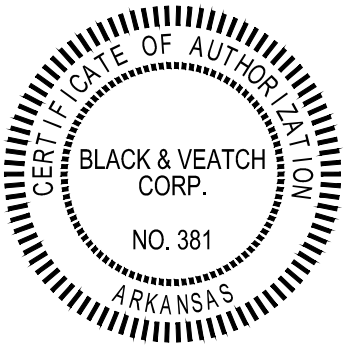
Beaver Water District

WESTERN CORRIDOR PUMP STATION

100% SPECIFICATIONS

January 24, 2023



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CERTIFICATIONS

BLACK & VEATCH – GENERAL, CIVIL, MECHANICAL PROCESS

Specifications: Division 01 (except for 01450 and 01611), Division 02, 09940, 10990, Division 11, 13110, 13800, 14630, 15010, 15020, 15060, 15061, 15062, 15064, 15065, 15067, 15091, 15093, 15096, 15098, 15099, 15100, 15101, 15108, 15115, 15140, 15180

_____(SEAL)

BLACK & VEATCH – STRUCTURAL

Specifications: 01450, 01611, Division 03, Division 04, Division 05, 13122

_____(SEAL)

BLACK & VEATCH – ARCHITECTURAL

Specifications: Division 04, Division 07, Division 08, Division 09 (except 09940), 10160, 10200, 10800, 12625

_____(SEAL)

BLACK & VEATCH – MECHANICAL

Specifications: 15050, 15069, 15070, 15094, 15250, 15400, 15500, 15650, 15990

_____(SEAL)

BLACK & VEACTH – ELECTRICAL

Specifications: Division 16

_____(SEAL)

BLACK & VEATCH – INSTRUMENTATION AND CONTROLS

Specifications: Division 13 (except 13110, 13122, and 13800)

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BEAVER WATER DISTRICT

WESTERN CORRIDOR PUMP STATION

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SECTION 01015 - WORK COVERED BY CONTRACT DOCUMENTS

1.1 GENERAL DESCRIPTION OF WORK.

A. The Work to be performed under these Contract Documents is generally described as follows:

1. Construction of the Western Corridor Pump Station (WCPS) and associated facilities for Beaver Water District (BWD) to pump treated water to their four Customer Cities from a new remote site. Initial construction will include equipment and piping for a complete and functional system to pump to discharge lines to the City of Springdale, AR and the City of Fayetteville, AR. The facilities will include available space and access points for future connections to the Cities of Bentonville, and Rogers, AR.

2. The WCPS building will include a pump room, medium-voltage electrical wing, and administrative wing. The pump room will include dual 60-inch treated water lines in a central trench, horizontal split case pumps, surge tank, valves, bridge crane, and appurtenances. The medium-voltage electrical wing shall consist of two air-conditioned rooms to house switchgear, variable frequency drives, and HVAC equipment. The administrative wing will include a workshop, mechanical room, low-voltage electrical room, control room, storage, restrooms, office, and laboratory space.

3. The Work also includes construction of an Electrical Building and two (2) 1,400kW natural gas generators in stand-alone sound attenuated enclosures and associated equipment. The Electrical Building will house the paralleling switchgear, ancillary electrical systems, storage, and HVAC equipment.

4. The Work shall include all miscellaneous electrical, instrumentation, mechanical systems, utility tie-ins, and sitework to provide a complete and functional system.

5. The Work also includes improvements to West Miller Road as shown in the Drawings.

1.2 UNITS OF MEASUREMENT.

A. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.3 OTHER CONSTRUCTION CONTRACTS.

A. Work at the site performed by others under separate contracts includes the following:

1. The WCPS will be served by a 60-inch Treated Water Transmission Main from the existing treatment plant site. The Treated Water Transmission Main will be constructed under a separate contract. The transition point between piping installed under this Contract and the piping installed by Others is shown on the Drawings.

2. The WCPS will discharge to a 48-inch Finished Water Main to the City of Springdale and a separate 48-inch Finished Water Main to the City of Fayetteville. The Finished

Water Mains to the City of Springdale and the City of Fayetteville will be constructed under separate contracts by Others. The transition point between piping installed under this Contract and the piping installed by Others is shown on the Drawings.

3. Additional utility work on site includes a new substation and fencing by Carrol Electric Cooperative Corporation (CEC), as well as a new gas line by Black Hill Energy. This utility work is shown on the Drawings by others and will be completed within the allotted easement.

1.4 COORDINATION.

A. Contractor shall plan, schedule, and coordinate its operations in a manner which will facilitate the simultaneous progress of the work included under other contracts outside the scope of these Contract Documents, including the 60-inch Treated Water Transmission Main Project, the Springdale 48-inch Finished Water Connection, and the Fayetteville 48-inch Finished Water Connection.

1.5 WORK BY PUBLIC UTILITIES

A. Work associated with overhead electrical feed to the site will be performed by Carroll Electric Cooperative Corporation.

B. Work associated with natural gas piping to the site will be performed by Black Hills Energy.

C. Work associated with network connection to the site for backup communications will be performed by Cox Communications.

1.6 WORK BY OWNER

A. Owner shall perform certain activities in connection with the Project with its own personnel as follows:

1. The Owner will provide Distributed Control Unit (DCU).

2. Owner shall configure the control system.

1.7 ITEMS FURNISHED BY OWNER.

A. The pad mount style electrical transformers (43-XFMR-1, 43-XFMR-2, 42-XFMR-3, 42-XFMR-3) shall be furnished by Owner for installation by Contractor.

B. Specifications under which the equipment will be procured are available for inspection at Owner's offices.

C. Shop and installation drawings pertaining to the equipment and accessories will be furnished to Contractor upon completion of review by Engineer.

1.8 RESPONSIBILITY FOR MATERIALS AND EQUIPMENT

A. Items Furnished by Owner

1. Contractor's responsibility for materials and equipment furnished by Owner shall begin at the point of delivery on acceptance by Contractor. Contractor shall carefully examine each shipment prior to acceptance and shall reject all defective items. Owner reserves the right, however, to accept items rejected by Contractor and to authorize their installation in the Work.
2. Defective materials and equipment discovered after installation and prior to final acceptance of the Work, where the defect is of a nature not detectable by visual examination and other appropriate field inspection methods, shall be replaced by Owner, together with such additional materials and supplies as may be necessary for their replacement. Contractor shall furnish all necessary tools, equipment, and appliances, and perform all necessary labor, for the removal and replacement of such defective items in a manner acceptable to Engineer; adjustment to the Contract Price for the costs of the removal and replacement shall be made in accordance with Article 11 of the General Conditions.
3. All materials and equipment furnished by Owner which disappear or are damaged after their acceptance by Contractor shall be replaced by and at the expense of Contractor. Replacements shall conform to the original procurement specifications.

B. Items Furnished by Contractor.

1. Contractor shall be fully responsible for all materials and equipment which it has furnished.

C. Delivery and Handling of Items Furnished by Owner

1. Equipment and materials furnished by Owner for installation by Contractor will be delivered to the jobsite.
2. Contractor shall be responsible for all unloading, reloading, transporting to the site, storage if necessary, rehandling, and installation.
3. All items shall be unloaded promptly after arrival. All charges for demurrage due to negligence or delay by Contractor shall be paid by Contractor. Equipment and materials shall be handled by methods which will prevent damage.
4. Equipment and materials shall be protected from exposure to the elements. All equipment shall be stored in accordance with the requirements of the Contract Documents.
5. Scheduled delivery dates for equipment and materials to be furnished by Owner will be coordinated with the Contractor.
6. All equipment shall be arranged and installed as indicated on the Drawings, and in conformity with installation drawings and instructions furnished to Owner by the manufacturer of the equipment.

1.9 OFFSITE STORAGE.

A. Offsite storage arrangements shall be approved by Owner for all materials and equipment not incorporated into the Work but included in Applications for Payment. Such offsite storage arrangements shall be presented in writing and shall afford adequate and satisfactory security and protection. Offsite storage facilities shall be bonded and insured for the value of the

equipment with the Owner named as an additional insured. The offsite storage facilities shall be accessible to Owner and Engineer.

1.10 SUBSTITUTES AND "OR-EQUAL" ITEMS

A. Provisions for evaluation of proposed "or-equal" items of materials or equipment are covered in Paragraph 7.04 of the General Conditions. Provisions for evaluation of proposed substitute items of materials or equipment are covered in Paragraph 7.05 of the General Conditions. Requests for review of equivalency will not be accepted by Engineer from anyone except Contractor, and such requests will not be considered until after the Effective Date of the Agreement.

1.11 PREPARATION FOR SHIPMENT.

A. All materials shall be suitably packaged to facilitate handling and protect against damage during transit and storage. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. All painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

B. Each item, package, or bundle of material shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

1.12 SALVAGE OF MATERIALS AND EQUIPMENT.

A. Existing materials and equipment removed by Contractor shall not be reused in the Work.

1.13 LAND FOR CONSTRUCTION PURPOSES.

A. Contractor will be permitted to use available land belonging to Owner, on or near the Site, for construction purposes and for storage of materials and equipment.

B. The locations and extent of the areas so used shall be as indicated on the Drawings.

1.14 NOTICES TO OWNERS AND AUTHORITIES

A. Contractor shall, as provided in the General Conditions, notify owners of adjacent property and utilities when execution of the Work may affect them.

B. When it is necessary to temporarily deny access to property, or when any utility service connection must be interrupted, Contractor shall give notices sufficiently in advance to enable the affected persons to provide for their needs. Notices shall conform to any applicable local ordinance and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

C. Utilities and other concerned agencies shall be notified at least 24 hours prior to cutting or closing streets or other traffic areas or excavating near underground utilities or pole lines.

1.15 LINES AND GRADES

A. All Work shall be done to the lines, grades, and elevations indicated on the Drawings.

B. Basic horizontal and vertical control points will be established or designated by Engineer to be used as datums for the Work. All additional survey, layout, and measurement work shall be performed by Contractor as a part of the Work.

C. Contractor shall provide an experienced instrument person, competent assistants, and such instruments, tools, stakes, and other materials required to complete the survey, layout, and measurement work. In addition, Contractor shall furnish, without charge, competent persons and such tools, stakes, and other materials as Engineer may require in establishing or designating control points , in establishing construction easement boundaries, or in checking survey, layout, and measurement work performed by Contractor.

D. Contractor shall keep Engineer informed, a reasonable time in advance, of the times and places at which it wishes to do Work, so that horizontal and vertical control points may be established and any checking deemed necessary by Engineer may be done with minimum inconvenience to Engineer and minimum delay to Contractor.

E. Contractor shall remove and reconstruct work which is improperly located.

1.16 CONNECTIONS TO EXISTING FACILITIES

A. Unless otherwise specified or indicated, Contractor shall make all necessary connections to existing facilities, including structures, drain lines, and utilities such as water, sewer, gas, telephone, and electric. In each case, Contractor shall receive permission from Owner or the owning utility prior to undertaking connections. Contractor shall protect facilities against deleterious substances and damage.

B. Connections to existing facilities which are in service shall be thoroughly planned in advance, and all required equipment, materials, and labor shall be on hand at the time of undertaking the connections. Work shall proceed continuously (around the clock) if necessary to complete connections in the minimum time. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility .

1.17 UNFAVORABLE CONSTRUCTION CONDITIONS

A. During unfavorable weather, wet ground, or other unsuitable construction conditions, Contractor shall confine its operations to work which will not be affected adversely by such conditions. No portion of the Work shall be constructed under conditions which would affect adversely the quality or efficiency thereof, unless special means or precautions are taken by Contractor to perform the Work in a proper and satisfactory manner.

1.18 CUTTING AND PATCHING

A. As provided in General Conditions, Contractor shall perform all cutting and patching required for the Work and as may be necessary in connection with uncovering Work for inspection or for the correction of defective Work.

B. Contractor shall perform all cutting and patching required for and in connection with the Work, including but not limited to the following:

1. Removal of improperly timed Work.

2. Removal of samples of installed materials for testing.

3. Alteration of existing facilities.

4. Installation of new Work in existing facilities.

C. Contractor shall provide all shoring, bracing, supports, and protective devices necessary to safeguard all Work during cutting and patching operations. Contractor shall not undertake any cutting or demolition which may affect the structural stability of the Work without Engineer's concurrence.

D. Materials shall be cut and removed to the extent indicated on the Drawings or as required to complete the Work. Materials shall be removed in a careful manner, with no damage to adjacent facilities or materials. Materials which are not salvable shall be removed from the site by Contractor.

E. All Work and existing facilities affected by cutting operations shall be restored with new materials, or with salvaged materials acceptable to Engineer, to obtain a finished installation with the strength, appearance, and functional capacity required. If necessary, entire surfaces shall be patched and refinished.

1.19 HAZARDOUS ENVIRONMENTAL CONDITIONS AT SITE

A. No Hazardous Environmental Conditions at the Site in areas that will be affected by the Work are known to the Owner.

1.20 CLEANING UP

A. Contractor shall keep the premises free at all times from accumulations of waste materials and rubbish.

B. Construction materials, such as concrete forms and scaffolding, shall be neatly stacked by Contractor when not in use. Contractor shall promptly remove splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from surfaces to prevent marring or other damage.

C. Volatile wastes shall be properly stored in covered metal containers and removed daily.

D. Wastes shall not be buried or burned on the Site or disposed of into storm drains, sanitary sewers, streams, or waterways. All wastes shall be removed from the Site and disposed of in a manner complying with local ordinances and antipollution laws.

E. Adequate cleanup will be a condition for recommendation of progress payment applications.

1.21 APPLICABLE CODES

A. References in the Contract Documents to local codes mean the following:

1. 2021 International Building Code
2. 2021 Arkansas Fire Prevention Code
3. 2020 National Electric Code
4. 2018 Arkansas Mechanical Code
5. 2018 Arkansas Plumbing Code
6. 2006 Arkansas Fuel Gas Code
7. 2014 Arkansas Energy Code
8. 2003 Life Safety Code
9. City of Springdale, Arkansas Planning Department
10. National Fire Protection Association Recommended Practices (NFPS) and Manuals
11. Occupational Safety and Health Act (OSHA) Standards Manual Other standard codes which apply to the Work are designated in the Specifications.

1.22 PRECONSTRUCTION CONFERENCE

A. Prior to the commencement of Work at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by:

1. Contractor and its superintendent.
2. Principal Subcontractors.
3. Representatives of principal Suppliers and manufacturers as appropriate.
4. Engineer and its Resident Project Representative.
5. Representatives of Owner.
6. Government representatives as appropriate.

7. Others as requested by Contractor, Owner, or Engineer.

B. Unless previously submitted to Engineer, Contractor shall bring to the conference a preliminary schedule for each of the following:

1. Progress Schedule.

2. Procurement schedule.

3. Schedule of Values for progress payment purposes.

4. Schedule of Shop Drawings and other submittals.

C. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The agenda will include:

1. Contractor's preliminary schedules.

2. Transmittal, review, and distribution of Contractor's submittals.

3. Processing Applications for Payment.

4. Maintaining record documents.

5. Critical Work sequencing.

6. Field decisions and Change Orders.

7. Use of premises, office and storage areas, security, housekeeping, and Owner's needs.

8. Major equipment deliveries and priorities.

9. Contractor's assignments for safety and first aid.

D. Engineer will preside at the conference and will arrange for keeping the minutes and distributing the minutes to all persons in attendance.

1.23 PROGRESS MEETINGS

A. Contractor shall schedule and hold regular progress meetings at least monthly and at other times as requested by Engineer or required by progress of the Work. Contractor, Engineer, and all Subcontractors active on the Site shall be represented at each meeting. Contractor may at its discretion request attendance by representatives of its Suppliers, manufacturers, and other Subcontractors.

B. Contractor shall preside at the meetings. Meeting minutes shall be prepared and distributed by Contractor. The purpose of the meetings will be to review the progress of the Work, maintain coordination of efforts, discuss changes in scheduling, and resolve other problems which may develop.

1.24 SITE ADMINISTRATION

A. Contractor shall be responsible for all areas of the Site used by it and by all Subcontractors in the performance of the Work. Contractor shall exert full control over the actions of all employees and other persons with respect to the use and preservation of property and existing facilities, except such controls as may be specifically reserved to Owner or others.

B. Contractor shall have the right to exclude from the Site all persons who have no purpose related to the Work or its inspection, and may require all persons on the Site (except Owner's employees) to observe the same regulations as Contractor requires of its employees.

End of Section

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SECTION 01025 - PROGRESS PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers methods of measurement and payment for items of Work under this Contract.

1.2 GENERAL.

A. The Contract Price shall cover all Work required by the Contract Documents. All costs in connection with the proper and successful completion of the Work, including furnishing all materials, equipment, supplies, and appurtenances; providing all construction plant, equipment, and tools; and performing all necessary labor and supervision to fully complete the Work, shall be included in the unit and lump sum prices bid. All Work not specifically set forth as a pay item in the Bid Form shall be considered a subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid.

B. Items designated in Contractor's Purchase Orders with subcontractors or suppliers to be paid directly by the Owner (Owner Direct Pay) shall be accompanied by the Contractor's Purchase Order, bills of lading or ship tickets, invoice, and evidence of receipt of materials. Invoices for Owner Direct Pay items shall be addressed to the Owner and shall be paid directly by the Owner. Contractor shall only submit these Owner Direct Pay items for payment upon receipt of the materials. Owner will provide applicable subcontractors or suppliers with the Sales Tax Exemption Certificate.

1.3 ESTIMATED QUANTITIES.

A. All estimated quantities stipulated in the Bid or other Contract Documents are approximate and are to be used only (a) as a basis for estimating the probable cost of the Work and (b) for the purpose of comparing the Bids submitted for the Work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. Contractor agrees that it will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the estimated amounts therefor.

1.4 EXCAVATION AND TRENCHING.

A. Except where otherwise specified, the unit or lump sum price bid for each item of Work which involves excavation or trenching shall include all costs for such Work. No separate payment shall be made for excavation or trenching. All trenching shall be unclassified as to materials which may be encountered, and trenches shall be unclassified as to depth. All excavation work required for structures shall be unclassified as to materials which may be encountered; such

excavation work shall be considered to be a subsidiary obligation of Contractor and the cost of such excavation shall be included in the prices bid for the structures.

PART 2 - PRODUCTS

PART 3 - EXECUTION

End of Section

SECTION 01070 - ABBREVIATIONS AND ACRONYMS

1.1 LIST OF ABBREVIATIONS.

A. Abbreviations for standards and organizations used in the Contract Documents are defined as follows:

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	Architectural Aluminum Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ABMA	American Bearing Manufacturers Association
ACI	American Concrete Institute
ACPA	American Concrete Pipe Association
AEIC	Association of Edison Illuminating Companies
AFBMA	Antifriction Bearing Manufacturers Association now recognized as the ABMA
AFPA	American Forest & Paper Association
AGA	American Gas Association
AGMA	American Gear Manufacturers Association
AHA	American Hardboard Association
AHRI	Air-Conditioning, Heating and Refrigeration Institute
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
AMCA	Air Movement and Control Association International
ANSI	American National Standards Institute
APA	Engineered Wood Association (formerly American Plywood Association)

API	American Petroleum Institute
AREMA	American Railway Engineers and Maintenance-of-Way Association
ASAHC	American Society of Architectural Hardware Consultants
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASSE	American Society of Sanitary Engineers
ASTM	ASTM International
AWG	American Wire Gauge
AWI	Architectural Woodwork Institute
AWPA	American Wood-Preservers' Association
AWS	American Welding Society
AWWA	American Water Works Association
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Institute of America (formerly SCPI)
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
CMAA	Crane Manufacturers Association of America
CRA	California Redwood Association
CRSI	Concrete Reinforcing Steel Institute
CS	Commercial Standard (U.S. Department of Commerce)
DHI	Door and Hardware Institute

DIPRA	Ductile Iron Pipe Research Association
EEI	Edison Electric Institute
EJCDC	Engineers' Joint Contract Documents Committee
EPA	Environmental Protection Agency
FCC	Federal Communications Commission
FCI	Fluid Controls Institute
Fed Spec	Federal Specification
FGMA	Flat Glass Marketing Association
FHWA	Federal Highway Administration
FIA	Factory Insurance Association
FM	Factory Mutual
FSA	Fluid Sealing Association
HEI	Heat Exchange Institute
HMI	Hoist Manufacturers Institute
HPMA	Hardwood Plywood Manufacturers Association
HTI	Hand Tools Institute
I-B-R	Institute of Boiler and Radiator Manufacturers
IEEE	Institute of Electrical and Electronics Engineers
IBC	International Building Code
IES	Illuminating Engineering Society
IFI	Industrial Fasteners Institute
IPCEA	Insulated Power Cable Engineers Association

IRI	Industrial Risk Insurers
ISA	International Society of Automation
LEED	Leadership in Energy and Environmental Design
MHI	Materials Handling Institute
MIL	Military Specification
MMA	Monorail Manufacturers Association
MSS	Manufacturers Standardization Society of Valve and Fitting Industry
NAAMM	National Association of Architectural Metals Manufacturers
NACE	NACE International
NBBPVI	National Board of Boiler and Pressure Vessel Inspectors
NBS	See NIST
NCSPA	National Corrugated Steel Pipe Association
NEBB	National Environmental Balancing Bureau
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEII	National Elevator Industry, Inc.
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NIST	National Institute of Standards and Technology (formerly NBS)
NLA	National Lime Association
NPC	National Plumbing Code
NPT	National Pipe Thread

NRMCA	National Ready Mixed Concrete Association
NSC	National Safety Council
NSF	NSF International (formerly National Sanitation Foundation)
NTMA	National Terrazzo and Mosaic Association
NWMA	National Woodwork Manufacturers Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PS	Product Standard
RIS	Redwood Inspection Service
SAE	SAE International
SDI	Steel Door Institute
SFPA	Southern Forest Products Association
SI	Systéme International des Unités (International System of Units)
SIGMA	Sealed Insulating Glass Manufacturers Association
SJI	Steel Joist Institute
SMA	Screen Manufacturers Association
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
SPFA	Steel Plate Fabricators Association
SPI	Society of the Plastics Industry
SPTA	Southern Pressure Treaters Association

SSFI	Scaffolding, Shoring & Forming Institute, Inc
SSPC	SSPC: The Society for Protective Coatings
TABB	Testing, Adjusting, and Balancing Bureau
UL	Underwriters' Laboratories
USBR	U.S. Bureau of Reclamation
USGBC	U.S. Green Building Council
WEF	Water Environment Federation

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SHOP DRAWINGS AND ENGINEERING DATA.

A. General.

1. The Project has been designed by Engineer and Engineer will perform design-intent reviews of submittals. Owner, Engineer, and Contractor may develop a protocol for the transmittal of shop drawings, samples, and other submittals.

2. Shop Drawings and engineering data (submittals) covering all equipment and all fabricated components and building materials which will become a permanent part of the Work under this Contract shall be submitted to Engineer for review, as required. Submittals shall verify compliance with the Contract Documents, and shall include drawings and descriptive information in sufficient detail to show the kind, size, arrangement, and the operation of component materials and devices; the external connections, anchorages, and supports required; the performance characteristics; and dimensions needed for installation and correlation with other materials and equipment.

3. Each submittal shall cover items from only one section of the specification unless the item consists of components from several sources. Contractor shall submit a complete initial submittal including all components. When an item consists of components from several sources, Contractor's initial submittal shall be complete including all components.

4. All submittals, regardless of origin, shall be approved by Contractor and clearly identified with the name and number of this Contract, Contractor's name, and references to applicable specification paragraphs and Contract Drawings. Each copy of all submittals, regardless of origin, shall be stamped or affixed with an approval statement of Contractor. Each submittal shall indicate the intended use of the item in the Work. When catalog pages are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.

5. Contractor shall be solely responsible for the completeness of each submittal. Contractor's stamp or affixed approval statement of a submittal, per Figure 1-01300, is a representation to Owner and Engineer that Contractor accepts sole responsibility for determining and verifying all field measurements, quantities, dimensions, specified performance and design criteria, installation requirements, materials, catalog numbers, and similar information with respect thereto, and that Contractor has reviewed and coordinated each submittal with other Shop Drawings and with the requirements of the Work and the Contract Documents.

6. All deviations from the requirements of the Contract Documents shall be identified as deviations on each submittal and shall be tabulated in Contractor's letter of transmittal using Figure 2-01300. Such submittals shall, as pertinent to the deviation, indicate essential details of all changes proposed by Contractor (including modifications to other

facilities that may be a result of the deviation) and all required piping and wiring diagrams.

7. For electronic submittals, drawings and the necessary data shall be submitted electronically to Engineer as specified below. Submittal documents shall be in color to facilitate use of red line markups.

   a. All electronic files shall be in Portable Document Format (PDF) as generated by Adobe Acrobat Professional Version 7.0 or higher.
   b. The PDF file(s) shall be fully indexed using the Table of Contents, searchable with thumbnails generated. PDF images must be at a readable resolution.
   c. For most documents, they should be scanned or generated at 300 dots per inch (dpi). Use of higher resolution is acceptable with Owner and Engineer approval.
   d. Optical Character Recognition (OCR) capture must be performed on these images so that text can be searched, selected and copied from the generated PDF file.
   e. The PDF documents shall have a bookmark created in the navigation frame for each major entry ("Section" or "Chapter") in the Table of Contents.
   f. Thumbnails shall be generated for each page or graphic in the PDF file.
   g. The opening view for each PDF document shall be as follows:
      1) Initial View: Bookmarks and Page
      2) Magnification: Fit In Window
      3) The file shall open to Contractor's transmittal letter, with bookmarks to the left. The first bookmark shall be linked to the Table of Contents.

   h. PDF document properties shall include the submittal number for the document title and Contractor's name for the author.
   i. Electronic submittal file sizes shall be limited to 10 MB. When multiple files are required for a submittal the least number of files possible shall be created.

8. Contractor shall post submittals and retrieve Engineer's submittal review comments through the Project website accessible through the Internet. Instruction on procedures for posting and retrieving submittals will be provided after award of the Contract.

9. Facsimiles (fax) will not be acceptable. Submittals will not be accepted from anyone but Contractor. Submittals shall be consecutively numbered in direct sequence of submittal and without division by subcontracts or trades.

B. Engineer's Review of Submittals.

1. Engineer's review of submittals covers only general conformity to the Drawings and Specifications, external connections, and dimensions that affect the layout; it does not indicate thorough review of all dimensions, quantities, and details of the material, equipment, device, or item covered. Engineer's review shall not relieve Contractor of sole responsibility for errors, omissions, or deviations in the drawings and data, nor of Contractor's sole responsibility for compliance with the Contract Documents.

2. Engineer's submittal review period shall be 21 consecutive calendar days and shall commence on the first calendar day following receipt of the submittal or resubmittal in Engineer's office.

3. The time required to mail the submittal or resubmittal back to Contractor shall not be considered a part of the submittal review period.

4. When the drawings and data are returned with review status "NOT ACCEPTABLE" or "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer.

    a. If submittals are made electronically, the corrected drawings and data shall be resubmitted through the Project website.
    b. Resubmittals by facsimile or e-mail will not be accepted. When the drawings and data are returned with review status "EXCEPTIONS NOTED", "NO EXCEPTIONS NOTED", or "RECORD COPY", no additional copies need be furnished unless specifically requested by Engineer.

C. Resubmittal of Shop Drawings and Data.

1. Contractor shall accept full responsibility for the completeness of each resubmittal. Contractor shall verify that all corrected data and additional information previously requested by Engineer are provided on the resubmittal. Resubmittals shall be in an organized and consistent format.

2. When corrected copies are resubmitted, Contractor shall direct specific attention to all revisions in writing and shall list separately any revisions made other than those called for by Engineer on previous submittals. Requirements specified for initial submittals shall also apply to resubmittals. Resubmittals shall bear the number of the first submittal followed by a letter (A, B, etc.) or a unique identification that indicates the initial submittal and correct sequence of each resubmittal.

3. If more than one resubmittal is required because of failure of Contractor to provide all previously requested corrected data or additional information, Contractor shall reimburse Owner for the charges of Engineer for review of the additional resubmittals. This does not include initial submittal data such as shop tests and field tests that are submitted after initial submittal.

4. Resubmittals shall be made within 30 days of the date of the letter returning the material to be modified or corrected, unless within 14 days Contractor submits an acceptable request for an extension of the stipulated time period, listing the reasons the resubmittal cannot be completed within that time.

5. The need for more than one resubmittal, or any other delay in obtaining Engineer's review of submittals, will not entitle Contractor to extension of the Contract Times unless delay of the Work is the direct result of a change in the Work authorized by a Change Order or failure of Engineer to review and return any submittal to Contractor within the specified review period.

D. Color Selection.

1. Contractor shall submit samples of colors and finishes for all accepted products before Engineer will coordinate the selection of colors and finishes with Owner. Engineer will prepare a schedule of finishes that includes the colors and finishes selected for both manufactured products and for surfaces to be field painted or finished and will furnish

this schedule to Contractor within 60 days after the date of acceptance of the last color or finish sample.

