Measure signal-to-noise ratio of complete system at normal gain settings as follows:
    a. Disconnect speaker microphone and replace it in the circuit with a signal generator using a 1000-Hz signal. Measure signal-to-noise ratio at paging speakers.
    b. Repeat test for four speaker microphones and for each separately controlled zone of paging loudspeakers.
    c. Minimum acceptable ratio is 35 dB.
6. Distortion Test: Measure distortion at normal gain settings and rated power. Feed signals at frequencies of 150, 200, 400, 1000, and 2500 Hz into each paging and all-call amplifier, and a minimum of two selected intercommunication amplifiers. For each frequency, measure distortion in the paging and all-call amplifier outputs. Maximum acceptable distortion at any frequency is 5 percent total harmonics.
7. Acoustic Coverage Test: Feed pink noise into system using octaves centered at 500 and 4000 Hz. Use sound-level meter with octave-band filters to measure level at three locations in each paging zone. Maximum permissible variation in level is plus or minus 3 dB; in levels between adjacent zones, plus or minus 5 dB.
8. Signal Ground Test: Measure and report ground resistance at system signal ground.

D. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Prepare a list of final tap settings of paging speaker-line matching transformers.

E. Intercommunications and program systems will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports.

3.8 STARTUP SERVICE

A. Perform startup service and initial system programming.
1. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements.
2. Complete installation and startup checks according to manufacturer's written instructions.

3.9 ADJUSTING

A. On-Site Assistance: Engage a factory-authorized service representative to provide on-site assistance in adjusting sound levels, resetting transformer taps, and adjusting controls to meet occupancy conditions.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the intercommunications and program systems.

1. Train Owner's maintenance personnel on programming equipment for starting up and shutting down, troubleshooting, servicing, and maintaining the system and equipment.

END OF SECTION

SECTION 28 31 11

DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Non-system smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Remote annunciator.
8. Addressable interface device.
9. Network communications.

B. Related Requirements:

1. Section 28 05 13 "Conductors and Cables for Electronic Safety and Security" for cables and conductors for fire-alarm systems.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

E. PC: Personal computer.

F. VESDA: Very Early Smoke-Detection Apparatus.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.

2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
12. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
    f. Show air-sampling detector pipe routing.

13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level IV minimum.
    c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Seismic Qualification Certificates: For fire-alarm control unit, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Field quality-control reports.

1.6 Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01 78 23 "Operation and Maintenance Data," include the following:

a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
d. Riser diagram.
e. Device addresses.
f. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.
g. Record copy of site-specific software.
h. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

1) Equipment tested.
2) Frequency of testing of installed components.

3) Frequency of inspection of installed components.
4) Requirements and recommendations related to results of maintenance.
5) Manufacturer's user training manuals.

i. Manufacturer's required maintenance related to system warranty requirements.
j. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.
8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

E. NFPA Certification: Obtain certification according to NFPA 72 in the form of a placard by an FM Global-approved alarm company.

F. NFPA Certification: Obtain certification according to NFPA 72 by.

1.10 PROJECT CONDITIONS

A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.

B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Construction Manager no fewer than seven days in advance of proposed interruption of fire-alarm service.
2. Do not proceed with interruption of fire-alarm service without Construction Manager's written permission.

C. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.11 SEQUENCING AND SCHEDULING

A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.12 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices:

1. Manual stations.
2. Heat detectors.
3. Flame detectors.
4. Smoke detectors.
5. Duct smoke detectors.
6. Air-sampling smoke-detection system (VESDA).
7. Carbon monoxide detectors.
8. Combustible gas detectors.
9. Automatic sprinkler system water flow.
10. Preaction system.
11. Fire-extinguishing system operation.
12. Fire standpipe system.
13. Dry system pressure flow switch.
14. Fire pump running.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate smoke-control system (smoke management) at firefighters' smoke-control system panel.
9. Activate stairwell and elevator-shaft pressurization systems.
10. Close smoke dampers in air ducts of designated air-conditioning duct systems.
11. Activate preaction system.
12. Recall elevators to primary or alternate recall floors.
13. Activate elevator power shunt trip.
14. Activate emergency lighting control.
15. Activate emergency shutoffs for gas and fuel supplies.
16. Record events in the system memory.
17. Record events by the system printer.
18. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Alert and Action signals of air-sampling detector system.
4. Elevator shunt-trip supervision.
5. Fire pump running.
6. Fire-pump loss of power.

7. Fire-pump power phase reversal.
8. Independent fire-detection and -suppression systems.
9. User disabling of zones or individual devices.
10. Loss of communication with any panel on the network.

D. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.
10. Voice signal amplifier failure.
11. Hose cabinet door open.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit.
3. Record the event on system printer.
4. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
5. Transmit system status to building management system.
6. Display system status on graphic annunciator.

2.3 FIRE-ALARM CONTROL UNIT

A. Manufacturers:
1. FCI
2. SimplexGrinnell LP.
3. Notifier
4. (Owner Selection)

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.

a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder and printer.
c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
d. The FACP shall be listed for connection to a central-station signaling system service.

e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, two or three] line(s) of 40 or 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

E. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class A or Class B.
2. Pathway Survivability:[Level 0 or Level 1.
3. Install no more than 256 addressable devices on each signaling-line circuit.
4. Serial Interfaces:

a. One dedicated RS 485 port for central-station or remote station operation using point ID DACT.
b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
c. One USB port for PC configuration.
d. One RS 232 port for VESDA HLI connection.
e. One RS 232 port for voice evacuation interface.

F. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
3. Record events by the system printer.
4. Sound general alarm if the alarm is verified.
5. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

G. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

H. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall [be] [not be] connected to fire-alarm system.

I. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

J. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

K. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided.

1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.

    a. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    b. Programmable tone and message sequence selection.
    c. Standard digitally recorded messages for "Evacuation" and "All Clear."
    d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters' two-way telephone communication zones.
3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

L. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

M. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

N. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed lead calcium.

O. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

P. Optional Protective Cabinet
1. A protective cabinet with AC/Heat options for equipment shall be provided as needed to meet the environmental condition limits of NFPA 72 or the equipment may be listed for use outside the environmental condition limits.
   a. STI Metal Protective Cabinet STI-7560AH or approved equal
2. Standby power to operate the artificial conditioning shall be installed to ensure the conditioning continues during a power outage for at least as long as the standby power required for the fire alarm system.
3. Environmental Condition Limits:
   a. At ambient temperatures of 0°C (32°F) and 49°C (120°F)
   b. At a relative humidity of 85 percent and an ambient temperature of 30°C (86°F)

2.4 MANUAL FIRE-ALARM BOXES

A. Manufacturers:
1. SimplexGrinnell LP.
2. Notifier
3. Bosch Security Systems
4. (Owner Selection)

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.
3. Indoor Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
4. Weatherproof Protective Shield: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

2.5 SYSTEM SMOKE DETECTORS

A. Manufacturers:
1. SimplexGrinnell LP.
2. System Sensor
3. Bosch Security Systems
4. (Owner Selection)

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four or two wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition.

    a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg per minute.
    b. Fixed-temperature sensing characteristic of combination smoke- and heat-detection units shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F
    c. Multiple levels of detection sensitivity for each sensor.
    d. Sensitivity levels based on time of day.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.
    b. Device type.
    c. Present average value.
    d. Present sensitivity selected.
    e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 CARBON MONOXIDE DETECTORS

A. General: Carbon monoxide detector listed for connection to fire-alarm system.

1. Mounting: Adapter plate for outlet box mounting.
2. Testable by introducing test carbon monoxide into the sensing cell.
3. Detector shall provide alarm contacts and trouble contacts.
4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
5. Comply with UL 2075.
6. Locate, mount, and wire according to manufacturer's written instructions.
7. Provide means for addressable connection to fire-alarm system.
8. Test button simulates an alarm condition.

2.7 HEAT DETECTORS

A. Manufacturers:
1. SimplexGrinnell LP.
2. System Sensor
3. Bosch Security Systems
4. (Owner Selection)

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.

1. Mounting: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: [Adapter plate for outlet box mounting] [Twist-lock base interchangeable with smoke-detector bases].
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

E. Continuous Linear Heat-Detector System:

1. Detector Cable: Rated detection temperature 155 deg F. Listed for "regular" service and a standard environment. Cable includes two steel actuator wires twisted together with spring pressure, wrapped with protective tape, and finished with PVC outer sheath. Each actuator wire is insulated with heat-sensitive material that reacts with heat to allow the cable twist pressure to short circuit wires at the location of elevated temperature.
2. Control Unit: Two-zone or multizone unit as indicated. Provide same system power supply, supervision, and alarm features as specified for fire-alarm control unit.
3. Signals to Fire-Alarm Control Unit: Any type of local system trouble shall be reported to fire-alarm control unit as a composite "trouble" signal. Alarms on each detection zone

shall be individually reported to central fire-alarm control unit as separately identified zones.

4. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

A. Manufacturers:
   1. SimplexGrinnell LP.
   2. Gentex Corp.
   3. Siemens Industry, Inc.
   4. (Owner Selection)

B. General Requirements for Notification Appliances: Individually addressed, connected to a signaling-line circuit, equipped for mounting as indicated, and with screw terminals for system connections.

C. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

D. Chimes, Low-Level Output: Vibrating type, 75-dBA minimum rated output.

E. Chimes, High-Level Output: Vibrating type, 81-dBA minimum rated output.

F. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

G. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

   1. Rated Light Output:
      a. 15/30/75/110 cd, selectable in the field.

   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.
   6. Mounting Faceplate: Factory finished, red or white.

H. Voice/Tone Notification Appliances:

   1. Comply with UL 1480.
   2. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.

3. High-Range Units: Rated 2 to 15 W.
4. Low-Range Units: Rated 1 to 2 W.
5. Mounting: Flush.
6. Matching Transformers: Tap range matched to acoustical environment of speaker location.

I. Exit Marking Audible Notification Appliance:

1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
2. Provide exit marking audible notification appliances at the entrance to all building exits.
3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.

2.9 GRAPHIC ANNUNCIATOR

A. Manufacturers:
1. SimplexGrinnell LP
2. Siemons Industry, Inc.
3. GE UTC Fire & Security
4. (Owner Selection)

B. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch-thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.

1. Comply with UL 864.
2. Operating voltage shall be 24-V dc provided by a local 24-V power supply provided with the annunciator.
3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
4. Surface mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
5. Graphic representation of the facility shall be a CAD drawing and each detector shall be represented by an LED in its actual location. CAD drawing shall be at 1/8-inch per foot scale or larger.
6. The LED representing a detector shall flash two times per second while detector is an alarm.

C. Graphic Annunciator Workstation: PC-based, with fire-alarm annunciator software with historical logging, report generation, and a graphic interface showing all alarm points in the system. PC with operating system software, minimum hard drive, <Insert inches digital display monitor, with wireless keyboard and mouse.

2.10 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.
2. Store an internal identifying code for control panel use to identify the module type.
3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.

C. Integral Relay: Capable of providing a direct signal.

1. Allow the control panel to switch the relay contacts on command.
2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.11 NETWORK COMMUNICATIONS

A. Provide network communications for fire-alarm system according to fire-alarm manufacturer's written requirements.

B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.

C. Provide integration gateway using [BACnet] [Modbus] <Insert protocol> for connection to building automation system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.

B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.

B. Connecting to Existing Equipment: Verify that existing fire-alarm system is operational before making changes or connections.

1. Connect new equipment to existing control panel in existing part of the building.
2. Connect new equipment to existing monitoring equipment at the supervising station.
3. Expand, modify, and supplement existing monitoring equipment as necessary to extend existing monitoring functions to the new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.

C. Equipment Mounting: Install fire-alarm control unit on finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

D. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.

1. Comply with requirements for seismic-restraint devices specified in Section 26 05 48.16 "Seismic Controls for Electrical Systems."

E. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

F. Smoke- or Heat-Detector Spacing:

1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.

G. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

H. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches long shall be supported at both ends.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

J. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

K. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

N. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

A. Pathways above recessed ceilings and in no accessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.4 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 08 71 00 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Alarm-initiating connection to smoke-control system (smoke management) at firefighters' smoke-control system panel.
2. Alarm-initiating connection to stairwell and elevator-shaft pressurization systems.
3. Smoke dampers in air ducts of designated HVAC duct systems.
4. Magnetically held-open doors.
5. Electronically locked doors and access gates.
6. Alarm-initiating connection to elevator recall system and components.
7. Alarm-initiating connection to activate emergency lighting control.

8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
9. Supervisory connections at valve supervisory switches.
10. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
11. Supervisory connections at elevator shunt-trip breaker.
12. Data communication circuits for connection to building management system.
13. Data communication circuits for connection to mass notification system.
14. Supervisory connections at fire-extinguisher locations.
15. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.
16. Supervisory connections at fire-pump engine control panel.

3.5 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 26 05 53 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction and engineer.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Visual Inspection: Conduct visual inspection prior to testing.

    a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.

4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

F. Fire-alarm system will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION

SECTION 31 10 00

SITE CLEARING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:

1. Protecting existing vegetation to remain.

2. Removing existing vegetation.

3. Clearing and grubbing.

4. Stripping and stockpiling topsoil.

5. Removing above- and below-grade site improvements.

6. Disconnecting, capping, or sealing site utilities.

7. Temporary erosion and sedimentation control.

1.2 RELATED SECTIONS

A. 015639 – TEMPORARY TREE AND PLANT PROTECTION

B. 015713 – TEMPORARY EROSION AND SEDIMENT CONTROL

C. 312000- EARTH MOVING

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.5 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."

PART 2 PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.4 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1.Notify Engineer not less than two days in advance of proposed utility interruptions.

2. Do not proceed with utility interruptions without Engineer's written permission.

C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.

2. Use only hand methods or air spade for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth indicated on Drawings of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 20 00

EARTH MOVING

PART 1 GENERAL

1.1 SUMMARY

A. The Section Includes:

1. Excavating and filling for rough grading the Site.

2. Preparing subgrades for, slabs-on-grade, walks, pavements, turf, and grasses, and plants.

3. Excavating and backfilling for buildings and structures.

4. Drainage course for concrete slabs-on-grade.

5. Subbase course for concrete walks, pavements.

6. Subbase course and base course for asphalt paving.

7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct pre-excavation conference at Project site.

1.4 INFORMATIONAL SUBMITTALS

A. Material test reports.

1.5 FIELD CONDITIONS

A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

B. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.

PART 2 PRODUCTS

1.6 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 294/D 2940M 0; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

1. Arkansas Highway and Transportation Department Class 7 Aggregate Base Course (ABC)

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

1.7 ACCESSORIES

A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored to comply with local practice or requirements of authorities having jurisdiction.

B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal

detector when tape is buried up to 30 inches deep; colored to comply with local practice or requirements of authorities having jurisdiction.

PART 3 EXECUTION

1.8 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

1.9 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

1.10 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

1.11 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

1.12 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:

1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

1.13 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired dump truck to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

1.14 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

1.15 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

1.16 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Section 321313 " Concrete Pavement."

D. Trenches under Roadways: Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Section 321313 " Concrete Pavement."

E. Initial Backfill: Place and compact initial backfill of subbase material or satisfactory soil, free of particles larger than 1 inch any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

F. Final Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.

G. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

1.17 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontals so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.

2. Under walks and pavements, use satisfactory soil material.

3. Under steps and ramps, use engineered fill.

4. Under building slabs, use engineered fill.

5. Under footings and foundations, use engineered fill.

1.18 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.

2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

1.19 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698/ASTM D 1557:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.

2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.

3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.

4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

1.20 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:

1. Turf or Unpaved Areas: Plus or minus 1 inch.

2. Walks: Plus or minus 1 inch.

3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

1.21 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:

1. Shape subbase course and base course to required crown elevations and cross-slope grades.

2. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.

3. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698/ASTM D 1557.

1.22 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:

1. Place drainage course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches.

2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

1.23 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform inspections:

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

1.24 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

1.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION

SECTION 31 21 16

TRENCHING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:

1. Excavating trenches for piped utilities.

B. Related Sections:

1. Section 312000 – Earthwork: For backfilling and compaction of utility trenches.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

2.ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

3. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.

4. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).

5. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

6. ASTM D6938 - 10 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 DEFINITIONS

A. Utility: Any buried pipe, duct, conduit, or cable.

1.4 SUBMITTALS

A. Section 013000 – Administrative Requirements: Requirements for submittals.

B. Excavation Protection Plan: Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations to support plan.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with all applicable codes, and City of Fayetteville Ordinances.

1.6 QUALIFICATIONS

A. Prepare excavation protection plan under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Arkansas.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.8 COORDINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Verify Work associated with lower elevation utilities is complete before placing higher elevation utilities.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 LINES AND GRADES

A. Lay pipes to lines and grades indicated on Drawings.

1. Engineer reserves right to make changes in lines, grades, and depths of utilities when changes are required for Project conditions.

B. Use laser-beam instrument with qualified operator to establish lines and grades.

3.2 PREPARATION

A. Call “One Call”, the local utility information service at 811 not less than three (3) working days before performing Work.

1. Request underground utilities to be located and marked within and surrounding construction areas.

B. Identify required lines, levels, contours, and datum locations.

C. Protect plant life, lawns, and other features remaining as portion of final landscaping.

D. Protect bench marks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic.

E. Maintain and protect above and below grade utilities indicated to remain.

F. Establish temporary traffic control and detours when trenching is performed in public right-of-way. Relocate controls and reroute traffic as required during progress of Work.

3.3 TRENCHING

A. Excavate subsoil required for utilities to utility service.

B. Remove lumped subsoil, boulders, and rock up of 1/6 of a cubic yard measured by volume. Remove larger material as specified in Section 312000 as rock excavation.

C. Perform excavation within 24 inches of existing utility service and in accordance with utility's requirements.

D. Do not advance open trench more than 200 feet ahead of installed pipe.

E. Cut trenches sufficiently wide to enable installation and allow inspection. Remove water or materials that interfere with Work.

F. Excavate bottom of trenches maximum 2 feet wider than outside diameter of pipe.

G. Excavate trenches to depth indicated on Drawings. Provide uniform and continuous bearing and support for bedding material and pipe utilities.

H. Do not interfere with 45 degree bearing splay of foundations.

I. When Project conditions permit, slope side walls of excavation starting 2 feet above top of pipe. When side walls cannot be sloped, provide sheeting and shoring to protect excavation as specified in this section.

J. When subsurface materials at bottom of trench are loose or soft, [excavate to greater depth as directed by notify Engineer, and request instructions.]

K. Cut out soft areas of subgrade not capable of compaction in place. Backfill with satisfactory fill material as defined in Section 312000, Earthwork and compact to density equal to or greater than requirements for subsequent backfill material.

L. Trim excavation. Hand trim for bell and spigot pipe joints. Remove loose matter.

M. Correct over excavated areas with compacted backfill as specified for authorized excavation or replace with satisfactory fill as directed by Engineer.

N. Remove excess subsoil not intended for reuse, from site.

3.4 SHEETING AND SHORING

A. Sheet, shore, and brace excavations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.

B. Support trenches more than 5 feet deep excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.

C. Design sheeting and shoring to be removed at completion of excavation work.

D. Repair damage caused by failure of the sheeting, shoring, or bracing and for settlement of filled excavations or adjacent soil.

E. Repair damage to [new] [and] [existing] Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.

3.5 BACKFILLING

A. Backfill trenches to contours and elevations with unfrozen fill materials.

B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

C. Refer to Drawings and Section 312000, Earthwork for backfill procedure and materials for various pipe types.

D. Employ placement method that does not disturb or damage utilities in trench.

E. Maintain optimum moisture content of fill materials to attain required compaction density.

F. Do not leave more than 50 feet of trench open at end of working day.

G. Protect open trench to prevent danger to the public.

3.6 TOLERANCES

A. Section 014000 - Quality Requirements: Tolerances.

3.7 FIELD QUALITY CONTROL

A. Quality Control Testing During Construction: Allow testing service to inspect and approve each subgrade and fill layer before further backfill or construction work is performed. Basis of acceptance shall include but not be limited to compacted density performed as specified herein.

1. Perform field density tests in accordance with ASTM D 1556 (sand cone method), ASTM D 2167 (rubber balloon method) or ASTM D 6938.

B. If in the opinion of the Engineer, based on testing service reports and inspection, subgrade or fills that have been placed are below specified density, Contractor shall perform additional compaction and testing, at his expense, until specified density is obtained.

3.8 PROTECTION OF FINISHED WORK

A. Reshape and re-compact fills subjected to vehicular traffic during construction.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section includes construction dewatering.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 FIELD CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

PART 3 EXECUTION

3.1 PREPARATION

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 015000 "Temporary Facilities and Controls," Section 311000 "Site Clearing," during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.

2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

3.3 OPERATION

A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.

C. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

3.4 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1.3 INFORMATIONAL SUBMITTALS

A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.4 FIELD CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.

1. Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.

PART 3 EXECUTION

3.1 SOLDIER PILES AND LAGGING

A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to dpths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.

Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.

C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.2 SHEET PILING

A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.

B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.

C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.3 TIEBACKS

A. Drill, install, grout, and tension tiebacks.

B. Test load-carrying capacity of each tieback and replace and retest deficient tiebacks.

1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.4 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.

2. Install internal bracing if required to prevent spreading or distortion of braced frames.

3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 FIELD QUALITY CONTROL

A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

3.6 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.

1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.

B. Leave excavation support and protection systems permanently in place.

END OF SECTION

SECTION 32 05 23

CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.

B. Related Sections:

1. 312000 – EARTH MOVING

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each concrete mixture.

C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement.

D. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Material certificates.

C. Material test reports.

D. Floor surface flatness and levelness measurements.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

2. Manufacturer shall provide concrete mix designs stamped and sealed by a licensed professional Engineer licensed in the State of Arkansas.

B. Testing Agency Qualifications: An independent agency, approved by Owner and Engineer qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Testing Agency shall be managed by a licensed professional engineer licensed in the State of Arkansas.

C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."

D. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.

2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

E. Concrete Testing Service: Engage and provide a qualified independent testing agency to perform material evaluation tests and to sample and test concrete mixtures.

F. Preinstallation Conference: Conduct conference at Project site.

PART 2 PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

2.2 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

1. Galvanized Reinforcing Bars: ASTM A 767/A 767M, Class I or Class II, as approved, zinc coated after fabrication and bending.

2. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.

C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

E. Galvanized-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from galvanized-steel wire into flat sheets.

F. Epoxy-Coated Welded Wire Reinforcement: ASTM A 884/A 884M, Class A coated, Type 1, plain or deformed steel, as approved.

G. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice.

2.3 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I or Type II gray. Supplement with the following:

a. Fly Ash: ASTM C 618, Class F or C.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, graded.

1. Maximum Coarse-Aggregate Size: 1 inch nominal.

2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M and potable.

2.4 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

2.5 WATERSTOPS

A. Flexible Rubber Waterstops: CE CRD-C 513,with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

B. Chemically Resistant Flexible Waterstops: Thermoplastic elastomer rubber waterstops with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints; resistant to oils, solvents, and chemicals. Factory fabricate corners, intersections, and directional changes.

C. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.

D. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

E. Self-Expanding Rubber Strip Waterstops: Manufactured rectangular or trapezoidal strip, bentonite-free hydrophilic polymer modified chloroprene rubber, for adhesive bonding to concrete, 3/8 by 3/4 inch.

2.6 VAPOR RETARDERS

A. Sheet Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

B. Sheet Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils thick.

2.7 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, non-dissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

G. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

H. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

1. VOC Content: Curing and sealing compounds shall have a VOC content of 200 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.9 CONCRETE MIXTURES

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Concrete mixture designs shall be stamped and signed by a registered professional Engineer registered in the State of Arkansas.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.

C. Admixtures: Use admixtures with approval from Engineer and according to manufacturer's written instructions.

1. Use water-reducing or plasticizing admixture in concrete, as required, for placement and workability.

2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.

D. Proportion normal-weight concrete trail and pavement mixture as follows:

1. Minimum Compressive Strength: 3500 psi at 28 days.

2. Maximum Water-Cementitious Materials Ratio: 0.45.

3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

4. Air Content: 5.0 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

E. Proportion normal-weight concrete bridge pier, abutment and structure mixture as follows:

1. Minimum Compressive Strength: 4000 psi at 28 days.

2. Maximum Water-Cementitious Materials Ratio: 0.45.

3. Slump Limit: 4 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.

4. Air Content: 5.0 percent, plus or minus 1.5 percent at point of delivery for 1-inch nominal maximum aggregate size.

2.10 FABRICATING REINFORCEMENT

A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.11 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116/C 1116M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.1 FORMWORK

A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

C. Chamfer exterior corners and edges of permanently exposed concrete.

3.2 EMBEDDED ITEMS

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR RETARDERS

A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches and seal with manufacturer's recommended tape.

3.4 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

E. Waterstops: Install in construction joints and at other joints indicated according to manufacturer's written instructions.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Concrete shall not be placed on top of mud, standing water, ice, trash, debris or anything other than the specified subbase material.

C. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

D. Cold-Weather Placement: Comply with ACI 306.1.

E. Hot-Weather Placement: Comply with ACI 301.

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces exposed to public view.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.

2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.

1. Apply scratch finish to surfaces indicated.

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces indicated.

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated.

2. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/4 inch.

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces indicated. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Cure concrete according to ACI 308.1, by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer[unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project].

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

3.11 FIELD QUALITY CONTROL

A. Testing and Inspecting: Engage and provide a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Sample concrete materials for slump, temperature and strength testing as required by ACI 301.

C. Provide one (1) set of concrete tests for each 50 cubic yards of material or fraction thereof.

D. Concrete test samples shall include four concrete cylinders for strength testing; one to be tested at 7 day, two to be tested at 28 day, and one spare to be tested at 56 days as required.

END OF SECTION

SECTION 32 11 23

AGGREGATE BASE COURSE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Aggregate base course for Portland cement or asphalt concrete paving.

1.2 RELATED SECTIONS:

A. Section 312000: Earthwork

B. Section 321216: Asphalt Pavement

C. Section 321313: Concrete Pavement

1.3 REFERENCES

A. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

B. ASTM D1557 – Test Methods for Moisture – Density Relations of Soils and Soil-Aggregate Mixtures Using 10lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.

C. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

D. ASTM D6938 - 10 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

PART 2 PRODUCTS

2.1 MATERIALS

A. Class 7 Base Course: Crushed stone base material with the following gradation:

SIEVE (mm)	Class 7 Percent Passing
3” (75)	-
2” (50)	-
1½" (37.5)	100
1” (25.0)	60 - 100
¾” (19.0)	50 - 90
3/8” (9.5)	-
#4 (4.75)	25 - 55
#10 (2.00)	-
#40 (0.425)	10 - 30
#200 (0.075)	3 - 10

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

3.2 PREPARATION

A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.

B. Do not place fill on soft, muddy, or frozen surfaces.

3.3 AGGREGATE PLACEMENT

A. Spread aggregate over prepared substrate to a maximum compacted thickness of 6 inches per lift.

B. Level and contour surfaces to elevations and gradients indicated.

C. Add water to assist compaction. If excess water is apparent, remove aggregate and aerate to reduce moisture content.

D. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

3.4 TOLERANCES

A. Flatness: Maximum variation of ¼ inch measured with 10 foot (3 m) straight edge.

B. Scheduled Compacted Thickness: Within ¼ inch.

C. Variation From Design Elevation: Within ½ inch.

3.5 FIELD QUALITY CONTROL

A. Compaction testing will be performed in accordance with ASTM D1557 and ASTM D6938, as indicated.

B. If tests indicate Work does not meet specified requirements, remove Work, replace and retest.

C. Frequency of Tests: One per lift per 2,500 square feet or as otherwise recommended by the Geotechnical Engineer.

END OF SECTION

SECTION 32 12 16

ASPHALT PAVEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Hot-mix asphalt paving.

B. Related Sections:

1. Section 321123 - Aggregate Base Course, for aggregate subbase and base courses.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: For each job mix proposed for the Work.

1.3 INFORMATIONAL SUBMITTALS

A. Material Certificates: For each paving material, from manufacturer.

1.4 QUALITY ASSURANCE

A. Allowable Tolerances:

1. Subgrade after fine grading:

a. Shall not vary more than 0.05 feet from plan elevation.

2. Aggregate base:

a. Shall not vary more than 0.05 feet from plan elevation.

3. Asphalt concrete hot mix binder course:

a. Shall not vary more than 0.04 feet from the plan elevation.

b. Shall not vary more than 0.04 feet from specified thickness.

4. Asphalt concrete hot mix wearing course:

a. Shall not vary more than 0.03 feet from the plan elevation.

b. Shall not vary more than 0.02 feet from specified thickness.

c. Shall not vary more than 0.015 feet from the edge of a 10 foot straight edge laid thereon parallel to or at right angles to the direction of paving.

5. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

a. Test and Design Mix Criteria:

1) Contractor, at his expense, shall employ the services of an independent testing laboratory to perform tests and design mixes. Materials and mix designs shall be approved at least 10 days before starting of construction.

a. Aggregate tests (Aggregate Base Course):

b. The material to be used for the aggregate base course shall conform to Section 321123, Aggregate Base Course.

c. Preliminary job mix formula (Asphalt Concrete Hot Mix Surfacing):

1. A preliminary job mix formula shall be developed for the asphalt concrete hot mix surfacing material in accordance with AASHTO MP 2 or equal to AHTD requirements.

2. Resubmit a new job mix formula for OWNER'S approval if it becomes necessary to change the source of aggregates or when unsatisfactory results or other conditions warrant a change in mixture requirements.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat: Minimum surface temperature of 60 deg F

2. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at time of placement.

3. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.

PART 2 – PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Bitumen for Binder Course and Surface Course: AASHTO M 320, PG 76-22

B. Bituminous Tack Coat: CSS-1, CSS-1h, RC-70, MC-250, or OWNER approved equal.

2.3 MIXES

A. Hot-Mix Asphalt: Each mix design shall be prepared by laboratory analysis. Each mix design will establish a mix gradation for the aggregates (based on the weight of material passing specified screen sizes), an optimum asphalt binder content (expressed as a percentage of the total mix weight), an optimum laboratory mixing temperature, and an optimum laboratory compaction temperature. Optimum laboratory mixing and compaction temperatures shall be established based on temperature-viscosity curves of the asphalt binder to be used in the mix. The optimum asphalt content is the asphalt binder content at 4% Air Voids (AV) for PG 76-22 mixes and 4.5% Air Voids (AV) for PG 64-22 and PG 70-22 mixes. The mix design will be designed in accordance with the volumetric mix design procedures contained in AASHTO MP 2 and its referenced standards or equal to AHTD specified mix designs.

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. Fine grade and compact subgrade to the plan cross section. Compaction shall be as specified in Section 312000.

B. After compaction, cut-out soft spots and unstable areas in the subgrade and fill with granular fill as defined in Section 312000 and compact as specified in Section 312000.

3.2 AGGREGATE BASE

A. Where required, construct the aggregate base as shown on Drawings on the prepared subgrade as soon as possible after final shaping and compaction of the subgrade is completed.

B. Construction requirements shall be compacted to a density of at least 95 percent as defined by ASTM D1557 (Modified Proctor).

C. Density tests shall be taken as specified in Section 312000 and no bituminous layer shall be applied on the aggregate base course until it is approved by OWNER.

3.3 BITUMINOUS TACK COAT

A. Apply a bituminous tack coat to an existing bituminous surface if it has been dirtied by traffic or by other means just before constructing another bituminous course. The face of all concrete surfaces to which the bituminous surface will come in contact with shall be sprayed or painted with tack oil.

3.4 BITUMINOUS BINDER COURSE

A. Construct a plant mixed bituminous binder course as shown on Drawings using a mechanical paver.

3.5 BITUMINOUS WEARING COURSE

A. Construct a plant mixed bituminous wearing course as shown on Drawings using a mechanical paver.

3.6 FIELD QUALITY CONTROL

A. From time to time during progress of the work and/or upon completion of the work, OWNER may require that testing be performed to determine that materials provided for the work and its installation meets the specified requirements.

3.7 DEFECTIVE WORK

A. When tests and inspections of the aggregate base and/or bituminous work indicate non-compliance with the Specification, Contractor and OWNER shall mutually agree on the number and location of additional tests to define and/or verify the deficiency. If the average of the tests for a given area indicate non-compliance, the area is considered defective and Contractor shall:

1. Remove and replace defective work at no cost to OWNER;

2. Correct the work at no cost to OWNER in a manner acceptable to OWNER; or

3. Give OWNER a credit towards the Contract Price if said credit is acceptable to OWNER.

3.8 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.

2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.

3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.9 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

END OF SECTION

SECTION 32 13 13

CONCRETE PAVEMENT

PART 1 GENERAL

1.1 DESCRIPTION

A. Furnish and construct all exterior portland cement concrete as shown on Drawings and herein specified.

1. Work to be included under this Section shall consist of the following:

a. Driveways, fire access lanes, dumpster approach, sidewalks, and any concrete pavement specified on the drawings.

B. Related Work Specified Elsewhere:

1. Section 312000: Earthwork

2. Section 321216: Asphalt Pavement

1.2 QUALITY ASSURANCE

A. Qualifications of Installers:

1. Provide at least 1 person at all times during execution of this portion of Work and who is thoroughly familiar with the type of materials being installed and is directly responsible for all Work performed under this Section.

B. Requirements of Regulatory Agencies:

1. It is Contractor's responsibility to comply with the requirements of the regulatory agencies, including the purchase of any permits at their own expense.

C. Construction Tolerances:

1. Vertical alignment shall not vary more than 1/8 inch from the edge of a 10-foot straight edge.

2. Horizontal alignment shall not vary more than 1/2 inch from the plan alignment for pavement.

3. Concrete thickness shall not be less than specified.

4. Reinforcing bars shall be placed to the following tolerances:

a. Clear distance to formed surface, plus or minus ¼ inch.
b. Sheared length, plus or minus 1 inch.

c. Concrete cover on top bars in slabs and beams 8 inches deep or less, 2 inches plus or minus 1/4 inch.

d. Concrete cover on top bars in members 8 inches to 24 inches deep, 2 inches plus or minus 1/2 inch.

e. Crosswise or lengthwise spacing, plus or minus 2 inches provided minimum spacing and cover requirements are not violated.

D. Referenced Standards:

1. The current editions of the following American Concrete Institute (ACI) publications shall govern all Work performed hereunder, unless otherwise specified:

a. Recommended Practice for Concrete Floor and Slab Construction - ACI 302.

b. Recommended Practice for Hot Weather Concreting – ACI 305.

c. Recommended Practice for Cold Weather Concreting - ACI 306.

d. Recommended Practice for Construction of Concrete Pavements and Concrete Bases - ACI 316.

e. Building Code Requirements for Reinforced Concrete - ACI 318.

E. Design Criteria:

1. Contractor shall employ an approved independent materials testing laboratory and pay for the service of setting up the design mixes and to analyze the fine and coarse aggregate for the various uses of concrete utilized on the project. Design mixes shall be in accordance with the previously cited ACI 318 publication and in compliance with this Specification. The proposed mixes shall be submitted to OWNER for approval prior to placing of any concrete. The approved mixes established by the laboratory shall be used in the Work as long as the characteristics of the ingredients remain unchanged. If any significant change is made in the ingredients, new mixes shall be prepared and submitted to OWNER for approval.

2. Concrete shall consist of a minimum 28 day compressive design strength of 4,000 psi using portland cement, aggregate, air entraining admixture, water and an air content ranging from 5 to 7 percent. Slump of concrete shall have a range of 2 to 4 inches.

a. If any of the conditions vary from those as described, Contractor shall submit a revised mix design prepared by the testing laboratory along with a written request for the variance desired to OWNER for their consideration and approval.

b. Concrete for portions of the structure required to be watertight, such as water storage, pumpstation wetwells and waste treatment tanks, shall be air-entrained and have a water-cement ratio not exceeding 0.48.

c. Admixtures shall be used only with the approval in writing by OWNER. All admixtures shall be used in accordance with the manufacturer's instructions and shall be added at the plant. Calcium chloride shall not be used as an admixture.

d. Mix designs shall be based on Type I cement. Type III (high early) cement or any other types of cement shall be used only when approved in writing by OWNER. When high-early cement is used, the 7-day strength test shall exceed the specified 28-day strength tests.

1.3 SUBMITTALS

A. Product Data:

1. Prepare and submit product data for OWNER'S approval. Product data shall include manufacturer's recommended installation instructions.

B. Samples:

1. If requested by OWNER, submit samples for approval of proposed materials.

C. Certification:

1. Submit 3 copies of certification of material compliance as requested by OWNER.

D. Delivery Tickets:

1. Submit a delivery ticket with each truck load of concrete delivered which indicates OWNER'S design mix, truck number, project number, Contractor, ready mix producer, time of batching and total yards of concrete.