1.2 OPERATION AND MAINTENANCE DATA AND MANUALS.

A. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The equipment Supplier shall prepare a Project specific operation and maintenance manual for each type of equipment indicated in the individual equipment sections or the equipment schedule.

B. Unless otherwise agreed by Engineer, the operation and maintenance manual for each type of equipment shall only be submitted for review following completion of review of all shop drawings and engineering data pertaining to that equipment.

C. Parts lists and operating and maintenance instructions shall be furnished for other equipment not listed in the individual equipment sections or the equipment schedule.

D. Operation and maintenance manuals shall include the following:

1. Equipment function, normal operating characteristics, and limiting conditions.

2. Assembly, installation, alignment, adjustment, and checking instructions.

3. Operating instructions for startup, routine and normal operation, regulation and control, shutdown, and emergency conditions.

4. Lubrication and maintenance instructions.

5. Guide to troubleshooting.

6. Parts lists and predicted life of parts subject to wear.

7. Outline, cross section, and assembly drawings; engineering data; and wiring diagrams.

8. Test data and performance curves, where applicable.

E. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or which may be required by Contractor.

F. Hard copy and Electronic Manuals

1. When the O&M manuals are returned with the review status "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer.

2. After review by Engineer, is complete four hard copies and one electronic copy of each operation and maintenance manual shall be prepared and delivered to Engineer not later than 30 days prior to placing the equipment in operation.

3. The electronic copy shall be submitted through the Project website, and will be reviewed for content and organization and assigned a review status by Engineer. When corrections are required, a corrected version of the electronic copy shall be resubmitted.

4. Procedures for submission of the electronic copy will be provided after award of the Contract.

5. When review of the electronic copy by Engineer is complete, three copies of each electronic O&M manual shall be delivered on CD-ROM to Engineer. Each CD shall contain only one copy of one manual.

6. The completed O&M manual shall also be filed to the Project website.

G. Electronic Manuals

1. Manuals shall be submitted in electronic format to Engineer prior to the date of shipment of the equipment. The manuals shall be submitted and Engineer's review comments retrieved, through the Project website accessible through the Internet. Instruction on procedures for posting and retrieving O&M submittals and review comments will be provided after award of the Contract. When the O&M manuals are returned with the review status "RETURNED FOR CORRECTION", the corrections shall be made as instructed by Engineer, and corrected manuals resubmitted to Engineer. When review by Engineer is complete, three copies of each electronic O&M manual shall be delivered on CD-ROM to Engineer. Each CD shall contain only one copy of one manual. The completed O&M manual shall also be filed to the Project website. Delivery of the final O&M shall be made 30 days prior to placing the equipment in operation.

H. All material shall be marked with Project identification, and inapplicable information shall be marked out or deleted.

I. Shipment of equipment will not be considered complete until all required manuals and data have been received.

J. Hard Copy Operation and Maintenance Manual Requirements.

1. All manuals and other data shall be printed on heavy, first quality 8-1/2 x 11 inch paper, with standard three-hole punching. Drawings and diagrams shall be reduced to 8-1/2 x 11 inches or 11 x 17 inches.

2. Where reduction is not practicable, larger drawings shall be folded separately and placed in envelopes, which are bound into the manuals. Each envelope shall be suitably identified on the outside.

3. Each volume containing data for three or more items of equipment shall include a table of contents and index tabs.

4. The final hard copy of each manual shall be prepared and delivered in substantial, permanent, three-ring or three-post binders with a table of contents and suitable index tabs.

K. Electronic Operation and Maintenance Manual Requirements.

1. Electronic manuals shall be in Adobe Acrobat's Portable Document Format (PDF), and shall be prepared at a resolution between 300 and 600 dots per inch (dpi), depending on document type.

2. Optical Character Recognition (OCR) capture shall be performed on these documents. OCR settings shall be performed with the "original image with hidden text" option in Adobe Acrobat Exchange.

3. File size shall be limited to 10 MB. A single PDF file greater than 10 MB may only be submitted if acceptable to Owner. When multiple files are required the least number of files possible shall be created.

4. File names shall be in the format OMXXXXX-YYYZ-V.pdf, where XXXXX is the five digit number corresponding to the specification section, YYY is a three digit O&M manual number, e.g. 001, Z is the letter signifying a resubmittal, A, B, C, etc., and V is a number used only when more than one 10 MB file is required for an O&M manual.

5. Documents prepared in PDF format shall be processed as follows:

    a. Pages shall be searchable (processed for optical character recognition) and indexed when multiple files are required.
    b. Pages shall be rotated for viewing in proper orientation.
    c. A bookmark shall be provided in the navigation frame for each entry in the Table of Contents.
    d. Embedded thumbnails shall be generated for each completed PDF file.
    e. The opening view for PDF files shall be as follows:
        1) Initial View: Bookmarks and Page
        2) Page Number: Title Page (usually Page 1)
        3) Magnification: Set to Fit in Window
        4) Page: Single Page

    f. Where the bookmark structure is longer than one page the bookmarks shall be collapsed to show the chapter headings only.
    g. When multiple files are required the first file of the series (the parent file) shall list every major topic in the Table of Contents. The parent file shall also include minor headings bookmarked based on the Table of Contents. Major headings, whose content is contained in subsequent files (children) shall be linked to be called from the parent to the specific location in the child file. The child file shall contain bookmark entries for both major and minor headings contained in the child file. The first bookmark of any child file shall link back to the parent file and shall read as follows "Return to the Equipment Name Table of Contents", e.g. Return to the Polymer Feed System Table of Contents.
    h. Drawings shall be bookmarked individually.
    i. Files shall be delivered without security settings to permit editing, insertion and deletion of material to update the manual provided by the manufacturer.

L. Labeling

1. As a minimum, the following information shall be included on all final O&M manual materials, including CD-ROM disks, jewel cases, and hard copy manuals:

a. Equipment name and/or O&M title spelled out in complete words.
b. Project Name.
c. Owner Project/Contract Number.
d. Specification Section Number. Example: "Section 15500"
e. Manufacturer's name.
f. File Name and Date.

2. Label example:

Pump Operation and Maintenance Manual

BWD Western Corridor Pump Station

Project/Contract No. ____

Specification Section 11110

Manufacturer

OM11110-001.pdf, 5/05/22

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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SUBMITTAL No. _____
SECTION _____
Do not combine multiple sections together unless required by specifications.

(Contractor's Letterhead)

SUBMITTAL IDENTIFICATION & CONTRACTOR'S APPROVAL STATEMENT

DATE: _____ COPIES _____ DRAWING SHEET NO._____

Description submittal contents: _____
Location: _____
Manufacturer_____
Subcontractor or Supplier (Optional) _____

REMARKS: _____
_____
_____
_____

CONTRACTOR'S APPROVAL

(Construction Company) has reviewed and coordinated the submitted documentation and verifies that the equipment and material meet the requirements of the Work and the Contract Documents. We accept sole responsibility for determining and verifying all quantities, dimensions, field construction criteria, materials, catalog numbers, and similar data contained in the submittal as required by the Contract Documents.

Deviations: □ None □ Yes (See attached Figure 2-01300 for written description)

Approved By: _____ Date: _____

This approval does not release subcontractor / vendor from the contractual responsibilities.

Black & Veatch
Project No. _____Phase_____
Contract No. _____
Project Description: _____
_____

SUBMITTAL No. _____
SECTION _____
Do not combine multiple sections together unless required by specifications.

(Contractor's Letterhead)

SUBMITTAL IDENTIFICATION & CONTRACTOR'S APPROVAL STATEMENT

DATE: _____ COPIES _____ DRAWING SHEET NO._____

Description submittal contents: _____
Location: _____
Manufacturer_____
Subcontractor or Supplier (Optional) _____

DEVIATIONS

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Black & Veatch
Project No. _____Phase_____
Contract No. _____
Project Description: _____
_____

SECTION 01310 - CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 GENERAL OVERVIEW.

A. A Progress Schedule shall be used to control the Work and to provide a definitive basis for determining project progress. The Progress Schedule shall be prepared, maintained and updated by Contractor and historical dates agreed monthly with Engineer. Contractor shall submit a preliminary Progress Schedule and a Progress Schedule for acceptance by Engineer. These schedules shall be Contractor's working schedules and shall be used to plan, organize and execute the Work, record and report actual performance and progress, and show how Contractor plans to complete all remaining Work as of the end of each progress report period.

B. The Progress Schedule shall comprise all the detailed construction-related activities using the critical path method (CPM). The Progress Schedule shall provide sufficient detail and clarity to reflect the intricacies and interdependencies of activities so Contractor can plan, schedule, monitor, control and report on the progress of his work. In addition, it shall provide Engineer and Owner a tool to monitor and follow the progress for all phases of the Work.

1.2 PRE-CONSTRUCTION SCHEDULING CONFERENCE.

A. Engineer will conduct a pre-construction scheduling conference with Contractor to review requirements for the schedules including Schedule of Values and schedule configuration. The conference shall be conducted sufficiently early to allow Contractor to submit the preliminary Progress Schedule within ten days of the Effective Date of the Contract.

B. At this meeting, Contractor shall explain in detail the procedure to be used to develop the schedule activity cost-loading or Schedule of Values and cash flow. This procedure is subject to the review and acceptance of Engineer.

1.3 PRELIMINARY PROGRESS SCHEDULE.

A. Following the pre-construction scheduling conference but within ten calendar days after the Effective Date of the Contract, Contractor shall submit a preliminary Progress Schedule for review by Engineer. The preliminary Progress Schedule shall show detailed construction-related activities for the first 60 days of the project. The remainder of the Contract activities shall be shown as summary bars within the milestones of the Work. If Engineer has comments on the preliminary Progress Schedule, Contractor shall make the necessary changes and resubmit it within ten calendar days. No progress payments will be made during the period specified above for the preliminary Progress Schedule until the preliminary Progress Schedule has been accepted by Engineer.

B. The preliminary Progress Schedule shall:

1. Illustrate a feasible schedule for completion of the Work within the Contract Times and Milestones specified.

2. Provide an elementary example of the schedule in the format to be used for the Progress Schedule.

3. Include the activity code structure as described in Paragraph 19 of this specification.

C. Preliminary Progress Schedule Submittal Format:

1. Contractor shall submit two compact disks of the preliminary Progress Schedule. Compact disks shall be read-write and enable the use of the schedule as an executable file as described herein.

2. A brief narrative shall accompany the submittal, describing Contractor's scheduling approach to the project. The narrative shall include a description of the Contract milestones, approach for construction activities during the period of the preliminary Progress Schedule, description of the general approach of the activities for the work beyond the preliminary Progress Schedule period, a description of the project's critical path, identification of critical long-lead submittals, and planned outages.

3. The narrative shall also incorporate activity codes, calendars, weather days, milestone constraints, and work breakdown structure in accordance with the requirements specified herein.

1.4 PROGRESS SCHEDULE.

A. The Progress Schedule comprises all the construction-related activities for the Work and shall show the order in which Contractor proposes to carry out the work. Contractor shall include milestones, coordination necessitated by limited access and available work areas, and the availability and use of manpower, material and equipment. Contractor shall use the Progress Schedule to plan, schedule and coordinate the Work including activities of subcontractors, equipment vendors, and suppliers.

B. The Progress Schedule shall be to the level of detail acceptable to Engineer, and shall include the following:

1. Organization and structural breakdown of the Project;

2. Milestones and completion dates;

3. Type of work to be performed and the labor trades involved;

4. Purchase, manufacture and delivery activities for major materials and equipment;

5. Preparation, submittal, and acceptance of shop drawings and material samples;

6. Acceptances required by regulatory agencies and/or other third parties;

7. Assignment of responsibility for each activity;

8. Access requirements to work areas;

9. Identification of interfaces and dependencies with preceding, concurrent and follow-on contractors;

10. Tests, submittal of test reports and acceptance of test results;

11. Planning for phased or total acceptance by Owner; including start up and commissioning;

12. Identification of any manpower, material and equipment restrictions.

13. Sequence of construction to maintain plant operations;

14. Planned outages.

C. The activities included in the Progress Schedule shall be defined in work days. Durations shall be based on the labor (crafts), equipment, and materials required to perform each activity on a normal workday basis. Activity durations shall be 20 working days or less except in the case of non-construction activities such as procurement of materials, delivery of equipment, and concrete curing. All durations shall be the result of definitive manpower and resource planning by Contractor to perform the Work, in consideration of contractually defined on-site work conditions and Contractor's planned means and methods.

D. When the Progress Schedule is accepted by Engineer, Engineer will save a copy of the Progress Schedule as the baseline schedule, and will use it for analysis of Contractor's progress.

E. Contractor shall update the Progress Schedule monthly.

1.5 COORDINATING PROGRESS SCHEDULE WITH OTHER CONTRACT SCHEDULES.

A. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Progress Schedule shall be coordinated with the schedules of the other contracts. Owner will provide the schedules of other contracts for preparation and updating of the Progress Schedule. Contractor shall revise the Progress Schedule as required by changes in schedules of other contracts.

B. In case of interference between the operations of different contractors, Owner will determine the work priority of each contractor and the sequence of work necessary to expedite the completion of the entire project. In all such cases, the decision of Owner shall be accepted as final.

1.6 SUBMITTALS.

A. Progress Schedule Submittals

1. The Progress Schedule and associated reports shall be submitted to Engineer for acceptance within the period of the preliminary Progress Schedule specified herein. If the Progress

Schedule is not submitted, no progress payments will be made after the due date until the Progress Schedule has been submitted.

2. Printouts and electronic layouts required as part of the Progress Schedule submittal and monthly updates are as follows:

   a. Critical Path Schedule: sorted based on the total Float, early-start, early-finish;
   b. 60-Day Look Ahead Schedule: sorted by total Float, early-start, early-finish;
   c. Activities in Progress: organized by WBS or area of work; sorted by total Float, early-start, early-finish;

1.7 MONTHLY SCHEDULE UPDATES.

A. Monthly Progress Schedule updates shall be submitted for the duration of the Contract on a date agreed to by Owner, Engineer, and Contractor. If monthly Progress Schedule updates are not submitted by the due date, progress payments will be withheld until the required information is submitted.

B. The updated schedule shall be reviewed each month in a meeting with Engineer to verify:

1. Actual start dates,

2. Actual completion dates,

3. Activity percent completion,

4. Revised logic (as-built and projected) and changes in activity durations, cost assigned,

5. Revisions due to extension of time.

C. Prior to each meeting, Contractor shall prepare a complete and accurate report of current procurement and construction progress through the end of the update period, and a depiction of how Contractor plans to continue the Work to meet all contract completion dates. All network changes and status data agreed to during each update meeting shall be considered as accepted by both parties unless written notice of any exceptions is given within five calendar days after the meeting.

D. For major network changes that cannot be agreed to during an updating meeting, Contractor shall submit the proposed changes for Engineer's acceptance prior to inserting such changes into the network. Submittals may be in the form of marked-up networks, fragnets, or schedule abstracts, provided they are submitted with a letter of transmittal. A fragnet is defined as a sequence of new activities and/or activity revisions that are proposed to be added to the existing schedule to demonstrate how project events have an impact on the schedule.

1.8 REVIEW PROCESS.

A. Engineer will review Contractor's preliminary Progress Schedule and full Progress Schedule submittals within 15 calendar days after receipt of all required information.

B. If any of the required submittals are returned to Contractor for corrections or revisions, they shall be resubmitted within ten calendar days after the return mailing date. Resubmittals shall include all information and media included in the first submittal. Review and response by Engineer will be given within 10 calendar days after receipt of each resubmittal.

C. Schedules shall show contract completion of the Work on the Contract completion date and with zero or positive total Float even if Contractor plans to finish early. In no event shall acceptance of the Progress Schedule be a basis for a claim for delay against Owner or Engineer by Contractor for an early finish. A Progress Schedule containing activities with negative Float or that extend beyond the date that the Work is completed and ready for final payment will not be acceptable.

D. Acceptance of the Progress Schedule by Engineer does not relieve Contractor of responsibility for accomplishing the Work by the Contract completion date. Omissions and errors in the accepted Progress Schedule shall not relieve Contractor of obligations under the Contract. Acceptance by Engineer in no way makes Engineer or Owner an ensurer of the Progress Schedule's success or liable for time or cost overruns. Engineer and Owner hereby disclaim any obligation or liability by reason of acceptance of the Progress Schedule by Engineer.

1.9 RESPONSIBILITY FOR SCHEDULE COMPLIANCE.

A. Whenever it becomes apparent from the current Progress Schedule that the critical path is delayed and the contract completion date will not be met, Contractor shall mitigate the delay by taking some or all of the following actions at no additional cost to Owner.

1. Increase construction manpower in such quantities and crafts as will bring the project back on schedule within the completion dates and milestones.

2. Increase the number of working hours per shift, shifts per day, working days per week, and the amount of construction equipment, or any combination of the foregoing, to substantially eliminate the backlog of work.

3. Re-schedule activities to achieve maximum practical concurrence of activities and to comply with the schedule date(s).

B. Within ten calendar days of Engineer’s request, Contractor shall submit a recovery schedule and written statement of the steps intended to remove or arrest the delay to the critical path in the schedule. If Contractor fails to submit the required information or should fail to take measures acceptable to Engineer, Engineer with Owner concurrence may direct Contractor to increase man-power, equipment and scheduled work hours to remove or arrest the delay to the critical path and Contractor shall promptly provide such level of effort at no additional cost to Owner.

C. In the event Contractor fails to follow the updated or revised recovery schedule, Owner may elect to withhold progress payments until Contractor complies with the revised schedule.

D. Should Contractor’s efforts not remove or arrest the delay to the critical path of the accepted schedule, then Owner shall be entitled to supplement Contractor’s work-force and equipment to remove and arrest any delay, and shall be entitled to deduct all costs and expenses associated therewith from payments due to Contractor. If insufficient Contract funds remain, Owner may recover such funds from Contractor and its Surety.

1.10 CHANGES IN THE WORK, DELAYS, AND EXTENSIONS OF TIME.

A. When changes in the Work or delays are experienced by Contractor and Contractor requests an extension of time, Contractor shall submit a written time impact analysis to Engineer illustrating the influence of each change or delay to the current Contract Times. Each time impact analysis shall include a fragnet incorporating the change or delay into the Progress Schedule to demonstrate how Contractor was delayed.

B. Each time impact analysis shall demonstrate the estimated time impact based on the events of the change or the delay; the date the change was given to Contractor or the delay incurred, the status of construction at that point in time, and the event time computation of all activities affected by the change or delay. The event times used in the analysis shall be those included in the latest update of the Progress Schedule or as adjusted for the events of delay.

C. Three copies of the time impact analysis and an electronic copy on compact disk shall be submitted within seven calendar days of delay occurrence or direction to proceed with a change is given to Contractor. No time extensions will be considered if the time impact analysis is not submitted within the specified time.

D. Engineer will review Contractor's time impact analysis. Contractor shall furnish such justification and supporting evidence as Engineer deems necessary to determine whether Contractor is entitled to an extension of time. Engineer's review of each time impact analysis will be made within five working days of receipt of the time impact analysis and additional information as required by Engineer, unless subsequent meetings and negotiations are necessary.

E. The Contract Times will be adjusted only for causes specified in paragraph 15. Time extensions will be granted only to the extent that equitable time adjustments for the activity or activities affected exceed the total or remaining Float along the critical path at the time of actual delay. Delays in activities which are not on the critical path and do not affect Contract Times, will not be considered for an extension of time.

1.11 CAUSES FOR EXTENSIONS OF TIME.

A. Additional positive total Float in the Progress Schedule generated by efficiencies of Owner or Contractor is a shared commodity to be reasonably used by either party, and belongs exclusively to the Project. Contractor is not entitled to any additional compensation for completion of the project prior to expiration of the Contract Times.

B. Owner-Initiated Changes. Owner initiated changes to the Work that absorb Float time will not be considered for an extension of time. Owner-initiated changes that affect the critical path of the Progress Schedule shall be grounds for extending or shortening completion dates. Use of Float time for Contractor initiated changes will require Owner's concurrence. Contractor's changes, however, shall give way to Owner-initiated changes competing for the same Float time.

C. Outside Contractor's Control. Events outside of Contractor's control that affect the critical path of the Progress Schedule will be considered for an extension or reduction of the Contract Times.

1. Weather Delays. Engineer will obtain weather data during construction from a reputable source, and will maintain weather records. Engineer will determine Contractor's entitlement to an extension of Contract Times as a result of weather delays. For any cleam, Contractor shall provide justification that the weather delay impacted critical path activities. An extension of Contract Time of no more than one day will be granted for one day of lost work, regardless of the number of allowable reasons for lost time. Any weather related extension of Contract Times shall be non-compensable. Efficiencies gained as a result of favorable weather within a calendar month, where the number of days of normally anticipated weather days is less than expected, shall contribute to the project Float and shall not affect the Contact Times. Application for a weather related extension of time shall be submitted to Engineer, and shall state the extension requested and be supported by the relevant weather data. Entitlement for weather delays will be based on the following criteria:

    a. For rain events, an extension of Contract Time will be given for the number of calendar days in a given month in which the daily precipitation exceeds 0.10 inches, less the monthly average as indicated in Table 1.
    b. For mud events, an extension of Contract Time of one calendar day will be given for the day following each 1 inch precipitation event.
    c. For snow events, an extension of Contract Time will be given for the number of days in which the daily snowfall exceeds 3 inches.
    d. For temperature events, an extension of Contract Time will be given for the number of calendar days in which the daily high temperature exceeds 105°F or is below 10°F.

Table 1
Average Number of Calendar Days with Precipitation of 0.10 Inches or More in a Single 24-hour Period

10 year average 2001 – 2010

NOAA NATIONAL DATA CENTER, ANNUAL CLIMATOLOGICAL SUMMARIES

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
4	5	7	6	8	7	6	5	5	3	5	5

1.12 MANDATORY MILESTONES

A. The Contract duration shall be equal to the time period between the Notice to Proceed and the completion of the Work in readiness for final payment. The following milestones are mandatory.

1. Notice to Proceed

2. Milestones, if any, as indicated in Contractor's Bid

3. Substantial Completion as indicated in Contractor's Bid

4. Completion and readiness for final payment, as indicated in Contractor's Bid

B. The following additional milestones are to be considered and incorporated into the Progress Schedule in accordance with the Contract, if applicable.

1. Permit constraints

2. Facility shut down or outage milestone requirements

3. Applicable phasing milestones

4. Other milestones deemed appropriate by Engineer

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01320 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SCHEDULE OF VALUES.

A. After review of the preliminary schedule at the preconstruction conference, and before submission of the first Application for Payment, Contractor shall prepare and submit to Engineer a Schedule of Values covering each lump sum item. The Schedule of Values, showing the value of each kind of work, shall be acceptable to Engineer before any Application for Payment is prepared.

B. The sum of the items listed in the Schedule of Values shall equal the Contract Price. Such items as Bond premium, temporary construction facilities, and plant may be listed separately in the Schedule of Values, provided the amounts can be substantiated. Overhead and profit shall not be listed as separate items.

C. The Schedule of Values shall have sufficient detail such that partial completion of separable items of work can easily be calculated. The Schedule of Values shall have separate lines for manufacturer's field services, O&M manuals, and performance testing for each item of equipment requiring such services.

D. An unbalanced Schedule of Values providing for overpayment of Contractor on items of Work which would be performed first will not be accepted. The Schedule of Values shall be revised and resubmitted until acceptable to Engineer. Final acceptance by Engineer shall indicate only consent to the Schedule of Values as a basis for preparation of applications for progress payments, and shall not constitute an agreement as to the value of each indicated item.

1.2 SCHEDULE OF PAYMENTS

A. Within 30 days after award of contract, Contractor shall furnish to Engineer a schedule of estimated monthly payments. The schedule shall be revised and resubmitted each time an Application for Payment varies more than 10 percent from the estimated payment schedule.

1.3 SURVEY DATA.

A. All field books, notes, and other data developed by Contractor in performing surveys required as part of the Work shall be available to Engineer for examination throughout the construction period. All such data shall be submitted to Engineer with the other documentation required for final acceptance of the Work.

1.4 LAYOUT DATA.

A. Contractor shall keep neat and legible notes of measurements and calculations made in connection with the layout of the Work. Copies of such data shall be furnished to the Resident

Project Representative for use in checking Contractor's layout as provided in the project requirements section. All such data considered of value to Owner will be transmitted to Owner by Engineer with other records upon completion of the Work.

End of Section

SECTION 01380 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 CONSTRUCTION PHOTOGRAPHS BY CONTRACTOR.

A. Contractor shall be responsible for the production of construction photographs as provided herein. Engineer shall designate the subject of each photograph.

B. At least fifty (50) photographs of the entire site, or pertinent features thereof, shall be taken before the commencement of Work and promptly submitted to Engineer. The same views shall be rephotographed upon completion of all construction activities and submitted with Contractor's application for final payment. At least twelve (12) aerial photographs and fifteen (15) additional photographs shall be made each month throughout the progress of the Work at such times as requested by Engineer, and submitted with Contractor's application for progress payment.

C. All photographs shall be color digital, produced by a competent professional photographer. Contractor shall submit the photographs electronically and two copies of 4 by 5 inch prints. Digital images shall be compiled on CD and provided with a descriptive index of the images. Prints shall be mounted on linen with flap for binding or enclosed in clear plastic binders, and marked with the name and number of the Contract, name of Contractor, description and location of view, and date photographed.

D. Engineer will transmit the digital files and one copy of the prints to Owner.

PART 2 - PRODUCTS

PART 3 - EXECUTION

End of Section

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SECTION 01400 - QUALITY CONTROL

PART 1 - GENERAL

1.1 TESTING SERVICES.

A. Testing services shall be provided in accordance with Paragraph 14.02 of the General Conditions. All tests to determine compliance with the Contract Documents shall be performed by an independent commercial testing firm acceptable to Engineer and/or Authority Having Jurisdiction excluding testing as specified to be conducted directly by Contractor. The testing firm's laboratory shall be staffed with experienced technicians, properly equipped and fully qualified to perform the tests in accordance with the specified standards.

B. Testing services provided by Owner are for the sole benefit of Owner and/or as required by the governing building code; however, test results shall be available to Contractor. Testing necessary to satisfy Contractor's internal quality control procedures shall be the sole responsibility of Contractor.

C. Testing Services Provided by Contractor.

1. Unless otherwise specified, Contractor shall provide all testing services in connection with the following:

a. Any Work or part thereof specifically to be inspected, tested or approved by an employee or representative of an Authority Having Jurisdiction. Contractor shall assume full responsibility for arranging and obtaining such inspections, tests or approvals. Contractor shall pay all costs associated for these activities and shall provide the required certificates of inspection or approval.
b. Any inspections, tests or approvals required for Owner or Engineer acceptance of materials or equipment to be incorporated in the Work. This includes any items required for acceptance of materials, concrete mix designs or equipment submitted for approval prior to Contractor's purchase for incorporation in the Work.
c. Testing, adjusting and balancing of mechanical, electrical and other equipment and systems as specified to be incorporated into the Work. This includes services required by manufacturers of equipment or other products such as concrete repair products, pipe, coatings, linings and roof membranes furnished under the Contract Documents.
d. Tightness testing of containment structures and pressure or leakage testing of piping as specified.
e. Any Work (or part thereof) required by the Contract Documents to be approved by Owner, Engineer or other designated individual or entity. Contractor shall assume full responsibility for arranging and obtaining such approvals, pay all costs in connection therewith and submit to Engineer the required certificates of approval.

2. Excluding those conducted directly by an Authority Having Jurisdiction or expressly specified to be conducted directly by Contractor, inspections and tests shall be performed by independent inspectors, approved agencies or other qualified individuals or entities acceptable to Owner and Engineer.

D. Testing Services and Special Inspections Provided by Owner.

1. Unless otherwise specified, Owner shall employ and pay for the services of an independent testing laboratory, approved agency or other qualified individual or entities for inspections, tests or approvals required by the Contract Documents for field quality control. These include items indicated as Owner provided in the following specifications:

a. Excavation and Fill for Structures
b. Trenching and Backfilling
c. Concrete Paving
d. Cleaning and Disinfection of Water Pipelines
e. Concrete
f. Masonry
g. Steel Joist Framing
h. Anchorage in Concrete and Masonry
i. Structural and Miscellaneous Metals
j. Steel Pipe
k. Other materials and equipment at the discretion of Owner.

E. Contractor shall provide access to the site and Work in accordance with 14.01 and 14.02 of the General Conditions. Contractor shall give timely notice of the readiness of the Work for inspection, tests or approvals and shall cooperate with the inspection and testing personnel to facilitate the required tests and inspections. Contractor shall furnish all sample materials and cooperate in the testing activities, including sampling. Contractor shall interrupt the Work when necessary to allow testing, including sampling, to be performed. Contractor shall have no Claim for an increase in Contract Price or Contract Times due to such interruption. When testing activities, including sampling, are performed in the field by Engineer or Agency personnel, Contractor shall furnish personnel and facilities to assist in the activities as required.