E. Test Reports and Design Mixes:

1. Submit 3 copies of design mixes and material test reports to OWNER.

PART 2 PRODUCTS

2.1 MATERIALS

A. Form Material:

1. Form material shall be either sound lumber or steel, free of defects and variations in dimensions. The sides of all lumber shall be surfaced and matched to prevent mortar leakage. Metal forms shall be of standard manufacture and need not be new, but shall be free from rust and dirt. Metal forms shall be flat and true to line without punctures. All form material shall be sized and of strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal of same.

a. Rigid forms are to be utilized on tangent alignment and curves having a radius of 150 feet or greater.

b. Curved forms shall be utilized on the curved Work with a radius of 150 feet or less, and shall consist of flexible spring steel or laminated lumber.

B. Reinforcement Materials:

1. Reinforcing bars and dowels shall be of new billet steel conforming to ASTM A615, Grade 60 (60,000 psi yield). Sizes of bars shall be as indicated on Drawings or herein specified.

a. Dowel bars when used for contraction and expansion joints shall be smooth steel bars coated with a thin uniform coating of liquid asphalt (MC-250) or grease on 1/2 the length of the bar plus 2 inches. In addition, dowel bars for expansion joints shall be furnished with end caps designed with one end closed, a minimum length of 3 inches and be positioned to allow bar movement of not less than 1 inch.

b. Dowel bar assemblies may be permitted if fabricated to the width of the pavement section.

c. Tie bars for control, longitudinal and construction joints shall be deformed bars.

C. Concrete Materials:

1. Portland cement shall conform to ASTM C150.

a. Cement shall be a low alkali cement (Type I) containing not more than 0.6 percent by weight of tri-sodium silicate oxide.

2. Coarse aggregate shall conform to Size 57 grade requirements of Table 2 of ASTM C33 standard.

3. Fine aggregate shall conform to ASTM C33 with fineness modulus not to vary more than 0.20 from value assumed in design mix.

4. Water shall be potable, clean and free from deleterious amounts of acid, alkali or organic material.

D. Admixtures:

1. Air entraining agent shall conform to ASTM C260 and shall be added at the mixer.

2. Water reducing agents, (such as super plasticizers), retarding agents, accelerating agents and all other admixtures, shall require approval by OWNER and if used, shall conform to ASTM C494. In no case shall admixtures be permitted as substitute for cement content specified, unless approved by OWNER.

E. Expansion Joint Material:

1. Joint filler material shall consist of a non-extruding standard bituminous bound type "Sealtight Asphalt Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois or OWNER approved equal.

a. Material shall conform to ASTM D994.

2. Joint filler material shall consist of preformed non-extruded bituminous bound type "Sealtight-Fibre Expansion Joint" as manufactured by W.R. Meadows, Inc., Elgin, Illinois; "Code 1390" as manufactured by W.R. Grace Company, Cambridge, Massachusetts or OWNER approved equal.

a. Material shall conform to ASTM D1751.

b. Material shall be 1/2 inch thick, unless otherwise noted, of widths equal to slab thickness less 1/2 inch or as otherwise indicated.

3. Joint sealant shall be a single component, polyurethane type "Sikaflex-la" as manufactured by Sika Chemical Corporation, Lyndhurst, New Jersey or OWNER approved equal. Color as selected by OWNER.

F. Curing Materials:

1. Kraft paper shall be waterproof and nonstaining "Sisalkraft 5K-10" conforming to ASTM C171.

2. Polyethylene film shall be white opaque sheet or roll material not less than 0.006 inch thick (6 mil) conforming to AASHTO-M171.

3. Contractor may at their option use a liquid curing compound for surfaces that will not receive treating oil or waterproofing membrane. Liquid curing compound shall conform to ASTM C309 and shall consist of the following:

a. Type 1D, translucent with fugitive dye.

b. Type 2, white pigmented, Class B (vehicle solids restricted to all resin).

2.2 PRODUCTION

A. Concrete shall be ready-mixed, and shall be batched, mixed and transported in accordance with "Specification for Ready-Mixed Concrete" ASTM C94. The production plant equipment and facilities shall meet the requirements of the National Ready Mixed Concrete Association.

PART 3 EXECUTION

3.1 JOB CONDITIONS

A. Hot Weather Conditions:

1. The following precautions shall be adhered to:

a. Reject concrete mixture having temperature of 85ºF or greater.

b. Pre wet subgrade.

c. Crushed or flaked ice may be utilized in reducing temperature of mixture.

d. If necessary, reduce temperature of reinforcing steel with wet burlap.

e. Reduce mixing time (agitating time) in truck to 45 minutes.

f. During periods of high winds, shelter windward side with adequate wind breaks.

g. Apply no chemical retarder to finished surface unless permission is granted in writing by OWNER.

B. Cold Weather Conditions:

1. When ambient temperature is 40ºF or less, the following precautions are to be adhered to:

a. Subbase shall not be frozen.

b. Concrete mixture delivered at Worksite shall be 55ºF (minimum), 85ºF (maximum).

c. No calcium chlorides, salts or other chemical accelerators shall be permitted, unless otherwise acceptable in writing by OWNER.

d. Concrete surface shall be maintained at a minimum of 50ºF with appropriate thermal insulation for a period of 7 days (normal concrete), 3 days (high early-strength concrete).

e. Refer to previously cited ACI 306 for minimum thickness of thermal protection required.

f. Any concrete that has frozen or disintegrated as a result of freezing shall be removed and replaced at Contractor's expense.

3.2 SUBGRADE PREPARATION

A. Fine grade and compact subgrade to the plan cross section. Compaction shall be as specified in Section 312000 of this Specification or as indicated on the Drawings.

B. After compaction, cut-out soft spots and unstable areas in the subgrade and fill with select fill material and compact as specified in Section 312000.

3.3 GRANULAR BASE

A. Construct the select fill and granular base as shown on Drawings on the prepared subgrade after the final shaping and compacting of the subgrade is completed.

B. Compact as specified base in Section 312000 of this Specification.

3.4 FORM CONSTRUCTION

A. Forms shall have the strength and rigidity, regardless of material, such that when they are set in place and braced, they will withstand weight of equipment and weight of concrete without settlement or lateral displacement.

B. Keyway forms in the edge of pavement slabs and at construction joints shall be constructed to the dimensions shown on Drawings. Wood keyway forms, if used, shall be bolted or nailed to the side forms. Metal keyway forms shall be fixed or held rigidly in place by staking or other OWNER approved method.

C. Forms shall be coated prior to the placement of concrete, with a nonstaining form release agent. Wooden form may be prewetted with water. No standing water, adjacent to forms, shall be permitted.

3.5 REMOVAL OF FORMS

A. Forms for slabs on grade shall not be removed earlier than 12 hours after the placement of concrete has been completed. Within 24 hours of form removal backfill adjacent to the pavement shall be completed.

B. Forms supporting the weight of concrete shall not be released until the concrete has reached its specified 28-day strength. Minimum time elapse after casting and before the false Work supports are released shall be 8 days for spans up to 96 inches center to center of supports, plus 1 additional day for each 12 inches of increase in span length over 84 inches up to 14 days for span of 14 feet and over. Such time period shall be exclusive of those time intervals during which the concrete surface temperature is below 40ºF. If temperature remains below 40ºF during the casting and curing period no forms shall be removed until approved field tests indicating adequate concrete strength have been provided.

3.6 REINFORCEMENT PLACEMENT

A. Tie bars, reinforcement bars and dowel bars shall be clean, free from rust and shall be placed on adequate supports in locations as shown on Drawings. Provide the following minimum thickness of concrete cover:

1. Concrete deposited on ground: 3 inches

2. Formed surfaces against ground: 1-1/2 inches

3. Beams, girders and columns: 1-1/2 inches

4. Slabs, walls and joists: 1 inch

5. Clear distance between parallel bars: 1 inch or nominal bar distance

6. For No. 6 bars or larger: 2 inches

7. No broken brick, block or concrete shall be permitted as reinforcement supports.

B. Welded steel wire fabric shall be placed free from rust, kinks and bends and shall be cut in such a way that the overlap measured between outermark cross wires of each fabric sheet is not less than 2 inches. The fabric shall be cut at contraction joints. It shall be supported by a layer of fresh concrete placed to the depth of the mesh shown on Drawings, followed by placement of the upper layer of concrete.

3.7 CONCRETE PLACEMENT

A. Place concrete to required depth and width to form a continuous mass requiring a minimum of rehandling. Concrete adjacent to side forms and fixed structures shall be consolidated by means of portable vibrators or by mechanical means with the use of hand spading. Vibrators shall not be used to move concrete horizontally.

B If it is necessary to place a construction joint prior to a contraction joint, the distance between the construction joint and the previous contraction joint shall not be less than 60 inches.

C. Automatic machine may be used for curb and gutter placement at Contractor's option, if acceptable to OWNER. If machine placement is to be used, submit revised mix design and laboratory test results, which meet or exceed the minimum herein specified. Machine placement must produce curbs and gutters to the required cross-section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified.

3.8 JOINTS

A. General:

1. Construct expansion, contraction and construction joints with face perpendicular to surface of concrete.

2. Where joining existing structures, match existing contraction or expansion joints.

B. Expansion Joints:

1. All fixed objects, such as buildings and structures or pavement, sidewalks or curb intersections shall be separated by a 1/2 inch expansion joint placed at the full depth of

the concrete thickness. Expansion joints, in addition to the above, shall be placed at 60 foot intervals in the following:

a. Concrete curb and gutter

b. Concrete walk

2. For pavement construction, place expansion joints as shown on Drawings.

C. Contraction Joints:

1. Contraction joints shall be placed at the following intervals and dimensions or as shown on Drawings:

a. Concrete curb and gutter – 10 feet; 1/8 inch wide by 1 1/2 inch depth.

b. Concrete walk – 10 feet; 1/8 inch wide by 1/4 the depth of concrete.

2. Cut plastic concrete with appropriate tool to specified depth. Finish edges with 1/4 inch radius tool.

3. Saw-cut joints to specified width and depth on hardened concrete as soon as concrete has hardened sufficiently to prevent raveling or damage to the joint.

D. Joint Sealer:

1. Apply joint sealer to a clean and dry expansion or contraction joint if specified to a point approximately 1/4 inch below the top surface. Where oil treatment is specified, joint sealer shall be applied prior to application of the oil.

3.9 CONCRETE FINISH

A. After initial strike-off and floating, and prior to finishing, test surface with 10-foot straightedge. Correct irregularities prior to final finishing operations.

B. Apply the following surface finish after surface sheen or excess moisture has disappeared:

1. Apply steel trowel finish followed by stiff-bristled broom drawn across concrete surfaces, perpendicular to line of traffic:

a. Sidewalk

b. Concrete pavement

c. Curb and gutter

3.10 CONCRETE CURING AND PROTECTION

A. Cure concrete surfaces for 7 days (normal concrete) and for 3 days (high early-strength concrete), using appropriate means of protection as previously cited in ACI 305 and ACI 306.
B. Curing methods shall consist of one of the following:

1. Keep concrete surface continuously wet by ponding with water.

2. Apply moisture proof fabric to entire area lapping joints and edges at least 3 inches. Tape interior joints and weight edges down with sand or other approved material.

3. Apply liquid membrane curing compound to the finished surface in a 2 coat continuous operation with second application applied transversely to the direction of the first application, and in accordance with the manufacturer's directions. Replace damaged areas with equal applications of membrane using compound. Liquid membrane curing compound shall not be permitted where the surface will be subjected to an application of waterproof coatings, bonding agents, treating oil or paint.

3.11 TESTING AND EVALUATION

A. Concrete materials and operations shall be tested and inspected as the Work progresses, by an independent testing laboratory. Contractor shall furnish any necessary labor who is familiar with methods of sampling and shall assist the testing agency in obtaining and handling samples, and for safe storage and proper curing of concrete test specimens on Worksite.

B. Mold and cure three standard 6-inch diameter specimens from each sample in accordance with ASTM C31. Compressive strength test specimens shall be in accordance with ASTM C39. Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The acceptance test results shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the test result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. When high-early strength concrete is used, the first specimen shall be tested at 3 days; the remaining two at 7 days.

C. Make at least one strength test for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any one day.

D. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using standard slump cone as per ASTM C143.

E. The testing laboratory shall report all test and inspection results to OWNER, OWNER’S Engineer, and Contractor immediately after they are performed. All concrete test reports shall include name of job, date of placement, date of test, batch mix design, slump and the exact location in the Work at which the batch represented by the test was deposited.

F. All costs necessary to prepare concrete test cylinders, make tests and furnishing of written reports shall be borne by the Contractor.

3.12 DEFECTIVE WORK

A. When tests and inspections of the aggregate base and/or concrete Work indicate non-compliance with the Specification, Contractor and OWNER shall mutually agree on the number and location of additional tests to define and/or verify the deficiency. If the average of the tests for a given area indicate non-compliance the area is considered defective and Contractor shall:

1. Remove and replace defective Work at no cost to OWNER;

2. Correct the Work at no cost to OWNER in a manner acceptable to OWNER;

3. Give OWNER a credit towards the Contract Price if it is acceptable to OWNER;

4. If Work is found to be in noncompliance, Contractor shall pay for the defective area removal and replacement, and the tests and inspection costs; or

5. If Work is found to be in compliance, OWNER shall pay for tests and inspection costs.

END OF SECTION

SECTION 32 13 73

CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:

1. Cold-applied joint sealants.

2. Hot-applied joint sealants.

3. Joint-sealant backer materials.

4. Primers.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each kind and color of joint sealant required.

C. Paving-Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.

2. Joint-sealant manufacturer and product name.

3. Joint-sealant formulation.

4. Joint-sealant color.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

PART 2 PRODUCTS

2.1 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service

and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant: ASTM D 5893/D 5893M, Type SL.

C. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use T.

D. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type S, Grade P, Class 25, for Use T.

E. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C 920, Type M, Grade P, Class 25, for Use T.

2.3 HOT-APPLIED JOINT SEALANTS

A. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I.

B. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I or Type II.

C. Hot-Applied, Single-Component Joint Sealant: ASTM D 6690, Type I, II, or III.

D. D 6690, Type IV.

2.4 JOINT-SEALANT BACKER MATERIALS

A. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

C. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 PRIMERS

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.

PART 3 EXECUTION

3.1 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Cleaning of Joints: Clean out joints immediately to comply with joint-sealant manufacturer's written instructions.

C. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer.

D. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions.

E. Install joint-sealant backings to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of joint-sealant backings.

2. Do not stretch, twist, puncture, or tear joint-sealant backings.

3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

F. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:

1. Place joint sealants so they fully contact joint substrates.

2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

G. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.

2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

H. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

I. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.

END OF SECTION

SECTION 321540 – EXTERIOR STONE SURFACING AND FEATURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. The Conditions of the Construction Contract and Division 1 - General Requirements apply to work specified in this Section.
   2. Furnish and construct exterior stone surfacing and features as shown on Drawings and herein specified.

B. Related Sections:
   1. Section 312000 – Earth Moving
   2. Section 323000 – Site Furnishings
   3. Section 329000 - Planting

1.2 QUALITY ASSURANCE

A. Installer Qualifications: Installer shall have successfully completed, within the last 3 years, at least 3 stone surfacing and feature applications similar in type and size to that of this project and who will assign mechanics from these earlier applications to this project, of which one will serve as lead mechanic.

B. Field-Constructed Mock-Up: Prior to installation of exterior stone surfacing and features fabricate mock-up using materials, pattern and joint treatment indicated for project work.
   1. Build mock-up at the site, in location indicated or directed. Range of color, texture and workmanship to be expected in the completed work.
   2. Obtain Architects acceptance of functional and visual qualities of mock-up before start of work. Retain mock-up during construction as a standard for judging completed work.
   3. Do not move or destroy mock-up until work is completed.

1.3 REFERENCES

A. ASTM: American Society of Testing Materials www.astm.org

1.4 SUBMITTALS

A. Samples: All products and certificates listed below in Part 2.

PART 2 PRODUCTS

2.1 MATERIALS

A. P4 Aggregate Surfacing:
   1. Material: Granite
   2. Color: Rustic Granite
   3. Size: 1/4” minus with binder
   4. Basis of Design: Kafka Granite https://www.kafkagranite.com/specialty-aggregates/rustic-granite

B. F1 Stone Bench:
   1. Material: Hackett Brown Beam Rock
   2. Size: 18”W, 9”THICK, 6’ LONG
   3. Installation: Refer to detail sheets, L500 series.

C. Bedding Sand:

Sieve according to ASTM C136. Clean, non-plastic, free from deleterious or foreign matter, natural or manufactured from crushed rock. Do not use limestone screenings or stone dust that do not conform to the grading requirements of the following table:

Grading Requirements for Bedding Sand

ASTM C 33

Sieve Size	Percent Passing
3/8-inch	100
No. 4	95 to 100
No. 8	85 to 100
No. 16	50 to 85
No. 30	40 to 75
No. 50	10 to 35
No. 100	2 to 10

D. Base Material for aggregate surfacing, Class 5 compacted aggregate road base.

E. Soil Separator Fabric:

1. Mirafi type 140N
2. Amoco type 4545
3. Synthetic Industries type 401
4. Or approved equal. Other manufacturers may be submitted, provided, all the information needed to indicate the geotextile has equal or better characteristics is included in the submittal.

F. Herbicide: Pre-emergent herbicide. Preen, manufactured by Greenview a Division of Lebanon Seaboard Corporation, 1600 E. Cumberland Street, Lebanon, PA 17042. www.preen.com. Obtain approval from Architect and Owner prior to use.

3.1 DELIVERY, STORAGE AND HANDLING

A. Protect stone during storage and construction against wetting by rain, snow or ground water and against soilage or inter mixture with earth or other types of materials.

3.2 PROJECT CONDITIONS

A. Frozen Materials: Do not use frozen materials or materials mixed or coated with ice or frost.

B. Frozen Work: Do not build on frozen subgrade or setting beds.

C. Existing Conditions: Review all conditions including levels, elevations and drainage before starting work; if subgrade conditions are unsatisfactory, have corrections made by Grading Contractor before proceeding. Commencement of this work shall be construed as acceptance of existing conditions and, therefore, the responsibility for proper results is part of the work of this section.

3.3 PREPARATION

A. Subgrade: Fine-grade as required to remove minor grade irregularities before installation of setting bed. Remove any rocks from subgrade surface and fine rake the surface to a uniform texture.

3.4 INSTALLATION

A. Per Landscape Drawings and Details

B. Herbicide: Apply pre-emergent herbicide according to manufacturer recommendations. Place in areas to be covered by Garden Surfacing. Coordinate with plantings.

3.5 CONSTRUCTION WASTE MANAGEMENT

A. Comply with requirements of Section 017419 - Construction Waste Management for removal, recycling, and disposal of construction debris and waste.