F. Transmittal of Test Reports.

1. Written reports of tests and engineering data furnished by Contractor for Engineer's review of materials and equipment proposed to be used in the Work shall be submitted as specified for Shop Drawings.

2. The Approved Agency retained by Owner will furnish five copies of a written report of each test. Two copies of each test report will be transmitted to the Resident Project Representative, one copy to the Special Inspector, one copy to Engineer, and one copy to Contractor, within 3 days after each test is completed or as directed by the Statement of Special Inspections as applicable.

1.2 OFFSITE INSPECTION.

A. Inspection of materials or equipment during the production, manufacturing, or fabricating process, or before shipment, will be performed by Engineer or an independent testing firm or Approved Agency acceptable to Engineer and Authority Having Jurisdiction as specified in the materials and equipment sections or Structural Tests and Special Inspections section.

B. Except as otherwise specified in other sections, Contractor shall give appropriate written notice to Engineer not less than 10 days before offsite inspection services are required, and shall provide for the producer, manufacturer, or fabricator to furnish safe access and proper facilities and to cooperate with inspecting personnel in the performance of their duties.

C. The inspection organization will submit a written report to Engineer, with a copy to Contractor, at least once each week or as directed by the Statement of Special Inspections as applicable.

1.3 MANUFACTURER'S FIELD SERVICES

A. Manufacturer's field services shall be as specified herein except as specifically specified in the respective equipment sections.

B. Services Furnished Under This Contract. An experienced, competent, and authorized representative of the manufacturer of each item of equipment for which field services are indicated in the respective equipment section or in the equipment schedule section shall visit the Site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. In each case, the manufacturer's representative shall be present when the equipment is placed in operation. The manufacturer's representative shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

C. Each manufacturer's representative shall furnish to Owner, through Engineer, a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

D. All costs for these services shall be included in the Contract Price.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

End of Section

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SECTION 01450 - CODE REQUIRED SPECIAL INSPECTIONS AND PROCEDURES (IBC 2021)

PART 1 - GENERAL

1.1 SCOPE

A. Owner, or Registered Design Professional in Responsible Charge of construction acting as Owner's Agent, will engage one or more Approved Agencies to conduct tests and special inspections specified in this section and related sections, and as may be specified in other sections of these specifications.

B. The Approved Agency shall not be employed by Contractor or a supplier materially participating in the project.

1.2 GENERAL

A. This Section includes administrative and procedural requirements indicated in the governing building code.

B. Structural testing and special inspection services are required to verify compliance with the construction documents and standards referenced herein. These services do not relieve Contractor of responsibility for compliance with the construction documents.

C. Specific quality-assurance and quality-control requirements for individual construction activities are also referenced in other Sections. Requirements in those Sections may also cover production of standard products.

D. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the construction documents.

E. Requirements for Contractor to provide quality-assurance and quality-control services required by Engineer, Owner, or Authority Having Jurisdiction (AHJ) are not limited by provisions of this Section.

1.3 DEFINITIONS.

A. Approved Agency: An established and recognized agency regularly engaged in conducting tests, furnishing inspection services, or furnishing product certification when such agency has been approved by the Authority Having Jurisdiction.

B. Approved Fabricator: An established and qualified person, firm or corporation approved by the Authority Having Jurisdiction to perform work without Special Inspection.

C. Authority Having Jurisdiction (AHJ): The officer or other designated authority charged with the administration and enforcement of the building code, or a duly authorized representative. Also commonly known as the Building Official.

D. Construction Documents: Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building permit. Construction documents include all supplemental instructions, sketches, addenda, and revisions to the drawings and specifications issued by the Registered Design Professional beyond those issued for a building permit.

E. Pre-Engineered Structural Elements: Structural elements specified by the Registered Design Professional but which may be designed by another Registered Design Professional. (Examples are items such as open web steel joists and joist girders, metal joists, pre-cast concrete elements, pre-fabricated metal buildings, pre-stressed wire wrapped tanks, tilt-up concrete panel reinforcement and lifting hardware.)

F. Registered Design Professional (RDP): An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

G. Registered Design Professional in Responsible Charge (RDPRC): A Registered Design Professional engaged by Owner to review and coordinate certain aspects of the project, as determined by the AHJ and Construction Documents, for compatibility with the design of the buildings or structure, including submittal documents prepared by others, deferred submittal documents and phased submittal documents.

H. Shop Drawings / Submittal Data: Written, graphic and pictorial documents prepared and / or assembled by Contractor or Supplier based on the Construction Documents.

I. Special Inspection: Inspection and/or testing required by the governing building code, as amended by the AHJ, of the materials, installation, fabrication, erection or placement of components and connections requiring special expertise to ensure compliance with approved Construction Documents and referenced standards.

J. Special Inspection, Continuous: The full-time observation or testing of work requiring special inspection by an approved Special Inspector who is present in the area where the work is being performed.

K. Special Inspection, Periodic: The part-time or intermittent observation or testing of work requiring Special Inspection by an approved Special Inspector who is present in the area where the work has been or is being performed and at the completion of the work.

L. Special Inspector: A qualified person demonstrating competence, to the satisfaction of the AHJ and RDPRC, for inspection of the particular type of construction or operation requiring special inspection. The Special Inspector will be qualified as specified herein.

M. Structural Observations: Visual observation of the structural system by a Registered Design Professional for general conformance to the approved Construction Documents. Structural observations are not considered part of the tests and special inspections and do not replace inspections and testing by the Approved Agency. Owner will employ a RDP to perform Structural Observations.

N. Testing Agency: A qualified materials testing laboratory under the responsible charge of a Registered Design Professional, approved by the AHJ and the RDPRC, to measure, examine,

test, calibrate, or otherwise determine the characteristics or performance of construction materials and verify confirmation with construction documents.

1.4 INSPECTION AND TESTING AGENCY QUALIFICATIONS.

A. Special Inspectors and testing agencies will be employed or retained by Owner, and will have the minimum qualifications as described in this section. The qualifications of all personnel performing special inspection and testing activities are subject to the approval of the AHJ.

B. Minimum qualifications of inspection and testing agencies and their personnel will comply with ASTM E329 "Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection," or IAS AC 291 "Accreditation Criteria for Special Inspection Agencies."

C. Inspectors and individuals performing tests will be certified for the work being performed as listed below and in Table 1 of IAS AC291, or by alternate certifications when acceptable to the AHJ. The AHJ may have additional requirements.

Abbreviation used in this Section	Description
AIA	Architect licensed in the state of the project, specializing in the design of building structures
Licensed Engineers	
PE/SE	Structural Engineer (SE) or Professional Engineer (PE) licensed in the state of the project, specializing in the design of building structures
PE/GE	Geotechnical Engineer (GE) or Professional Engineer (PE) licensed in the state of the project, specializing in soil mechanics and foundations
PE/EE	Electrical Engineer (EE) or Professional Engineer (PE) licensed in the state of the project, specializing in electrical systems
PE/ME	Mechanical Engineer (ME) or Professional Engineer (PE) licensed in the state of the project, specializing in mechanical systems
EI/EIT	Engineering Intern or Engineer-in-Training: a graduate engineer who has passed the Fundamentals of Engineering examination working under the direct supervision of a Professional Engineer licensed in the state of the project and with a minimum of one year of experience performing inspections.

Abbreviation used in this Section	Description
American Concrete Institute (ACI) Certification	
ACI-CFTT	Concrete Field Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1 or 2
ACI-STT	Strength Testing Technician
American Welding Society (AWS) Certification	
AWS-CWI	Certified Welding Inspector
AWS/AISC-SSI	Certified Structural Steel Inspector
American Society of Non-Destructive Testing (ASNT) Certification	
ASNT	Non-Destructive Testing Technician For Ultrasonic Testing (UT) and Radiographic Testing (RT) Certified as Level III through examination by ASNT or certified as Level II by their employer for flaw detection. For Magnetic Particle Testing (MT) and Liquid Penetrant Testing (PT) certified as Level II by their employer or certified as Level III through examination by ASNT and certified by their employer
International Code Council (ICC) Certification	
ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fire-proofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector
ICC-SBSI	Structural Steel and Bolting Special Inspector
ICC-WSI	Structural Welding Special Inspector

Abbreviation used in this Section	Description
National Concrete Masonry Association	
NCMA	Concrete Masonry Testing Technician
National Institute for Certification in Engineering Technologies (NICET)	
NICET-CT	Concrete Technician – Levels II, III & IV
NICET-ST	Soils Technician - Levels II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels II, III & IV
Exterior Design Institute (EDI) Certification	
EDI-EIFS	EIFS Third Party Inspector

Inspection or Testing Item	Qualification Standards
Fabricators	Varies by product as listed below
Steel Construction – Welding Inspection	ICC-SWSI, ICC-WSI, AWS-CWI or AWS/AISC-SSI
Steel Construction – Non-Destructive Weld Testing	ASNT
Steel Construction – Details	PE/SE, ICC-SWSI, ICC-SBSI or AWS/AISC-SSI
Steel Construction – High Strength Bolts	PE/SE or ICC-SBSI
Concrete Construction - Field Tests	ACI-CFTT or NICET-CT
Concrete Construction - Field Inspection	PE/SE, ICC-RCSI, ACI-CCI or NICET-CT
Concrete Construction - Laboratory Testing	ACI-LTT, ACI-STT or NICET-CT
Prestressed Concrete Construction	ICC-PCSI
Masonry Construction - Field Inspection	PE/SE or ICC-SMSI
Masonry Construction - Laboratory Testing	NCMA

Inspection or Testing Item	Qualification Standards
Soils (special grading, excavation and filling)	PE/GE, NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pile Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Pier Foundations	PE/GE, Appropriate structural material inspection and NICET-ST or NICET-GET under the direct supervision of Registered Civil (geotechnical) Engineer
Wall Panels and Veneers	ICC-SMSI
Sprayed Fire-Resistant Materials	ICC-SFSI
Exterior Insulation and Finish Systems (EIFS)	ICC Building Inspector or EDI-EIFS
Post Installed Anchors in Concrete	ICC Building Inspector, ICC-RCSI, or PE/SE
Post Installed Anchors in Masonry	ICC Building Inspector, ICC-SMSI, or PE/SE
Smoke Control Systems	IBC 1705.18.2
Other Architectural Systems	ICC Building Inspector, AIA, or PE/SE
Mechanical Systems	ICC Building Inspector or PE/ME
Electrical Systems	See NFPA 70

1.5 CONFLICTING REQUIREMENTS, REPORTS AND TEST RESULTS

A. General

1. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the RDPRC for a decision before proceeding.

B. Minimum Quantity or Quality Levels.

1. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as

appropriate, for the context of requirements. Refer uncertainties to the RDPRC for a decision before proceeding.

C. Precedence.

1. The Approved Agency reports and testing results shall have precedence over reports and test results provided by Contractor.

D. Conflict.

1. Where a conflict exists between the construction documents and approved shop drawings/submittal data, the construction documents shall govern unless the shop drawings/submittal data are more restrictive. All conflicts shall be brought to the attention of the RDPRC.

1.6 TECHNICAL ATTACHMENTS

A. The following forms are required as part of the comprehensive administrative, testing and inspection requirements. The forms are available from the AHJ, or are included herein, as indicated:

Form Title	AHJ Provided	Included Herein	Notes
Statement of Special Inspections (SSI)		x	To be completed jointly by the RDPRC and the Approved Agency, and sealed by the RDPRC after completion. Contractor or Owner shall submit the form to the AHJ as part of the building permit application process.
Request for Approval of Special Inspector		x	To be completed by Approved Agency. Approved Agency will submit the form to the AHJ and RDPRC for their approval of individual inspectors.
Request for Approval to Provide Special Inspection of Non-Local Fabrication		x	To be completed by Approved Agency and submitted to Owner, AHJ and RDPRC.
Contractor's Statement of Responsibility		x	To completed by Contractor and his relevant suppliers and submitted to Owner and AHJ.
Fabricator's Certificate of Compliance		x	To be completed by Contractor's fabricators, as applicable, and submitted to AHJ.

Final Report of Special Inspections		x	To be completed and sealed by Approved Agency. Approved Agency or Owner will submit to AHJ at the completion of construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 CONTRACTOR AND FABRICATOR RESPONSIBILITIES.

A. Each Fabricator or Contractor responsible for the construction of a seismic-force-resisting system, designated seismic system, seismic resisting component, main wind force-resisting system, or a wind-resisting component listed in the SSI shall submit a Contractor's Statement of Responsibility to the AHJ and to Owner prior to the commencement of work.

B. To be considered an Approved Fabricator that may perform work without Special Inspection, the Fabricator shall submit copies of certifications from the International Accreditation Service (IAS) or other recognized and acceptable accreditation organization a minimum of 30 days prior to the start of fabrication. Acceptance as an Approved Fabricator is subject to approval by the AHJ. If the project specifications required an Approved Fabricator, and the AHJ does not accept the Fabricator as an Approved Fabricator, special inspection may become necessary in the Fabricator's shop. Such inspections will be performed by Approved Agency and Contractor shall reimburse Owner for the cost for the inspections.

C. Contractor shall assist in coordination of the inspection and testing services with the progress of the work. Contractor shall provide sufficient notice to allow proper scheduling of all inspection and testing personnel. Contractor shall provide safe access to inspection and testing personnel and shall ensure that all work requiring special inspection is inspected and/or tested prior to concealment.

D. Contractor shall submit schedules to Owner, RDPRC and testing and inspecting agencies. Schedules will note milestones and durations of time for materials requiring tests and special inspections.

E. Contractor shall provide the Special Inspector access to approved plans at the job site or fabrication shop as applicable.

F. Contractor shall retain at the job site or fabrication shop, as applicable, all special inspection records submitted by an Approved Agency or Special Inspector and shall provide these records for review by the AHJ's inspector upon request.

G. Contractor shall repair and/or replace work that does not meet the requirements of the construction documents.

H. Contractor shall engage an engineer to prepare repair and/or replacement procedures for any deficiencies identified. Contractor's engineer shall be registered in the state in which the

project is located. Contractor's engineer shall be acceptable to the RDPRC, AHJ, and Owner. Procedures shall be submitted for review and acceptance by the RDPRC, AHJ, and Owner before proceeding with corrective action.

I. Contractor shall be responsible for costs of:

1. Re-testing and re-inspection of materials, work, and/or products that do not meet the requirements of the Contract Documents or shop drawing/submittal data.

2. Review of proposed repair and/or replacement procedures by the RDPRC and the inspectors and testing agencies.

3. Repair or replacement of work that does not meet the requirements of the Construction Documents.

3.2 APPROVED AGENCY AND SPECIAL INSPECTOR RESPONSIBILITIES.

A. Preliminary Approvals

1. The Approved Agency will submit a "Request for Approval of Special Inspector" form to the AHJ for each proposed Special Inspector or testing technician. The form will include the individual's credentials, which as a minimum will meet the requirements indicated in Inspection and Testing Agency Qualifications paragraphs of this Section. Inspector certifications by organizations other than those listed herein will not be acceptable without approval of the AHJ. The AHJ may have additional requirements to those specified herein. It is the responsibility of the testing and inspection agencies to meet local requirements and comply with local procedures.

2. When fabrication will take place away from the local proximity of the project, Approved Agency will submit a "Request for Approval to Provide Special Inspection of Non-Local Fabrication" form for review and approval by Owner, the RDPRC, and the AHJ prior to subcontracting with an inspection/testing agency in the locale of the fabricating plant.

B. Perform Inspections and Tests

1. Be present for and perform continuous or periodic inspections and tests as listed in the SSI for conformance of the work to the AHJ approved Construction Documents. Notify Contractor personnel of their presence and responsibilities. Reference the applicable "Code or Standard Reference" column in the SSI for the minimum level of inspections and testing. When the SSI column titled "Code or Standard Reference" indicates "Manufacturer's research reports", inspector will obtain the most current ICBO-ES Report, ICC-ES Legacy Report, ICC-ES Report, or IAPMO UES Evaluation Report (as applicable) prior to the applicable inspection, for the type and brand of products or materials being inspected.

2. Provide additional inspections and testing as necessary to determine compliance with the Construction Documents. Perform special inspections in a timely manner to avoid delay of work.

3. The Approved Agency shall be responsible to ensure that any non-local inspection/testing agency fully complies with this Section and the SSI.

C. Defective Work

1. Immediately notify Contractor of the need for corrective action when work does not conform to Construction Documents.

D. Uncorrected Defective Work

1. Notify the AHJ and RDPRC when deficiencies have not been corrected. Notice will be made prior to the completion of that phase of the work.

E. Interim Inspection Reports

1. Furnish interim inspection reports to the AHJ, the RDPRC, Contractor, Engineer, and Owner during the progress of the work. Frequency of reports will be as established in the SSI. Reports will indicate that work inspected was done in conformance to the approved Construction Documents, or that the work was defective, as applicable.

2. Special inspection reports and test results will include, but not be limited to, the following:

   a. Project name and address.
   b. Permit number.
   c. Special Inspection Agency name, address, and phone number.
   d. Unique identification of the report and of each page.
   e. Date and time of inspection.
   f. Description of inspections or tests performed, including item description and location (reference grid lines, floors, elevations, etc.). Identify approved agencies employed to carry out tests.
   g. Identification of test/inspection equipment used.
   h. Statement noting that the work, material, and/or product conforms or does not conform to the construction document requirements. Describe defective items.
   i. Name and signature of Contractor's representative who was notified of work, material, and/or products that do not meet the construction document requirements.
   j. Name and signature of Special Inspector and/or testing agency representative performing the work.

F. Report of Defective Work

1. Each agent will maintain a log that identifies work that does not meet the requirements of the construction documents. Include:

   a. Description and exact location.
   b. Reference to applicable drawings and specifications.
   c. Reference to original inspection/test report and subsequent dates of re-inspection/retesting.
   d. Name and title of each individual notified and method of notification.
   e. How defective items were resolved or unresolved, as applicable.

f. Itemized changes authorized by the RDPRC and AHJ if not included in a defective item.

G. Submittal Schedule.

1. Documentation of reports, test results, and non-compliant work will be submitted at the frequency indicated in the SSI.

H. Final Report of Special Inspections.

1. Each agent listed in the SSI shall submit a final report to the Approved Agency documenting the performed special inspections and the correction of any discrepancies noted. The Approved Agency shall cumulate the reports and submit a comprehensive final report at a point in time as agreed upon by the permit applicant and the AHJ prior to the start of work.

3.3 STRUCTURAL OBSERVATION.

A. Owner, or RDPRC on Owner's behalf, shall employ a RDP to perform Structural Observation. Prior to the commencement of observations, the structural observer shall submit to the AHJ a written statement identifying the frequency and extent of structural observations. Structural observations may be made periodically as determined by the Registered Design Professional.

B. At the conclusion of the work requiring observation, the structural observer shall submit to the AHJ a written statement that the site visits have been made and identify any reported deficiencies which, to the best of the structural observer's knowledge, have not been resolved.

End of Section

Statement of Special Inspections

Project:
Project Address:
Permit Applicant:
Applicant Address:
Owner:
Owner Address:

Registered Design Professional in Responsible Charge (RDPRC) :

Discipline	Name	License Number	Expiration Date
Structural Engineer			
Geotechnical Engineer			
Mechanical Engineer			
Electrical Engineer			
Architect			

This Statement of Special Inspections includes a *Schedule of Special Inspections* applicable to the above referenced project as well as the identity of the individuals, agencies, or firms intended to be retained for conducting these inspections.

The Special Inspector(s) shall keep records of all inspections and shall furnish interim inspection reports to the Authority Having Jurisdiction (AHJ) and to the Registered Design Professional in Responsible Charge (RDPRC). Discrepancies shall be brought to the immediate attention of the Contractor for correction. If the discrepancies are not corrected, the discrepancies shall be brought to the attention of the AHJ and the RDPRC prior to completion of that phase of work. A *Final Report of Special Inspections* documenting required special inspections and correction of any discrepancies noted in the inspections shall be submitted by each agent.

The Special Inspection program does not relieve the Contractor of the responsibility to comply with the Contract Documents. Jobsite safety and means and methods of construction are solely the responsibility of the Contractor.

Inspection work shall be performed in accordance with the following codes and standards. Unless otherwise indicated within the Statement of Special Inspections, the applicable edition for all codes and standards shall be as follows.

Work	In Accordance With
Building Code	2021 International Building Code (IBC)
Seismic Criteria for Nonstructural Components	ASCE 7-16
Standard Tests and Practices	Listed American Society for Testing and Materials (ASTM) specifications
Concrete	ACI 318-19 and ACI 350-06
Masonry	TMS 402-16 and TMS 602-16
Structural Steel	AISC 360-16 and AISC 341-16
Structural steel welding	AWS D1.1 Structural Welding Code - Steel
Aluminum welding	AWS D1.2 Structural Welding Code – Aluminum
Sheet steel welding	AWS D1.3 Structural Welding Code – Sheet Steel

Work	In Accordance With
Structural steel bolting	Research Council on Structural Connections Specification for Structural Joints Using High Strength Bolts, August 1, 2014
Intumescent Fire-Resistive Coating	Association of the Wall and Ceiling Industry (AWCI) Technical Manual 12-B, Second Edition; Standard Practice for the Testing and Inspection of Field Applied Thin Film Intumescent Fire-Resistive Materials; an Annotated Guide

RDPRC - Structural	RDPRC - Civil/Geotechnical	RDPRC - Mechanical
RDPRC – Electrical	RDPRC - Architect	

Owner's Acknowledgement:

Signature Date

Acceptance by Authority Having Jurisdiction:

Signature Date

Permit No.

Frequency of interim report submittals to AHJ:

□ 1 week □ 2 weeks □ Monthly □ Bi-Monthly □ At Completion □ Per attached Schedule

Statement of Special Inspections
(Schedule of Inspections)

The attached tables as listed below define the applicable Special Inspections and Procedures.

Table 1 of 9	Geotechnical Special Inspections
Table 2 of 9	Structural Special Inspections
Table 3 of 9	Architectural Special Inspections
Table 4 of 9	Inspections for Special Cases
Table 5 of 9	Testing for Special Inspections
Table 6 of 9	Special Inspections for Seismic Resistance
Table 7 of 9	Testing for Seismic Resistance
Table 8 of 9	Not Used
Table 9 of 9	Inspection Agents

The Seismic Design Category for the project is C.