END OF SECTION 321540

SECTION 32 16 13

CONCRETE CURB AND GUTTER

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:
1. Cast in place concrete curb and gutter.
2. Cast in place ribbon curb.

1.2 RELATED SECTIONS

A. 033000 – CAST IN PLACE CONCRETE

B. 312000 - EARTH MOVING

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.4 QUALITY ASSURANCE

A. Perform cast-in-place concrete in accordance with ACI 301 and Section 033000.Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.

1. Standard Specifications for Highway construction, Edition of 2003, hereafter referred to as “AHTD Standard Specifications”.

PART 2 PRODUCTS

2.1 MATERIALS

A. Ready Mixed concrete: ASTM C94 and Articles 2.01 through 2.11 of Section 033000.

B. Curing Compound: ASTM C309

C. Pre-formed expansion joint fillers: ASTM D1751.

1. Thickness: One-half (1/2) inch.

PART 3 EXECUTION

3.1 SUBGRADE PREPARATION

A. Grade subgrade and compact in same manner and density as specified in Section 312000

3.2 GENERAL

A. Notify Architect/Engineer for inspection at least 24 hours before the planned time to pour concrete.

B. Inspection:

1. Ensure that excavation and formwork are completed and within the allowed tolerances.

2. Ensure that ice and excess water are removed, no frost is present, and that ground is not frozen.

3. Check that reinforcement is secured in place.

4. Verify that insulation, anchors, and other embedded items are secured in position.

C. Install concrete work in accordance with ACI 301-99 except as amended by this section.

3.3 INSTALLATION

A. Cast in place concrete: Refer to Section 033000.

1. See Detail Drawings for Curb and Gutter, Ribbon Curb, and for Handicap Ramp.

2. Prepare subgrade in accordance with Section 312000.

3. Set forms to line and grade.

4. Install forms over full length of curb.

5. Form contraction joints at maximum 10 feet spacing using steel templates, division plates or saw cuts.

6. Remove templates or plates as soon as concrete has hardened sufficiently to retain its shape.

7. Install preformed expansion joint fillers at maximum 60 feet spacing, at curb returns, and behind curb at abutment to sidewalks and other structures.

8. Place top of expansion joint material ¼ inch below curb surface.

9. Place concrete in position without separation of concrete materials.

10. Consolidate concrete with mechanical vibrators.

11. Round face of curbs at top with finishing tool of correct radius.

12. Finish exposed surfaces with wood float followed by light brushing with broom.

13. Apply curing material and cure for seven days.

14. DO NOT rub concrete, patch before curing.

B. Repair of surface defects: Comply with requirements within Section 033000

C. Field Quality Control: Comply with requirements within Section 033000

D. Protection of Completed Work

1. It is the contractor's responsibility to protect all work until Final Acceptance. Repair or replace all work deemed unacceptable by Engineer at Contractor's expense.

END OF SECTION

SECTION 32 17 13

PARKING BUMPERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes steel wheel stops.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and shop drawings.

PART 2 PRODUCTS

2.1 PARKING BUMPERS

A. Steel Wheel Stops: Fabricated 5” x 5” x 3’16” tube steel to be 6’ length.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install wheel stops according to Steel Wheel Stop detail within Construction Documents.

B. Install at locations shown on Construction Documents.

END OF SECTION

SECTION 32 17 23

PAVEMENT MARKINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes painted markings applied to asphalt and concrete pavement.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples: For each exposed product and for each color and texture specified.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design".

B. Markings Standards: Comply with applicable MUTCD current Standards.

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.

1. Asphalt Application

a. Color: Pantone Cool Gray 3 C or approved equal.

2. Concrete Application

a. Color: Pantone Cool Gray 10 C or approved equal.

3. Fire Lane Application

a. Color: Pantone 484 C or approved equal.

4. ADA Application

a. Color: Pantone 7691 C or approved equal.

b. Color: Pantone Cool Gray 3 C or approved equal (asphalt).

c. Color: Pantone Cool Gray 10 C or approved equal (concrete).

B. Glass Beads: AASHTO M 247, Type 1.

2.3 PAVEMENT – MARKING THERMOPLASTIC

A. All public rights of way shall receive thermoplastic markings stipes. Color to be approved through submittal.

1. Color: White

2. Color Yellow

PART 3 EXECUTION

3.1 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils. Apply paint so that it cannot run beneath stencil.

2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

END OF SECTION

SECTION 32 17 26

TACTILE WARNING SURFACING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Cast-in-place detectable warning tiles.

2. Cast-in-place detectable warning tiles.

3. Detectable warning mats applied to existing concrete paving.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for each type of exposed finish requiring color selection.

PART 2 PRODUCTS

2.1 TACTILE WARNING SURFACING, GENERAL

A. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines for Buildings and Facilities and ICC A117.1 for tactile warning surfaces.

1. For tactile warning surfaces composed of multiple units, provide units that when installed provide consistent side-to-side and end-to-end dome spacing that complies with requirements.

2.2 DETECTABLE WARNING TILES

A. Cast-in-Place Detectable Warning Tiles: Accessible truncated-dome detectable warning tiles with replaceable surface configured for setting flush in new concrete walkway surfaces, with slip-resistant surface treatment on domes and field of tile.

1. Material: Molded glass- and carbon-fiber-reinforced polyester.

2. Color: Safety yellow or As selected by Architect from manufacturer's full line.

3. Shapes and Sizes:

a. Rectangular panel, 24 inches by width of crossing, or as shown on plans

b. Radius panel, nominal 24 inches deep by 6-foot outside radius, or as shown on plans.

4. Dome Spacing and Configuration: 1.67-inch, in square pattern.

5. Mounting:

a. Permanently embedded detectable warning tile wet-set into freshly poured concrete.

b. Detectable warning tile set into formed recess in concrete and adhered with adhesive.

c. Replaceable detectable warning tile wet-set into freshly poured concrete and surface-fastened to permanently embedded anchors.

B. Surface-Applied Detectable Warning Tiles: Accessible truncated-dome detectable warning concrete tiles configured for surface application on existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of tile, and beveled outside edges.

1. Material: Molded glass- and carbon-fiber-reinforced polyester.

2. Color: Safety yellow or As selected by Architect from manufacturer's full line.

3. Shapes and Sizes:

a. Rectangular panel, 12 by 12 inches.

b. Radius panel, nominal 24 inches deep by 6-foot outside radius.

4. Dome Spacing and Configuration: 1.67-inch spacing, in square pattern.

5. Mounting: Adhered and fastened to existing concrete walkway.

2.3 DETECTABLE WARNING MATS

A. Surface-Applied Detectable Warning Mats: Accessible truncated-dome detectable warning resilient mats, UV resistant, manufactured for adhering to existing concrete walkway surfaces, with slip-resistant surface treatment on domes, field of mat, and beveled outside edges.

1. Material: Modified rubber compound, UV resistant.

2. Color: Yellow

3. Shapes and Sizes:

a. Rectangular panel, 24 by 36 inches.

4. Dome Spacing and Configuration: 1.67-inch spacing, in square pattern.

5. Mounting: Adhered to pavement surface with adhesive and fastened with fasteners.

2.4 ACCESSORIES

A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of tactile warning surfaces, noncorrosive and compatible with each material joined, and complying with the following:

1. Furnish Type 316 stainless-steel fasteners for exterior use.

2. Fastener Heads: For nonstructural connections, use flathead or oval countersunk screws and bolts with tamper-resistant heads, colored to match tile.

B. Adhesive: As recommended by manufacturer for adhering tactile warning surfacing unit to pavement.

C. Sealant: As recommended by manufacturer for sealing perimeter of tactile warning surfacing unit.

PART 3 EXECUTION

3.1 INSTALLATION OF TACTILE WARNING SURFACING

A. General: Prepare substrate and install tactile warning surfacing according to manufacturer's written instructions unless otherwise indicated.

B. Place tactile warning surfacing units in dimensions and orientation indicated. Comply with location requirements of AASHTO MP 12.

C. Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place and completely seat tile back and embedments in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean using methods recommended in writing by manufacturer.

D. Removable Cast-in-Place Detectable Warning Tiles: Set each detectable warning tile accurately and firmly in place with embedding anchors and fasteners attached, and firmly seat tile back in wet concrete by tamping or vibrating. Set surface of tile flush with surrounding concrete and adjacent tiles. Remove concrete from tile surfaces and clean tiles using methods recommended in writing by manufacturer.

E. Surface-Applied Detectable Warning Tiles: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of tiles in amounts and pattern recommended by manufacturer, and set tiles in place. Install anchor devices through face of tiles and into pavement using anchors located as recommended by manufacturer. Apply sealant in continuous bead around perimeter of installation.

F. Surface-Applied Detectable Warning Mats: Prepare existing paving surface by grinding and cleaning as recommended by manufacturer. Apply adhesive to back of mat and set mat in place. Firmly seat mat in adhesive bed. Install anchor devices through face of mat and into pavement using anchors located as recommended by manufacturer. Set heads of anchors flush with mat surface. Apply sealant in continuous bead around perimeter of mat.

G. Remove and replace tactile warning surfacing that is broken or damaged or does not comply with requirements in this Section. Remove in complete sections from joint to joint unless otherwise approved by Architect. Replace using tactile warning surfacing installation methods acceptable to Architect.

H. Protect tactile warning surfacing from damage and maintain free of stains, discoloration, dirt, and other foreign material.

END OF SECTION

SECTION 32 20 00 – SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Information regarding custom and manufactured site furnishings
   2. Protection and warranty of work

B. Related Sections:
   1. Section 055000 Miscellaneous Fabrications
   2. Section 019113 Commissioning Requirements
   3. Section 017836 Warranties
   4. Division 16 – Electrical

C. Drawing references
   1. L101, L102 - Plans
   2. L506, L507 - Details

1.2 REFERENCES

A. ANSI: American National Standards Institute www.ansi.org

B. ASTM: American Society of Testing Materials www.astm.org

1.3 SUBMITTALS

A. Submit in accordance with Section 013300 and Section 055000.

B. Shop Drawings:
   1. Submit shop drawings of all fabrications to Architect for approval prior to start of fabrication in accordance with Section 055000.
   2. Shop drawings for all assembles shall be stamped by a licensed structural engineer to be coordinated by the fabricator.

C. Samples:
   1. All materials showing representative color and finishes

D. Contract Closeout Submittals:
   1. Record documents
   2. Maintenance instructions
   3. List of warranty dates

1.4 QUALITY ASSURANCE

A. Contractor Qualifications: Utilize experienced personnel familiar with equipment, methods and procedures for job.

B. Equipment: Utilize equipment of proper size and in good working condition to prosecute the work to full completion in a satisfactory manner.

C. Mock-Up: Prior to fabrication of the site furnishings, fabricate mock-up using materials, pattern and joint treatment indicated for project work. Build mock-up in form of full thickness and approximately 4 feet by 4 feet of each type, unless otherwise indicated, range of color, texture and workmanship to be expected in the completed work. Obtain A/E's acceptance of functional and visual qualities of mock-up before start of final fabrication.

D. Protection of Property:
   1. Bear full responsibility for damage to fabrications, adjacent areas, and work by others
   2. Report damage to Architect and Owner immediately for approval of repairs
   3. Accomplishment of repairs shall be equal to original installation prior to damage
   4. Procure materials from a single source with certification to ensure conformity with project specifications as to type, quality, size and finish.

E. Notify Architect immediately if conflicts, omissions, mis-alignments or redundancies exist among drawings.

1.5 DELIVERY, STORAGE AND HANDLING

A. Protect fabricated elements and accessories from damage and deterioration during delivery and storage on site.

1.6 WARRANTY

A. Provide warranty for a period of one-year after date of Substantial Completion against defects but not including defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are entirely beyond Contractor's control.

PART 2 - PRODUCTS

2.1 MATERIALS

A. F2 – Bike Rack
   1. Manufacturer: Dero
   2. Model: Hoop Rack
   3. Installation: Surface Mounted
   4. Finish: Powder Coat
   5. Color: Black

B. F3 – Drinking Fountain
   1. Manufacturer: Most Dependable
   2. Model: 10145 SMFR
   3. Options: ADA bottle filler, pet fountain
   4. Installation: Surface Anchored
   5. Finish: Powder Coat
   6. Color: Black

C. F4 – Bike Tire Pump
   1. Manufacturer: Saris Infrastructure
   2. Model: Outdoor Public Bike Pump with Gauge
   3. Installation: Surface Anchored
   4. Finish: Stainless Steel
   5. Color: N/A

D. F5 – Bike Fix It Station
   1. Manufacturer: Saris Infrastructure
   2. Model: Deluxe Public Work Stand
   3. Installation: Surface Anchored
   4. Finish: Powder Coat
   5. Color: Black

E. F7 – Power Pedestal
   1. Manufacturer: Landscapeforms
   2. Model: Base Power Pedestal

3. Options: 2 Gang Option – 1 GFCI, 1 USB
4. Installation: Anchored to concrete footing
5. Finish: Powder Coat
6. Color: Black

PART 3 - EXECUTION

3.1 PROJECT CONDITIONS

A. Field Measurements:
   1. Verify project conditions in accordance with Section 055000.

B. Utilities:
   1. Locate all utilities prior to beginning work.
   2. Perform work to avoid damage to such utilities.

C. Field Stakes:
   1. Maintain stakes set by others until removal is mutually agreed upon by all parties concerned.

3.2 INSTALLATION

A. Install all fabricated elements per Drawings in accordance with Section 055000.

3.3 ACCEPTANCE

A. Acceptance of Work is subject to Architect’s approval.

B. After inspection, Architect will notify Contractor in writing if there are any deficiencies or unmet requirements for acceptance of work.

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with requirements of Section 017419 - Waste Materials Management and Recycling for removal, recycling, and disposal of construction debris and waste is the responsibility of the Contractor.

END OF SECTION 322000

SECTION 32 8400 – PLANTING IRRIGATION (PERFORMANCE)

PART 1 - GENERAL

1.1 SUMMARY

Design, furnish, install and service a complete, automatic underground irrigation system connected to the buildings mechanical systems. Provide 100 percent irrigation coverage for all landscaped areas within the limit of work for the project, including turf areas, shrubs, perennials, grasses, trees, native seeding areas, rainwater gardens and stormwater retention areas. The system design shall be capable of watering the entire area designated within an 8-hour period. Instruct the Owner, in person and in written form, as to the proper operation and maintenance of the total system. Winterize the system the first fall and start the system the following spring.

A. Section Includes:
   1. Designing a fully automatic subsurface drip irrigation system
   2. Coordination with other trades
   3. Materials and labor related to the irrigation system
   4. As-Installed Drawing and Owner's Service Manual
   5. Warranty
   6. First Year Winterization and Start-up

B. Related Sections:
   1. Division 22 - Plumbing
   2. Division 26 - Electrical
   3. Section 32 9000 – Plants
   4. Section 32 9200 – Turf and Grasses
   5. Section 32 9205 – Native Seeding

   General Note: Although many of the components listed within this Section specify PVC, use HDPE in lieu of PVC to the greatest extent practicable. Identify all proposed materials on the shop drawings.

1.2 TEMPORARY IRRIGATION (PLANTING ESTABLISHMENT)

A. In case of no permanent irrigation system in place, all new trees to get water bags. All new planting to receive regular watering during the establishment period which is 1(one) year and minimum 1(one) full growing season via hose connected to the nearest water source.

1.3 REFERENCES

A. ASIC: American Society of Irrigation Consultants www.asic.org

B. ASAE: American Society of Agricultural Engineers www.asae.org
   1. Standard S398.1, Procedure for Sprinkler Testing and Performance Reporting

C. ASTM: American Society of Testing Materials www.astm.org

D. IA: Irrigation Association www.irrigation.org
   1. CIC: Certified Irrigation Contractor
   2. CID: Certified Irrigation Designer

E. AGIA: Arkansas Green Industry Association: www.argia.org

1.4 SUBMITTALS

A. State Issued Contractor License

B. Certified Irrigation Contractor and Designer information

C. Provide a scaled shop drawing of the proposed system for approval by the Landscape Architect. Include the following information:
   1. Plants and planting areas (screened for legibility).
   2. Water source(s), backflow prevention, controller(s), filters and other components of the system.
   3. Location, size and type of all valves, piping, control wires, heads, isolation valves and quick couplers using ASIC graphic symbols.
   4. Irrigation Zones with control valve and chart.
   5. Controller timing schedule.
   6. Means by which liquid fertilizer can be delivered to plants via the irrigation system.
   7. Drawing notes and notations as necessary.
   8. North arrow and scale.

D. Provide a complete list of manufacturers and model numbers of all components to be used.

E. Note: The Landscape Architect will not check the design calculations of the proposed irrigation system. The performance of the system is solely the responsibility of the Contractor. The Landscape Architect will:
   1. Review the proposed system generally for compliance with overall objectives.
   2. File the drawing for the Owner's records

F. Operation and Maintenance Data: For sprinklers, controllers and automatic control valves to include in operation and maintenance manuals.

G. As-Built Plan: After completion of the installation, the Contractor shall provide an AutoCAD drawing and drawing file (.dwg format, AutoCAD 2010 or greater). The drawing shall be to scale, showing all sprinkler heads, valves, piping, controller(s), zone numbers and all related equipment with dimensions where required.

H. Guarantee: The Contractor, for a period of one year from date of final acceptance, shall promptly repair or replace, at no cost to the Owner, any and all parts which prove to be defective from manufacturer or workmanship.

I. Acceptance: Before final acceptance is made, the Contractor must have in writing, from the Owner and Consultant that the system meets top quality installation and these plans and specifications have been executed 100%.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: As a prerequisite of qualification to bid, the irrigation construction company shall provide verifiable documentation that such person or company is licensed by the Arkansas Board of Electrical Examiners and that company employs not less than one Licensed Electrician and that such licenses are considered "in good standing" by the State of Arkansas. "Verifiable Documentation" shall include but not be limited to submission of copies of Licenses and Technical Credentials and proof of insurance. The irrigation construction company selected to perform the work shall, prior to being awarded work, provide verifiable documentation of successful completion of not less than three projects of similar type, size, and scope to the project outlined herein and/or provide verifiable documentation of not less than five years experience undertaking projects of similar size, style, and scope. "Verifiable Documentation" shall include but not limited to contact names and current telephone numbers of clients/owners of past projects cited as similar in type, size, and scope to the project outlined herein.

B. Electrical Components, Devices, and Accessories: UL Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Verify that the area of coverage, and materials to be used meet these specifications.

D. Utilize equipment of proper size and good working condition to prosecute the work to full completion in a satisfactory manner.

E. Maintain skilled journeymen on the job and a competent superintendent who has the authority to act in all matters pertaining to the work.