Schedule of Special Inspections - Table 1 of 9 (Geotechnical Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Soils						
Verify material below foundation is adequate to achieve design bearing capacity, free of loose, deleterious or foreign material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)		
Verify excavations are extended to proper depth, proper size and material.	1705.6	Geotechnical Report		**X** (foundation excavation complete)		
Prior to placement of controlled fill, inspect subgrade and verify site is properly prepared.	1705.6	Geotechnical Report		**X** (prior to placement of fill)		
Perform classification and testing of compacted fill material.	1705.6	Geotechnical Report		**X** (during placement of fill)		
Verify materials, densities, and lift thicknesses during placement and compaction of controlled fill for foundations.	1705.6	Geotechnical Report	**X**		Note the exception of Article 1705.6.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Structural Load-Bearing Members Fabricated in a Shop						
If approved by the AHJ to perform work without special inspection, submit "Fabricator's Certificate of Compliance" at the completion of work that fabricated items were constructed in accordance with the approved construction documents.	1704.2.5.1 1704.5 1705.10			**X** (at end of fabrication)		N/A
Concrete (inspections not required for nonstructural concrete slabs supported directly on the ground)						
Reinforcing steel and prestressing tendon condition (free of oil, dirt and loose rust and that properly coated and/or sheathed) and placement. Verify size, spacing, bar clearances, cover, and adequate support to prevent displacement during concrete placement. Verify lap splices, mechanical splices, and embedment lengths. Verify dowels for work above are properly aligned and spaced to match other work.	1705.3	ACI 318 (Ch. 20) ACI 318 (25.2-25.3) ACI 318 (26.6.1-26.6.3		**X** (prior to closing of forms or delivery of concrete, for each placement)		
Cast-in-place anchor bolts prior to and during placement of concrete.	1705.3	ACI 318 (17.8.2)	**X**		All bolts visually inspected to verify anchor diameter, location, and embedment length.	
Verify use of approved mix design(s).	1705.3	ACI 318 (Ch. 19) ACI 318 (26.4.3-26.4.4)		**X**	RDPRC to approve contractor's proposed mix design prior to construction. Inspector to verify from concrete delivery ticket that the appropriate mix has been provided prior to placement.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Formwork shape, location, and dimensions of the concrete member being formed, construction joints properly prepared.	1705.3	ACI 318 (26.11.1.2(b))		**X** (prior to delivery of concrete for each placement)		
Prior to concrete placement, fabricate specimens for strength tests, perform slump and air content test, and determine the temperature of the concrete.	1705.3	ASTM C31 ASTM C172 ACI 318 (26.12)		**X**	Sampling and testing frequency shall be as indicated in the cast-in-place concrete specification.	
Concrete placement.	1705.3	ACI 318 (26.5.2)	**X**		Verify that water added at the site does not exceed that allowed by the mix design. Verify conveying, depositing, and consolidation of concrete. Observe placement procedures for evidence of segregation, possible cold joints, displacement of reinforcing or forms, and proper support of embedded items, anchor bolts, etc.	
Concrete curing – maintain temperature and techniques.	1705.3	ACI 318 (26.5.3-26.5.5)		**X** (during hot, cold, and windy conditions)	For wet-curing, check at the beginning of each day during 7 day curing period	
Verification of in-situ concrete strength prior to removal of forms and shores from elevated beams and slabs.	1705.3	ACI 318 (26.11.2)		**X** (prior to form or shore removal)		
Verification of in-situ concrete strength prior to backfilling against walls.				**X** (prior to backfilling operations)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Masonry for Risk Category I, II, or III Structures						
Verification of proportions for site-prepared mortar.	1705.4	TMS 602 (2.1) TMS 602 (2.6A) TMS 602 (2.6C)		**X** (at beginning of masonry construction)		
Verification of proportions for site-prepared grout.	1705.4	TMS 602 (2.6B)		**X** (at beginning of masonry construction and prior to grouting)		
Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site.	1705.4	TMS 602 (1.4B)		**X** (at beginning of masonry construction and prior to grouting)	RDPRC to approve contractor's proposed mix designs prior to construction. Inspector to verify from grout delivery ticket that the appropriate mix has been provided prior to placement.	
Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	1705.4	TMS 602 (1.5) TMS 602 (1.6.3)	**X**			
Verification of f'_m and f'_{AAC} prior to construction.	1705.4	TMS 602 (1.4B)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Sample panel construction.	1705.4	TMS 602 (1.6D)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Placement of masonry units and mortar joint construction.	1705.4	TMS 602 (3.3B)		**X** (at beginning of masonry construction, once daily for each crew, and prior to grouting)	Inspect size, layout, bonding and placement of masonry units. Inspect construction of mortar joints including tooling and filling of head joints.	
Verification of size and location of structural elements.	1705.4	TMS 602 (3.3F)		**X** (at beginning of masonry construction and prior to grouting)		
Anchors grouted in masonry and anchorage of masonry to frames, structural members, and diaphragms including type, size, and location of anchors.	1705.4	TMS 402 (6.2.1) TMS 402 (6.3.1)		**X** (at beginning of masonry construction and prior to grouting)		
Type, grade, and size of reinforcing steel, connectors, and anchor bolts.	1705.4	TMS 602 (3.4)		**X** (when staged and prior to installation)		
Application and measurement of prestressing force.	1705.4	TMS 602 (3.6B)	**X**			
Verify grout space is clean prior to grouting.	1705.4	TMS 602 (3.2D) TMS 602 (3.2F)		**X** (prior to each grouting operation)	Verify that cells and starting beds are clean.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Reinforcing steel and connector placement: verify size, spacing, surface condition, correct location, type of embedments.	1705.4	TMS 402 (6.1) TMS 602 (3.2E) TMS 602 (3.4)		**X** (prior to grouting)	Verify dowels and inserts are secured in place, particularly at roof lines, floor lines, and intersecting wall lines.	
Grout placement.	1705.4	TMS 602 (3.5)	**X**		Verify that the grout lift height is in conformance with the code and specifications. Verify installation of cleanout closures. Verify that grouting operations are held below the top if keying is required for subsequent lifts, as required by code and specifications. Verify mechanical vibration during placement, and later during reconsolidation. Verify that curing requirements are being followed.	
Grout placement at prestressing tendons.	1705.4	TMS 602 (3.6C)	**X**			
Cold/hot weather masonry protection.	1705.4	TMS 602 (1.8C) TMS 602 (1.8D)		**X** (at beginning of each day's work)	When temperatures are expected to be below 40 degrees F or above 90 degrees F.	
Observe preparation of required grout specimens, mortar specimens, and/or prisms.	1705.4	TMS 602 (1.4)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Masonry for Risk Category IV Structures						
Verification of proportions for site-prepared mortar.	1705.4	TMS 602 (2.1) TMS 602 (2.6A) TMS 602 (2.6C)		**X** (at beginning of masonry construction)		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verification of proportions for site-prepared grout.	1705.4	TMS 602 (2.6B)		**X** (at beginning of masonry construction and prior to grouting)		
Verification of proportions of materials in premixed or preblended mortar and grout as delivered to the site.	1705.4	TMS 602 (1.4B)		**X** (at beginning of masonry construction and prior to grouting)	RDPRC to approve contractor's proposed mix designs prior to construction. Inspector to verify from grout delivery ticket that the appropriate mix has been provided prior to placement.	
Verification of slump flow and VSI as delivered to the site for self-consolidating grout.	1705.4	TMS 602 (1.5) TMS 602 (1.6.3)	**X**			
Verification of f'_m and f'_{AAC} prior to construction and for every 5000 square feet during construction.	1705.4	TMS 602 (1.4B)		**X**	Verification by unit strength or prism testing, see masonry specification.	
Sample panel construction.	1705.4	TMS 602 (1.6D)	**X**			
Placement of masonry units and mortar joint construction.	1705.4	TMS 602 (3.3B)		**X** (at beginning of masonry construction, once daily for each crew, and prior to grouting)	Inspect size, layout, bonding and placement of masonry units. Inspect construction of mortar joints including tooling and filling of head joints.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verification of size and location of structural elements.	1705.4	TMS 602 (3.3F)		**X** (at beginning of masonry construction and prior to grouting)		
Anchors grouted in masonry and anchorage of masonry to frames, structural members, and diaphragms including type, size, and location of anchors.	1705.4	TMS 402 (6.2.1) TMS 402 (6.3.1)	**X**			
Type, grade, and size of reinforcing steel, connectors, and anchor bolts.	1705.4	TMS 602 (3.4)		**X** (when staged and prior to installation)		
Application and measurement of prestressing force.	1705.4	TMS 602 (3.6B)	**X**			
Verify grout space is clean prior to grouting.	1705.4	TMS 602 (3.2D) TMS 602 (3.2F)	**X**		Verify that cells and starting beds are clean.	
Reinforcing steel and connector placement: verify size, spacing, surface condition, correct location, type of embedments.	1705.4	TMS 402 (6.1) TMS 602 (3.2E) TMS 602 (3.4)	**X**		Verify dowels and inserts are secured in place, particularly at roof lines, floor lines, and intersecting wall lines.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Grout placement.	1705.4	TMS 602 (3.5)	**X**		Verify that the grout lift height is in conformance with the code and specifications. Verify installation of cleanout closures. Verify that grouting operations are held below the top if keying is required for subsequent lifts, as required by code and specifications. Verify mechanical vibration during placement, and later during reconsolidation. Verify that curing requirements are being followed.	
Cold/hot weather masonry protection.	1705.4	TMS 602 (1.8C) TMS 602 (1.8D)		**X** (at beginning of each day's work)	When temperatures are expected to be below 40 degrees F or above 90 degrees F.	
Observe preparation of required grout specimens, mortar specimens, and/or prisms.	1705.4	TMS 602 (1.4)	**X**		Verification by unit strength or prism testing, see masonry specification.	
Structural Steel						
Main structural steel elements: review material test reports.	1705.2.1	AISC 360 (A3.1) AISC 360 (N5.2)		**X**	3 pieces from each lot; verify at fabricator's shop prior to cutting.	
Steel castings and forgings: review material test reports.	1705.2.1	AISC 360 (A3.2) AISC 360 (N5.2)		**X**	Each lot.	
Anchor rods and threaded rods: review material test reports.	1705.2.1	AISC 360 (A3.4) AISC 360 (N5.2)		**X**	Each lot.	
Headed stud anchors: review manufacturer's certifications.	1705.2.1	AISC 360 (A3.6) AISC 360 (N5.2)		**X**	Each lot.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
Galvanized steel members: inspect exposed cut surfaces of galvanized main members and rectangular HSS for cracks after galvanizing.		1705.2.1	AISC 360 (N5.7)		X	Each main member and HSS shape. Inspect at jobsite.	
Verify the following prior to welding:							
	Welding consumables: review manufacturer's certifications.	1705.2.1	AISC 360 (A3.5) AISC 360 (N5.2) AISC 360 (N5.4)		X	3 rods from each lot; verified at fabricator's shop and at jobsite.	
	Welding filler metals and fluxes: review manufacturer's product data sheets or catalog data.	1705.2.1	AISC 360 (N5.2)		X	Each lot. Review products, limitations of use, recommended or typical welding parameters, and storage and exposure requirements, includng baking, if applicable.	
	Welding procedures specifications (WPS's): review procedures.	1705.2.1	AISC 360 (N5.2) AISC 360 (N5.4)		X	For each welded joint or member.	
	Welding procedures not prequalified per AWS D1.1 or D1.3: review procedure qualification records (PQR's).	1705.2.1	AISC 360 (N5.2)		X		
	Welding personnel qualification records (WPQR's) and continuity records: review welder qualifications.	1705.2.1	AISC 360 (N5.2) AISC 360 (N5.4)		X	Perform for each welder.	
	Welder identification system: review system of marking joints for purpose of identifying welders.	1705.2.1	AISC 360 (N5.4)		X		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
	Fit up of groove welds: observe joint preparations, dimensions, cleanliness, tacking, and backing.	1705.2.1	AISC 360 (N5.4)		X		
	Fit up of CJP groove welds of HSS T-, Y-, and K- joints without backing: observe joint preparations, dimensions, cleanliness, and tacking.	1705.2.1	AISC 360 (N5.4)		X		
	Access holes: configuration and finish.	1705.2.1	AISC 360 (N5.4)		X		
	Fit up of fillet welds: observe dimensions, cleanliness, and tacking.	1705.2.1	AISC 360 (N5.4)		X		
Verity the following during welding:							
	Welding consumables: packaging and appropriate exposure control.	1705.2.1	AISC 360 (N5.4)		X		
	No welding over cracked tack welds.	1705.2.1	AISC 360 (N5.4)		X		
	Environmental conditions: wind speed, precipitation, and ambient temperature limits are observed.	1705.2.1	AISC 360 (N5.4)		X		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
	Welding procedure specifications (WPS's): settings on welding equipment, travel speed, selected welding materials, shielding gas type/flow rate, preheat applied, interpass temperature maintained (min/max), proper position.	1705.2.1	AISC 360 (N5.4)		**X**		
	Welding techniques: interpass and final cleaning, each pass is within profile limitations, each pass meets quality requirements.	1705.2.1	AISC 360 (N5.4)		**X**		
	Headed stud anchors: placement and installation of anchors.	1705.2.1	AISC 360 (N5.4)		**X**	Observe once daily for each welder and visually inspect all anchors at the completion of their welding.	
Verify the following after welding:							
	Welds cleaned.	1705.2.1	AISC 360 (N5.4)		**X**		
	Weld size, length and location.	1705.2.1	AISC 360 (N5.4)	**X**			
	Welds meet visual inspection criteria (crack prohibition, weld/base metal fusion, crater cross section, weld profiles, weld size, undercut, porosity).	1705.2.1	AISC 360 (N5.4)	**X**			
	Arc strikes.	1705.2.1	AISC 360 (N5.4)	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
	K-area.	1705.2.1	AISC 360 (N5.4)	**X**		When welding doubler, continuity, or stiffener plates in the k-area of a web, visually inspect the web k-area for cracks within 3 inches of the weld.	
	Weld access holes in rolled heavy shapes and bult-up heavy shapes.	1705.2.1	AISC 360 (N5.4)	**X**		Visually inspect the weld access holes for cracks after welding.	
	Backing removed and weld tabs removed.	1705.2.1	AISC 360 (N5.4)	**X**			
	Repair activities.	1705.2.1	AISC 360 (N5.4)	**X**			
	Document acceptance or rejection of welded joint or member.	1705.2.1	AISC 360 (N5.4)	**X**			
	No prohibited welds have been added without approval of EOR.	1705.2.1	AISC 360 (N5.4)		**X**		
Verify the following prior to bolting:							
	Fasteners: review manufacturer's certifications.	1705.2.1	AISC 360 (A3.3) AISC 360 (N5.2) AISC 360 (N5.6)		**X** (3 bolts from each lot)	Verified at jobsite.	
	Fasterners: review markings per ASTM requirements.	1705.2.1	AISC 360 (N5.6)		**X**		
	Correct fasteners selected for the joint detail (grade, type, bolt length).	1705.2.1	AISC 360 (N5.6)		**X**		
	Correct bolting procedure selected for joint detail.	1705.2.1	AISC 360 (N5.6)		**X**		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
	Connecting elements, including the appropriate faying surface condition (for slip-criitcal joints) and hole preparation.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.3)		X		
	Pre-installation verification testing by installing personnel.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2)		X	Required for all pretensioned and slip-critical joints.	
	Protected storage for bolts, nuts, washers, other fastener components.	1705.2.1	AISC 360 (N5.6)		X		
	Pretensioned joints; direct tension indicator.	1705.2.1	RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.4)		X	Verify the appropriate feeler gage is accepted in at least half ot the spaces between the protrusions, and that the protrusions are properly oriented away from the work.	
Verify the following during bolting:							
	Fastener assemblies placed in all holes and washers and nuts positioned as required.	1705.2.1	AISC 360 (N5.6)		X		
	Joint brough to the snug-tight position prior to pretensioning.	1705.2.1	AISC 360 (N5.6)		X		

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		Inspection				Remarks	Inspection Agent No. (see Table 9)
		Building Code Reference	Code or Standard Reference	Frequency			
				Continuous	Periodic		
	Fastener component not turned by the wrench is prevented from rotating.	1705.2.1	AISC 360 (N5.6)		X		
	Fasteners pretensioned in accordance with RCSC specification, progressing systematically from the most rigid point to the free edges.	1705.2.1	AISC 360 (N5.6)		X		
	Pretensioned joints; calibrated wrench.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.2)		X	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify that the crew properly applies the calibrated wrentch to the turned element.	
Verify the following after bolting:							
	Snug-tight joints.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.1)		X	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Nuts shall not be turnable without a wrench.	
	Pretensioned joints; turn-of-nut.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.1)		X	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the turned element is rotated relative to the unturned element by the amount indicated in RCSC Table 8.2.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)							
System or Material		**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
		Building Code Reference	**Code or Standard Reference**	**Frequency**			
				Continuous	**Periodic**		
	Pretensioned joints; twist-off type tension control bolts.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.3)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the splined ends are properly severed.	
	Pretensioned joints; direct tension indicator.	1705.2.1	AISC 360 (N5.6) RCSC Specification for Structural Joints Using High-Strength Bolts (Section 9.2.4)		**X**	All connections visually inspected to confirm that plies of the connected elements are in firm contact and washers have been used. Verify the appropriate feeler gage is refused entry into at least half ot the spaces between the protrusions.	
After bolting, document acceptance or rejection of bolted connections.		1705.2.1	AISC 360 (N5.6)		**X**		
Railing systems composed of structural steel elements.		1705.2.1	AWS D1.1 (Section 6.9)		**X**	Inspection required only at the base of cantilevered rail posts.	
Verification of steel frame braces, stiffeners, member locations and joint details.		1705.2.1	AISC 360 (N5.8)		**X**	At 50% complete and 100% complete, for each structure.	
Proprietary moment resisting frame connection systems.		1703.4.2				Refer to welding and high strength bolting requirements.	
Open Web Steel Joists and Joist Girders							
Review "Fabricator's Certificate of Compliance" at the completion of work that fabricated items were constructed in accordance with the approved construction documents, and submit certificate to the AHJ.		1704.5 2207.5			**X**	After fabrication.	

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
End connections, welded or bolted.	1705.2.3	SJI Specifications		**X**		
Standard bridging, horizontal or diagonal.	1705.2.3	SJI Specifications		**X**		
Bridging that differs from the SJI Specifications.	1705.2.3			**X**		
Steel Deck						
Prior to deck placement, verify compliance of deck and accessories with construction documents, including profiles, material properties, and base metal thickness.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of deck and accessories.	
After deck placement, verify deck mill certiifications and compliance of deck and accessories installation.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of deck and accessories.	
Prior to welding, observe welding procedure specifications, welding consumables certifications, welding material types and grades, and welding equipment.	1705.2.2	SDI QA/QC Standard		**X** (all materials)		
During welding, observe the use of qualified welders, control and handling of welding consumables, environmental conditions, and following of welding procedure specifications.	1705.2.2	SDI QA/QC Standard. AWS D1.3	**X** (all materials)			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
After welding, verify size and location of all welds (at supports, sidelaps, and perimeters), verify welds meet visual acceptance criteria, and verify repair activities.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of welds.	
Prior to mechanical fastening, verify manufacturer's installation instructions and proper tools are available.	1705.2.2	SDI QA/QC Standard		**X** (all materials)		
During mechanical fastening, verify fasteners are positioned as required and are installed in accordance with the manufacturer's instructions.	1705.2.2	SDI QA/QC Standard	**X** (all materials)			
After mechanical fastening, verify spacing, type, and installation of all fasteners (at supports, sidelaps, and perimeters), and verity repair activities.	1705.2.2	SDI QA/QC Standard		**X** (all materials)	Document acceptance or rejection of mechanical fasteners.	
Post-Installed Anchors – Expansion and Undercut Anchors into Concrete						
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		**X**	Continuous inspection is required if mandated by manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Concrete						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Adhesive anchors installed in overhead, upwardly inclined, or horizontal positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report	X			
Adhesive anchors installed in other positions: Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, concrete compressive strength, concrete thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1705.3 1703.4.2 1705.1.1	Manufacturer's research report		X	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically, unless continuous inspections are mandated by the manufacturer's research report. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection.	
Post-Installed Anchors – Expansion Anchors into Grouted Masonry						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verify anchor type, size, dimensions, location, spacing, edge distance, drill bit type, drill bit diameter, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, mortar type, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Grouted Masonry						
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection. Continuous inspection is required if mandated by the manufacturer's research report.	
Post-Installed Anchors – Adhesive Anchors into Hollow Masonry						

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Verify anchor type, size, dimensions, location, spacing, edge distance, embedment depth, tightening torque, hole dimensions, hole cleaning procedure, masonry compressive strength, masonry thickness, screen tube type and size, adhesive identification, adhesive expiration date, and adherence to the manufacturer's installation instructions.	1703.4.2 1705.1.1	Manufacturer's research report		**X**	Inspection required at start of job for each type and size of adhesive anchor by construction personnel on site. Subsequent installations of the same anchor type and size by the same personnel shall be inspected periodically. Any change in the anchor product being installed or the personnel performing the installation shall require another initial inspection. Continuous inspection is required if mandated by the manufacturer's research report.	
Aluminum						
Material verification of structural aluminum: Certified mill test reports.	1705.1.1			**X** (each mill order)		
Material verification of bolts: Manufacturer's certified test reports.	1705.1.1			**X** (each lot)		
Material verification of weld filler metals.	1705.1.1	AWS D1.2 (Section 5)		**X** (3 rods from each lot)	Checked at fabricator's shop and at jobsite.	
Verify use of proper WPS's.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of work)	Obtain copy of welding procedure specifications.	
Verify welder qualifications.	1705.1.1	AWS D1.2 (Section 5)		**X** (prior to start of each welder's work)	Obtain copy of qualification records.	
Complete and partial penetration groove welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			

Schedule of Special Inspections - Table 2 of 9 (Structural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Multipass fillet welds.	1705.1.1	AWS D1.2 (Section 5)	**X**			
Single pass fillet welds.	1705.1.1	AWS D1.2 (Section 5)		**X** (observe once daily for each welder and visually inspect all welds at the completion of each weld)		

Schedule of Special Inspections - Table 3 of 9 (Architectural Special Inspections)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Exterior Insulation and Finish Systems						
Installation	1705.16		X		Not required when install over a water-resistive barrier with a means of draining moisture to the exterior or when installed over masonry or concrete walls. If the water-resistive barrier coating is installed over sheathing substrate, it requires special inspection.	
Fire-Resistant Penetrations and Joints						
Penetration firestops (locations indicated on drawings).	1705.17.1				Systems that are tested and listed in accordance with IBC Sections 714.4.1.2 and 714.5.1.2 shall be inspected in accordance with ASTM E2174.	
Fire-resistant joint systems (locations indicated on drawings).	1705.17.2				Systems that are tested and listed in accordance with IBC Sections 715.3 and 715.4 shall be inspected in accordance with ASTM E2393.	

Schedule of Special Inspections - Table 4 of 9 (Inspections for Special Cases)						
	Inspection					
System or Material	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
			Continuous	Periodic		
Pre-Engineered Structures						
Fabrication and erection	1705.1.1				Refer to Table 2 for fabricator, welding, and high strength bolting special inspection requirements	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	Building Code Reference	Code or Standard Reference	Frequency	Remarks	Inspection Agent No. (see Table 9)
Geotechnical					
Classification of controlled fill material.	1705.6	ASTM D2488	One per stratum of on-site excavated material. One per common supply of off-site material.	Per Geotechnical Report and excavation and fill for structures specification.	
Foundation subgrade, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 1,000 SY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	
Controlled fill beneath foundations, in-place density.	1705.6	ASTM D2922 ASTM D1556 or ASTM D2167 (10% of tests to be ASTM D1556 or ASTM D2167)	One test per 200 CY, or as required in the excavation and fill for structures specification. Min one per foundation for foundations over 10 SY.	Per Geotechnical Report and excavation and fill for structures specification.	

Schedule of Special Inspections - Table 5 of 9 (Testing for Special Inspections)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
Concrete					
Concrete strength.	1705.3	ASTM C31 ASTM C39 ASTM C172	See concrete specification	See concrete specification for quantity of cylinders.	
Concrete slump, air content, temperature, unit weight, water soluble chloride ion, shrinkage.	1705.3	ASTM C31 ASTM C138 ASTM C143 ASTM C157 ASTM C172 ASTM C231 ASTM C1064 ASTM C1218	See concrete specification		
Masonry					
Unit strength.	2105.1	ASTM C140	See masonry specification		
Mortar strength.	2105.1	ASTM C270	See masonry specification		
Grout strength.	2105.1	ASTM C1019	See masonry specification		
Prism strength.	2105.1	ASTM C1314	See masonry specification	Partially grouted walls require a set of tests for both the grouted and ungrouted conditions.	

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
	Building Code Reference	Code or Standard Reference	Frequency		Remarks	Inspection Agent No. (see Table 9)
System or Material			Continuous	Periodic		
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)						
Visually inspect the following before welding: material type and grade; welder identification system; fit up of groove welds including joint preparation, dimensions, cleanliness, tacking, backing type and fit; configuration and finish of access holes; fit up of fillet welds including dimensions, cleanliness and tacking.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect during welding: WPS followed, use of qualified welders, control and handling of welding consumables, environmental conditions, welding techniques, no welding over cracked tacks.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		
Visually inspect after welding: Welds cleaned, size, length, and location of welds.	1705.12.1	AISC 341 (J6.1)		**X** (Once daily for each individual welder)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
Visually inspect welds after welding to acceptance criteria for: crack prohibition, weld/base metal fusion, crater cross section, weld profile, weld size, undercut, and porosity.	1705.12.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
When welding doubler, continuity, or stiffener plates in the k-area of a web, visually inspect the web k-area for cracks.	1705.12.1	AISC 341 (J6.1)	**X**		Inspection area shall include the k-area base metal within 3 inches of the weld. Inspection shall be performed no sooner than 48 hours following completion of the welding.	
Visually inspect welds after welding for placement of reinforcement fillets, removal of backing bars and weld tabs and finish (where required on drawings or per specifications), and repair activities.	1705.12.1	AISC 341 (J6.1)	**X**		Periodic inspection (observe once daily for each welder and visually inspect all welds at the completion of each weld) is permitted only for single pass fillet welds not exceeding 5/16" and for floor and roof deck welding.	
Prior to high strength bolting: verify proper fasteners and bolting procedures selected for the detail, connecting elements fabricated properly including faying surface preparation and hole preparation, proper storage for bolts, nuts, washers and other components.	1705.12.1	AISC 341 (J7)		**X** (Once daily for each bolting crew)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
System or Material	**Inspection**				**Remarks**	**Inspection Agent No.** (see Table 9)
	Building Code Reference	**Code or Standard Reference**	**Frequency**			
			Continuous	**Periodic**		
During high strength bolting: Fasteners assemblies properly positioned, joints snug tight prior to pretensioning, fastener component not turned by the wrench prevented from rotating, pretensioning progresses systematically from most rigid point to free edges.	1705.12.1	AISC 341 (J7)		**X** (observe once daily for each bolting crew)		
After installation of high strength bolting, document accepted and rejected connections.	1705.12.1	AISC 341 (J7)		**X** (at completion of each connection)		
Plumbing and Mechanical Components						
Installation of automatic fire sprinkler systems that do not have flexible sprinkler hose fittings. Verify 3 inch minimum clearances between the sprinkler drops and sprigs and: • Permanently attached mechanical or electrical equipment, including ductwork, other piping systems, and their associated structural supports and bracing. • Structural members not used as supports of the sprinkler system.	1705.12.6	ASCE 7, Section 13.2.3.		**X** (observe once daily for each crew and completed installation of each applicable piece of equipment)		

Schedule of Special Inspections - Table 6 of 9 (Special Inspections for Seismic Resistance)						
	Inspection					
			Frequency			
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Continuous**	**Periodic**	**Remarks**	**Inspection Agent No.** (see Table 9)
Electrical						
Anchorage of electrical equipment for emergency and standby power.	1705.12.6			**X** (observe completed installation of each applicable piece of equipment)	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components that must be anchored.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Inspection				
System or Material	Building Code Reference	Code or Standard Reference	Frequency	Remarks	Inspection Agent No. (see Table 9)
Structural Steel and Structural Steel Elements Within the Seismic Force-Resisting System (systems identified on the drawings)					
Ultrasonic (UT) of base metal thicker than 1-1/2" subject to through-thickness weld shrinkage strains. Test is for discontinuities behind and adjacent to each weld.	1705.13.1	AWS D1.1(6.13 & 6.14.3)	Each weld		
For CJP groove welds in material 5/16" thick and greater, perform ultrasonic testing (UT).	1705.13.1	AISC 341 (J6.2)	Each weld	Weld discontinuities shall be accepted or rejected on the basis of critiera of AWS D1.1 Table 6.2. In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for possible reduction in testing frequency.	
For beam to column CJP groove welds, perform magnetic particle testing (MT).	1705.13.1	AISC 341 (J6.2)	25% of all such welds for each welder	In structures designed as ordinary moment frames, testing is only required for demand critical welds (locations identified on the drawings). See AISC 341 for permitted reduction in testing frequency.	
For PJP groove welds in column splices and in column to base plate welds, perform ultrasonic testing (UT).	1705.13.1	AISC 341 (J6.2)	Each weld	UT shall be performed using written procedures and UT technicians qualified in accordance with AWS D1.8. Refer to AISC 341 for weld joint mock-up requirements.	
When base metal thicker than 1-1/2" is loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than 3/4" thick and contains CJP welds, perform ultrasonic testing (UT) to detect discontinuities behind and adjacent to the fusion line of each weld.	1705.13.1	AISC 341 (J6.2)	Each weld	See AISC 341 for permitted reduction in testing frequency.	

Schedule of Special Inspections - Table 7 of 9 (Testing for Seismic Resistance)					
	Inspection				
System or Material	**Building Code Reference**	**Code or Standard Reference**	**Frequency**	**Remarks**	**Inspection Agent No.** (see Table 9)
For welded splices and connections, perform magnetic particle testing (MT) or liquid penetrant testing (PT) at thermally cut surfaces of beam copes and access holes when the flange thickness exceeds 1-1/2" for rolled shapes or the web thickness exceeds 1-1/2" for built-up shapes.	1705.13.1	AISC 341 (J6.2)	Each weld		
For welds where weld tabs have been removed, except for continuity plate weld tabs, perform magnetic particle testing (MT) on the ends of the weld.	1705.13.1	AISC 341 (J6.2)	Each weld or location	See AISC 341 for permitted reduction in testing frequency.	
Pre-installation testing of fastener assemblies and methods used.	1705.13.1	AISC 341 (J7) RCSC Specification for Structural Joints Using High Strength Bolts (Section 7)	3 assemblies of each diameter, grade, length, and lot prior to use		
Non-Structural Components (Architectural, Mechanical and Electrical)					
For non-structural components and their anchorage that are qualified by means of analysis, testing, or experience data, examine the certificate of compliance furnished by the product manufacturer.	1705.13.2 1705.13.3	ASCE 7 (13.2.1, part 2), ASCE 7 (13.2.2 parts 1, 2)	Each applicable piece of equipment	See the Meteorological and Seismic Design Criteria section (Non-Structural Components Schedule) for the specific components and their anchorages that must be qualified.	

Schedule of Special Inspections - Table 8 of 9 (Special Inspections for Wind Resistance)

NOT USED

Schedule of Special Inspections - Table 9 of 9 (Inspection Agents)					
AGENT NAME	**LICENSE NO.**	**FIRM**	**ADDRESS**	**EMAIL**	**TELEPHONE NO.**
1.					( )
2.					( )
3.					( )
4.					( )
5.					( )
6.					( )
7.					( )
8.					( )
9.					( )
10.					( )

Request for Approval of Special Inspector

Project:
Project Address:
Name of Inspection/Testing Agency:
Address:
Phone Number:
Testing agency manager/supervisor responsible for this project:

Special Inspector Name:

Special Inspector Signature: _____
(as it will appear on reports)

This individual is qualified to inspect:

[ ] Verification of Soils
[ ] Earth Retaining Structure
[ ] Excavation and Filling
[ ] Piling
[ ] Drilled Piers
[ ] Testing of Concrete
[ ] Placement of Concrete
[ ] Placement of Shotcrete
[ ] Placement of Rebar
[ ] Prestressing Concrete
[ ] High Strength Bolting
[ ] Structural Welding
[ ] Steel Frame Inspection
[ ] Structural Masonry
[ ] Erection of Precast
[ ] Inspection of Fabricators
[ ] Precast Fabrication
[ ] Structural Steel
[ ] Metal Building
[ ] EIFS Inspection
[ ] Smoke Control
[ ] Seismic Resistance
[ ] Sprayed Fireproofing
[ ] Architectural Systems
[ ] Mechanical Systems
[ ] Electrical Systems

Current certifications and/or professional licenses retained by the individual:

[ ] Professional Engineer
[ ] Geotechnical Engineer
[ ] Structural Engineer
[ ] Registered Architect
[ ] Registered Geologist
[ ] EI/EIT (min. of 1 yr. related experience)
[ ] GIT (min. of 1 yr. related experience)
[ ] ACI Concrete Field Testing Technician Grade 1
[ ] ACI Concrete Construction Inspector
[ ] ACI Laboratory Testing Technician, Grade 1 or 2
[ ] ACI Strength Testing Technician
[ ] AWS Certified Welding Inspector
[ ] AWS/AISC Certified Structural Steel Inspector
[ ] ASNT NDT Technician Level II or III
[ ] ICC Building Inspector
[ ] ICC Structural Masonry
[ ] ICC Structural Steel and Welding
[ ] ICC Spray-Applied Fire Proofing
[ ] ICC Prestressed Concrete
[ ] ICC Reinforced Concrete
[ ] ICC Structural Steel and Bolting
[ ] ICC Structural Welding
[ ] NCMA Concrete Masonry Testing Technician
[ ] NICET Concrete Technician Level II, III, or IV
[ ] NICET Soils Technician Level II, III, or IV
[ ] NICET Geotechnical Engineering Technician Level II, III, or IV
[ ] EDI EIFS
[ ] Other _____

Copies of current certifications and/or professional licenses and a resume showing the special inspector's work experience are attached.

I hereby certify that in my judgment the individual is qualified to inspect and/or test the items indicated above.

Special Inspection Agency:

Signed:_____Date:_____
(Testing agency manager/supervisor responsible for this project)

Request for Approval to Provide Special Inspection of Non-Local Fabrication

Project:
Project Address:

Testing / Inspection Agent:
Testing / Inspection Agent Address:
Scope of Testing / Inspections:

We propose to have the following testing agency provide special inspection of fabrication of :

Fabricator name:
Fabricator address:

Name of Testing Agency:
Address:
Phone Number:
Testing agency manager/supervisor responsible for this project:
Primary special inspector for this project:

Copies of the Request for Approval of Special Inspector, resumes, and certifications are attached.

The fabrication inspections to be performed are:

The undersigned hereby acknowledge that they have read, understand and will properly enforce the inspection and testing requirements for the above referenced project, as specified in the Code-Required Special Inspections and Procedures section. Further, the undersigned acknowledge that they have no interest (financial, personal or otherwise) in the performance or management of the above identified Fabricator.

Signature of Primary Special Inspector	Date
Signature of Responsible Agency Manager/Supervisor	Date
Signature of Responsible Manager for Approved Agency employed by the Owner	Date

Contractor's Statement of Responsibility

Each Fabricator, Contractor, or Supplier responsible for the construction or fabrication of a system or component designated in the Statement of Special Inspections shall submit this Statement of Responsibility.

Project:
Contractor's or Supplier's Name:
Address:
License No.:

Description of designated building systems and components included in the Statement of Responsibility:

Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the Code Required Special Inspections and Tests program and the Schedule of Special Inspections.

I hereby acknowledge that control will be exercised to obtain conformance with the construction documents approved by the Authority Having Jurisdiction.

Signature _____ Date _____

Title _____

Provisions for Quality Control

Procedures for exercising control within the Fabricator's, Contractor's, or Supplier's organization, the method and frequency of reporting and the distribution of reports are attached to this Statement.

Identification and qualifications of the person(s) exercising such control and their position(s) in the organization are attached to this Statement.

Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per the governing building code shall submit this *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project:
Fabricator's Name:
Address:
Certification or Approval Agency:
Certification Number:
Date of Last Audit or Approval:

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the approved construction documents.

Signature

Date

Title

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

Final Report of Special Inspections

Project:
Project Address:

Testing / Inspection Agent:
Testing / Inspection Agent Address:
Scope of Testing / Inspections:

To the best of my information, knowledge, and belief, the special inspections or testing required for this project, and designated for this Agent in the Statement of Special Inspections submitted for permit, have been completed in accordance with the contract documents. Based upon my personal observations and written reports, it is my judgment that the inspected work was performed, to the best of my knowledge, in accordance with the building department approved design drawings, specifications, approved change orders, and applicable workmanship provisions of the governing building code.

Interim reports submitted prior to this final report and numbered _____ to _____, form a basis for, and are to be considered an integral part of this final report.

The following discrepancies that were outstanding since the last interim report dated have been corrected:

Items not in conformance, unresolved items or any discrepancies in inspection coverage (i.e., missed inspections, periodic inspections when continuous was required, etc.) are as follows:

Special Inspector's Seal

Prepared By:

Type or print name

Signature Date

(Licensed Professional)

SECTION 01500 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 UNITS OF MEASUREMENT.

A. When both inch-pound (English) and SI (metric) units of measurement are specified herein, the values expressed in inch-pound units shall govern.

1.2 OFFICE AT SITE OF WORK.

A. During the performance of this Contract, Contractor shall maintain a suitable office at or near the Site which shall be the headquarters of its representative authorized to receive drawings, instructions, or other communication or articles.

B. Any communication given to the said representative or delivered at Contractor's office at the Site in the representative's absence shall be deemed to have been delivered to Contractor.

C. Copies of the Drawings, Specifications, and other Contract Documents shall be kept at Contractor's office at the Site and available for use at all times.

D. Locate the offices and other Contractor facilities to limit site disturbance as specified in the Project Requirements section.

1.3 WATER.

A. All water required for and in connection with the Work to be performed shall be provided by and at the expense of Contractor. No separate payment for water used or required will be made and all costs in connection therewith shall be included in the Bid.

1.4 POWER.

A. Contractor shall provide all power for heating, lighting, operation of Contractor's plant or equipment, or for any other use by Contractor. Temporary heat and lighting shall be maintained until the Work is accepted.

1.5 VOICE AND DATA SERVICES.

A. Contractor shall make all necessary arrangements and pay all installation charges for voice and data lines in its offices at the Site and shall provide all telephone instruments.

1.6 SANITARY FACILITIES.

A. Contractor shall furnish temporary sanitary facilities at the Site, as provided herein, for the needs of all construction workers and others performing work or furnishing services on the Project.

B. Sanitary facilities shall be of reasonable capacity, properly maintained throughout the construction period, and obscured from public view to the greatest practical extent. If toilets of the chemically treated type are used, at least one toilet will be furnished for each 20 persons. Contractor shall enforce the use of such sanitary facilities by all personnel at the Site.

1.7 MAINTENANCE OF TRAFFIC.

A. Contractor shall conduct its work to interfere as little as possible with public travel, whether vehicular or pedestrian. Whenever it is necessary to cross, obstruct, or close roads, driveways, and walks, whether public or private, Contractor shall provide and maintain suitable and safe bridges, detours, or other temporary expedients for the accommodation of public and private travel, and shall give reasonable notice to owners of private drives before interfering with them. Such maintenance of traffic will not be required when Contractor has obtained permission from the owner and tenant of private property, or from the authority having jurisdiction over public property involved, to obstruct traffic at the designated point.

B. In making open-cut street crossings, Contractor shall not block more than one-half of the street at a time. Whenever possible, Contractor shall widen the shoulder on the opposite side to facilitate traffic flow. Temporary surfacing shall be provided as necessary on shoulders.

C. Detours.

1. Where required by the authority having jurisdiction that traffic be maintained over any construction work in a public street, road, or highway, and the traffic cannot be maintained on the alignment of the original roadbed or pavement, Contractor shall, at its own expense, construct and maintain a detour around the construction work.

2. Each detour shall include a bridge across the pipe trench and all necessary barricades, guardrails, approaches, lights, signals, signs, and other devices and precautions necessary for protection of the Work and safety of the public.

1.8 BARRICADES AND LIGHTS.

A. All streets, roads, highways, and other public thoroughfares which are closed to traffic shall be protected by effective barricades on which shall be placed acceptable warning signs. Barricades shall be located at the nearest intersecting public highway or street on each side of the blocked section.

B. All open trenches and other excavations shall have suitable barricades, signs, and lights to provide adequate protection to the public. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.

C. All barricades and obstructions shall be illuminated with warning lights from sunset to sunrise. Material storage and conduct of the Work on or alongside public streets and highways shall cause the minimum obstruction and inconvenience to the traveling public.

D. All barricades, signs, lights, and other protective devices shall be installed and maintained in conformity with applicable statutory requirements and, where within railroad and highway rights-of-way, as required by the authority having jurisdiction.

1.9 FENCES.

A. All existing fences affected by the Work shall be maintained by Contractor until completion of the Work. Fences which interfere with construction operations shall not be relocated or dismantled until written permission is obtained from the owner of the fence, and the period the fence may be left relocated or dismantled has been agreed upon. Where fences must be maintained across the construction easement, adequate gates shall be installed. Gates shall be kept closed and locked at all times when not in use.

B. On completion of the Work across any tract of land, Contractor shall restore all fences to their original or to a better condition and to their original locations.

1.10 PROTECTION OF PUBLIC AND PRIVATE PROPERTY.

A. Contractor shall protect, shore, brace, support, and maintain all underground pipes, conduits, drains, and other underground construction uncovered or otherwise affected by its construction operations. All pavement, surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, fences, and other surface structures affected by construction operations, together with all sod and shrubs in yards, parkways, and medians, shall be restored to their original condition, whether within or outside the easement. All replacements shall be made with new materials.

B. Contractor shall be responsible for all damage to streets, roads, highways, shoulders, ditches, embankments, culverts, bridges, and other public or private property, regardless of location or character, which may be caused by transporting equipment, materials, or workers to or from the Work or any part or site thereof, whether by Contractor of its Subcontractors. Contractor shall make satisfactory and acceptable arrangements with the owner of, or the agency or authority having jurisdiction over, the damaged property concerning its repair or replacement or payment of costs incurred in connection with the damage.

C. All fire hydrants and water control valves shall be kept free from obstruction and available for use at all times.

1.11 DAMAGE TO EXISTING PROPERTY.

A. Contractor will be held responsible for any damage to existing structures, Work, materials, or equipment because of his operations and shall repair or replace any damaged structures, Work, materials, or equipment to the satisfaction of, and at no additional cost to, Owner.

B. Contractor shall protect all existing structures and property from damage and shall provide bracing, shoring, or other work necessary for such protection.

C. Contractor shall be responsible for all damage to streets, roads, curbs, sidewalks, highways, shoulders, ditches, embankments, culverts, bridges, or other public or private property, which may be caused by transporting equipment, materials, or workers to or from the Work. Contractor shall make satisfactory and acceptable arrangements with the agency having jurisdiction over the damaged property concerning its repair or replacement.

1.12 TREE AND PLANT PROTECTION.

A. All trees and other vegetation which must be removed to perform the Work shall be removed and disposed of by Contractor; however, no trees or cultured plants shall be unnecessarily removed unless their removal is indicated on the Drawings. All trees and plants not removed shall be protected against injury from construction operations.

B. Trees considered by Engineer to have any significant effect on construction operations are indicated on the Drawings and those which are to be preserved are so indicated.

C. Contractor shall take extra measures to protect trees designated to be preserved, such as erecting barricades, trimming to prevent damage from construction equipment, and installing pipe and other Work by means of hand excavation or tunneling methods. Such trees shall not be endangered by stockpiling excavated material or storing equipment against their trunks.

D. When injuring or removal of trees designated to be preserved cannot be avoided, or when removal and replacement is indicated on the Drawings, each tree injured beyond repair or removed shall be replaced with a similar tree of the nearest size possible.

E. All trimming, repair, and replacement of trees and plants shall be performed by qualified nurserymen or horticulturists.

1.13 SECURITY.

A. Contractor shall be responsible for protection of the Site, and all Work, materials, equipment, and existing facilities thereon, against vandals and other unauthorized persons.

B. No Claim shall be made against Owner by reason of any act of an employee or trespasser, and Contractor shall make good all damage to Owner's property resulting from Contractor's failure to provide security measures as specified.

C. Security measures shall be at least equal to those usually provided by Owner to protect Owner's existing facilities during normal operation, but shall also include such additional security fencing, barricades, lighting, and other measures as required to protect the Site.

1.14 ACCESS ROADS.

A. Contractor shall establish and maintain temporary access roads to various parts of the Site as required to complete the Project. Such roads shall be available for the use of all others performing work or furnishing services in connection with the Project.

1.15 PARKING.

A. Contractor shall provide and maintain suitable parking areas for the use of all workers and others performing work or furnishing services in connection with the Project, as required to avoid any need for parking personal vehicles where they may interfere with public traffic, Owner's operations, or construction activities.

1.16 NOISE CONTROL.

A. Contractor shall take reasonable measures to avoid unnecessary noise. Such measures shall be appropriate for the normal ambient sound levels in the area during working hours. All construction machinery and vehicles shall be equipped with practical sound-muffling devices, and operated in a manner to cause the least noise consistent with efficient performance of the Work.

B. During construction activities on or adjacent to occupied buildings, and when appropriate, Contractor shall erect screens or barriers effective in reducing noise in the building and shall conduct its operations to avoid unnecessary noise which might interfere with the activities of building occupants.

1.17 DUST CONTROL.

A. Contractor shall take reasonable measures to prevent unnecessary dust. Earth surfaces subject to dusting shall be kept moist with water or by application of a chemical dust suppressant. When practicable, dusty materials in piles or in transit shall be covered to prevent blowing dust.

B. Buildings or operating facilities which may be affected adversely by dust shall be adequately protected from dust. Existing or new machinery, motors, instrument panels, or similar equipment shall be protected by suitable dust screens. Proper ventilation shall be included with dust screens.

1.18 TEMPORARY DRAINAGE PROVISIONS.

A. Contractor shall provide for the drainage of storm water and such water as may be applied or discharged on the Site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the Site, and adjacent property.

B. Existing drainage channels and conduits shall be cleaned, enlarged, or supplemented as necessary to carry all increased runoff attributable to Contractor's operations. Dikes shall be constructed as necessary to divert increased runoff from entering adjacent property (except in natural channels), to protect Owner's facilities and the Work, and to direct water to drainage channels or conduits. Ponding shall be provided as necessary to prevent downstream flooding.

1.19 EROSION CONTROL.

A. Refer to Section 02850 Erosion and Sediment Control.

1.20 POLLUTION CONTROL.

A. Contractor shall prevent the pollution of drains and watercourses by sanitary wastes, sediment, debris, and other substances resulting from construction activities. No sanitary wastes shall be permitted to enter any drain or watercourse other than sanitary sewers. No sediment, debris, or other substance shall be permitted to enter sanitary sewers, and reasonable measures shall be taken to prevent such materials from entering any drain or watercourse.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01610 - GENERAL EQUIPMENT STIPULATIONS

PART 1 - GENERAL

1.1 SCOPE.

A. When an equipment specification section in this Contract references this section, the equipment shall conform to the general stipulations set forth in this section, except as otherwise specified in other sections.

1.2 COORDINATION.

A. Contractor shall coordinate all details of the equipment with other related parts of the Work, including verification that all structures, piping, wiring, and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Drawings or Specifications.

1.3 MANUFACTURER'S EXPERIENCE.

A. Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.4 WORKMANSHIP AND MATERIALS.

A. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

B. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

C. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4 inch 6.3 mm thick. When dissimilar metal components are used, consideration shall be given to prevention of galvanic corrosion.

1.5 STRUCTURAL DESIGN REQUIREMENTS.

A. All equipment, including non-structural components and non-building structures as defined in ASCE 7, and their anchorage, shall be designed and detailed in accordance with the Meteorological and Seismic Design Criteria section.

1.6 LUBRICATION.

A. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.

B. Lubricants of the types recommended by the equipment manufacturer shall be provided in sufficient quantities to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner. Lubricants for equipment where the lubricants may come in contact with water before or during a potable water treatment process or with potable water, shall be food grade lubricants. This includes lubricants for equipment not normally in contact with water, but where accidental leakage of the lubricants may contaminate the water.

C. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

1.7 ELEVATION.

A. The elevation of the site shall be as indicated in the Meteorological and Seismic Design Criteria section. All equipment furnished shall be designed to meet stipulated conditions and to operate satisfactorily at the specified elevation.

1.8 ELECTRIC MOTORS.

A. Unless otherwise specified, motors furnished with equipment shall meet the requirements specified in Common Motor Requirements for Process Equipment section or specified in specific equipment sections.

1.9 DRIVE UNITS.

A. The nominal input horsepower rating of each gear or speed reducer shall be at least equal to the nameplate horsepower of the drive motor. Drive units shall be designed for 24 hour continuous service.

B. V-Belt Drives.

1. Each V-belt drive shall include a sliding base or other suitable tension adjustment. V-belt drives shall have a service factor of at least 1.75 at maximum speed based on the nameplate horsepower of the drive motor.

1.10 SAFETY GUARDS.

A. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard. Safety guards shall be fabricated from 16 USS gage thick or thicker galvanized, aluminum-clad sheet steel, or stainless sheet steel or from 1/2 inch mesh galvanized expanded metal, or pultrusion molded UV resistant materials. Each safety guard shall be reinforced or shaped to provide suitable strength to prevent vibration and deflection and shall comply with OSHA. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.

1.11 ANCHOR BOLTS.

A. Equipment suppliers shall design and detail suitable anchor bolts for each item of equipment. Anchor bolts shall be designed for all operating conditions of the equipment, including wind and seismic loadings when applicable. Wind and seismic loads shall be as indicated in the Meteorological and Seismic Design Criteria section.

B. Requirements for anchor bolt type, material, and minimum diameter shall be as indicated in the Anchorage in Concrete and Masonry section.

C. Anchor bolts, together with templates or setting drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete or masonry grout is placed.

D. Unless otherwise indicated or specified, anchor bolts for items of equipment mounted on baseplates shall be long enough to permit 1-1/2 inches of grout beneath the baseplate and to provide adequate anchorage into structural concrete.

1.12 EQUIPMENT BASES.

A. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches. Cast iron or welded steel baseplates shall be provided for pumps, compressors, and other equipment. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components, and adequate grout holes. Baseplates for pumps shall have a means for collecting leakage and a threaded drain connection. Baseplates shall be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in the Grouting section.

1.13 SPECIAL TOOLS AND ACCESSORIES.

A. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

1.14 SHOP PAINTING.

A. All iron and steel surfaces of the equipment shall be protected with suitable protective coatings applied in the shop. Surfaces of the equipment that will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an epoxy or polyurethane enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

B. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of a universal primer.

C. Machined, polished, and nonferrous surfaces which are not to be painted shall be coated with rust-preventive compound as recommended by the equipment manufacturer.

1.15 PREPARATION FOR SHIPMENT.

A. Equipment shall be prepared for shipment as specified in the Product Delivery Requirements section.

1.16 STORAGE.

A. Handling and storage of equipment shall be as specified in the Product Storage and Handling Requirements section.

1.17 INSTALLATION AND OPERATION.

A. Installation and operation shall be as specified in respective equipment sections and the Startup Requirements section.

1.18 OBSERVATION OF PERFORMANCE TESTS.

A. Where the Specifications require the presence of Engineer, initial tests shall be observed or witnessed by Engineer. Owner shall be reimbursed by Contractor for all costs of subsequent visits by Engineer to witness or observe incomplete tests, retesting, or subsequent tests.

1.19 PROGRAMMING SOFTWARE.

A. Programming software shall be provided for any equipment which includes a programmable logic controller or other digital controller that is user-programmable.

B. The software shall be suitable for loading and running on a laptop personal computer operating with a Windows-based operating system.

C. A copy of the manufacturer's original operating logic program shall be provided for use in maintaining and troubleshooting the equipment.

D. Where multiple pieces of equipment, from the same or different vendors, use the same programming software, only one copy of the software need be provided.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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Section 01611 -METEOROLOGICAL AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SCOPE

A. Buildings and non-structural components shall be designed in accordance with this section. In the event of conflict with requirements in other sections, the more stringent criteria shall be followed.

1.2 DESIGN CRITERIA.

A. Buildings, non-structural components and, non-building structures including anchorage of such items, shall be designed in accordance with the following criteria.

1. General Design Data		
	Building code and references	IBC 2021, ASCE 7-16 "Minimum Design Loads and Associated Criteria for Buildings and Other Structures", AISC 360 "Specification for Structural Steel Buildings", AISC 341 "Seismic Provisions for Structural Steel Buildings"
	Site elevation, above mean sea level (ft)	1230 - 1287
	Design flood elevation (ft)	Zone X
	Design groundwater elevation (ft)	Set at lowest adjacent ground surface at each structure less 1.00 feet
2. Wind Design Data		
	Basic (Ultimate) design wind speed, V (mph)	120
	Allowable Stress (Nominal) design wind speed, V_{asd} (mph)	95
	Exposure category	Exposure C
	Ground elevation factor, K_e	1.0
	Risk Category	IV

3. Snow Design Data		
	Ground snow load, P_g (psf)	10
	Importance factor (snow loads), I	1.1
	Exposure factor (C_e)	0.9
	Thermal factor (C_t)	1.1
4. Seismic Design Data		
	Mapped MCE short period spectral response acceleration, S_S	0.163
	Mapped MCE one second period spectral response acceleration, S_1	0.091
	Design short period spectral response acceleration, S_{DS}	0.174
	Design one second period spectral response acceleration, S_{D1}	0.146
	Risk Category	IV
	Pump Station Building Importance factor, I	1.50
	Pump Station Building Seismic Design Category	C
	Electrical Building Importance factor, I	1.50
	Electrical Building Seismic Design Category	C
	Non-Structural Components Importance Factor, I_P	As indicated in the Non-Structural Components Schedule
	Non-Structural Components Seismic Design Category	1.50
	Non-Building Structures Importance Factors, I	As indicated in the Non-Building Structure Schedule or in the applicable reference documents, whichever is greater.

1.3 WIND ANCHORAGE

A. Equipment that is to be located outdoors shall have anchor bolts designed for the effects of wind forces, as determined in accordance with ASCE 7, Chapters 26-31.

B. Design of anchorage shall be in accordance with the Anchorage in Concrete and Masonry section.

1.4 SEISMIC DESIGN

A. General.

1. Structural systems shall provide continuous load paths, with adequate strength and stiffness to transfer all seismic forces from the point of application to the point of final resistance.

B. Pre-Engineered Buildings

1. Pre-engineered buildings shall have sufficient strength and ductility to resist the specified seismic effects defined for buildings and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code.

2. "W" for buildings shall include the total dead load, the total operating weight of permanent equipment and the effective contents of vessels, and applicable portions of other loads, as required by the specified building code.

C. Non-Structural Components.

1. Non-structural components are architectural, mechanical, and electrical items that are permanently attached to and supported by a structure but are not part of the structural system, as indicated in Chapter 13 of ASCE 7. The Non-Structural Components Schedule identifies the components that require seismic design. The requirements of this paragraph are applicable only to the items listed in the Non-Structural Components Schedule.

2. General

   a. Design of non-structural components shall be in accordance with all applicable provisions of ASCE 7, Chapter 13.
   b. “Wp” shall include the total operating weight of the component or system, including, but not limited to, any insulation, fluids, and concentrated loads such as valves, condensate traps, and similar components.

3. Submerged Components

   a. Components that are to be submerged in water shall be designed to withstand loads from the effects of water sloshing during the seismic event.
   b. The calculation of the sloshing effects shall be in accordance with the latest edition of ACI 350.3.

4. Anchorage Design

   a. Every component in the Non-Structural Components Schedule shall have its anchorage to the supporting structure designed in accordance with ASCE 7, Chapter 13.
   b. Design of anchorage shall be in accordance with the Anchorage in Concrete and Masonry section.
   c. Components shall be attached so that seismic forces are transferred to the structural system. Curbs that support roof-mounted equipment shall be designed to transfer

forces from the equipment into the main structural roof members. All structural attachments shall be bolted, welded, or otherwise positively fastened. Frictional resistance due to gravity shall not be considered in evaluating the required resistance to seismic forces.

5. Component Design

   a. Components indicated in the Non-Structural Components Schedule to require design of the component itself, as opposed to an anchorage design alone, shall be designed in accordance with ASCE 7, Chapter 13.
   b. Components shall have sufficient strength and ductility to resist the specified seismic effects, and shall meet all of the design, proportioning, detailing, inspection, and quality assurance provisions of the specified building code and other referenced codes. Components shall be designed to be operable during and following a design level seismic event without collapsing, breaking away from supports, creating an ignition hazard, or releasing any contents.
   c. Seismic effects that shall be analyzed in the design of piping systems include the dynamic effects of the piping system, contents, and supports. The interaction between piping systems and the supporting structures, including other mechanical and electrical equipment, shall also be considered. Where pipe supports are to be designed by Contractor, as required by the Pipe Supports section, both the piping and support systems shall be designed to meet the applicable requirements of ASCE 7, Chapter 13.

6. Seismic Certification

   a. Design of components and their anchorage shall be certified by one of the following methods.
      1) Analysis and design by a design professional registered in the state of the project. Certification by analysis shall be permitted only for nonactive components, and shall be based on seismic demand considering Rp/Ip equal to 1.0.
      2) Shake table testing based upon a nationally recognized testing standard procedure, such as ICC-ES AC 156, acceptable to the authority having jurisdiction.
      3) Experience data, based upon nationally recognized procedures acceptable to the authority having jurisdiction.

   b. Components indicated in the Non-Structural Components Schedule to require special seismic certification shall be certified only by methods 2 or 3 above, except that certification for containment of hazardous materials may be by any of the three methods.

7. Construction Documents

   a. Construction documents (fabrication or shop drawings) of non-structural components shall be sealed by a design professional that is registered in the state of the project.
   b. Documents shall be sealed whether the basis for certification is analysis and design, shake table testing, or experience data.

c. The sealing method shall clearly indicate that the anchorage system, and the component itself when applicable, have been designed for the code required seismic forces.

8. Submittals

a. The construction documents, structural design calculations, shake table certification, and experience data certification, as applicable, shall be submitted in accordance with the Submittal Procedures section.

Non-Structural Components Schedule				
Component	Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
Steel Doors and Frames	08110	1.0	X	
Overhead Coiling Steel and Fire Doors	08330	1.0	X	
Glass Glazing	08800	1.0	X	
Acoustical Panel Ceilings	09510	1.0	X	
Louvers and Vents	10200	1.0	X	
Horizontal Split Case Centrifugal Pumps	11110	1.0		
Engine Generators	11910	1.5	X	
Traveling Bridge Cranes	14630	1.5	X	
Piping Systems and Related Pipe Supports	See Division 15	1.0		
Plumbing	15400	1.0		
HVAC Equipment	15500	1.0		
Refrigeration Systems	15650	1.0		
Electrical Equipment	16050	1.0		
Medium Voltage Adjustable Frequency Drives	16155	1.0		
Primary Unit Substations	16312	1.0		
Medium Voltage, Pad Mounted Transformers	16320	1.0		
Medium Voltage Switchgear	16345	1.0		
Medium-Volt Fusible Interrupter Switchgear	16350	1.0		

Non-Structural Components Schedule				
Component	Applicable Specification Section	Importance Factor (I_p)	Component Design Required	Special Seismic Certification Required
600 Volt Class Motor Control Centers	16480	1.0		
Lightning Protection Systems	16670	1.0		
Fire Detection and Alarm Systems	16271	1.5	x	

Note: Some specification sections listed in the Non-Structural Components Schedule cover multiple items. Within those sections, some components may be exempt from seismic design based on their weight and/or their height above the floor. Reference ASCE 7, Paragraph 13.1.4 for specific conditions of the exemptions. Some distribution systems such as conduit, cable tray, raceways, duct systems, and piping and tubing systems may also be exempt from seismic design based on their loads and support mechanisms as indicated in their respective paragraphs in ASCE 7, Chapter 13.

PART 1 - PRODUCTS (Not Used)

PART 2 - EXECUTION (Not Used)

End of Section

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SECTION 01612 - PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers packaging and shipping of materials and equipment.

1.2 PREPARATION FOR SHIPMENT.

A. All equipment shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.

B. Painted and coated surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted and coated surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Grease and lubricating oil shall be applied to all bearings and similar items.

1.3 SHIPPING.

A. Before shipping each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

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SECTION 01614 - PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers delivery, storage, and handling of materials and equipment.

1.2 DELIVERY.

A. Contractor shall bear the responsibility for delivery of equipment, spare parts, special tools, and materials to the site and shall comply with the requirements specified herein and shall provide required information concerning the shipment and delivery of the materials specified in this Contract. These requirements also apply to any subsuppliers making direct shipments to the Site.

B. Contractor shall, either directly or through contractual arrangements with others, accept responsibility for the safe handling and protection of the equipment and materials furnished under this Contract before and after receipt at the port of entry. Acceptance of the equipment shall be made after it is installed, tested, placed in operation and found to comply with all the specified requirements.

C. All items shall be checked against packing lists immediately on delivery to the site for damage and for shortages. Damage and shortages shall be remedied with the minimum of delay.

D. Delivery of portions of the equipment in several individual shipments shall be subject to review of Engineer before shipment. When permitted, all such partial shipments shall be plainly marked to identify, to permit easy accumulation, and to facilitate eventual installation.

1.3 STORAGE.

A. Upon delivery, all equipment and materials shall immediately be stored and protected until installed in the Work.

B. Stacked items shall be suitably protected from damage by spacers or load distributing supports that are safely arranged. No metalwork (miscellaneous steel shapes and reinforcing steel) shall be stored directly on the ground. Masonry products shall be handled and stored in a manner to hold breakage, chipping, cracking, and spalling to a minimum. Cement, lime, and similar products shall be stored off the ground on pallets and shall be covered and kept completely dry at all times. Pipe, fittings, and valves may be stored out of doors, but must be placed on wooden blocking. PVC pipe, geomembranes, plastic liner, and other plastic materials shall be stored off the ground on pallets and protected from direct sunlight.

C. Pumps, motors, electrical equipment, and all equipment with antifriction or sleeve bearings shall be stored in weathertight structures maintained at a temperature above 60°F. Electrical

equipment, controls, and insulation shall be protected against moisture and water damage. All space heaters furnished in equipment shall be connected and operated continuously.

D. Equipment having moving parts, such as gears, bearings, and seals, shall be stored fully lubricated with oil, grease, etc., unless otherwise instructed by the manufacturer. Manufacturer's storage instructions shall be carefully followed by Contractor.

E. When required by the equipment manufacturer, moving parts shall be rotated a minimum of twice a month to ensure proper lubrication and to avoid metal to metal "welding". Upon installation of the equipment, Contractor shall, at the discretion of Engineer, start the equipment at one-half load for an adequate period of time to ensure that the equipment does not deteriorate from lack of use.

F. When required by the equipment manufacturer, lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment by Contractor at the time of acceptance.

G. Equipment and materials shall not show any pitting, rust, decay, or other deleterious effects of storage when installed in the Work.

H. In addition to the protection specified for prolonged storage, the packaging of spare units and spare parts shall be for export packing and shall be suitable for long-term storage in a damp location. Each spare item shall be packed separately and shall be completely identified on the outside of the container.

1.4 HANDLING.

A. Stored items shall be laid out to facilitate their retrieval for use in the Work. Care shall be taken when removing the equipment for use to ensure the precise piece of equipment is removed and that it is handled in a manner that does not damage the equipment.

B. During handling, carbon steel constructed material including chains, straps, and forks on lifting equipment shall not directly contact any equipment or material constructed of stainless steel. It shall be the Contractor’s responsibility to correct any carbon steel contamination of stainless steel.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01615 - EQUIPMENT AND VALVE IDENTIFICATION

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and installation of nameplates and tags for identification of equipment, valves, panels, and instruments.