F. Execute all work in accordance with all governing ordinances, laws and regulations.

G. Coordinate work with other trades as necessary.

H. Submit As-Installed drawing at project close-out.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

C. The Contractor shall provide and pay for all transportation required to deliver and remove from the site all materials and equipment as required for all the work shown and specified.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Minimize the disruption to the existing water service and irrigation system. Coordinate the relocation of the existing POC with the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner’s Representative no fewer than two days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner’s Representative written permission.

1.8 WARRANTY

A. Warranty the work against all defects and malfunctions due to faulty workmanship or defective material for a period of one (1) year from the date of final acceptance. This shall include one full growing season after final acceptance and may be longer than 365 days.

B. Repair and/or replace defects or malfunctions equipment in expedient manner. Emergency repairs may be made by the Owner without relieving the Contractor of warranty responsibilities.

C. Properly repair any settling of backfilled trenches during the warranty period.

D. Restore damaged plantings, paving, or other site improvements within the warranty year period. If the Contractor does not respond to the Owner's request for repair work within a period of 14 days, the Owner may proceed with such necessary repairs and charge the Contractor for all expenses incurred in the repair work.

1.9 WATER SUPPLY

A. Irrigation connection and backflow prevention is to be located and shown on shop drawings for at-grade and rooftop irrigation.

B. Locate controller within a mechanical room designated for this purpose.

C. Verify performance level of the water supply prior to installation of the irrigation system. Supply and install pump if additional pressure for the system is required.

1.10 CONTROLLER AND ELECTRICAL PROVISIONS

A. Mount the controller within the mechanical room and furnish 120V power to the controller. Stub a conduit from the controller to a point 5 feet outside of the building.

1.11 DESIGN

A. Performance:
   1. Assume full responsibility for the proper design, execution and performance of the entire irrigation system.

B. Coordination with Plantings:
   1. Give priority to plantings regarding location of irrigation lines. Location of trees and planting beds will not be adjusted.
   2. Install irrigation lines in orderly patterns that are orthogonal to the building and tree plantings whenever possible.
   3. Do not install irrigation lines within the root zones of new or existing trees unless otherwise noted. Consult with the Landscape Architect prior to installation if root zones must be affected.

C. Limits
   1. Irrigate all areas designated on the Drawings.
   2. Keep each type of vegetation on a separate zone. For example, a single zone may not cover two plant types with different watering requirements.

D. Spacing of Drip Lines:
   1. Spacing: Locate and space subsurface drip lines 24” on center, parallel to each other, at depth(s) shown on the Drawings.
   2. Layout lines to best fit the areas to be covered.

E. Quick Couplers:
   1. Provide one quick coupler adjacent to the water supply line to facilitate winterization.
   2. Provide additional quick couplers at locations shown on Drawings.
   3. Note: Quick couplers will be used to facilitate washing of concrete surfaces and sculpture.

F. Line Sizes and Types:
   1. Size piping to provide a maximum flow velocity of 5 feet per second.

G. Coupler Placement:
   1. Install all quick couplers on 3-elbow, PVC swing joints and attached to a metal stake driven into the ground within the valve box by two stainless steel automotive type hose clamps.

H. Fertilizer Delivery:
   1. Install equipment as necessary to allow delivery of liquid fertilizer to plants via the irrigation system (i.e., fertigation).
   2. Include shut-offs or bypass valves as necessary to ensure that fertilizers and other unwanted chemicals do not contaminate the water that will be used for washing the concrete surfaces and sculpture via the quick-coupler system.

I. Root Intrusion Prevention:
   1. Use a renewable cartridge system to prevent root intrusion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. Use equipment designed by Toro, Rainbird or Hunter Unless otherwise specified. Provide new materials only.
   2. Guarantee all materials for one-year minimum against defects or defective workmanship.

3. All mainline piping to control valves shall be PVC. Lateral piping less than 2-1/4 inches in diameter from the control valves to heads may be polyethylene or PVC. Lateral piping 2-1/4 inches in diameter or larger, shall be PVC.

B. PVC Pipe and Fittings:
1. All plastic pipes less than 1-inch in diameter shall be Class 200 unplasticized polyvinyl chloride pipe, Type 1120 or 1220, manufactured by Crestline or approved equal.
2. Provide Schedule 40 PVC, Type 1 fittings of domestic manufacture. Identify pressure rating or schedule of all fittings.
3. Provide solvent for use on PVC pipe and fittings of a type approved by the manufacturer of the pipe for the temperature of installation.
4. Provide 1-1/2 inch diameter or larger plastic pipe, belled-spigot type, unplasticized PVC, Class 160, as manufactured by Crestline or approved equal.
5. Provide fittings for belled-spigot type pipe of the same manufacture as the pipe and unplasticized PVC.

C. PVC Risers and Swing Joint Nipples:
1. Provide unplasticized PVC Schedule 80 threaded pipe for all risers and swing joint nipples.
2. Provide PVC Schedule 80 threaded 90 degree elbows at swing joints.

D. Polyethylene Pipe:
1. Provide "poly" pipe as follows:
a. Material: PE3408 conforming to ASTM 2239
b. Type: 3
c. Grade: 4
d. Tensile strength: 5190
e. Burst Properties: 800
f. Make connections with barbed fittings and stainless steel automotive type clamps.

E. Electric Controller:
1. Provide controller(s) with control electric valves appropriate for the number and type of valves used.
2. Supply controller(s) with the following options if not standard equipment:
a. Remote-controlled
b. Master valve circuit
c. Lock kit
d. Primary Surge Protection
e. Valve surge protection
3. Provide two-wire controllers for use on systems with 16 zones or more.
a. Provide grounding and lightning protection for all two-wire systems per manufacturer's recommendations.
b. Provide in-line surge protection and end-line protection.
c. Types:
1) Weathermatic SmartLine SL4800
2) Rainbird
3) Toro
4) Hunter
4. Provide Smart Control System:
a. Weathermatic SmartLine SL4800 or approved equal www.smartline.com
b. SLW20 On-site weather station
c. SLM48DM 2-Wire system decoder
d. SLRC Wireless handheld remote control

F. Electric Control Valves: Two-Wire Decoder
1. Size the electric control valves based on the design flow, manufacturer's pressure loss charts and a maximum pressure loss of 6 psi. Projects with low supply pressure (50 psi or less) shall limit pressure loss in the valve to 4 psi. Use the following valves.
2. Plastic flow control valves:
a. Rainbird

b. Toro
c. Hunter

3. Brass flow control valves:
   a. Rainbird
   b. Toro
   c. Hunter
4. Pressure regulated valves:
   a. Rainbird
   b. Toro
   c. Hunter

G. Sleeves:
1. Provide Schedule 40 PVC sleeves, a minimum of 2 inches in diameter greater than pipe passing through.
2. Place sleeves wherever an irrigation line or control wire passes beneath pavement, walks, or other hard surfacing.

H. 115 Volt Electric Wiring:
1. Install all 115-volt AC wiring in accordance with local electrical codes and the manufacturer's literature stating maximum voltage drops allowed to controllers.

I. 24 Volt Control Wiring (By State Licensed Contractor):
1. 24 volt electric control lines from controller to automatic valves shall be direct burial UF wire, 20 inch minimum bury and of a different color than the 110 volt service to controllers. The 24-volt common ground shall be of one continual color and a different color than other 24-volt lines and the 110-volt service.
2. Minimize wire splicing. Make splices waterproof with the use of waterproof Scotchlok, Pen-Tite or Rainbird ST-03 connector kits or approved equal. Install all 24-volt wiring in accordance with applicable codes.
3. Size wire using the valve manufacturer's wiring charts based on distance and number of valves to be operated. Use 14 gauge minimum.
4. Coil wire around a 1" pipe six times every 100 feet for expansion/ contraction and repairs.

J. 24 Volt Control Two-Wire system (By State State Licensed Contractor):
1. Use 12 gauge shielded wire approved for two-wire irrigation systems.
2. Use 3M DBY connectors or approved equal.

K. Valve Boxes:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Carson Industries LLC.
3. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
   a. Material: Plastic, PVC
   b. Size: As required for valves and service (minimum of 10” round).
   c. Shape: Round or Rectangular.
   d. Sidewall Material: PE, ABS.
   e. Cover Material: PE, ABS.
   f. Lettering: "VALVE NUMBER."
   g. Description of equipment contained: “Iso Valve”

4. Drainage Base: Cleaned gravel or crushed stone, graded from 2” minimum to 3” maximum.

L. Rain Sensor: Provide wireless sensor to deactivate irrigation system during rain events.
1. Rainbird RSD Wireless Rain Sensor
2. Toro 53770 Wireless Rain Sensor
3. Hunter Wireless Rain-Clik

M. Moisture Sensor: Provide moisture sensor to deactivate system during periods of excessive ground moisture.

1. Nelson 8701 EX Pro Xtra Moisture Sensor, or approved equal.

N. Sprinkler Heads:
   1. None allowed.

O. Rotary Nozzles:
   a. None allowed.

P. Quick Coupler Valves: Rainbird, Toro, and Hunter. Supply Owner with three keys.

Q. Subsurface Dripline: Pressure compensating, inline emitter tubing.
   1. Provide valves with pressure reducing and screening capabilities.
   2. Manufacturer: Rainbird, Toro, Hunter and Netafim

PART 3 - EXECUTION

3.1 PRECAUTIONS AND PROTECTION OF WORK

A. Locate all the existing underground structures and utilities, and ensure that no conflicts exist between the irrigation system and other elements.

B. Repair and/or replace sleeves, piping, or any equipment damaged during construction. Clearly stake equipment with signs and flags to reduce the likelihood of damage caused by other trades.

3.2 INSTALLATION

A. Excavating and Backfilling:
   1. Perform necessary excavation required for the proper installation of the work.
   2. Backfill material shall be free from rock, large stone or other unsuitable substance to prevent damage to the pipe.
   3. Backfill trenches when pipe is cool to avoid excessive contraction of the plastic piping.
   4. Install the following depth of cover based on the diameter of the pipe:
      a. 24-inch minimum cover over 6-inch diameter pipe
      b. 18-inch minimum cover over 2-inch to 4-inch diameter pipe
      c. Per Drawings or standard practice for pipe less than 2-inch diameter.
   5. Compact backfill material in 6 inch layers up to finish grade to ensure proper compaction and prevention of future settling.
   6. Do not to mix surfacing material with underlying subgrade.

B. Piping:
   1. Securely cap piping at the end of each day's work to prevent entrance of foreign material.
   2. Do not pull pipe.
   3. Use directional boring to install pipe and sleeves beneath existing pavements.
   4. Install lateral pipes and fittings in accordance with the manufacturer's recommendations unless otherwise noted otherwise.
   5. Thoroughly flush lines prior to the installation of automatic valves.

C. Sleeving: Enclose pipe and wire in PVC sleeves at locations where necessary to allow future access without need for demolition of paved surfaces, sculpture, tree planting areas or the like. Coordinate installation of sleeves with other trades.

D. Joint Construction:
   1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
   2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
   3. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

a. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

4. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
5. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.
6. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified
7. Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.
8. Copper-Tubing Soldered Joints: Apply ASTM B 813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.
9. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
10. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    b. PVC Pressure Piping: Join schedule number, ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
    c. PVC Non-pressure Piping: Join according to ASTM D 2855.

E. 24 Volt Control Valve Wiring:
1. Install adjacent to the main line piping. Provide sufficient slack at each connection to the valve to accommodate future service.
2. Provide underground splices only in valve boxes with proper connectors.

F. Control Valves: Place all control valves inside a valve box such that the valve is plumb and centered within the box.

G. Valve Installation:
1. Remote Control Valves: Install in valve boxes of adequate size (10” round minimum) to allow for ease of service.
2. Shall have globe/angle configuration with FPT inlet and outlet.
3. Shall have manual flow control and internal bleed for manual operation.
4. Provide a minimum of two feet of slack in control wires for each valve.
5. Refer to irrigation design for valve size and location.

H. Valve Boxes:
1. Provide a box for each valve.
2. Install all valve boxes, drain boxes, and other miscellaneous markers or access, flush with finished grade.

I. Sprinkler Installation:
1. Install sprinklers after hydrostatic test is completed.
2. Install sprinklers at manufacturer's recommended heights.
3. Locate part-circle sprinklers to maintain a minimum distance of 4” from walls and 4” from other boundaries unless otherwise indicated.
4. Sprinklers shall be installed plumb and level (within 1/16”).

J. Drip Irrigation Installation:
1. Install landscape drip line as per details and manufactures recommendations.
2. Drip line shall be installed directly on soil, with wood mulch on top, stapled every four feet and at every change in direction.

3. 1” PVC headers shall be used on all drip zones and drip lines shall be run in a straight line and connected to 1” PVC footer.
4. Install remote control valve, filter and pressure regulator in piping near drip line, and in rectangular valve box – 1 control valve assembly per valve box.
5. Install air relief valves and flush valves in piping (1 per zone), and in control-valve boxes.
6. Install operation indicators in each zone and in area that is easily visible.
7. Verify placement of all irrigation equipment, before placement, with Owner’s Representative to ensure compliance.
8. Drip irrigation shall be inspected before placement of plant material and medium to ensure compliance with manufacturer’s details & recommendations.

K. Rain Sensor: Install per manufacturer specifications.

L. Moisture Sensor: Install per manufacturer specifications.

M. Quick Couplers:
1. Install all quick couplers on PVC swing joints with three 90 degree elbows to allow for grade adjustment and stability.
2. Attach with a metal stake driven into the ground within the valve box using two stainless steel automotive type hose clamps for additional support.

N. CONNECTIONS
1. Comply with local Codes & Requirements for piping specified in Division 22 Section "Facility Water Distribution Piping" for water supply from exterior water service piping, water meters, protective enclosures, and backflow preventer. Drawings indicate general arrangement of piping, fittings, and specialties for review by consultant team, owner, and city officials.
2. Install piping adjacent to equipment, valves, and devices to allow service and maintenance.
3. Connect wiring between controllers and automatic control valves.

O. Automatic Irrigation Control System Installation:
1. Equipment Mounting:
a. Install per manufacturers requirements.
b. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
c. Install anchor bolts to elevations required for proper attachment to supported equipment.
d. Contractor to ensure connection to Sentinel Central control and modify antenna as needed.
e. Install control cable in same trench as irrigation piping above or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.
f. All control wires will be contained in conduit at all times when above ground.

3.3 INSPECTION, CLEAN-UP, TESTING, AND ACCEPTANCE OF THE SYSTEM

A. Field Quality Control
1. Perform tests and inspections.
2. Tests and Inspections:
a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
b. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
c. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Any irrigation product will be considered defective if it does not pass tests and inspections.
4. Demonstrate to Consultant and/or Owner’s Representative the operation of the irrigation system and controls. Contractor to make available a copy of the plan for the purposes of this test.
5. If repeated trips by the Consultant and/or the Owner’s Representative are required to successfully complete the demonstration the contractor will be liable for all related expenses.

B. Acceptance Meeting: Schedule a meeting with the Landscape Architect and the Owner's operating personnel for the following purposes:
   1. Turn over Owner's service manual.
   2. Demonstrate operation of the system using the "As-Installed" drawing.
   3. Show locations of all drain valves, isolation valves and quick couplers.
   4. Provide repair parts and tools.
   5. Generate a punch list of incomplete or unacceptable items.

C. Schedule the Acceptance Meeting only after the following items are complete:
   1. All planting operations are completed.
   2. The irrigation system is balanced and adjusted.
   3. The As-Installed drawing has been received by the Landscape Architect.
   4. Pressure testing has been completed and approved by the Landscape Architect.

D. Balancing and Adjustment: Balance and adjust the various components of the system so the operation is most efficient, including programming the controllers, adjustments to pressure regulators, and flow valves.

E. Pressure Testing:
   1. Evacuate all air from lines to be tested.
   2. Pressure test lines before joint areas are backfilled.
   3. Backfill over the pipe to maintain pipe stability during test period.
   4. Test piping at hydraulic pressure of 150 psig for two hours. Maximum loss shall be 0.8 gallons per inch pipe diameter per 1000 feet. Locate the pump at low point in line and apply pressure gradually. Inspect each joint and repair leaks. Re-test lines until all are satisfactory.

F. Clean-Up:
   1. Any soil or similar material which has been brought onto paved areas by hauling operations or otherwise shall be removed promptly, keeping the area clean at all times. Upon completion of the installation of the irrigation system all excess soils, stones, and debris, which have not previously been cleaned up, shall be removed from the site or disposed of.
   2. All ground areas disturbed as a result of installation of the irrigation system shall be restored to their original condition or to the desired new appearance.

G. As-Installed Drawing:
   1. Prepare a drawing of the As-Installed irrigation system with exact locations of all components location. Submit the drawing to the Landscape Architect for approval.

H. Owner's Service Manual:
   1. Provide the manufacturer's installation directions, diagrams and service maintenance instructions to the Owner for each item furnished. Provide two copies of each in the form of a bound manual. Include a complete lists of spare and replacement parts for all equipment including names and addresses of all suppliers.

I. First-Year Winterization and Start-up:
   1. Drain the irrigation system and connect an air compressor of sufficient size to discharge any water from low points of the system.
   2. Recharge the system the following spring. Correct any leaks, malfunctions, or problems.

J. Miscellaneous Parts and Tools for Maintenance Personnel:
   1. Provide the following maintenance parts and tools for use by the Owner's maintenance personnel:
      a. Two (2) inner components of automatic valves. (each model)
      b. One (1) each of special tools for use in repairing or replacing valves.
      c. One (1) one-quart can of PVC solvent and cement.
      d. Five (5) compression repair couplings for each size of PVC pipe up to 2-1/2 inch, and two (2) for 4-inch and larger pipe diameters.
      e. Three (3) elbows, tees, and couplings for each size of PVC pipe used.

3.4 CONSTRUCTION WASTE MANAGEMENT

A. Comply with requirements of Section 017419 - Waste Materials Management and Recycling for removal, recycling, and disposal of construction debris and waste.

END OF SECTION 32 8400

SECTION 32 91 13 PLANTING SOIL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Mixing and testing of topsoil, sand and organic material to create planting mixes
2. Installation of planting soil mix
3. Compacting and grading of planting soil mix

B. Related Requirements:
1. Section 32 93 00 Plants
2. Section 32 92 05 Native seeding
3. Section 32 92 00 Turf and grasses

1.2 DEFINITIONS

A. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.

B. Imported Soil: Soil that is transported to Project site for use.

C. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.

D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

E. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

F. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.

G. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.

H. USCC: U.S. Composting Council.

1.3 PREINSTALLATION MEETINGS

A. Pre-installation Conference: Conduct conference at Project Site.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Material source locations: Submit locations of soil material sources. Submit the name, address and telephone number of the source contact, and the location of the soil source including directions to the specific field location on the property.

C. Samples: Submit samples of each product and material where required by the specification. Label samples to indicate product, specification umber, characteristics, and locations in the work. Samples will be reviewed for appearance only. Compliance with all other requirements is the exclusive responsibility of the contractor. Delivered materials shall closely match the samples.

1. Samples of all topsoil, sand and Planting mixes shall be submitted at the same time as the particle size and physical analysis of that material.
2. Each test report shall be marked with the following information:
   a. Date issued
   b. Project Title and names of Contractor and material supplier
   c. Name of material and reference number from Part 2 of the specifications identifying the type of material
   d. Date, place, and time of sampling with a record temperature and weather conditions
   e. Testing laboratory name, address and telephone number, and name(s) s applicable, of each field and laboratory inspector
   f. Type(s) of test
   g. Results of tests including recommendations of acceptable ranges of the text data for the types of plants to be planted in the soil

D. Submit for review soil test analysis report to the consultant within 60 days of contract award for each sample of topsoil and planting mix from an approved soil-testing laboratory

1. The testing laboratory shall be approved by the Landscape Architect in advance. All soil and planting mix tests shall be conducted by soil laboratories accredited by the State of Arkansas.
2. All tests shall be performed in accordance with the current standards of the Association of Official Agriculture Chemists or the “Methods of Soil Analysis Part 1-3” as published by the Soil Scientist Society of America.
3. Provide a particle size analysis for all topsoil and planting mixes including the following gradient of mineral content:

USDA Designation	Size in mm
Gravel	+2 mm
Very Coarse Sand	1-2 mm
Coarse Sand	0.5-1 mm
Medium Sand	0.25-0.5 mm
Fine Sand	0.1-0.25 mm
Very Fine Sand	0.05-0.1 mm
Silt	0.002-0.05 mm
Clay	minus 0.002 mm

4. Particle size analysis for topsoil and planting mixes to include sand sieve analysis shall be performed and compared to the USDA Soil Classification System per ASTM D422 (hydrometer test) or ASTMF1632 (pipette test). The silt and clay content shall be determined on soil passing the #270 sieve and shall be reported separately.
5. Provide a chemical analysis including the following:

a. Reaction (pH)

6. Provide percentage of organic matter by weight as determined by ignition (Ash Burn Test or Walkley/Black Test, ASTM F1647) with the following modification. Samples of planting mix shall be screened through a 6mm screen rather than the standard 2mm screen. Planting mix samples shall not be “floated” to remove plant matter prior to testing for organic matter.
7. Submit the manufacturer’s particle size analysis for all sand and gravel to the Landscape Architect for review of the general contract. Provide the manufacturer’s Fine Modulus Index for each sand source.
8. Submit the manufacturer’s particle size analysis, pH and certificate of length of composting period for all pine bark and other organic materials to the Landscape Architect for review.
9. The Landscape Architect reserves the right to require additional soil analysis at any time such additional samples of materials are deemed necessary for verification of conformance to specification requirements. Contractor shall furnish samples for this purpose upon request and shall perform testing as requested.
10. All testing will be at the expense of the Contractor.
11. For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.
12. Contractor shall not begin final grading or planting operations until analysis of subsoil(s) has been received from Architect.

1.6 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 PRODUCTS

2.1 GENERAL

A. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 Product Requirements and 01 25 00 Substitution Procedures.

2.2 EXISTING PLANTING SOIL

A. Soils currently within planted areas may be used where designated on the Planting Plan. Existing tree roots less than 25mm in diameter and organic material present in the soil shall be acceptable. Remove all stumps prior to harvesting. Harvest the soil in a manner to preserve clumps and soil peds where possible. Do not screen the soil.

B. Stockpile soil in areas where work can be phased around the soil, confirm location with owner’s representative. Store the soil in an area adjacent to the proposed soil mixing area. Cover the stockpile with non-woven geotextile fabric to protect the stockpile from erosion and contamination by liquids; chemicals and dust material including lime or lime based building materials that are harmful to plants.

C. Test the existing soil for chemical properties and analyze for particle size and texture as described in the submittal section of Part 1 of this section. Take a minimum of 3 samples from locations and depths selected by the Landscape Architect to determine the levels of pH. Make fertilizer additions recommended by the soil test when preparing the soil mix.

2.3 COARSE SAND

A. Coarse Sand or Drainage Sand.

2.4 ORGANIC MATTER

A. Organic Yard Compost or Supersoil by a local nursery.

2.5 IMPORTED TOPSOIL MIXES

A. Topsoil Borrow Planting Soil: Provide topsoil borrow consisting mostly of loam ranging into sandy clay loam, sandy loam, silt loam, and clay loam soils as a plant growing medium for landscape and planting beds and in accordance with Table 3877-2.

Loam Topsoil Borrow Requirements		
Requirement	Range	Test Method
Material Passing the ¾ in	100%	ASTM D 422
Material passing No. 4	≥ 90%	-
Clay	5% – 35%	ASTM D 422
Silt	10% – 60%	ASTM D 422
Sand	15% – 60%	ASTM D 422
Organic matter	3% – 15%	ASTM D 2974
pH	6.1 – 7.5	ASTM G 51
Soluble salts	≤ 0.15 siemens/m	—

PART 3 INSTALLTION

3.1 GENERAL

A. Place planting soil and fertilizers according to requirements in planting preparation and earthwork specification section.

B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

3.2 SOIL DEPTHS

A. Rain Garden, Stormwater Basin: 18” Imported Topsoil.

B. Shrub & Perennial Plant Beds: 18” Imported Topsoil

C. Turf Grass/Lawn: 4” Imported Topsoil

3.3 PLACING PLANTING TOPSOIL OVER EXPOSED SUBGRADE

A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

B. Subgrade Preparation: Till subgrade to a minimum depth of 12 inches (300 mm). Remove stones larger than 1-1/2 inches (38 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

C. Application: Spread planting soil to depth required by planting zone; but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.

D. Lifts: Apply planting soil in lifts not exceeding 12 inches (300 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.

E. Compaction: Compact each lift of planting soil to 75 percent of maximum Standard Proctor density according to ASTM D 698.

F. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.4 MIXING

A. Till soil amendments into existing soil for grassed areas with the use of mechanical tiller to a depth of 4 inches.

B. Mix soil base, amendments, and chemical additives by mechanical means. Do not mix additives with excavated material at the plant pit site.

C. Mechanical means should thoroughly mix all amendments with soil or soil-less base.

D. Soil and sand bases shall be completely pulverized and free of lumps or aggregated material.

E. Moisture content of base materials shall not be such that chemical granular or pelletized additives become dissolved before thorough mixing.

F. Mix media in quantities of not less than 50 cubic yards or mix total quantity required if less than 100 cubic yards. Contractor shall be responsible for continuity between batches.

G. The Contractor shall keep in storage, at his own expense, sufficient quantities of mix to repair any settling or to adjust grades throughout the warranty period.

3.5 PROTECTION AND CLEANING

A. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:

B. Storage of construction materials, debris, or excavated material.

C. Parking vehicles or equipment.

D. Vehicle traffic.

E. Foot traffic.

F. Erection of sheds or structures.

G. Impoundment of water.

H. Excavation or other digging unless otherwise indicated.

I. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

J. Dispose of excess subsoil and unsuitable materials on-site where directed by Landscape Architect.

3.6 FIELD QUALITY CONTROL

A. The Landscape Architect reserves the right to take and have a Soils Testing Laboratory analyze soil samples at the site.

B. Immediately remove rejected materials from site. Replacements are subject to all specified requirements.

C. The Contractor shall bear final responsibility for proper surface drainage of planted areas. Any discrepancy in the Drawings or Specifications, obstructions on the site, or prior work done by another party, which Contractor feels precludes establishing proper drainage shall be brought to the attention of the Landscape Architect in writing for correction or relief of said responsibility.

END OF SECTION PLANTING SOIL – 32 91 13

SECTION 32 92 00 TURF AND GRASSES

PART 1 - GENERAL

2.0 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and all Specification Sections, apply to this Section.

2.1 SUMMARY

A. Section Includes:

1. Seeding
2. Sodding
3. Turf renovation.
4. Erosion-control material(s).

B. Related Sections:

1. Section 321313 – Concrete Paving
2. Section 321540 – Aggregate Surfacing & Features
3. Section 329300 – Plants

2.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

2.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

1. Certification of each seed mixture for turfgrass seed and sod. Include identification of source and name and telephone number of supplier.

C. Conformance Submittal: Submit Installer's Qualifications as indicated prior to beginning work for qualified landscape NC Certified landscape contractor.

D. Product Certificates: For soil amendments and fertilizers, from manufacturer.

E. Material Test Reports: For standardized ASTM D 5268 topsoil and imported or manufactured topsoil.

2.4 SUBSTITUTIONS:

A. The species or varieties, materials, products or sizes specified herein by botanical and common name, shall be provided as specified.

B. Substitutions will be permitted only upon written application by the Contractor to the Landscape Architect, and when approved by said LA in writing.

C. Request for permission to substitute will not be entertained unless adequate evidence substantiating the unavailability of the specified item accompanies the request for substitution.

2.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.

1. Professional Membership: Installer shall be a member in good standing of either the American Landscape Contractors Association or the American Nursery and Landscape Association.
2. Registration. Installer shall be a Registered Landscape Contractor (where applicable).
3. Experience: Five years' experience in turf installation in addition to requirements in Division 01, Section 01 – Quality Requirements.
4. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
6. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: refer to 329300 Plants.

C. Preinstallation Conference: Conduct conference at Project site.

D. Soil Analysis: Provided by the Contractor and available for each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd. for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

2. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

2.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

C. Fertilizer: Deliver to site in original unopened standard size bags showing weight, analysis and name of manufacturer. Store in weatherproof place and keep dry to maintain effectiveness. Store partially used bags in sealed containers.

D. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide perimeter-control measures to prevent displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

2.7 PROJECT CONDITIONS

A. Planting Restrictions: See drawings for planting periods and specific species for specific planting dates.

B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

2.8 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer until project reaches Substantial Completion. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established and project is Substantially Complete, but for not less than the following periods:

1. Seeded Turf: 90 days from date of planting completion.
   a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
2. Sodded Turf: 90 days from date of installation.

B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options. Include with Maintenance Service Proposal as defined in Section 32 9300 - Plants.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: State-certified seed of grass species as follows:

C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Kentucky bluegrass (Poa pratensis), a minimum of three cultivars.
2. Sun and Partial Shade: Proportioned by weight as follows:

    a. 50 percent Kentucky bluegrass (Poa pratensis).
    b. 30 percent chewings red fescue (Festuca rubra variety).
    c. 10 percent perennial ryegrass (Lolium perenne).
    d. 10 percent redtop (Agrostis alba).

D. Shade: Proportioned by weight as follows:

    a. 50 percent chewings red fescue (Festuca rubra variety).
    b. 35 percent rough bluegrass (Poa trivialis).
    c. 15 percent redtop (Agrostis alba).

2.2 TURFGRASS SOD

A. Sod shall be Bermuda sod, ‘TifTuf’, Premium Quality, grown from certified seed or sprigs, and complying with TPI’s “Specifications for Turfgrass Sod Materials” in its “Guideline Specifications to Turfgrass Sodding.” Sod shall be Blue Tag Certified. Variety of sod, where shown, shall be as specified on plan. Sod shall be two years old minimum

B. Sod shall be fresh cut, installed not over 24 hours after harvest, and consist of live, growing plants secured from sources where the soil is fertile. Sod shall have a healthy, virile root system, or dense, thickly matted roots throughout the soil of the sod for a minimum of one inch. Sod shall be free from obnoxious weeds or other grasses and shall not contain any matter deleterious to growth or which might affect its subsistence or hardiness when transplanted, including any neeting.

C. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Full Sun: Kentucky Bluegrass (Poa pratensis), a minimum of three cultivars.

D. Contractor to submit sod supplier to Landscape Architect prior to purchase and installation. Only sod secured from approved sources shall be used.

2.3 TURFGRASS SOIL:

A. Turfgrass Soil to be placed as part of the demolition of the existing paved surfaces, structures, or other existing features noted for removal on the demolition plan. Contaminated soils are to be hauled off-site and replaced with soil types listed on L-Series soils plan.

B. Contractor to verify Turfgrass Soils were placed at a minimum depth of 6” throughout turfgrass areas shown on the L-Series drawings. If insufficient depth is observed on site, it is the Contractors responsibility to import additional Topsoil to ensure required depth is achieved prior to seeding or sodding turfgrass.

2.4 INORGANIC SOIL AMENDMENTS:

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone or calcitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.

E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde and potassium in the following composition:

1. Composition: Nitrogen and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen and potassium in the following composition:

1. Composition: Nitrogen and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

D. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

E. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

F. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.7 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.8 EROSION-CONTROL MATERIALS

A. Rolled Erosion-Control Blankets (RECP): Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

B. Erosion-Control Fiber Mesh: Biodegradable burlap or spun-coir mesh, a minimum of 0.92 lb/sq. yd. (0.5 kg/sq. m), with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches (150 mm) long.

C. Turf Reinforcement Mats (TRM): Cellular, non-biodegradable slope-stabilization mats designed to isolate and contain small areas of soil over steeply sloped surface, thickness as detailed on the drawings. Include manufacturer's recommended anchorage system for slope conditions.

1. Products: See drawings and details and confirm with Landscape Architect for final product selection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Owner and replace with new planting soil.

3.2 PREPARATION

A. Turf subgrade preparation applies to all areas designated for turf grass seed and sod.

B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches. Remove surface stones larger than 1.5 inch in dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.
2. Thoroughly blend top soil off-site before spreading if additional depth needed.
   a. Delay mixing fertilizer with top soil if planting will not proceed within a few days.
   b. Mix lime with dry soil before mixing fertilizer.

C. Spread top soil to a depth of 4 inches minimum but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if top soil or subgrade is frozen, muddy, or excessively wet.

1. Spread approximately 1/2 the thickness of top soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of top soil.
2. Reduce elevation of top soil to allow for soil thickness of sod.

D. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
2. Loosen surface soil to a depth of at least 4 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
   a. Apply fertilizer directly to surface soil before loosening.
3. Remove surface stones larger than 1 inch in dimension and sticks, roots, trash, and other extraneous matter.
4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

E. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

F. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

G. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.3 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph (8 km/h). Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Revise first paragraph below to suit Project. Sowing rates vary with grass species and mixtures.

C. Sow seed at a total rate of 3 to 4 lb/1000 sq. ft.

D. Rake seed lightly into top 1/8 inch (3 mm) of soil, roll lightly, and water with fine spray.

E. Retain one or all options in first paragraph below if specifying blankets or mesh. Coordinate erosion-control materials with slope ratios and revise if required.

F. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets and 1:6 with erosion-control fiber mesh installed and stapled according to manufacturer's written instructions.

G. Retain first paragraph below if specifying erosion-control mats.

H. Protect seeded areas with erosion-control mats where necessary; install and anchor according to manufacturer's written instructions.

I. Retain first paragraph below if straw protection is required for seeded areas.

J. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

1. Retain one of two subparagraphs below for anchoring or bonding straw against erosion.
2. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
3. Bond straw mulch by spraying with asphalt emulsion at a rate of 10 to 13 gal./1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

K. Protection in paragraph below is usually required in warm, dry climates.

L. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

3.4 SODDED / SPRIGGED AREAS:

A. Soil Testing: Testing shall be requested 30 working days prior to delivery of topsoil or planting mix or the work site. Deficiencies in the topsoil or planting mix shall be corrected by the Contractor. Retesting cost shall be at the Contractor’s expense.

B. Preparation of Bed: Unless otherwise approved by the Grounds Superintendent or designee, all other site work required by this contract shall be complete and in place before grassing operations are begun.

C. Work may be completed in parts if so requested by the Contractor and approved by the Landscape Architect or designee. Prior to planting operations, all proposed lawn areas shall be scarified to 6" depth and pulverized until the surface is smooth, friable and of a uniformly fine texture.
For areas to receive new planting soil under sod, spread planting soil to a depth of 6 inches (150 mm) but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
    a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.
    b. Reduce elevation of planting soil to allow for soil thickness of sod where used.

D. Remove stones and foreign material over one inch in diameter and grade for positive drainage as required to prevent ponding of water.

E. Pre-emergent Herbicide: A pre-emergent herbicide and fertilizer combination (oxadiazon + fertilizer, or approved equal) shall be broadcast according to label recommendations.

F. Sod / Sprig Planting: Prepare sub-grade as specified above. Allow for thickness of sod to finished grade.
    1. Turf types for sod or sprigs to be used will be specific to that given job / project. To be approved by the Grounds Superintendent or designee prior to installation.
    2. Where Bermuda sod or sprigs are to be used – 'TifTuf' Bermuda or approved equivalent will be used as specified by Grounds Superintendent or designee.
    3. Lay sod within 24 hours from time of stripping. Protect any sod stored on site from damage due to weather. Do not lay sod on frozen ground.
    4. Sprigs should be fresh used within 24 hours from digging.
    5. Soil should be moist, but not wet, prior to laying sod. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod strips; do not overlap. Stagger strips to offset joints in adjacent courses. Work from boards to avoid damage to sub-grade or sod. Tamp or roll lightly to ensure contact with sub-grade. Work sifted soil into minor cracks between pieces of sod, and remove excess to avoid smothering of adjacent grass.
    6. Anchor sod on slopes with wood pegs to prevent slippage. Lay sod perpendicular to slope directions.
    7. Sprigged areas will be rolled with 250pd. rolled weight. Sprigs must be pushed into the ground with a grooved roller.

G. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.5 PREPARATION FOR EROSION-CONTROL MATERIALS

A. Prepare area as specified in "Turf Area Preparation" 3.3 article above.

B. For turf reinforcement mats (TRM), install planting soil in two lifts, with second lift equal to thickness of erosion-control mats. Install erosion-control mat and fasten as recommended by material manufacturer.

C. Fill cells of turf reinforcement mat with planting soil and compact before planting.

D. For rolled erosion-control blanket (RECP) or mesh, seed area, install RECP from top of slope, working downward, and as recommended by material manufacturer for site conditions and as shown on the details. Fasten as recommended by material manufacturer.

E. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.6 SODDING

A. Area: Shall be as indicated on the drawings or at minimum a three (3) foot wide strip along walks, roadways and parking areas to reduce erosion.

B. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.

C. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.

   1. Lay sod across angle of slopes exceeding 4:1.
   2. Anchor sod on slopes exceeding 6:1 with steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

D. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches (38 mm) below sod.