1.2 GENERAL.

A. Except as otherwise specified in equipment, valve, and instrumentation sections, nameplates and tags shall be as specified herein. Nameplates or tags shall be provided for all equipment, valves, operator interfaces, control and electrical panels, cabinets, instruments, and instrument racks that have been named and/or tagged on the Drawings.

1.3 SUBMITTALS.

A. Drawings and Data

1. Drawings and data shall be submitted in accordance with the requirements of the Submittals Procedures section for each type of tag provided including materials, colors, sizes, letter sizes, and installation instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT NUMBER PLATES.

A. All equipment tagged on the drawings, except for submerged equipment shall be provided with number plates bearing the equipment tag number identified on the Drawings.

B. Number plates shall be bevelled, 1/8th inch thick laminated black phenolic plastic engraving stock with white core. Lettering on number plates shall be capitalized block letters ¾ inch high.

C. Number plate height shall be twice the letter height. Number plate length shall be as needed, with suitable margins all around.

D. Lettering shall be placed in one row where practicable; however, where necessary due to excessive length, lettering shall be placed on more than one row and centered.

E. Number plates shall be attached with stainless steel panhead screws, rivets, or drive screws.

F. When a number plate cannot be installed due to the physical size, space, or mounting surface geometry of the equipment, the Contractor shall provide a 12 gauge stainless steel tag with

engraved or imprinted equipment tag number. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges and shall be fastened to the equipment with stainless steel mechanical fasteners or with a stainless steel chain.

2.2 EQUIPMENT INFORMATION PLATES.

A. Equipment shall be provided with engraved or stamped equipment information plates securely affixed with mechanical fasteners to the equipment in an accessible and visible location.

B. Equipment information plates shall be in addition to the number plates specified.

C. Equipment information plates shall indicate the manufacturer's name, address, product name, catalog number, serial number, capacity, operating and power characteristics, labels of tested compliances, and any other pertinent design data.

D. Equipment information plates listing the distributing agent only will not be acceptable.

2.3 VALVE TAGS.

A. Permanent Tags.

1. All valves, except buried or submerged valves, that have been assigned a number on the Drawings or in the valve schedule, shall be provided with a permanent number plate.

2. Tags shall be permanently attached to valves with stainless steel mechanical fasteners or with stainless steel chains. Numerals shall be ¾ inch high and shall be black baked enamel on an anodized aluminum plate.

B. All buried valves shall be tagged with a brass plate cast into a 6-inch by 6 inch concrete pad at grade next to the valve box. The valve number shall be engraved in the brass plate with lettering and numerals at least 1 inch high.

2.4 PANEL NAMEPLATES.

A. Nameplates shall be provided on the face of each panel and cabinet. Panel identification nameplates shall be mounted at the top of the panel shall include the panel descriptive name and tag number as indicated on the Drawings, in two or three lines of text. Lettering shall be ¾ inch high.

B. Nameplates for devices mounted on or in the panel shall be inscribed with the text as indicated on the Drawings. Where nameplate information is not indicated on the Drawings, inscriptions shall be in accordance with information in the supplier's submittal drawings as guided by information in the relevant specification section. Panel device nameplates shall have engraved letters 3/16 inch high.

C. Nameplate material and size shall be as specified above for equipment number plates. Nameplates shall be secured to the panel with stainless steel panhead screws.

2.5 INSTRUMENT TAGS.

A. Temporary Tags.

1. Where instruments are not provided with permanent tags furnished from the factory, instruments shall be tagged or marked in the factory with the instrument tag number indicated on the Drawings.

B. Permanent Tags.

1. Instruments shall be tagged with the instrument tag number indicated on the Drawings. Tags shall be 12 gauge stainless steel with engraved or imprinted symbols. Lettering on tags shall be ¼ inch high. Tags shall be rectangular with smooth edges, and shall be fastened to the instrument with stainless steel mechanical fasteners or with a stainless steel chain.

PART 3 - EXECUTION (NOT USED)

End of Section

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SECTION 01620 - EQUIPMENT SCHEDULE

PART 1 - GENERAL

1.1 SCOPE.

A. This section consists of an equipment schedule for items for which a basic level of manufacturer's field services or operation and maintenance manuals are required, but not covered in other sections. When other sections indicate that manufacturer's field services and operation and maintenance manuals are required, the requirements shall be as specified in the other sections.

B. Specific requirements for manufacturer's field services are covered in the Quality Control section and the equipment specifications.

C. Specific requirements for operation and maintenance manuals are covered in the Submittals Procedures section and the equipment specifications.

1.2 SCHEDULE.

A. Manufacturer's field services, including equipment installation checks and training, and operation and maintenance manuals shall be provided for the items of equipment indicated in the following schedule:

B.

Spec Section	Type of Equipment	Mfr's. Field Services	O&M Manual
11110	Horizontal Split Case Centrifugal Pumps	x	x
11630	Air Compressors	x	x
11910	Engine-Generators	x	x
13110	Cathodic Protection	x	x
13500	Instrumentation and Control System	x	x
13800	Surge Tank	x	x
14630	Bridge Crane	x	x
15093	Check Valves	x	x

Spec Section	Type of Equipment	Mfr's. Field Services	O&M Manual
15101	AWWA Butterfly Valves	x	x
15108	Air Valves	x	x
15180	Valve Actuators	x	x
15400	Plumbing	x	x
15500	HVAC	x	x
15650	Refrigeration Systems	x	x
16050	Electrical	x	x
16155	Medium-Voltage AFD	x	x
16320	Medium-Voltage Transformer	x	x
16480	Motor Control Centers	x	x
16670	Lightning Protection	x	x
16721	Fire Detection and Alarm System	x	x

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

End of Section

SECTION 01630 – PIPE SCHEDULE

1.1 SCOPE

A. This section consists of a schedule of 4 inch and larger pipelines indicating the type of pipe to be used. Pipe materials, installation, testing, and disinfection, when specified, are covered in other sections.

B. Piping smaller than 4 inch is covered in the various miscellaneous piping sections. Piping for plumbing, heating and air conditioning systems is covered in other sections. Piping to be furnished with equipment is covered in the applicable equipment section.

1.2 ALTERNATIVE PIPE TYPES

A. Where more than one type of pipe is indicated in the schedule, the type of pipe material to be installed may be selected by Contractor. The details on the drawings cover only one type of pipe for each line. If a different material is selected by Contractor, all details of connections, jointing, wall fittings, support, anchorage, and harnesses shall be modified as necessary to produce an equivalent design acceptable to Engineer.

1.3 WALL FITTINGS

A. A wall pipe or sleeve will be required for all pipe passing through concrete or masonry block walls. Wall fittings and sleeves shall be as indicated on the drawings and as specified in the applicable piping section.

1.4 SCHEDULE INDEX

A. Pipe material abbreviations and their applicable specification section number are as indicated:

Abbreviation	Pipe Material	Section No.
CI	Cast iron soil pipe	15069
CS	Miscellaneous steel pipe	15065
CSG	Galvanized steel pipe	15065
CU	Copper tubing	15070
DIP	Ductile iron pipe	15061
PE	Polyethylene	15067
PVC	PVC	15067
RCP	Concrete sewer pipe	02618
SP	Steel pipe	15062
SS	Stainless steel pipe	15064

1.5 SCHEDULE

A. Pipe materials shall conform to Schedule 01630-S01. All pipelines indicated on the drawings and all pipelines required for proper operation of the equipment furnished shall be provided whether listed in the schedule or not.

End of Section

PIPELINE SCHEDULE 01630-S01

Size (in)	Service	Location	Material
60	Treated Water Transmission Main	Interior, Buried	SP
48	Finished Water	Buried	SP
36	Finished Water	Interior, Buried	SP
24	Treated Water	Interior	SP
24	Emergency Flood Drain	Buried	DIP
15, 24, 30	Storm Drain	Buried	RCP
20	Finished Water	Interior	SP
18	Roof Drain	Buried	PVC, DIP
18	Treated Water	Interior	SP
16	Surge Tank Pipe	Interior	SP
12	Roof Drain	Buried	PVC, DIP
8	Roof Drain	Buried	PVC, DIP
6	Roof Drain	Buried	PVC, DIP
6, 8	Private Fire Water	Buried	DIP
4	Natural Gas	Buried	PE
4	Natural Gas	Exposed	CS
4	Building Drain and Clear Water Waste	Buried	CI
4, 6	Cooling Water Piping	Exposed, Engine-Generator Enclosures	CS

End of Schedule

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SECTION 01650 - STARTUP REQUIREMENTS

1.1 SCOPE.

A. This section covers startup requirements for all items of equipment and systems including mechanical equipment. Additional requirements may be specified in specific equipment specifications. The requirements of this section shall be satisfactorily completed prior to any field tests specified in the specific equipment sections.

1.2 GENERAL.

A. Equipment shall not be operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results. All items of equipment and systems shall be tested for proper operation, efficiency, and capacity. All required adjustments, tests, operation checks, and other startup activity shall be provided by qualified personnel. Contractor shall be responsible for planning, supervising, and executing the installation of Work.

1.3 Coordination.

A. Contractor shall coordinate all tests related to startup of equipment and systems and shall report the results to Engineer in accordance with the submittals section. Contractor shall accept the equipment and the test results related to starting of equipment and systems before Engineer will accept the equipment and the test results.

B. When equipment is ready for a witness test, Contractor shall give written notice to Engineer at least 14 days before any offsite witness testing is performed or any field witnessed performance testing, unless otherwise specified.

1.4 EQUIPMENT TESTS.

A. Factory Tests.

1. When specified in the specific equipment sections, the equipment will be test run at the point of manufacture and the test results will be delivered to Engineer. Such equipment will not be shipped until Engineer has reviewed the test results and advised the Contractor, in writing, that the equipment is acceptable for shipment. Such acceptance, however, will not be considered as final acceptance, which will only be made on the basis of the test results of the equipment after installation.

B. Preliminary Field Tests.

1. All items of mechanical equipment shall be given a preliminary field test by Contractor after installation for proper operation, efficiency, and capacity. The preliminary field test shall consist of the requirements listed herein, unless exceptions or additions are indicated in the specific equipment sections.

2. Contractor's test operation of each piece of mechanical equipment shall continue for not less than 8 hours without interruption. All moving parts of equipment and machinery shall be carefully tested for operation, and adjusted so all parts move freely and function to secure satisfactory operation. All equipment shall be tested continuously under actual or simulated operating conditions. All parts shall operate satisfactorily in all respects, under continuous full load and in accordance with the specified requirements, for the full duration of the 8 hour test period. If any part of a unit shows evidence of unsatisfactory or improper operation during the 8 hour test period, correction or repairs shall be made and the full 8 hour test operation, as specified, shall be completed after all parts operate satisfactorily.

3. Tests of all process and pumping equipment, drive motors, including auxiliaries shall be made in accordance with the appropriate and approved test codes such as the American Society of Mechanical Engineers, Hydraulic Institute Standards, and IEEE.

4. Tests shall be conducted after the Work is substantially complete so each item of equipment is ready for integrated operation with other equipment at the plant. Testing, measuring, and calibrating procedures shall be submitted to Engineer for review and acceptance prior to startup and testing of equipment.

5. The equipment shall be properly filled, by Contractor, with oil and grease, and Contractor shall furnish all power, personnel, water, chemicals, fuels, oil, grease, and auxiliaries necessary for conducting the testing of the equipment for proper operation, efficiency, and capacity.

6. The period of inspection, initial startup operation, and field adjustment shall be as needed to achieve satisfactory installation and operation of the items furnished. Any period required for instruction of Owner's personnel shall be as specified in the Contract Documents.

7. When the specific equipment sections indicate that an installation check is required by the equipment manufacturer, the manufacturer's representative will make all necessary field adjustments and correct defects in materials or workmanship during this test period.

8. All equipment installed under this Contract, including that furnished by others, shall be placed into successful operation according to the written instructions of the equipment manufacturer and the instructions of the manufacturer's field representative.

C. Field System Operation Test.

1. After all equipment is installed and the entire plant or system is ready to operate, Contractor shall conduct a field system operation test. The test shall consist of the requirements listed herein, unless exceptions or additions are indicated in the specific equipment sections.

2. The test period shall be at least 7 days, and each system shall operate under actual or simulated operating conditions before a certificate of Substantial Completion of the Work is issued. All defects of material, workmanship, or equipment which appear during this test period shall be corrected by Contractor. After such corrections are made, the 7 day test shall be repeated before a certificate of Substantial Completion of Work is issued, unless waived by Engineer.

3. Contractor shall supply all power, water, oil, grease, auxiliaries, and operating personnel required for this operation test.

4. When necessary for certain items of equipment, the final adjustments and inspections will be made by factory trained service personnel (other than sales representatives), rather than by Contractor. The service personnel will also supervise the test operation. This requirement will be stated under the detailed specification for the particular piece or pieces of equipment. The manufacturer's service personnel will make adjustments and supervise testing by Contractor until such tests have been accepted by Engineer.

1.5 ACCEPTANCE.

1. When no other field tests for acceptance are specified in the equipment sections, at the end of the field system operation testing, each system will be accepted if, in the opinion of Engineer, it has operated satisfactorily without excessive power use, wear, or need for lubrication, or requiring undue attention; and if all its rotating parts operate without excessive vibration or noise at any operating condition.

2. When other field tests for acceptance are specified in the equipment sections, acceptance shall be after all tests are satisfactorily conducted as specified in the appropriate equipment procurement specification.

3. When a field performance test for baseline is specified in the equipment sections, acceptance shall be after a completion of the baseline performance test that is conducted as specified in the pumping unit field testing - baseline performance section.

4. Acceptance of Work in connection with the installation of equipment furnished by others will be subject to approval of the manufacturer's field representative. Acceptance by Owner or approval of the manufacturer's field representative will not relieve Contractor of responsibility for defective Work.

End Section

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SECTION 02110 - CLEARING AND GRUBBING

PART 1 - GENERAL

1.1 SCOPE

A. Work described in this Section includes furnishing all labor, equipment, tools and incidentals required for all clearing and grubbing including, but not limited to, the removal of trees, stumps, roots, brush, structures, abandoned utilities, trash, debris and all other materials found on or near the ground surface within the construction area. Precautionary measures to prevent damage to existing features to remain shall be part of the work.

1. Clearing and grubbing operations shall be coordinated with temporary and permanent erosion control procedures.

B. Field Conditions. Contractor's Work shall consider existing conditions of the site and adjacent areas and be executed as to have no adverse impact on adjacent sites or protected areas on the project site. At a minimum, Contractor shall consider the following:

1. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

2. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises.

3. Utility Locator Service: Notify Arkansas 811 for area where Project is located before site clearing.

4. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

5. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

6. 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.

7. Restore damaged improvements to their original condition, as acceptable to Owner or Engineer.

1.2 GOVERNING STANDARDS

A. The Contractor shall comply with applicable codes, ordinances, rules, regulations, and laws of local, municipal, state or federal authorities having jurisdiction over the Project. All required permits of a temporary nature shall be obtained for construction operations by the Contractor.

1.3 SUBMITTALS

A. Drawings and data shall be submitted in accordance with the Submittals section. Drawings and data shall include, but shall not necessarily be limited to, the following:

1. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

2. Topsoil stripping and stockpiling program.

3. Rock stockpiling program.

4. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Not used.

PART 2 - PRODUCTS

A. Not used.

PART 3 - EXECUTION

3.1 CLEARING OF SITE

A. Before removal of topsoil, and start of excavation and grading operations, the areas within the clearing limits shall be cleared and grubbed.

1. Clearing shall consist of cutting, removal, and satisfactory disposal of all trees, fallen timber, brush, bushes, rubbish, sanitary landfill material, fencing, and other perishable and objectionable material within the areas to be excavated or other designated areas. Prior to the start of construction, the Contractor shall survey the entire Contract site and shall prepare a plan which defines the areas to be cleared and grubbed, trees to be pruned, extent of tree pruning, and/or areas which are to be cleared but not grubbed. This plan shall be submitted to the Engineer for approval. Should it become necessary to remove a tree, bush, brush or other plants adjacent to the area to be excavated, the Contractor shall do so only after permission has been granted by the Engineer.

2. Excavation resulting from the removal of trees, roots and the like shall be filled with suitable material, as approved by the Engineer, and thoroughly compacted per the requirements contained in Section 02222 - Excavation and Backfill for Utilities.

3. Unless otherwise shown or specified, the Contractor shall clear and grub a strip at least 15 ft. wide along all permanent fence lines installed under this Contract.

4. In temporary construction easement locations, only those trees and shrubs shall be removed which are in actual interference with excavation or grading work under this Contract, and removal shall be subject to approval by the Engineer. However, the Engineer reserves the right to order additional trees and shrubs removed at no additional cost to the Owner, if such, in his opinion, are too close to the work to be maintained or have become damaged due to the Contractor's operations.

3.2 STRIPPING AND STOCKPILING EXISTING TOPSOIL

A. Existing topsoil and sod on the site within areas designated on the Plans shall be stripped to whatever depth it may occur, and stored in locations directed by the Engineer.

1. The topsoil shall be free of stones, roots, brush, rubbish, or other unsuitable materials before stockpiling the topsoil. Care shall be taken not to contaminate the stockpiled topsoil with any unsuitable materials.

3.3 GRUBBING

A. Grubbing shall consist of the removal and disposal of all stumps, roots, logs, sticks and other perishable materials to a depth of at least 6-inches below ground surfaces.

1. Large stumps located in areas to be excavated may be removed during grading operations, subject to the approval of the Engineer.

3.4 DISPOSAL OF MATERIAL

A. All debris resulting from the clearing and grubbing work shall be disposed of by the Contractor as part of the work of this Contract. Material designated by the Engineer to be salvaged shall be stored on the construction site as directed by the Engineer for reuse in this Project or removal by others.

B. Burning of any debris resulting from clearing and grubbing work will not be permitted at the site. All trees, stumps, roots, bushes, and refuse shall be removed from the site and disposed of by the Contractor. On-Site and off-site disposal areas are subject to approval by the Engineer.

End of Section

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SECTION 02200 - EXCAVATION AND FILL FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers earthwork and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation; handling, storage, transportation, and disposal of all excavated material; all necessary temporary earth retention and other protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; construction of fills and embankments; grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed professional engineer in the state of Arkansas, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

B. Temporary Excavation Design Certificate

1. Before starting construction on the temporary excavation and in accordance with OSHA requirements enumerated above, the Contractor shall ensure that the temporary excavation design engineer shall complete and submit to Engineer the Temporary Excavation Design Certificate , Figure 1 – 02200 and the Contractor shall use the temporary excavation design. If required by the OSHA requirements enumerated above or to protect existing facilities, the Contractor is responsible for ensuring that a separate certificate shall be submitted for each unique design. Refer to paragraph in this specification titled, “Temporary Excavations.”

C. Filter Fabric Data

1. Complete descriptive and engineering data for the fabric shall be submitted in accordance with the Submittals Procedures section. Data submitted shall include:

a. A 12 inch square sample of fabric.
b. Manufacturer's descriptive product data.
c. Installation instructions.

D. Test Results for Review of Materials

1. Complete test results for tests performed on fill and backfill, and other material specified herein, by an independent commercial laboratory retained by the Contractor, as described in the paragraph titled, "Review of Materials".

E. CLSM Mix Design

1. Mix design by in independent commercial laboratory retained by the Contractor.

1.4 INSURANCE

A. Professional Liability insurance shall be provided as specified in the General Conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric

1. Filter fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

2. Filter Fabric Type A

a. Filter fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter fabric Type A shall be a non-woven fabric consisting of only continuous chains of polypropylene filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

Property	Test Method	Unit	Min Roll Value*
Grab Strength	ASTM D4632	lbs	160
Grab Elongation	ASTM D4632	percent	50
CBR Puncture Strength	ASTM D6241	lbs	410
Trapezoidal Tear	ASTM D4533	lbs	60
UV Resistance at 500 hours	ASTM D4355	% Strength Retained	70

*Minimum average roll value in weakest principal direction.

b. The apparent opening size (diameter) for the filter fabric Type A shall be no larger than the U.S. Standard Sieve Size 70 per ASTM D4751.

B. Polyethylene Film

1. Polyethylene film beneath concrete slabs or slab base course material shall comply with requirements of ASTM D4397, 6 mil minimum thickness.

C. Fill and Embankment Materials

1. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of site fills and embankments

2. Additional material shall be provided from Contractor's offsite source.

3. All material placed in fills and embankments shall be free from rocks or stones larger than 3 inches in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.

D. Granular Fill

1. Granular fill material shall be crushed rock or gravel suitable for use as a free draining subbase beneath slabs and foundations. Granular fill shall be free from dust, clay, and trash; hard, durable, non-friable; and shall be graded 3/4 inch to No. 4 as defined in ASTM C33 for No. 67 coarse aggregate. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate. The edges of granular fill shall be confined, either by placing against an excavation face or other fill.

E. Structure Backfill

1. Structure backfill shall be defined as the material placed around and outside of structures. For structures constructed in open excavations, structure backfill shall extend to the temporary excavation slope so that the entire excavation outside the structure shall be filled with structure backfill. For structures constructed in supported excavations, the structure backfill shall completely fill the space between structure and temporary earth retention, or between structure and excavation face, if these specifications permit removal of the system. Structure backfill shall meet the requirements of the previous paragraph entitled "Fill and Embankment Materials", unless the Drawings indicate crushed rock or clean sand structure backfill is to be used.

2. Crushed Rock Structure Backfill

a. Crushed rock for structure backfill shall meet the following gradation requirements:

Size	Percent Passing
1/2 inch	100
3/8 inch	90 – 100
No. 4	30 – 60
No. 8	0 – 10

Size	Percent Passing
No. 200	0 - 5

3. Clay Cap Structure Backfill. The top 18 inches of structure backfill shall consist of lean clay material classifies as CL per ASTM D2487.

F. Select Fill

1. Select fill shall be defined as the material placed beneath the structure foundations and slabs below any granular material layer or lean concrete slab indicated on the Drawings. Select fill shall be used to replace any unsuitable material below the structure foundations and slabs and to raise the site grades below and within 5 feet horizontally(unless a different dimension is otherwise indicated on the Drawings or specified) of structural footprints and at locations indicated on the Drawings. Select fill shall meet the requirements of the previous paragraph entitled "Fill and Embankment Materials", except that material classifications shall be limited to materials classified as CL, SC, CL, GM or GC per ASTM D2487. Contractor shall perform a minimum of three (3) test pits in cut areas of the new Pump Station prior to earthwork activities to obtain bulk samples for laboratory testing to evaluate suitability of onsite materials to be used as select fill.

G. Controlled Low Strength Material (CLSM)

1. CLSM shall consist of a mixture of Portland cement, fly ash, sand, and water and shall be placed at locations indicated on the Drawings or as directed by Engineer. The class of CLSM shall be as specified below.

2. The type of cement in CLSM shall be ASTM C150 Type I.. The class of fly ash in CLSM shall be ASTM C618 Class C, except loss on ignition shall not exceed 4 percent. Fine aggregate in CLSM shall be clean natural sand, ASTM C33, except that clay particles shall not exceed one percent. Water in CLSM shall be potable.

3. Contractor shall design and test the CLSM. The mix design shall be such as to ensure that the CLSM hardens sufficiently to support the weight of an average person in one to four hours after placement and support equipment weight in 24 hours. The mixture shall be designed such that when tested in the field with the Kelly Ball apparatus per ASTM D6024, the maximum depression diameter shall be 3 inches. CLSM shall be self-leveling and shall have an average patty diameter from 8 to 12 inches when the flow is measured in accordance with ASTM D6103.

4. The batch proportions accepted by Engineer apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the acceptance of Engineer.

5. If a change in sources of materials is proposed, a new mix design shall be developed by Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, Contractor shall develop a new mix design to get the desired results.

6. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the acceptance of Engineer.

7. Class C CLSM

a. The initial trial mixture for Class C CLSM shall consist of the following minimum proportions per cubic yard to provide minimum compressive strength listed below:

Cement	80 lbs
Fly Ash	275 lbs
Sand (SSD)	2795 lbs
Water	370 lbs
Air Entraining Agent	4 percent
Minimum compressive strength at 28 days	370 psi

2.2 MATERIAL TESTING

A. Review of Materials

1. As stipulated in the Quality Control section, all tests required for preliminary review of materials and materials delivered to the Site shall be made by an acceptable independent testing laboratory at the expense of Contractor. Tests performed by the aggregate supplier are not acceptable. Tests shall have been performed within 2 months of submittal and shall be representative of the material that will be delivered to the Site. Acquisition of samples for testing, both for preliminary review of materials and for testing of materials at the Site, shall be by the Contractor's independent testing laboratory. Samples acquired at the Site shall be obtained after placement and compaction of the material. Aggregate material shall be sampled in accordance with ASTM D75.

2. Two initial gradation tests shall be made for each type of general fill, select fill, structure backfill, granular fill, or other specified material, and one additional gradation test shall be made for each additional 500 tons of each material delivered (imported) to the jobsite or suitable onsite material incorporated in select fill or structure backfill. One additional gradation test shall be performed for each additional 2,000 tons of general fill material delivered to the jobsite or suitable onsite material incorporated in general fill. In addition, one set of initial Atterberg Limits test shall be made for each fill material containing more than 20 percent by weight pass the No. 200 sieve and for materials specified by Atterberg Limits. One additional Atterberg Limits test shall be made for each additional 500 tons of each material delivered to the job site or otherwise incorporated in select fill or structure backfill. One additional Atterberg Limits test shall be made for each additional 2,000 tons of general fill material delivered to the jobsite or suitable onsite material incorporated in general fill.

3. All material testing on CLSM shall be made by an independent testing laboratory at the expense of Contractor.

B. Field Testing Expense

1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of Owner.Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

C. Required Field Tests

1. For planning purposes, the Owner's testing laboratory will use the following general guidelines for frequency of field tests. Additional tests will be performed as necessary for job conditions and number of failed tests.

   a. For area fills and embankments, an in-place field density and moisture test for each 1000 cubic yards of material placed.
   b. One in-place field density and moisture test for every 100 to 200 cubic yards of structure backfill or select fill.
   c. One in-place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
   d. At least one test for every full shift of compaction operations on mass earthwork.
   e. Testing of CLSM will be as follows.
      1) Compressive Strength. For every 200 cubic yard of CLSM placed, prepare, cure, remove from molds, and test four 6 by 12 inch test cylinders in accordance with ASTM D4832. Cure cylinders in the molds in accordance with ASTM D4832 until time of testing, at least 14 days. Two cylinders will be tested at 7 days and the other two cylinders will be tested at 28 days.
      2) Flow. Once each day, the CLSM material will be tested for flow in accordance with ASTM D6103.
      3) Unit Weight, Yield, and Air Content. Once each day that flowable fill is placed, unit weight, yield and air content will be determined in accordance with ASTM D6023.
      4) Penetration. Once a day that CLSM is placed, the resistance to penetration from ball-drop apparatus (Kelly Ball) will be measured in accordance with ASTM D6103. (Compliance will be based on maximum depression diameter of 3 inches.)

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments and sites to be occupied by permanent construction shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of Contractor.

3.2 EXCAVATION

A. General

1. Permanent excavations shall conform to the lines and grades indicated on the Drawings. Temporary excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

2. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

B. Temporary Excavations

1. Except where excavation side slopes are cut to a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding. Temporary earth retention systems shall be furnished and installed as necessary to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower structures, and to protect adjacent structures and facilities from damage due to excavation and subsequent construction.

2. Design of excavations by a professional engineer retained by Contractor is required when necessary to protect adjacent existing facilities, or when design by an engineer is required by the OSHA regulations cited herein. The Contractor's professional engineer shall be licensed in the state of Arkansas and is responsible for design of entire excavation (both the sloping and supported portions of the excavation). The design of temporary earth retention shall comply with the paragraph of this specification titled, "Temporary Earth Retention."

3. Before starting construction on a temporary excavation requiring design by a professional engineer in compliance with requirements of this specification (to protect existing structures, utilities, and other facilities), the Contractor shall ensure that the temporary excavation design engineer shall complete the Temporary Excavation Design Certificate (Figure 1 – 02200) and the Contractor shall submit the certificate along with proof of professional liability insurance for the temporary excavation designer. The Contractor shall use the temporary excavation design. The Contractor shall submit a separate certificate for each unique design.

C. Classification of Excavated Materials

1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

D. Preservation of Trees

1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from damage by construction operations.

E. Unauthorized Excavation

1. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced

with concrete or lean concrete at the expense of Contractor. If structural concrete replacement is chosen, it shall be with concrete placed at the same time and monolithic with the concrete foundation.

F. Blasting

1. Blasting or other use of explosives for excavation will not be permitted.

G. Dewatering

1. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater and all water, regardless of the source, entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

2. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 12 inches, beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.

3. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

4. Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

H. Temporary Earth Retention

1. Temporary excavations shall be supported with temporary earth retention systems when excavation side slopes cannot be excavated to a stable slope.

2. If the soldier pile and lagging method is used for temporary earth retention, the soldier piles shall be installed by drilling. The lagging shall be seasoned hardwood, with maximum board width (vertical height) of 12 inches. The lagging boards shall be installed from the top down as the excavation advances.

3. The use of the following devices or systems are prohibited for use as temporary earth retention systems when the retention system is required to limit ground movement to protect structures, utilities, and other adjacent facilities.

   a. soldier piles with plate lagging
   b. slide rail systems
   c. trench shields i.e. trench boxes (trench shields are considered worker protection only, not temporary earth retention systems)

4. The above prohibition does not prevent Contractor from using soldier piles with plate lagging, slide rail systems, and trench shields to protect workers in an excavation.

5. Excavation support systems and sheeting and shoring shall be all removed after completion of work.

I. Foundation Subgrade Preparation

1. Subgrades for foundations shall be prepared using the same procedure as required for fills and embankments. However, Pump Station foundation areas requiring cut shall be undercut an additional 2 ft. and replaced with compacted select fill as specified herein.

2. After preparation, foundation subgrades shall be firm, dense, and thoroughly compacted and consolidated; and shall be sufficiently stable to remain firm and intact under the feet of the workers. Reinforcing steel and concrete shall be placed as soon as possible after subgrade preparation. Subgrades that are disturbed due to weather or other conditions shall be repaired by removing the disturbed material and replacing with crushed rock select fill. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

J. Roadway Excavation

1. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the Drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 12 inches and shall meet the following:

Test method to determine maximum density and moisture.	ASTM D698.
Relative compaction and moisture content relative to the optimum.	95%.
Moisture content relative to the optimum.	% to +3%.

2. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

3.3 FILLS AND EMBANKMENTS

A. Fills and embankments shall be constructed to the lines and grades indicated on the Drawings. Fills and backfills placed beneath and around structures shall comply with the requirements of this specification for select fill and structure backfill, respectively. Construction of fills and embankments shall begin from the lowest elevation in each excavation or area and progress upward. Materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness. Unless otherwise specified herein, the following governing standards apply:

Test method to determine maximum density and moisture.	ASTM D698.
Relative compaction.	95%.
Moisture content relative to the optimum.	

B. Where new fill is placed adjacent to an existing sloping surface steeper than 5 horizontal to 1 vertical, the existing slope shall be benched in advance of placement of new fill. The bench shall be of sufficient width to allow compaction of the junction between the new fill and existing earth surface.

C. Backfilling of excavations and construction of fills and embankments during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

D. Subgrade Preparation

1. After preparation of the fill or embankment site, the subgrade shall be scarified and moisture conditioned to a minimum depth of 6 inches, leveled and compacted to the same relative compaction and moisture content relative to optimum as specified for fill.

2. Unless otherwise directed by Engineer, the subgrade shall be proof-rolled by a rubber-tired roller, a loaded dump truck, or other suitable rubber-tired equipment acceptable to Engineer. A minimum of four passes of the proof-rolling equipment shall be provided such that the last two passes are made perpendicular to the first two passes.

3. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with compacted fill.

E. Placement and Compaction

1. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches in un-compacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

2. Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried to achieve the moisture content relative to optimum as specified above, and shall be thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to the required degree of compaction at the required moisture content. If the material fails to meet the density specified, compaction methods shall be altered. The

changes in compaction methods shall include, but not be limited to, changes in compaction equipment, reduction in uncompacted lift thickness, increase in number of passes, and better moisture control.

3. Wherever a pipe is to installed within a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench for pipe installation is excavated.

4. Fills and embankments over reservoir or basin roof slabs shall be placed and compacted by using methods that will not damage or overload the structure; compaction in addition to that attained by placement operations will not be required. Rubber-tired equipment shall be used insofar as possible. Individual items of equipment operated on reservoir or basin roof slabs shall not have loaded weight in excess of 14,000 lbs and shall be so operated that no impact loads are imposed on the structure. Fill material shall not be piled on the roof slab to a depth greater than 12 inches above finished grade elevation. Fill construction shall begin at the walls, and construction equipment shall operate on a layer of fill material at least 12 inches deep. Special care shall be taken to avoid damaging or disturbing any roofing membrane, tile drains, or granular fill material.

F. Borrow Pits

1. Borrow pits are not permitted.

3.4 FILL AND BACKFILL FOR STRUCTURES

A. Earth and aggregate materials placed for structures include granular fill, structure backfill, select fill, gravel base beneath slabs, and controlled low strength material In addition to the specific requirements specified herein, all requirements for placement of fills and embankments shall apply to granular fill, structure backfill, select fill, and gravel base beneath slabs. These requirements include, but are not limited to subgrade preparation, lift thickness, and moisture conditioning requirements. All fills and backfills for structures shall be constructed to the lines and grades indicated on the Drawings. Backfilling and construction of fills during freezing weather shall not be done. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

B. Granular Fill

1. Granular fills shall be provided where indicated on the Drawings. Granular fills shall be placed on suitably prepared sub-grades in uncompacted lift thickness of 6 inches or less and compacted by vibration. Granular fills shall be compacted to not less than 70 percent relative density as determined by ASTM D4253 and D4254. If the thickness of the granular fill is less than 6 inches, the compaction shall be by a minimum four passes (round trips) of a self-propelled or walk-behind type vibratory roller operating in full vibration mode in accordance with manufacturer's instructions.

2. Where granular fills are to be covered with concrete, the top surface shall be graded to the required sub-grade elevation. The completed fill shall be covered by polyethylene film.

C. Structure Backfill

1. Backfill materials shall be deposited in approximately horizontal layers not to exceed 8 inches in uncompacted thickness and shall meet the following requirements:

Test method to determine maximum density and moisture.	ASTM D698.
Relative compaction.	.100 %, 95% for clay cap structure backfill.
Moisture content relative to the optimum.	-3% to +3%, 0% to =3% for clay cap structure backfill.

2. Compaction of structure backfill shall be performed in such a manner that damage to the structure is prevented. The compaction equipment used within 8 feet of the walls and for the top 8 feet of backfill shallhave no restriction on type. Limit of equipment weight shall be 2 ton. Compaction of structure backfill by inundation with water will not be permitted.

3. No backfill shall be deposited or compacted in water.

4. Care shall be taken to compact structure backfill which will be beneath pipes, drives, roads, parking areas, walks, curbs, gutters, or other surface construction or structures. In addition, wherever a pipe is to be installed within structure backfill, the structure backfill shall be placed and compacted to an elevation not less than 12 inches above the top of pipe before the trench for pipe installation is excavated. Compacted areas, in each case, shall be adequate to support the item to be constructed or placed thereon.

D. Select Fill

1. Select fill shall be placed in approximately horizontal layers in uncompacted lift thickness of 8 inches or less and shall meet the following requirements:

Test method to determine maximum density and moisture.	ASTM D698.
Relative compaction.	100 %.
Moisture content relative to the optimum.	-3 % to +3%.

E. Gravel Base Beneath Slabs

1. The gravel base beneath building floor slabs shall be placed in uncompacted lift thickness of 6 inches or less and compacted with a minimum of four passes (round trips) of a self-propelled or walk-behind type vibrating roller. The roller shall be operated in the full vibrating mode and in accordance with the manufacturer's instructions.

F. Controlled Low Strength Material (CLSM) Fill

1. CLSM shall not be placed on frozen ground. Batching, mixing, and placing of CLSM may be started when weather conditions are favorable and when the temperature is at least 34°F and rising. At time of placement of CLSM the temperature shall be at least

40°F. Mixing and placing shall stop when the temperature is 38°F and falling. Each filling stage shall be as continuous an operation as is practicable.

2. CLSM shall be discharged from the mixer by an acceptable procedure into the area to be filled. CLSM shall be placed to limits indicated on the Drawings. Mixing CLSM with in-situ soil shall be avoided.

3. When CLSM is placed over culverts or pipelines, they shall be anchored to prevent flotation during the placement of CLSM. Unless otherwise required, CLSM shall be placed to one foot below the finished grade elevation if the finished grade elevation is not more than 5 feet over the top of the culvert or pipe. If the finished grade is more than 5 feet over the top of the culvert or pipe, CLSM shall be placed to an elevation 2 feet over the top of the culvert or pipe, and the remainder shall be backfilled with the specified backfill or as indicated on the Drawings.

3.5 FILTER FABRIC INSTALLATION

A. Filter fabric shall be placed as specified herein and at the locations specified or otherwise indicated on the Drawings.

B. Filter fabric shall be protected from contamination by foreign material and damage. Any contaminated or damaged filter fabric shall be replaced with new filter fabric at no additional cost to the Owner. The fabric shall be covered within 7 calendar days after placement.

C. The subgrade for placement of filter fabric shall be smooth and free of irregularities and undulations. Filter fabric shall be laid smooth and free of tension, stress, folds, wrinkles, or creases. Type A filter fabric shall be overlapped a minimum of 2 feet between adjacent roll ends and adjacent strips.

D. All filter fabric placed shall be fixed to the subgrade to prevent filter fabric slippage or movement during placement of subsequent materials. Pins or staples shall not be used to fix the filter fabric to the subgrade when a geomembrane is to be placed on top of the filter fabric.

E. The Contractor shall exercise care during filter fabric installation to prevent damage to the prepared supporting subgrade surface. The Contractor shall exercise care to prevent the entrapment of rocks, clods of earth or other material which could damage the filter fabric, clog the filter fabric or hamper seaming. Filter fabric damaged or distressed by foreign objects shall be repaired or replaced.

F. No foot traffic will be allowed on the filter fabric except with approved smooth-sole shoes. The Contractor shall not use the filter fabric surface as a work area or storage area for tools and supplies.

G. Tracked or rubber tired construction equipment shall not be operated directly upon the filter fabric until a minimum thickness of 6 inches of the cover material is placed over the filter fabric. Turning of construction vehicles shall be minimized to avoid distorting or damaging the filter fabric. All damaged filter fabric shall be replaced at Contractor's expense.

3.6 FINAL GRADING AND PLACEMENT OF TOPSOIL

A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Any additional topsoil required to provide the required minimum thickness shall be at no additional cost to the Owner.

B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris. Seeding and sod placement shall be in accordance with specification Section 02930.

3.7 DISPOSAL OF EXCAVATED MATERIALS

A. Suitable excavated materials may be used in fills and embankments as needed. Excess material shall be disposed of at the locations indicated on the Drawings; all such material shall be graded for drainage but need not be compacted.

B. All debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, Contractor.

3.8 SETTLEMENT

A. Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.

B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section

TEMPORARY EXCAVATION
DESIGN CERTIFICATE – Figure 1 - 02200

I, the undersigned professional engineer licensed in the state where the earthwork is located, hereby certify that the temporary excavation for the _____(structure name) excavation at _____ (structure location) has been designed by me, is appropriate for the _____ (structure name), as represented to me, and is in compliance with the Contract Documents (including protecting adjacent structures, utilities, and other facilities from damage, and not providing a temporary earth retention design to Contractor that includes soldier piles with steel plate lagging, slide rail systems, and trench shields).

Name: _____ State of License: _____

Signature: _____ P.E. Number _____

Date: _____

_____
(Seal)

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SECTION 02202 - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching; tunneled (trenchless construction) crossings; the handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary; protection of adjacent property; backfilling; pipe embedment; surfacing and grading; and other appurtenant work.

1.2 GENERAL

A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a licensed or registered professional engineer, to act upon all pertinent matters of the work of this section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the Submittals Procedures section.

B. Certifications.

1. At least 30 days before starting construction on the sheeting and shoring, and in accordance with the OSHA requirements identified above, the Contractor shall ensure that the sheeting and shoring design engineer shall complete and submit to Engineer the WTR-FM-EN-1001, Protective System Design Certificate -2 and the Contractor shall use the sheeting and shoring design. If required by the OSHA requirements identified above or to protect existing facilities, the Contractor shall submit a separate certificate for each unique design. If required for protection of existing facilities or as required by the OSHA regulations identified above, the certificate(s) shall be signed and sealed by the registered professional engineer that designed the protection system.

C. Filter Fabric Data

1. Complete descriptive and engineering data for the fabric shall be submitted. Data submitted shall include:

a. A 12 inch square sample of fabric.

b. Manufacturer's descriptive product data.
c. Installation instructions.

D. Embedment and Backfill Materials

1. Complete test results covering tests performed by an independent commercial testing laboratory retained by the Contractor for all materials described in the Materials Testing section shall be submitted.

1.4 BASIS FOR PAYMENT

A. Trench Sheeting

1. No additional payment above the Contract Price will be made for trench sheeting left in place.

1.5 INSURANCE

A. Professional liability insurance shall be provided as specified in the General Conditions section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Filter Fabric

1. The fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust, and debris.

2. Filter Fabric Type A

a. Filter fabric Type A shall be provided for installation at locations indicated on the Drawings and as specified herein. Filter Fabric Type A shall be a nonwoven fabric consisting of only continuous chains of polymeric filaments or yarns of polyester formed into a stable network by needle punching. The fabric shall be inert to commonly encountered chemicals; shall be resistant to mildew, rot, ultraviolet light, insects, and rodents; and shall have the indicated properties:

Property	Test Method	Unit	Minimum Average Roll Value *
Fabric Weight	ASTM D3776	oz/yd^2	5.7
Grab Strength	ASTM D4632	lb	155
Grab Elongation	ASTM D4632	percent	50
Mullen Burst Strength	ASTM D3786	psi	190

Property	Test Method	Unit	Minimum Average Roll Value *
Apparent Opening Size	CW-02215	U.S. Standard Sieve Size	70

* Minimum average roll value in weakest principal direction.

B. Polyethylene Film

1. Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.

C. Backfill Materials

1. Job Excavated Material

a. Job excavated material may be used for either uncompacted or compacted trench backfill when the job excavated material is finely divided and free from debris, organic material, cinders, corrosive material, and stones larger than 3 inches in greatest dimension. Masses of moist, stiff clay shall not be used.

2. Granular Fill

a. Granular fill material shall be crushed rock or gravel. Granular fill shall be free from dust, clay, and trash; shall be hard, durable, and non-friable; and shall be graded 3/4 inch to No. 4 as defined in ASTM C33 for No. 67 coarse aggregate. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate.

D. Controlled Low Strength Material (CLSM) Fill

1. CLSM shall consist of a mixture of Portland cement, fly ash, sand, and water and shall be placed at locations indicated on the Drawings or as directed by Engineer. The class of CLSM shall be as specified below.

2. The type of cement in CLSM shall be ASTM C150 Type I.. The class of fly ash in CLSM shall be ASTM C618 Class C, except loss on ignition shall not exceed 4 percent. Fine aggregate in CLSM shall be clean natural sand, ASTM C33, except that clay particles shall not exceed one percent. Water in CLSM shall be potable.

3. Contractor shall design and test the CLSM and submit the mix design and test results to Engineer for review and acceptance. Initial set time shall be 8 hours plus or minus one hour as determined by ASTM C403. CLSM shall have an efflux time of 10 to 26 seconds through a special flow cone with a 1/2 inch discharge tube.

4. The batch proportions accepted by Engineer shall apply only for materials from the same source and having the same characteristics as the materials used in the mix design. Materials from any other source shall be used only with the acceptance of Engineer. If a change in sources of materials is proposed, a new mix design shall be developed by Contractor before the new material is used. When unsatisfactory results or other

conditions make it necessary, Contractor shall develop a new mix design to obtain the desired results.

5. During the progress of the work, no change shall be made in the batch proportions of the ingredients without the acceptance of Engineer.

6. Class B CLSM

   a. The initial trial mixture for Class B CLSM shall consist of the following minimum proportions per cubic yard:

Cement	100 lb
Fly Ash	100 lb
Sand (SSD)	2760 lb
Water	386 lb
Air Entraining Agent	5 percent
Compressive strength Range at 56 days	125-250 psi

E. Pipe Embedment Material

1. Pipe embedment material shall be placed as indicated in Figure 1-02202.

2. Granular Embedment

   a. Granular embedment shall consist of crushed rock and crushed gravel, meeting the quality and gradation requirements of coarse aggregate size number 7 of ASTM C33.

3. Hand Placed Embedment

   a. Hand placed embedment shall be finely divided job excavated or imported material, free from organic materials, debris, and stones.

4. Compacted Embedment

   a. Compacted embedment shall be finely divided job excavated material free from debris, organic material, and stones. Graded gravel may be substituted for compacted embedment. Granular embedment may be substituted for all or part of the compacted embedment at the option of the Contractor.

2.2 MATERIALS TESTING

A. Preliminary Review of Materials

1. As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of embedment, fill, backfill, or other material, and one additional gradation test shall be made for each additional 500 tons of each material delivered to the site. In addition, one set of initial Atterberg Limits test shall be made for each fill materials containing more than 20 percent by weight passing the No. 200 sieve. One additional Atterberg Limits test shall be made for each additional 500 tons of each material delivered to the site.

2. All material testing on CLSM shall be made by an independent testing laboratory at the expense of Contractor.

B. Field Testing Expense

1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory at the expense of Owner . Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

C. Required Tests

1. For planning purposes, the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as specified in the Submittals Procedures section.

   a. Two moisture density (Proctor) tests in accordance with ASTM D698 (or, when required, ASTM D1557), or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general fill, designated fill, backfill, or other material proposed.
   b. In-place field density and moisture tests (ASTM D6938) at intervals of 1000 feet maximum along the trench.
   c. One in-place field density and moisture test (ASTM D6938) for every 200 cubic yards of backfill.
   d. One in-place density and moisture test (ASTM D6938) whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
   e. Additional gradation, Proctor, and relative density tests whenever the source or quality of material changes.
   f. Testing of CLSM shall be as follows:

      1) Compressive Strength. For every 200 cubic yards of CLSM placed, fill four 6 by 12 inch plastic cylinder molds to overflowing and then tap sides lightly. Cure cylinders in the molds covered until time of testing, at least 14 days. Strip the cylinders carefully using a knife to cut away the plastic mold. Cap the cylinders with high strength gypsum plaster or other capping process that will not break these low strength materials. Test cylinders in

accordance with ASTM C39. Two cylinders shall be tested at 7 days and the other two cylinders shall be tested at 56 days.

2) Flow of Fill. Once each day that CLSM is placed, test the fill material in accordance with ASTM C939 for the efflux time. Wet screening may be required to remove coarse particles.
3) Unit Weight and Yield. Once each day that CLSM is placed, determine unit weight and yield in accordance with ASTM C138.
4) Air Content. Once each day that CLSM is placed, determine air content in accordance with ASTM C231.
5) Penetration Resistance. Once each day that CLSM is placed, determine early bearing strength in accordance with ASTM C403 penetration procedure.

PART 3 - EXECUTION

3.1 CLEARING

A. All clearing shall be performed as necessary for access, stringing of pipeline materials, and construction of the pipeline and appurtenant structures.

3.2 EXCAVATION

A. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.

B. Subgrade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon.

C. Except where exterior surfaces are specified to be damp-proofed, monolithic concrete manholes and other concrete structures or parts thereof, which do not have footings that extend beyond the outside face of exterior walls, may be placed directly against excavation faces without the use of outer forms, provided that such faces are stable and also provided that a layer of polyethylene film is placed between the earth and the concrete.

D. Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches clearance is provided for outside plastering.

E. Classification of Excavated Materials

1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

F. Preservation of Trees

1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by Owner. Trees left standing shall be adequately protected from permanent damage by construction operations.

2. For limits of tree removal along pipeline routes, see the Temporary Facilities section under "Protection of Public and Private Property".

G. Blasting

1. Blasting or other use of explosives for excavation will not be permitted.

H. Dewatering

1. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure or tunnel to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

2. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 12 inches, beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.

3. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.

4. Contractor shall be responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

5. Contractor shall obtain from the appropriate agencies and authorities, the dewatering and stormwater discharge permits required to remove and dispose of groundwater, surface water, and any other water used in Contractor's operations. The permits shall be obtained prior to start of construction.

I. Sheeting and Shoring

1. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported with steel sheet piling and shoring as necessary to prevent caving or sliding.

2. Sheet piling or other excavation support systems shall be installed as necessary to limit the extent of excavations for deeper structures and to protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for, and shall install adequate protection systems for prevention of damage to existing facilities.

3. Sheeting, shoring and excavation support systems shall be designed by a professional engineer registered in the state where the project is located.

4. Trench sheeting may be removed if the pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting. Trench sheeting shall not be pulled after backfilling. Where trench sheeting is left in place, it shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed. Trench sheeting shall be removed unless, in the opinion of Engineer, removal of the sheeting will cause damage to the facility it is protecting or loss of necessary piping support from the piping embedment. If left in place, the sheeting shall cut off 12 inches below finished grade. The design of the support system shall be such as to permit complete removal while maintaining safety and stability at all times.

5. A movable trench support may be used, provided care is exercised in placing and moving the trench box or support bracing to prevent movement of the pipe and bedding and backfill material meets the required compaction without voids.

J. Stabilization

1. Sub-grades for concrete structures and trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.

2. Sub-grades for concrete structures or trench bottoms which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the Drawings.

3.3 TRENCH EXCAVATION

A. No more trench shall be opened in advance of pipe laying than is necessary to expedite the work. One block or 400 feet, whichever is the shorter, shall be the maximum length of open trench on any line under construction.

B. Except where tunneling is indicated on the Drawings, is specified, or is permitted by Engineer, all trench excavation shall be open cut from the surface.

C. Prior to excavation, Contractor shall contact local underground alert hotlines, “Dig Safe” and/or individual utility owners for marking underground utilities. Once utilities are marked, Contractor shall hand dig or pothole to expose the existing utilities. A survey shall be made of the utility size, material, location, and elevation prior to trench excavation and information shall be recorded on the record Drawings maintained by the Contractor.

D. Alignment, Grade, and Minimum Cover

1. The alignment and grade or elevation of each pipeline shall be fixed and determined from offset stakes. Vertical and horizontal alignment of pipes, and the maximum joint deflection used in connection therewith, shall be in conformity with requirements of the section covering installation of pipe.

2. Where pipe grades or elevations are not definitely fixed by the Drawings, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe of 36 inches over pipes below paved and graded streets and, of 36 inches over pipes in other locations. Greater pipe cover depths may be necessary on vertical curves or to provide adequate clearance beneath existing pipes, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades. Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finished ground or pavement surface elevation, except where future surface elevations are indicated on the Drawings.

E. Maximum Trench Widths

1. Maximum trench widths shall be limited as indicated in Schedule 02202-S01 for designated conduits. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment. However, the limiting trench widths from the bottom of the trench to an elevations 12 inches above the top of installed pipe, and the minimum permissible sidewall clearances between the installed pipe and each trench wall, shall be as indicated in Schedule 02202-S01 or on the Drawings.

2. Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.

3. Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits. Slopes shall not extend lower than 12 inches above the top of the pipe.

4. If, for any reason, the width of the lower portion of the trench, as excavated at any point, exceeds the maximum permitted, pipe of adequate strength, special pipe embedment, or concrete arch encasement, for the applicable loading conditions and with the concurrence of Engineer, shall be furnished and installed by and at the expense of Contractor.

F. Minimum Trench Widths

1. Except when maximum trench width is required for certain conduits, trenches shall be excavated to the minimum trench widths indicated in the following table. Trenches shall be excavated to a width which will provide adequate working space and sidewall clearances for proper pipe installation, jointing, and embedment.

Nominal Pipe Size	Minimum Trench Width	Clearance
Less than 27 in	Pipe OD plus 24 in	12 in
27 in through 60 in	Pipe OD plus nominal pipe size	ID/2

Clearance = Minimum sidewall clearance
OD = Outside diameter (or span) of conduit
ID = Inside diameter (or span) of conduit.

2. Specified minimum sidewall clearances are not minimum average clearances but are minimum clear distances which will be required to the trench excavation or the trench protective system.

3. Cutting trench banks on slopes to reduce earth load to prevent sliding and caving shall be used only in areas where the increased trench width will not interfere with surface features or encroach on right-of-way limits.

G. Mechanical Excavation

1. The use of mechanical equipment will not be permitted in locations where its operation would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand excavating methods shall be used.

2. Mechanical equipment used for trench excavation shall be of a type, design, and construction, and shall be so operated, that the rough trench excavation bottom elevation can be controlled, and that trench alignment is such that pipe, when accurately laid to specified alignment, will be centered in the trench with adequate sidewall clearance. Undercutting the trench sidewall to obtain sidewall clearance will not be permitted.

3. In locations where maximum trench widths are required for designated rigid conduits, mechanical equipment shall be operated so that uniform trench widths and vertical sidewalls are obtained at least from an elevation 12 inches above the top of the installed pipe to the bottom of the trench.

H. Excavation Below Pipe Sub-grade

1. Except where otherwise required, pipe trenches shall be excavated below the underside of the pipe, as indicated on Figure 1-02202, to provide for the installation of granular embedment.

2. Bell holes shall provide adequate clearance for tools and methods used for installing pipe. No part of any bell or coupling shall be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

I. Artificial Foundations in Trenches

1. Whenever unsuitable or unstable soil conditions are encountered, Contractor shall notify Engineer immediately. When authorized by the Engineer , trenches shall be excavated below grade and the trench bottom shall be brought to grade with suitable material. In such cases, adjustments will be made in the Contract Price in accordance with the provisions of the General Conditions.

J. Over-Excavation

1. Over-excavation carried below the grade, unless authorized by the Engineer, shall be backfilled to the required grade with material acceptable to the Engineer and compacted to the satisfaction of the Engineer, at no additional cost to the Owner.

3.4 PIPE EMBEDMENT

A. Embedment materials both below and above the bottom of the pipe, classes of embedment to be used, and placement and compaction of embedment materials shall conform to the requirements indicated on Figure 1-02202 and to the following supplementary requirements.

B. Embedment material shall contain no cinders, clay lumps, or other material which may cause pipe corrosion.

C. Embedment Classes.

1. Class A Arch Encasement. Not used.
2. Class B Embedment. Class B bedding shall be used for all steel, ductile iron, and for all other pipelines not otherwise specified.
3. Class B Special Embedment. Not used.
4. Class C Embedment. Class C embedment shall be used for all reinforced concrete pipelines.

D. Embedment for Ductile Iron, Steel, FRP, and PVC Pipelines

1. Granular embedment for polyethlene tube protected ductile iron, coal tar or tape coated steel, and PVC pipelines shall be crushed rock or crushed gravel with rounded or subrounded particles. Crushed rock or gravel with sharp edges which could cause significant scratching or abrasion of the pipe or damage to the coating or polyethylene tube protection shall not be used unless otherwise approved by Engineer and all damage is repaired to the satisfaction of Engineer.

2. Inundated sand may be used for granular embedment in locations where the use of water will cause no damage to adjacent property and where it can be placed and properly compacted without damage to the pipe.

3. Inundated sand for granular embedment shall be deposited in, or placed simultaneously with the application of water so that the sand is inundated during compaction. During placement, the sand shall be compacted with a mechanical probe type vibrator. Water shall be allowed to escape or shall be removed during vibration, and no ponding shall be allowed to take place. Inundated sand shall be compacted to 70 percent relative density as determined by ASTM D4253 and D4254. If the required density cannot be achieved, placement and compaction methods shall be altered.

E. Placement and Compaction

1. Granular Embedment

a. Granular embedment material shall be spread and the surface graded to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. It will be permissible to slightly disturb the finished subgrade surface by withdrawal of pipe slings or other lifting tackle.
b. After each pipe has been graded, aligned, and placed in final position on the bedding material, and shoved home, sufficient pipe embedment material shall be deposited and compacted under and around each side of the pipe and back of the bell or end thereof by shovel slicing or other suitable methods to hold the pipe in proper position and alignment during subsequent pipe jointing and embedment operations.
c. Placing and compaction of embedment material shall not damage the pipe coating or polyethylene encasement. Embedment material shall not be dumped directly on the pipe or polyethylene encasement unless a suitable temporary isolation layer such as a 60 mil HDPE sheeting, is used to cover the pipe and polyethylene encasement.
d. Embedment material shall be deposited and compacted uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
e. Granular embedment shall be placed in layers not more than 6 inches deep and compacted as specified.
f. Each lift of granular embedment material shall be vibrated with a mechanical probe type vibrator or shovel sliced during placement to ensure that all spaces beneath the pipe are filled. Granular embedment shall be placed in maximum lift thickness of 6 inches and compacted. Each lift of embedment material shall be compacted with three passes (round trip) of a platform type vibrating compactor and to at least 70 percent relative density as determined by ASTM D4253 and D4254.

2. Compacted Embedment

a. Compacted embedment shall be placed in uniform layers not more than 8 inches thick and compacted to not less than 95% maximum density as determined by ASTM D698.
b. Where Class C embedment is required, compacted embedment shall be placed to the top of the pipe in all areas where compacted trench backfill is specified and around restrained pipe sections. Placing and compaction of embedment shall not damage the pipe or coating.