3.7 TURF RENOVATION

A. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

   1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
   2. Install 4” depth of new topsoil borrow soil in all areas to be re-sodded.

B. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.

C. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.

D. Mow, dethatch, core aerate, and rake existing turf.

E. Remove weeds before sodding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

F. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.

G. Till stripped, bare, and compacted areas thoroughly to a soil depth of 4 inches.

H. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.

I. Apply sod as required for new turf.

J. Water newly planted areas and keep moist until new turf is established.

3.8 TURF MAINTENANCE

A. Prior to acceptance: The Contractor shall be responsible for all maintenance of plants, turf and facilities until final acceptance. This includes all necessary watering, application of appropriate fertilizer, based on planting season, and the appropriate application of fungicides and insecticides necessary to maintain plants free from disease and insect activity.

B. Sodded / Sprigged Areas:

   1. Contractor shall maintain Sodded / sprigged areas as follows:
      a. Watering: Water sod / sprigs immediately after installation. Soak sod / sprigs thoroughly enough to penetrate soil below the newly installed sod / sprigs.Then water as follows:

0-14 day's	170 gallons/1,000 s.f. every day
15-28 days	225 gallons/1,000 s.f. every other day
29-42 days	340 gallons/1,000 s.f. every three days
43-84 days	680 gallons/1,000 s.f. once per week
After 84 days	As needed to maintain acceptable turf

   b. In the event the project is accepted prior to the watering requirements being fulfilled, the contractor will be required to provide water up to 90 days after sodding / sprigging.
2. Fertilizing Sodded / Sprigged Areas: Fertilizing will be specific to the given job or as follows:
   a. Fertilize sod 2 to 3 weeks after laying sod with high phosphorus fertilizer. Apply a complete nitrogen fertilizer every three weeks until the sod has achieved satisfactory establishment.
   b. As a follow-up for Bermuda sod /sprigs, the contractor or University (applicator is to be specified in the contract) will apply ½ pd. of Nitrogen from Ammonium Nitrate (34-0-0) or Ammonium Sulfate (28-0-0) within 4 weeks of the initial installation.
3. Mowing Sodded / Sprigged Areas: Mowing will be specific to the given job or as follows:
   a. Grass mowing operations shall be performed by the Contractor until final acceptance of the work.
   b. Trash and debris shall be removed prior to mowing.
   c. Mowing shall be performed only when the grass is dry.
   d. Mowing of Fescue shall be performed whenever grass height is 5". It shall be cut to a height of 3" to 4".
   e. All maintenance performed prior to acceptance shall be considered incidental to the project and no separate payment shall be made.
4. Fertilizer Top-Dressing: Where directed by PM/Engineer, Contractor shall top-dress lawn areas as needed to restore turf grass.
5. Maintenance Manual:
   a. Refer to 329300 PLANTS for general content and process for submittal of manual.

3.9 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Owner:

   1. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities. It shall include a maximum of three (3) percent scattered bare spots, none of which is larger than 5" by 5".

B. After grass growth has started all areas or parts of areas, which fail to show a uniform stand of grass for any reason whatsoever shall be re-seeded repeatedly until all areas are covered with a satisfactory growth of grass at no additional cost to the Owner.

C. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.10 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

B. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

C. Remove nondegradable erosion-control measures after grass establishment period.

3.12 FINAL ACCEPTANCE

A. Inspection to determine final acceptance of sodded lawns will be made upon the Contractor's request. Provide notification at least 10 working days before requested inspection date.

1. Sodded areas will be acceptable provided all requirements, including maintenance, have been completed and a healthy, uniform, close stand of grass is established, free of weeds, undesirable grass species, disease and insects.
2. No individual lawn areas shall have bare spots or unacceptable cover totaling more than 1% of the individual areas, in areas requested to be inspected
3. Contractor will remove all soil, debris and barricades created by soil preparation and sodding operation, including thoroughly cleaning all pavements, walks and building surfaces, or automobiles parked nearby.

B. Upon Final Acceptance of the sodded area, the Owner will assume lawn maintenance responsibilities, based on Maintenance Instructions submitted by the Contractor.

3.13 WARRANTY AND REPLACEMENT

A. Contractor will provide a one (1) year warranty for the sod starting from the date of final acceptance. If a satisfactory stand of maintained turf is NOT established in this period, the contractor will re-sod the area to conform with these specifications. A satisfactory stand of turf will be vigorous and growing well, and shall include a maximum of three (3) percent scattered bare spots, none of which is larger than 5" by 5".

B. Guarantee: The contractor shall guarantee a live stand of permanent grass consisting of 95% coverage minimum for seeded grass with no bare spots greater than 1 square foot. Acceptance will be made after the grass has been mowed three times and shows sufficient stand and cover as specified.

END OF SECTION 32 9200

SECTION 32 92 19 NATIVE GRASSES AND GROUNDCOVERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plants, planting and necessary planting operations including site preparation, plants and planting, mulching and management
   2. Protection, maintenance and warranty

B. Related Sections:
   1. Section 321540 -- Exterior Stone Surfacing and Features
   2. Section 329119 -- Landscape Grading – N/A
   3. Section 329000 -- Planting
   4. Section 329200 -- Turf Grasses

1.2 REFERENCES

A. AOAC: Association of Official Agricultural Chemists www.aoac.org

B. ASTM: American Society of Testing Materials www.astm.org

A. AGIA: Arkansas Green Industry Association https://www.argia.org/

B. USDA: United States Department of Agriculture www.usda.gov

1.3 SUBMITTALS

A. Product Data: Submit product data, schedules and certificates in accordance with Section 013000, Submittals.

B. Submit work schedule prior to start of work. Include the following:
   1. Installation schedule
   2. Maintenance and management of plantings

C. Samples: Submit to Architect for approval prior to procurement.
   1. Seed Mixes

D. Quality Control Submittals:
   1. Submit certificates upon arrival on site and prior to use or installation.
      a. Analysis and Standards: Deliver products with manufacturer's certified analysis.
      b. Provide healthy, vigorous stock free of disease, insects, eggs, larvae and defects.
   2. Contractor's Field Reports: During the construction period, submit a monthly report to the Architect indicating any soil loss, drainage problems, poor maintenance, vandalism, insect damage, disease or any other conditions that are detrimental to the plantings.
   3. Substantial Completion:
      a. Submit letter of completion to Architect upon substantial completion of work indicating:
         1) Finished work
         2) Unfinished work with explanation
         3) Unmet specifications with explanation
         4) Schedule for completion

E. Contract Closeout Submittals:
   1. Project record documents
   2. Description of first growing season management
   3. Owner operations and maintenance manuals

1.4 QUALITY ASSURANCE

A. Contractor Qualifications:
   1. Crew Foreman shall be a AGIA Certified
   2. Contractor shall have successfully installed at least three projects similar to that of this project within the last three years.
   3. Maintain at least one mechanic on site at all times who has worked on one or more of these previous installations.

B. Utilize equipment of proper size and in good working condition to prosecute the work to full completion in a satisfactory manner.

C. Utilize experienced personnel familiar with the equipment, methods and procedures for the job.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packaged Products:
   1. Deliver packaged products in original containers showing product name, weight, analysis and instructions for use and name of manufacturer.
   2. Protect products from deterioration, contamination or leaking during delivery and storage on site.

B. Seedlings:
   1. Protect from weather and mechanical damage.
   2. Plant and water within 24 hours of product arrival on site

C. Protection: Assume responsibility for any damage to other areas resulting from planting operations and bear the full cost to repair the damage. Accomplishment of repairs shall be equal to the original installation prior to damage. Any damage shall be immediately reported to the Architect and Owner. Repairs will be subject to approval by both.

1.6 PROJECT/SITE CONDITIONS

A. Grade Stakes: Maintain grade stakes set by others until removal is mutually agreed by parties concerned.

1.7 WARRANTY

A. Provide a warranty for plantings for a period of one-year after date of Substantial Completion against defects including death and unsatisfactory growth, but not including defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are entirely beyond the Contractor's control.

B. Inspect planted areas on at least a monthly basis during warranty period. During the warranty period, submit to the Architect periodic reports as necessary indicating any soil loss, drainage problems, poor maintenance, vandalism, insect damage, disease or any other conditions that are detrimental to the plantings. By failing to report any condition which leads to compromised health or death of the plantings, Contractor forfeits any claim of non-responsibility.

C. Remove and replace any plantings found to be dead or in unhealthy condition during the warranty period. Make replacements immediately or during next growth season as appropriate.

D. All replacements shall be plants of same kind and size as previously installed. All replacement costs shall be borne by Contractor.

E. Each replacement planting required at end of the warranty period shall be guaranteed for one year from date of installation, and itself is subject to replacement and a one-year warranty.

F. Inspection: At end of warranty period, inspection will be made by Architect upon written notice by the Contractor at least ten (10) days prior to end of the warranty period. Plantings required under this Contract that are dead or in unsatisfactory condition, as determined by Architect, shall be removed from site and replaced as soon as conditions permit during the planting season.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Planting Soil:
   1. Refer to Specification 32 9113 Planting Soil Mixes

B. Herbicide:
   1. Roundup® or Rodeo® herbicide, or approved equal.

2.2 PLANTING TYPES

A. VI – Native Planting Seed Mix
   1. Mix: Midwest Native Wildflower Seed Mix
   2. Supplier: Holland Wildflower Farm, Elkins, AR 72727 (479-283-6709)
      a. https://hollandwildflowerfarm.com/product/midwest-native-wildflowers/
   3. Seed Rate: 8-16 lbs per acre, 1 lb per 2500 sq. ft.
   4. Cover with seed free wheat or pine straw.

2.3 SOURCE QUALITY CONTROL

A. All plant materials are subject to review and approval by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Conditions
   1. Prior to starting work, verify soil conditions and grades.
   2. If site conditions appear unsatisfactory, make corrections before proceeding. Start of work indicates satisfaction with site conditions and responsibility for proper results.

3.2 SITE PREPARATION

A. Fine grade all areas prior to start of planting operations. Hand-rake all areas within designated tree protection areas. Do not use machinery within tree protection areas.

B. Pick-up and remove sticks branches, stones and other debris.

C. Herbicide:
   1. In areas with actively growing unwanted vegetation, apply herbicide per manufacturer's recommendations.
   2. Allow a minimum of 7 days before proceeding with planting operations.

3.3 PLANTING

A. Numbers of plants shown in the plant schedule are approximate. Contractor shall do calculations to determine number of plants required so that all areas designated to receive them are covered uniformly at the spacing designated.

B. Notify Architect prior to purchase of plants if the number of plants shown on Drawings is less than necessary to ensure uniform coverage at the spacing designated.

C. All seeded areas are to be hydroseeded at rates and volumes recommended by supplier.

D. All seeded areas to receive an erosion control blanket.

E. Install plugs and pots by hand with no disruption to existing tree roots.

F. Minimize soil compaction and disturbance to grades during planting and seeding operations.

3.4 MAINTENANCE

A. During the one-year warranty period, maintain all plantings to ensure healthy growth and survival.

B. In years following the first warranty period, management services shall include spot spraying, spot cutting, hand weeding, volunteer tree sapling removal and controlled burning if advantageous and feasible.

C. Maintenance Instructions: Submit typewritten instructions recommending procedures to be established by Owner for maintenance/management of the plantings during the warranty period. Submit prior to expiration of required maintenance period.

D. Maintenance of seeded areas:
   1. Continue maintenance until a healthy stand of grass results and the seeded area has been accepted by the owner.
   2. Frequently water seeded areas as required to supplement natural precipitation; each watering should result in wetting the upper 5" of soil profile. Depth of wetting may be determined by using a soil probe at several spots throughout the turf.
   3. Remove weeds in areas where an excessive quantity of weeds develop. Re-seed as required to meet intended results of a healthy stand of grass.
   4. Place seed materials in excess of rates given above as required to prevent erosion. Re-distribution of topsoil and re-seeding of eroded areas shall occur at the Contractors expense.

3.5 INSPECTION AND ACCEPTANCE

A. Inspection: Inspection of work will be made by the Architect at the conclusion of the planting period. Request an inspection at least ten (10) days prior to the desired date.

B. Acceptance: After inspection, the Contractor will be notified in writing by the Architect if there are any deficiencies in the work that require correction.

C. Clean-Up:
   1. Any soil, peat, or similar material, which has been brought onto paved areas by planting operations shall be removed promptly, keeping the area clean at all times.
   2. All ground areas disturbed by planting operations shall be restored to their original condition or to the desired new appearance.

3.6 CONSTRUCTION WASTE MANAGEMENT

A. Comply with requirements of Section 017419 - Waste Materials Management and Recycling for removal, recycling, and disposal of construction debris and waste.

END OF SECTION 329219

SECTION 32 93 00 - PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Plants.
   2. Planting Soils.
   3. Tree stabilization.
   4. Landscape edgings.
   5. Landscape Mulch.

B. Related Sections:
   1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, and site clearing.
   2. Division 31 Section "Grading" for excavation, filling, and rough grading and for subsurface preparation.
   3. Division 32 Section "Turf and Grasses" for turf lawn and erosion-control materials.
   4. Division 32 Section “Planting Irrigation”

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size, grade and quality of plant required. No substitutions of specified plant material shall be made without written permission for the owner’s representative.

E. Finish Grade: Elevation of finished surface of planting soil.

F. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

G. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

H. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

I. Planting Area: Areas to be planted.

J. Planting Soil: Manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth to meet nursery standards

K. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

L. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

M. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

O. Subsoil: All soil beneath the topsoil layer of the soil profile and typified by the lack of organic matter and soil organisms.

P. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.
   1. Plant Materials:
      a. Include quantities, sizes, quality, and sources for plant materials.
      b. Submit certification from grower that plant material has been grown without the use of substances that are toxic to pollinators. This includes the use of neonicotinoid insecticides in plants or seeds.
   2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.
   3. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
   4. Submit certification from grower that plant material has been grown without the use of substances that are toxic to pollinators. This includes the use of neonicotinoid insecticides in plants or seeds.

B. Samples for Verification: For each of the following:
   1. Organic and Compost Mulches: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
   2. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

C. Qualification Data: For qualified landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
   1. Manufacturer's certified analysis of standard products.
   2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Material Test Reports: For imported or manufactured topsoil.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.
   1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
   2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
   3. Installer's Field Supervision: Require Installer to maintain an experienced full-time English speaking supervisor on Project site when work is in progress.
   4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
      a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior.
      b. Certified Landscape Technician - Interior, designated CLT-Interior.
      c. Certified Ornamental Landscape Professional, designated COLP.
   5. Pesticide Applicator: State licensed, commercial.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the Arkansas Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Planting Percolation Test: A minimum of two tests, per development site is required. Mark testing locations with visible stake. Prior to testing, submit site plan with proposed test locations marked for approval by Landscape Architect. Additional tests may be needed as required by Landscape Architect.
   1. Fill planting hole with water and allow it to drain completely.
   2. Hardpan Layer: Drill 6-inch diameter holes, 24 inches apart, into Hardpan Layer
   3. Fill planting hole with water again and immediately measure the depth of the water in the pit with a ruler. Record the time.
   4. After 15 minutes have passed, measure the depth of the water in the pit again.
   5. Multiply the number of inches that have drained by 4 to get drainage in inches per hour.
   6. Drainage will fall into one of three categories:
      a. Poorly drained = less than 2” per hour
      b. Well drained = 3” to 6” per hour

c. Excessively drained = more than 6” per hour

7. Prepare written test results and submit to Landscape Architect. If soils are poorly drained, immediately notify Landscape Architect of this condition. Upon direction, contractor shall install a drain stack at the bottom of the planting pit. Auger a 4” minimum diameter hole to a depth of 42” from the bottom of the plant pit and fill it with ¾” gravel. Install plant material as directed.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size, and 12 inches above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
1. Notify Landscape Architect of sources of planting materials seven days in advance of delivery to site.

G. Pre-installation Conference: Conduct conference at Project site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable.

B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

D. Handle planting stock by root ball only.

E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F until planting.

F. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate

aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
2. Do not remove container-grown stock from containers before time of planting.
3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of each service or utility.

C. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
   1. Spring Planting: Last frost date to June 15th.
   2. Fall Planting: August 15 - November 15th.
   3. Fall Evergreen plantings: August 15 – October 1

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas: Plant trees, shrubs, and other plants after finish grades are established and before planting seeded/sod areas unless otherwise indicated.
   1. When planting trees, shrubs, and other plants after planting turf areas, protect seed/turf areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
      b. Structural failures including plantings falling or blowing over.
      c. Faulty performance of tree stabilization, edgings
      d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
      e. Trees that are planted too deep.
   2. Warranty Periods from Date of Substantial Completion:
      a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
      b. Perennials and Other Plants: 12 months.
      c. When Substantial Completion occurs outside of planting dates. The warranty will start the following spring or fall beginning of the planting dates.

3. Include the following remedial actions as a minimum:
   a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
   b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
   c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
   d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: The contractor is responsible for all maintenance until the owner's representative accepts responsibility. Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each plant is installed and continue until installation of all planting is complete, inspection has been made and planting is accepted exclusive of guarantee.

PART 2 - PRODUCTS

2.1 PLANTING SOILS

A. Planting soil to be placed as part of the project within the limits of work and all areas disturbed by construction activity. Contaminated soils are to be hauled off-site and replaced with topsoil suitable for planting shrubs, perennials and trees.
   1. ARDOT "**Select**" Topsoil Borrow to be used as a plant growing medium in designated areas, such as landscape beds, shall meet the requirements of ARDOT Table 3877-2.
   2. Contractor to verify depth of "**Common**" Topsoil Borrow placed in areas to receive shrub, perennial or native grass plantings. Depth required for these planting areas shall be 15", Common Topsoil Borrow already placed on site may be mixed with Select Topsoil Borrow to achieve depth of 15" for all plant beds receiving shrubs, perennials and grasses. Maximum mixed ratio of "Common" to "Select" mix to be 50/50 to achieve required depth.

2.2 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with current ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide plants that have been grown without the use of materials that are toxic to pollinators including neonicotinoid insecticides.

B. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
   1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch in diameter; or with stem girdling roots will be rejected.
   2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting. Prior

to planting remove soil from top of rootball as needed to expose first true root. Nursery stock with more than 4" of soil covering the first tree root will be rejected.

E. Labeling: Label one plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant as shown on Drawings.

F. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

G. No substitutions of specified plant material sizes, grades, species, qualities or forms shall be made without the written permission from the owner's representative.

2.3 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
   1. Class: O, with a minimum of 95 percent passing through No. 8 sieve and a minimum of 55 percent passing through No. 60 sieve.
   2. Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

2.4 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
   1. Organic Matter Content: 30 to 60 percent of dry weight.
   2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.5 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde and potassium in the following composition:
   1. Composition: Nitrogen and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen and potassium in the following composition:
   1. Composition: Nitrogen and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

2.6 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
   1. Type Trees, shrubs and perennial: 100% Double shredded hardwood, tub-ground to medium fine texture, including no pieces larger than 4” in any dimension and free of deleterious materials.

B. Mineral Mulch: Free from deleterious materials and suitable for use.
   1. Refer to plans for type and depth, install over filter fabric.

2.7 TREE STABILIZATION MATERIALS

A. Stakes and Guys:
   1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
   2. Wood Deadmen: Timbers measuring 8 inches in diameter and 48 inches long, treated with specified wood pressure-preservative treatment.
   3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles
   4. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch in diameter.
   5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
   6. Guy Cables: Five-strand, 3/16-inchdiameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches long, with two 3/8-inch galvanized eyebolts.
   7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches long.
   8. Proprietary Staking-and-Guying Devices: Proprietary stake and adjustable tie systems to secure each new planting by plant stem; sized as indicated and per manufacturer's written recommendations.

2.8 LANDSCAPE EDGINGS

A. Steel Edging: Standard commercial-steel edging, rolled edge, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.
   1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ryerson Steel, J.T. & Son, Inc.
      b. Sure-Loc Edging Corporation.
      c. Approved Equal
   2. Edging Size: 3/16 inch wide by 4 inches deep.
   3. Stakes: Tapered steel, a minimum of 15 inches long.
   4. Accessories: Standard tapered ends, corners, and splicers.

5. Finish: Standard paint.
6. Paint Color: Black.

2.9 MISCELLANEOUS PRODUCTS

A. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

B. Rodent Trunk Protection: ½" hard wirecloth mesh cylinder. Dimensions: 8" diameter or greater, x 3' height. Stake securely in place, avoiding roots. Carefully anchor collar into top of rootball and surround with mulch. Do not allow mulch between trunk and collar. Maintain this condition for duration of warranty period.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
   1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
   2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
   3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
   4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transport.

E. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.

F. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving.

3.3 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 18 inches, Remove stones larger than 1½ inches in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

B. Apply fertilizer directly to subgrade before loosening.

C. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.

D. Delay mixing fertilizer with planting soil if planting will not proceed within a few days

E. Mix lime with dry soil before mixing fertilizer

F. Spread topsoil to a depth of 18 inches but not less than required to meet finish grades after natural settlement. Blend the first 2 inches of topsoil into the rough sub-grade material by rototilling. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

G. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top 4 inches of subgrade. Spread remainder of planting soil.

H. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Perform Finish grading and planting when soil is dry. Compaction shall be a minimum of 80 percent and maximum of 85 percent of maximum density in all lawn and planting areas.

I. Compaction Testing: The Contractor will retain an independent testing agency to conduct compaction tests. The Contractor shall pay for the original tests. Areas that do not meet compaction requirements shall be compacted and tested again until specifications are met. The contractor shall pay the cost for re-compaction as well as revisit the areas.

J. Before planting, obtain Landscape Contractor acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

K. Scarify sides and bottom of entire bod with spade by hand.

L. Loosen roots of container grown material prior to planting.

M. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Planting Percolation Test: The contractor to conduct percolation test to verify water drains from soil. Tests are as follows: Drill a 4- inch hole to a depth of 24” pour 6 inches of gravel into the hole and cover with water. Allow water to drain for one hour and refill the entire hole with water. To pass the test the water must drain out at a rate of 1 inch per hour or greater. If hardpan zones are encountered while drilling a second test using a 4” diameter tube shall be conducted to verify vertical drainage.

B. Upon direction, contractor shall install a drain stack at the bottom of the planting pit. Auger a 4” minimum diameter hole to a depth of 42” from the bottom of the plant pit and fill it with ¾” gravel. Cover the gravel with filter fabric and install plant material as directed.

C. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from

center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
2. Excavate at least 12 inches wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected overnight.
8. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

D. Subsoil and topsoil removed from excavations may be used as 50% of backfill soil combine with 50% new topsoil. (See Fill specification)

E. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

1. Hardpan Layer: Drill 6-inch- diameter holes, 24 inches apart, into free-draining strata or to a depth of 10 feet, whichever is less, and backfill with free-draining material.

F. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

G. Fill excavations with water and allow it to percolate away before positioning trees and shrubs.

3.5 TREES AND SHRUBS

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements. Reject any tree with more than 4” of soil covering first true root.

B. Plant trees and shrubs with the root flare of the plant at grade level. The radius of the tree pit shall be a minimum of 12 inches larger than the radius of the tree ball. After placing in planting pit, remove the material around the ball, as well as the burlap, including the burlap, twine and wire from the upper one-third of the ball.

C. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

D. Set balled and burlapped stock plumb and in center of planting pit or trench with first higher order root flare level with adjacent finish grades. Landscape Architect will not accept trees that are planted to deep.

1. Use topsoil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. Prune, thin, and shape trees and shrubs according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

F. Do not apply pruning paint to wounds.

3.6 TREE STABILIZATION

A. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
1. Wood Hold-Down Method: Place vertical stakes against side of root ball and drive them into subsoil; place horizontal wood hold-down stake across top of root ball and screw at each end to one of the vertical stakes.
2. Install stakes of length required to penetrate at least 18 inches below bottom of backfilled excavation. Saw stakes off at horizontal stake.
3. Install screws through horizontal hold-down and penetrating at least 1 inch into stakes. Predrill holes if necessary to prevent splitting wood.
4. Install second set of stakes on other side of root trunk for larger trees as indicated.
5. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

3.7 PLANT PLANTING

A. Set out and space plants other than trees and shrubs as indicated in even rows with triangular spacing or as shown on plans.

B. Use manufactured topsoil meeting ASTM standards for backfill.

C. Dig holes large enough to allow spreading of roots.

D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.

E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.8 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

B. Trees in Turf Areas: Apply organic mulch ring of 3-inch uniform thickness, with 24-inch radius around trunks or stems. Do not place mulch within 3 inches of trunks or stems.

C. Organic Mulch in Planting Areas: Shrubs: Apply 3-inch uniform thickness of organic mulch over whole surface of planting area, and finish level with adjacent finish grades. Herbaceous plants: Apply 3-inch average thickness of organic mulch without weed barrier over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

3.9 EDGING INSTALLATION

A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging. All lines to be true, straight and smooth and all curves to have smooth continuous arcs.

3.10 PLANT MAINTENANCE

A. The contractor shall be responsible for all maintenance until the owner's

B. Representative accepts responsibility. Maintenance shall begin immediately after each plant is planted and shall continue until installation of all planting is complete, inspection has been made and planting is accepted exclusive of the guarantee.

C. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

D. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

E. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

F. The maintenance of planted materials shall include watering, straightening plants, protecting plant areas from erosion, maintaining erosion material, supplementing mulch, maintaining edging of beds, checking for girdling of plants and maintaining plant labels, weeding, removing and replacing unhealthy plants. Straightening, resetting plants to proper grade or upright positions and other necessary operations.

G. A plant shall be considered unhealthy or dead when the main leader had died back, or 25 percent of the crown is dead, or it has been determined that a plant’s health is being compromised due to disease or pests. Determine the cause for an unhealthy plant. Unhealthy or dead plants shall be removed immediately and shall be replaced as soon as seasonal conditions permit in accordance with the warranty paragraph. Maintenance shall include watering, weeding, mowing, mulching, pruning.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.13 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

3.14 PROJECT WALK THROUGH

A. The contractor shall complete the work and submit a written request for a walk through.

B. The Landscape Architect will walk through the project and develop a punchlist.

C. The contractor will complete the punchlist, care for plants as necessary and request a final walkthrough.

D. When the final walk through is accepted a Certificate of Substantial Completion will be issued. The Owner will assume care of lawns and plantings.

END OF SECTION 32 9300

SECTION 33 05 00

COMMON WORK RESULTS UTILITIES

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping joining materials.

2. Dielectric fittings.

3. Sleeves.

4. Identification devices.

5. Grout.

6. Piping system common requirements.

7. Equipment installation common requirements.

8. Concrete bases.

9. Metal supports and anchorages.

1.2 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

B. Concealed Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.

2. Identification devices.

1.4 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Steel Piping Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 PRODUCTS

2.1 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness, unless otherwise indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

4. PVC to ABS Piping Transition: ASTM D 3138.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 DIELECTRIC FITTINGS

A. Dielectric Fittings, General: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Description: Factory fabricated, union, NPS 2 and smaller.

a. Pressure Rating: 250 psig at 180 deg F.

b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

1. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 and larger.

a. Pressure Rating: 300 psig.

b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:

1. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 and smaller.

a. Pressure Rating: 300 psig at 225 deg F.

b. End Connections: Threaded.

E. Dielectric Nipples:

1. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.

a. Pressure Rating: 300 psig at 225 deg F.

b. End Connections: Threaded or grooved.

2.3 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

B. Galvanized-Steel Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

C. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized, plain ends.

D. Cast-Iron Sleeves: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

E. Molded PVC Sleeves: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe Sleeves: ASTM D 1785, Schedule 40.

G. Molded PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.4 IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.

2. Location: Accessible and visible.

B. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

C. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

D. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.

E. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

F. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

G. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.

2. Color: Comply with ASME A13.1, unless otherwise indicated.

H. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch- thick, aluminum.

2. Material: 0.0375-inch- thick stainless steel.

3. Material: 3/32-inch- thick plastic laminate with 2 black surfaces and a white inner layer.

4. Material: Valve manufacturer's standard solid plastic.

5. Size: 1-1/2 inches in diameter, unless otherwise indicated.

6. Shape: As indicated for each piping system.

I. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

J. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore, unless otherwise indicated. Fabricate in sizes required for message. Provide holes for mechanical fastening.

1. Engraving: Engraver's standard letter style, of sizes and with terms to match equipment identification.

2. Thickness: 1/8 inch, unless otherwise indicated.

3. Thickness: 1/16 inch, for units up to 20 sq. in. or 8 inches in length, and 1/8 inch for larger units.

4. Fasteners: Self-tapping, stainless-steel screws or contact-type permanent adhesive.

K. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.

2. Yellow: Heating equipment and components.

3. Brown: Energy reclamation equipment and components.

4. Blue: Equipment and components that do not meet criteria above.

5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.

6. Terminology: Match schedules as closely as possible. Include the following:

a. Name and plan number.

b. Equipment service.

c. Design capacity.

d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.5 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

1. Characteristics: Post hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts for Main Lines:

1. Description: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.

2. Top-Loading Classification(s): Heavy Duty and Extra-Heavy Duty.

3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

B. Cast-Iron Cleanouts for RV Stalls:

1. Description: 4” RV Female Footloose Sewer Cap (White), Enviro Design Products or equal. Submit shop drawing.

2. Sewer Pipe Fitting and Riser to Cleanout: Schedule 40 PVC

PART 3 EXECUTION

3.1 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric unions.

2. NPS 2-1/2 and Larger: Dielectric flanges.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 and Smaller: Dielectric couplings or dielectric nipples.

2. NPS 2-1/2 and Larger: Dielectric nipples.

3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on the Coordination Drawings.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Sleeves are not required for core-drilled holes.

J. Permanent sleeves are not required for holes formed by removable PE sleeves.

K. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of equipment areas or other wet areas 2 inches above finished floor level.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

a. PVC Pipe Sleeves: For pipes smaller than NPS 6.

b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

M. Refer to equipment specifications in other Sections for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

G. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

H. Soldered Joints: Apply ASTM B 813 water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B 32.

I. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

J. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

K. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.

5. PVC Nonpressure Piping: Join according to ASTM D 2855.

6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

L. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

M. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

N. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End PE Pipe and Fittings: Use butt fusion.

2. Plain-End PE Pipe and Socket Fittings: Use socket fusion.

O. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Install dielectric fittings at connections of dissimilar metal pipes.

3.5 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference with other installations. Extend grease fittings to an accessible location.

C. Install equipment to allow right of way to piping systems installed at required slope.

3.6 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.

2. Locate pipe markers on exposed piping according to the following:

a. Near each valve and control device.

b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.

c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.

d. At manholes and similar access points that permit view of concealed piping.

e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch high for name of unit if viewing distance is less than 24 inches, 1/2 inch high for distances up to 72 inches, and proportionately larger

lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.

2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 055000 "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor piped utility materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.9 GROUTING

A. Mix and install grout for equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and use cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

1. Use Light-Duty, top-loading classification cleanouts in earth or unpaved foot-traffic areas.

2. Use Medium-Duty, top-loading classification cleanouts in paved foot-traffic areas.

3. Use Heavy-Duty, top-loading classification cleanouts in vehicle-traffic service areas.

4. Use Extra-Heavy-Duty, top-loading classification cleanouts in roads.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding grade.

C. Set cleanout frames and covers in concrete pavement and roads with tops flush with pavement surface.

END OF SECTION

SECTION 33 41 11

STORM DRAINAGE

PART 1 GENERAL

1.1 SCOPE OF WORK

A. Section Includes:

1. Storm drainage piping.

2. Accessories.

3. Underground pipe markers.

4. Catch basins and plant area drains.

B. Related Sections:

1. Section 312000 – Earthwork: Backfill and compaction for structures and storm piping.

2. Section 312116 - Trenching: Execution requirements for trenching required by this section.

3. Section 330513 - Manholes and Structures.

4. Section 033000 - Cast-in-Place Concrete: Concrete type for catch basin base pad construction.

1.2 REFERENCES

A. American Association of State Highway and Transportation Officials:

1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop.

B. ASTM International:

1. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.

2. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.

3. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

4. ASTM C443 - Standard Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

5. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.

6. ASTM C924 - Standard Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method.

7. ASTM C969 - Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

8. ASTM C1103 - Standard Practice for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines.

9. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).

10. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft3 (2,700 kN-m/m3)).

11. ASTM D2235 - Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.

12. ASTM D2321 - Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

13. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.

14. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

15. ASTM D2751 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.

16. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.

17. ASTM D6938 - 10 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

18. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.

19. ASTM F477 - Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.

1.3 SUBMITTALS

A. Section 013000 – Administrative Requirements: Requirements for submittals.

B. Product Data: Submit data indicating pipe, pipe accessories, and appurtenances.

C. Manufacturer's Installation Instructions: Submit special procedures required to install Products specified.

1.4 CLOSEOUT SUBMITTALS

A. Project Record Documents:

1. Accurately record actual locations of pipe runs, connections, catch basins, structures, and invert elevations.

2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with the City North Little Rock's applicable standards requirements.

1.6 COORDINATION

A. Section 013000 - Administrative Requirements: Coordination and project conditions.

B. Coordinate the Work with termination of storm sewer connection outside building, trenching, and to the connection to municipal storm sewer utility service.

PART 2 PRODUCTS

2.1 STORM DRAINAGE PIPING

A. Polyethylene Pipe:

1. Piping and fittings shall be ADS N-12 ST IB pipe as manufactured by Advanced Drainage Systems (ADS) of Hilliard, OH, or equal.

2. Piping and fittings shall have a smooth interior and annular exterior corrugations.

3. Pipe shall be manufactured in accordance with AASHTO M252, Type S or SP for 4-inch through 10-inch diameter, and AASHTO M294 or ASTM F2306 for 12-inch through 60-inch diameter.

4. Pipe shall be joined using a bell and spigot joint meeting AASHTO M252, AASHTO M294 or ASTM F2306. The joint shall be soil-tight and gaskets shall meet the requirements of ASTM F477.

5. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.

6. Virgin material for pipe and fitting production shall be high density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch diameters, or 435400C for 12- through 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.

B. Perforated Pipe for Underdrains:

1. Piping and fittings shall be perforated ADS single wall corrugated HDPE pipe as manufactured by Advanced Drainage Systems (ADS) of Hilliard, OH, or equal.

2. Perforations shall be Type B pattern as specified by ADS. Contractor shall obtain approval if perforation pattern other than Type B is to be used.

3. Perforated pipe shall be wrapped in geotextile fabric. Fabric shall be 4-oz non-woven geotextile fabric, Mirafi 140N or equivalent.

C. Reinforced Concrete Pipe:

1. Reinforced concrete pipe and flared-end sections: ASTM C 76, Type III, tongue and groove joints.

2. Joint material: cold-applied preformed plastic gasket type sealant conforming to ASTM C 443.

2.2 ACCESSORIES

A. Filter Fabric: Non-biodegradable, non-woven, 6 oz minimum weight.

B. Grout: Specified in Section 033000.

2.3 UNDERGROUND PIPE MARKERS

A. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Storm Sewer Service" in large letters.

2.4 CATCH BASINS

A. Cast-in-place concrete or as indicated on the Drawings.

2.5 BEDDING AND COVER MATERIALS

A. Bedding: As indicated on the Drawings.

B. Cover: As indicated on the Drawings.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 013000 - Administrative Requirements: Verification of existing conditions before starting work.

B. Verify excavation base is ready to receive work and excavations, dimensions, and elevations are as indicated on [layout] drawings.

3.2 PREPARATION

A. Hand trim excavations to required elevations. Correct over excavation with fine aggregate.

B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

3.3 BEDDING

A. Excavate pipe trench in accordance with Section 312116 for work of this Section. Hand trim excavation for accurate placement of pipe to elevations indicated.

B. Place bedding material at trench bottom, level materials in continuous layer not exceeding 8 inches compacted depth.

C. Maintain optimum moisture content of bedding material to attain required compaction density.

3.4 INSTALLATION - PIPE

A. Install pipe, fittings, and accessories in accordance with [ASTM D2321]. Seal joints watertight.

B. Place pipe on bedding material as indicated on the Drawings.

C. Lay pipe to slope gradients noted on drawings with maximum variation from indicated slope of 1/8 inch in 10 feet.

D. Place bedding backfill around pipe as indicated on the Drawings.

E. Install trace wire continuous over top of pipe buried 12 inches below finish grade, above pipe line.

3.5 INSTALLATION - CATCH BASINS AND STRUCTURES

A. Perform work in accordance with Drawings.

B. Refer to Section 330513, Manholes and Structures.

3.6 FIELD QUALITY CONTROL

A. Section 014000 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.

B. Request inspection prior to and immediately after placing aggregate cover over pipe.

3.7 PROTECTION OF FINISHED WORK

A. Protect pipe and aggregate cover from damage or displacement until backfilling operation is in progress.

1. Take care not to damage or displace installed pipe and joints during construction of pipe supports, backfilling, testing, and other operations.

2. Repair or replace pipe that is damaged or displaced from construction operations.

END OF SECTION