3. Hand Placed Embedment

a. Hand placed embedment shall be placed by hand shovels or using methods that prevent dropping the material for more than 24 inches above the pipe. Hand placed embedment shall be lightly tamped using hand equipment. Care shall be taken so as to not damage the pipe or coating.

4. Compaction - Trench Box Support Systems

a. Where trench box support systems are used embedment compaction shall be performed outside the limits of the trench box so that relocating the trench box will not disturb the compacted embedment. Where necessary to protect workers, the compaction may be performed by compaction rollers or other compaction systems that are operated from above the trench and achieve the required compaction.
b. Trench boxes for earth trenches shall be positioned such that the bottom of the trench box is no lower than approximately two feet above the bottom of pipe invert elevation so that initial compaction of the haunch area of the pipe, from within the trench box, extends the full width of trench. Trenches shall be shaped to support the trench box above the bottom of trench.
c. When in rock and where it is not practicable to shape the trench to provide the trench box support above the bottom of the trench, initial compaction of the haunch area may be performed within the trench box.
d. Final compaction of the haunch area and all other compaction shall be performed outside the limits of the trench box after the trench box has advanced into the next section of trench..

3.5 TRENCH BACKFILL

A. All trench backfill above pipe embedment shall conform to the following requirements.

B. Compacted Backfill

1. Compacted backfill will be required for the full depth of the trench above the embedment in the following locations:

   a. Where beneath pavements, surfacings, driveways, curbs, gutters, walks, or other surface construction or structures.
   b. Where in street, road, or highway shoulders.
   c. In established lawn areas.

2. The top portion of backfill beneath established lawn areas shall be finished with at least 12 inches of topsoil corresponding to, or better than that which is underlying adjoining lawn areas.

3. Trench backfill material shall be suitable job excavated material or graded gravel and shall be as specified herein.

4. Job Excavated Material

   a. Job excavated materials shall be placed in uniform layers not exceeding 8 inches in uncompacted thickness. Each layer of material shall have the best possible moisture content for satisfactory compaction. The material in each layer shall be wetted or dried as needed and thoroughly mixed to ensure uniform moisture content and adequate compaction. Increased layer thickness may be permitted for noncohesive material if Contractor demonstrates to the satisfaction of Engineer that the specified compacted density will be obtained. The method of compaction and the equipment used shall be appropriate for the material to be compacted and shall not transmit damaging shocks to the pipe. Job excavated material shall be compacted to 95 percent of maximum density at a moisture content within 2

percent of the optimum moisture content as determined by ASTM D698 when that test is appropriate, or to 70 percent relative density as determined by ASTM D4253 and D4254 when those tests are appropriate.

5. Graded Gravel

   a. Gravel backfill shall be deposited in uniform layers not exceeding 12 inches in uncompacted thickness. The backfill shall be compacted with a suitable vibratory roller or platform vibrator to at least 70 percent relative density as determined by ASTM D4253 and D4254.
   b. Groundwater barriers specified under pipe embedment shall extend to the top of the graded gravel backfill.

C. Ordinary Backfill

1. Compaction of trench backfill above pipe embedment in locations other than those specified will not be required except to the extent necessary to prevent future settlement. Contractor shall be responsible for backfill settlement as specified.

2. Ordinary earth backfill material to be placed above embedments shall be free of brush, roots more than 2 inches in diameter, debris, cinders, and any corrosive material, but may contain rubble and detritus from rock excavation, stones, and boulders in certain portions of the trench depth.

3. Backfill material above embedments shall be placed by methods which will not impose excessive concentrated or unbalanced loads, shock, or impact on installed pipe, and which will not result in displacement of the pipe.

4. Compact masses of stiff clay or other consolidated material more than 1 cubic foot in volume shall not be permitted to fall more than 5 feet into the trench, unless cushioned by at least 2 feet] of loose backfill above pipe embedment.

5. No trench backfill material containing rocks or rock excavation detritus shall be placed in the upper 18 inches of the trench, nor shall any stone larger than 8 inches in its greatest dimension be placed within 3 feet of the top of pipe. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill settlement will result.

D. Water-Settled Earth Backfill

1. Settlement or consolidation of trench backfill using water jetting or ponding shall not be performed.

E. Structure Backfill

1. Backfill around manholes and small concrete vaults shall meet the requirements specified for structure backfill specified in the Excavation and Fill for Structures section.

F. Controlled Low Strength Material (CLSM)

1. CLSM shall not be placed on frozen ground. Batching, mixing, and placing of CLSM may be started when weather conditions are favorable and when the temperature is at least 34°F and rising. At time of placement, CLSM shall have a temperature of at least 40°F. Mixing and placing shall stop when the temperature is 38°F and falling. Each filling stage shall be as continuous an operation as is practicable.

2. CLSM shall be discharged from the mixer by an acceptable procedure into the area to be filled. CLSM shall be placed to limits indicated on the Drawings. Mixing CLSM with in-situ soil shall be avoided.

3. When CLSM is placed over culverts or pipelines, they shall be anchored to prevent flotation during the placement of CLSM. Unless otherwise required, CLSM shall be placed to one foot below subgrade elevation if the subgrade elevation is not more than 5 feet over the top of the culvert or pipe. If the subgrade is more than 5 feet over the top of the culvert or pipe, CLSM shall be placed to an elevation 2 feet over the top of the culvert or pipe, and the remainder shall be backfilled with soil designated by Engineer.

3.6 DRAINAGE MAINTENANCE

A. Trenches across roadways, driveways, walks, or other trafficways adjacent to drainage ditches or watercourses shall not be backfilled prior to completion of backfilling the trench on the upstream side of the trafficway, to prevent impounding water after the pipe has been laid. Bridges and other temporary structures required to maintain traffic across such unfilled trenches shall be constructed and maintained by Contractor. Backfilling shall be done so that water will not accumulate in unfilled or partially filled trenches. All material deposited in roadway ditches or other watercourses crossed by the line of trench shall be removed immediately after backfilling is completed, and the original section, grades, and contours of ditches or watercourses shall be restored. Surface drainage shall not be obstructed longer than necessary.

3.7 PROTECTION OF TRENCH BACKFILL IN DRAINAGE COURSES

A. Where trenches are constructed in ditches or other watercourses, backfill shall be protected from surface erosion. Where the grade of the ditch exceeds 1 percent, or as otherwise required, ditch checks shall be installed. Unless otherwise indicated on the Drawings, ditch checks shall be concrete. Ditch checks shall extend at least 2 feet below the original ditch or watercourse bottom for the full bottom width and at least 18 inches into the side slopes, and shall be at least 12 inches thick.

3.8 FINAL GRADING AND PLACEMENT OF TOPSOIL

A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas which are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas which have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of at least 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth. Topsoil required to provide the minimum thickness shall be imported and placed at no additional cost to the Owner.

B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.

C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3.9 DISPOSAL OF EXCESS EXCAVATED MATERIALS

A. Disposal of excess material from trench excavations shall be accomplished as specified in the Excavation and Fill for Structures section of the Specifications for the major construction.

B. Broken concrete and other debris resulting from pavement or sidewalk removal, excavated rock in excess of the amount permitted to be installed in trench backfill, debris encountered in excavation work, and other similar waste materials shall be disposed of away from the site.

3.10 RESODDING

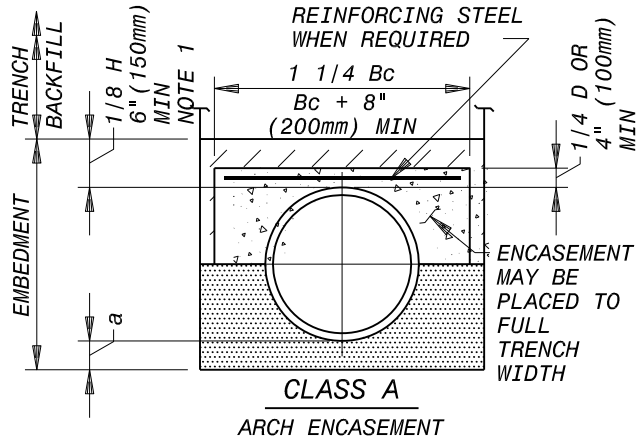
A. All established lawn areas cut by the line of trench or damaged during the work shall be re-sodded, after completion of construction, to the complete satisfaction of the property owner and Owner. All sod used shall be the same type as removed or damaged, shall be best quality, and, when placed, shall be live fresh growing grass with at least 1-1/2 inches of soil adhering to the roots. See Section 02930 for additional requirements.

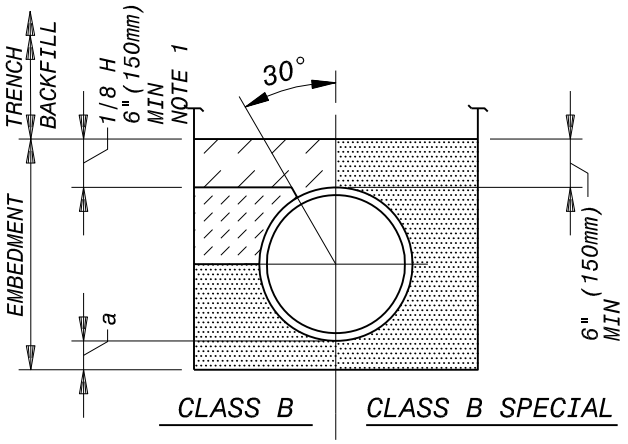
3.11 SETTLEMENT

A. Contractor shall be responsible for all settlement of trench backfill which may occur within the correction period stipulated in the General Conditions.

B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from Engineer or Owner.

End of Section





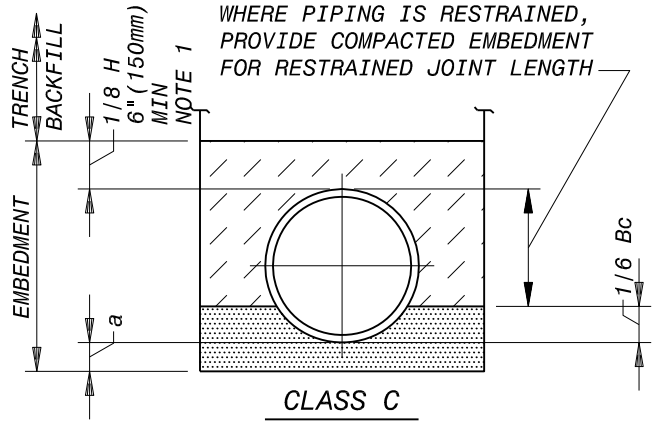


TABLE OF EMBEDMENT DEPTHS BELOW PIPE

D	a MIN SOIL		a MIN ROCK	
	in	mm	in	mm
27"(675 mm) & SMALLER	3	75	6	150
30"(750 mm) TO 60"(1500 mm)	4	100	9	225
66"(1650 mm) & LARGER	6	150	12	300

NOTES:

1. EMBEDMENT ABOVE THE TOP OF THE PIPE SHALL BE AN UNCOMPACTED LAYER FOR ALL INSTALLATIONS.
2. REFER TO SPECIFICATIONS FOR GEOTECHNICAL FABRIC OR SPECIAL EMBEDMENT REQUIREMENTS FOR TRENCHES IN FINE SOILS EXTENDING BELOW GROUNDWATER LEVEL.
3. TRENCH OUTLINES DO NOT INDICATE ACTUAL TRENCH EXCAVATION SHAPE, SOIL CONDITIONS, OR PRESENCE OF SHEETING LEFT IN PLACE. EMBEDMENT MATERIAL SHALL EXTEND THE FULL WIDTH OF THE ACTUAL TRENCH EXCAVATION.
4. FOR RESTRAINED JOINT PIPE LENGTH WITH CLASS C EMBEDMENT THE BACKFILL ABOVE THE GRANULAR EMBEDMENT AND BELOW THE TOP OF THE PIPE SHALL BE COMPACTED EMBEDMENT.

LEGEND

Bc OUTSIDE DIAMETER OF PIPE
H COVER ABOVE TOP OF PIPE
D NOMINAL PIPE SIZE
a EMBEDMENT BELOW PIPE (SEE TABLE)

HAND PLACED EMBEDMENT *

COMPACTED EMBEDMENT *

GRANULAR EMBEDMENT

CONCRETE

* OR GRANULAR EMBEDMENT

EMBEDMENTS FOR CONDUITS

BLACK & VEATCH	TRENCHING AND BACKFILLING	FIG 1-02202

PROTECTIVE SYSTEM
DESIGN CERTIFICATE – 2

I, the undersigned professional engineer registered in the state where the Project is located, hereby certify that the protection system for _____(trench location) has been designed by me, is appropriate for the (trench location) as represented to me, and is in compliance with the Contract Documents.

Name: _____ State of Registration: _____

Signature: _____ P.E. Number _____

Date: _____

_____
(Seal)

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SECTION 02512 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of labor, materials and equipment for the construction of asphaltic concrete base or binding course, bituminous tack coat, and asphaltic concrete surface or wearing course for the roadway, driveways and parking area as indicated on the Drawings.

B. Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

C. Asphaltic concrete paving shall be constructed to the lines, grades, and cross sections indicated on the drawings. Type of construction shall be as indicated on the Drawings and as specified herein.

1.2 GENERAL

A. Governing Standards

1. Except as otherwise specified or indicated, materials, equipment, details, and construction methods shall comply with the applicable Arkansas DOT provisions.

B. Coordination

1. Contractor shall coordinate the construction of asphaltic concrete paving with the excavation, the construction of concrete curb and gutters and other construction.

1.3 SUBMITTALS

A. Design Mix Reports

1. All submittals of design mix reports including design mix test results and other data, shall be in accordance with the Submittals Procedures section.

B. Submittal Schedule.

1. Design mix data as specified below.

PART 2 - PRODUCTS

2.1 MATERIALS

A. The sources of materials shall be acceptable to Engineer. Except as modified herein, materials shall conform to the requirements of the governing standards. Delivery tickets for all materials delivered to the site shall be submitted to Engineer at the end of each day during the progress of the work.

B. Asphaltic concrete materials shall be as follows:

Base Course.

Aggregate designation.	Table 303-1 of Arkansas 2014 Standard Specification for Highway Construction
Aggregate Class.	Class 7

Surface Course.

Asphalt concrete mix designation.	Table 407-1 of Arkansas 2014 Standard Specification for Highway Construction
Asphalt cement designation.	PG 76-22, 64-22, & 70-22 (1/2")

Tack coat.

Designation.	Rapid curing cut-back or emulsified asphalt
Rate.	0.30 gallon per square yard

2.2 DESIGN MIXES

A. A design mix for the asphalt base course and for the surface course, based upon the aggregates to be furnished, shall be determined by an independent testing laboratory at the expense of Contractor and shall be submitted to Engineer for review.

B. The design mixes shall be based on the Superpave Mix Design Method, and upon acceptance by Engineer, shall be the basis for the mixes to be used in asphaltic concrete pavement construction. The proposed design mix data submitted for review shall include at least the following:

1. Gyrations

   a. Nini
   b. Ndes
   c. Nmax

2. Effective voids (%)

3. Voids in mineral aggregate (%)

4. Minimum Asphalt Cement Content (%)

PART 3 - EXECUTION

3.1 EQUIPMENT

A. Equipment and facilities for storage, measuring, mixing, heating, transporting, spreading, compacting, and other operations shall be in accordance with the applicable requirements of the governing standards. Improved or modernized equipment which will produce results equal in quality to those which would result from the specified equipment will be considered for use. All equipment and facilities shall be acceptable to Engineer.

3.2 SUBGRADE PREPARATION

A. As a minimum, the top *6* inches of the subgrade shall be compacted to *95* percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing materials are placed. All subgrade and surfacing shall be sloped toward drains or outer edges.

3.3 PAVEMENTS

A. Unless otherwise specified, the new pavements to be constructed shall consist of an asphaltic concrete base course and an asphaltic concrete surface course, each of the thickness indicated on the Drawings. Asphaltic concrete base course shall be placed in compacted lifts no greater than 4 inches. Asphaltic concrete surface course shall be placed in compacted lifts no greater than 2 inches.

B. Grade control shall be maintained by Contractor by means of automatic screed controls on the paving machine and by use of erected and mobile string lines as applicable. The use of the automatically controlled paver may be waived by Engineer on irregular sections. Finished surfaces shall conform to the lines and grades indicated on the Drawings.

C. Asphaltic concrete pavements shall be constructed on previously prepared subgrades in accordance with the sections, in compliance with the governing standards.

D. Asphalt mixtures may be spread and finished by hand methods only where machine methods are impractical as determined by Engineer. Hand placed mixtures shall not be cast or otherwise manipulated in such manner that segregation occurs.

E. Minimum temperatures under which asphaltic concrete pavements may be constructed shall be as stipulated in the governing standards.

3.4 REPAIR OF DEFECTS

A. Contractor shall remove and replace defective areas by cutting to the full depth of the course. Cuts shall be made perpendicular and parallel to the direction of traffic with edges vertical.

B. A tack coat shall be applied to all exposed surfaces. The area shall be filled with fresh hot asphaltic concrete mix in lifts of the same depths as the adjacent area, then compacted by rolling to specified surface density and smoothness.

3.5 CLEANING

A. After completion of paving operation, all areas shall be cleaned of excess spilled asphalt materials to the satisfaction of Engineer.

3.6 PROTECTION

A. In addition to the requirements for protection stipulated in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.

B. Special care shall be taken to prevent tack or other asphalt materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

SECTION 02522 - CONCRETE SIDEWALK, CURB, AND GUTTER

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the construction of concrete sidewalks, curb and gutter. This section also covers the reconstruction of concrete sidewalks, curb, and gutter.

B. Subgrade preparation shall be as indicated in the Excavation and Fill for Structures section, unless otherwise specified in the governing standards or herein.

1.2 GENERAL

A. All existing sidewalks, and curb and gutters disturbed or damaged during construction of new work, or indicated on the Drawings to be demolished and replaced shall be reconstructed to the lines, grades, and cross sections indicated on the Drawings. Damaged curbs, sidewalks and/or gutters shall be to restored to their original locations, cross sections, and style unless indicated otherwise on the Drawings.

B. Contractor shall be responsible to remove, construct, reconstruct, and adjust as necessary all existing or new manhole tops, curb and gutter, and area drainage structures to match new grades as needed.

C. Governing Standards

1. Except as otherwise specified or indicated on the Drawings, materials, equipment, details, and construction methods shall comply with the applicable Arkansas DOT standards.

PART 2 - PRODUCTS

2.1 MATERIALS

A. **[**The sources of materials shall be acceptable to Engineer. **]**Except as otherwise modified herein, materials shall conform to the requirements of the governing standards.

B. Concrete materials shall be as follows:

Sidewalks, Curbs, and Gutters

Concrete designation.	City of Springdale Standard Specification Section Division 600 Class A
Portland cement designation.	*AASHTO M85 Type 1*
Membrane curing compound.	*AASHTO M148, Type I-D or Type 2*

2.2 DESIGN MIXTURE DATA

A. The design mixture shall be as follows:

Cement content.	*5.5*	bags\/yd³
Water content.	*6.5*	gallons/bag
Consistency (slump).	*1-4*	
Compressive strength (28 days).	*3,000*	

PART 3 - EXECUTION

3.1 SUBGRADE PREPARATION

A. As a minimum, the top 6 inches of the subgrade shall be compacted to a 95 percent of standard proctor density at optimum moisture content as determined by governing standards. In addition, the stability of subgrades shall be such that when materials for construction are deposited on the subgrade no rutting or displacement of the subgrade by material hauling vehicles will occur. No materials shall be placed on subgrades which are muddy, frozen, or have frost, snow, or water thereon. Subgrades shall be thoroughly compacted and properly shaped before any surfacing, curb and gutter, or sidewalk materials are placed. All subgrade and surfacing shall be sloped as indicated on the Drawings, and as needed to achieve a uniform slope between new and existing surfaces. Sidewalks shall slope toward one edge.

3.2 CONCRETE SIDEWALKS

A. Concrete shall be placed, vibrated, and finished as described in the governing standards.

B. One-half inch expansion joints shall be provided where sidewalks abut a curb, structure, existing sidewalk, at changes in directions, and at intervals of not more than 40 feet . Expansion joints shall be filled to within 3/4 inch of the surface with bituminous expansion joint material, and then filled flush to the surface with self-leveling caulking in accordance with the Joint sealant section. The joint sealing compound shall be finished slightly concave, and shall not be allowed to overflow the joint.

C. Concrete sidewalks shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. A second floating at the time of initial set shall follow initial floating.

D. Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be at right angles to the length of the curb, walk, or gutter.

E. Sidewalks shall be edged using a 3 to 4 inch wide edging tool with a 1/4 inch corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be

provided at right angles to the length of the walk, using a grooving tool with 1/4 inch radius and a depth of 1.25 inch . The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.

F. The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.

G. The finished concrete shall be cured and protected as stipulated in the governing standards.

3.3 CONCRETE CURB AND GUTTER

A. New concrete curb and gutter shall be as indicated on the Drawings and specified herein. Replacement concrete curb and gutter shall match the existing curb and gutter. Unless otherwise authorized by Engineer, adjacent and enclosed curbs, drainage structures, and gutters shall be placed before placement of pavement sections.

B. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and/or gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the section, being secured so that they are not moved by depositing, compacting or finishing the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.

C. Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet .

D. Contraction joints shall be a minimum of 1-1/2 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the section. These templates shall be secured so they are not moved by depositing, compacting or finishing the concrete.

E. Unless otherwise indicated on the drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch .

F. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

G. Forms

1. Forms shall be in conformance with the governing standards. All forms shall be in good condition, with not more than 1/8 inch variation in horizontal and vertical alignment for each 10 feet in length. Side forms shall have a depth at least equal to the edge thickness of the concrete being formed. The forms shall be set true to line and grade and shall be adequately supported to stay in position while depositing and consolidating the concrete. Forms shall be designed and constructed so as to permit their removal without damage to the concrete.

H. Joints

1. Expansion and contraction joints shall be formed at right angles to the alignment of the curb and gutter and to the depths as specified, as indicated on the Drawings, and in conformance with the governing standards.

   a. Expansion Joints. One half inch wide expansion joints shall be placed full depth using a premolded expansion joint material, cut to the configuration of the full size of the Curb and Gutter section, being secured so that they are not moved by depositing and compacting the concrete at these joints. The edges of these joints shall be rounded by an edging tool of 1/8 inch radius.

      Expansion joints shall be placed at the beginning and end of radii, where curbs and gutters abut structures, and at intervals of approximately 45 feet .

   b. Contraction Joints. Contraction joints shall be a minimum of 1-1/2 inches deep on all sides, shall be spaced at approximately 15 foot intervals, and shall be formed by a 1/8 inch thick steel template, cut to the configuration of the Curb section. These templates shall be secured so that they are not moved by depositing and compacting the concrete.

      Unless otherwise indicated on the Drawings, and as soon as the concrete has hardened sufficiently, the templates shall be removed from all contraction joints. The edges of the joint shall be rounded with an edging tool having a maximum radius of 3/8 inch .

2. All expansion and contraction joints shall be filled flush to the surface with joint sealing compound. The joint sealing compound shall be finished slightly concave and shall not be allowed to overflow the joint.

I. Finishing

1. Curb and gutter shall be finished to the shape indicated on the Drawings. After the forms have been removed, all exposed edges shall be rounded, using an edging tool with a 1/8 inch corner radius. Exposed surfaces shall be float finished and given a light broom finish applied at right angles to the curb at the time of initial set, using a horsehair broom. Mortar or dryer shall not be used to remove imperfections. In all cases, the resulting surface shall be smooth and of uniform color with all rough spots, projections, and form stakes removed. No plastering of the concrete will be allowed. The finished curb shall have a true surface, free from sags, twists, or warps; shall have a uniform appearance; and shall be true to the original lines, grades, and configurations indicated on the Drawings.

3.4 PROTECTION

A. In addition to the requirements for protection set forth in the governing standards, Contractor shall protect all adjacent concrete and masonry so that no damage will occur as the result of subsequent construction operations. All damage or discoloration shall be repaired to the satisfaction of Engineer before final acceptance by Owner.

B. Special care shall be taken to prevent bituminous materials from spraying or splashing. Adjacent construction shall be protected by covering with suitable fabric or paper.

End of Section

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SECTION 02605 - STORMWATER MANHOLES, FRAMES, AND COVERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of standard and drop sewer manholes. Standard and drop manholes shall be constructed complete with covers, steps, fittings, and other appurtenances, in accordance with the details in the figures at the end of this section.

B. Where required, special manholes shall be constructed in accordance with the details indicated on the Drawings.

C. Steps, frames, and covers for structures other than sewer manholes are covered in other sections.

1.2 GENERAL

A. At the option of Contractor, standard and drop manholes may be constructed with cast-in-place concrete bases or precast concrete (developed) bases.

B. Only manholes which are required to have inside/outside pipe and fittings for dropping sewage into the lower line will be designated as drop manholes. Inside drop manholes where the incoming line discharges directly into the manhole and which do not require special fittings will be considered standard manholes.

1.3 SUBMITTALS

A. Drawings and Data

1. Drawings and data covering precast concrete sections and castings shall be submitted in accordance with the Submittals Procedures section.

B. Manhole Step Submittals

1. When steel-reinforced plastic manhole steps are specified, data submitted shall include verification of the type and grade of steel used for step reinforcement, typical chemical analysis of the steel, type and classification of the plastic, and reports of acceptance tests performed in accordance with ASTM C478, Section 16, and C497, Section 10.

C. Corrosion Protection Submittals

1. When corrosion protection systems are specified, data submitted shall include corrosion protection materials, method of application, maintenance requirements, and other pertinent data.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Precast concrete sections shall not be delivered to the job until representative concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.

C. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces.

PART 2 - PRODUCTS

2.1 MATERIALS

Precast Concrete Manholes and Reinforcement	ASTM C478, except as modified herein.
Cement	Cement type shall comply with ASTM C150, Type I or II. Water-cementitious materials ratio shall not exceed 0.40. Alternative materials proposed by Contractor that will provide equivalent corrosion protection and durability may be submitted subject to review and acceptance by Engineer.
Cast-in-Place Concrete Bases	Materials, handling, forms, finishing, curing, and other work as specified in the cast-in-place concrete section.
Nonshrinking Grout	L&M "Crystex", BASF Master Builders "Masterflow 713 " or "Set Grout", Sauereisen Cements "Grout No. F-100 Level Fill Grout", , or Five Star Products "Five Star Grout".
Resilient Manhole/Pipe Connectors	A-LOK Premium manhole pipe seal.
Mastic Fill	Butyl rubber compatible with resilient connector material.
Gaskets	
Mastic	ASTM C990; Hamilton-Kent "Kent-Seal No. 2", or Henry Company "Ram-Nek". Cross-sectional area as recommended by manhole manufacturer.
Rubber	ASTM C361, Section 6.9, except gasket shall be synthetic, with hardness of 40 ± 5 when measured by ASTM D2240, Type A durometer. Natural rubber will not be acceptable.

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300M", or Tnemec "46H-413 Hi-Build Tneme-Tar".

2.2 MANUFACTURE

A. Precast base sections shall be provided with circular openings, with continuous, circular, resilient connectors cast into the wall.

B. Resilient connectors shall be installed in accordance with the manufacturer's recommendations, except that connectors shall be positioned so that sealing or resealing operations may be accomplished from inside the manhole.

C. Precast sections may be provided with lifting notches on the inside faces of walls to facilitate handling. Lifting notches shall be not more than 3 inches deep; holes extending through the wall will not be acceptable.

D. If precast concrete base sections are used, part of the concrete invert fill may be furnished with the precast unit; however, a rough surface shall be provided to improve bond with the final invert fill. At least the top 2 inches of the concrete invert fill shall be installed in the field.

PART 3 - EXECUTION

3.1 INSPECTION

A. Precast concrete sections shall be inspected when delivered and all cracked or otherwise visibly defective units shall be rejected.

3.2 CONSTRUCTION

A. Bases

1. If cast-in-place concrete bases are used, concrete shall be placed on undisturbed earth in accordance with applicable requirements of the Concrete section.

2. If precast concrete (developed) bases are used, the subgrade materials shall be excavated to undisturbed earth and to a uniform elevation which will permit at least 4 inches of granular embedment material, as specified in the Excavation and Fill for Structures section, to be installed and compacted. The surface of the granular material shall be carefully graded and the base section accurately set so that connecting pipes will be on proper line and grade. The elevation of the granular material shall be adjusted until proper grade and alignment of the base section has been attained.

3. No wedging or blocking under precast concrete bases will be permitted.

4. When resilient connectors are used with cast-in-place bases, the concrete fill under the connecting pipe outside the manhole shall be deleted and shall be replaced with granular embedment material to undisturbed earth.

5. In no case shall the invert section through a manhole be greater than that of the outgoing pipe. The shape of the invert shall conform exactly to the lower half of the pipe it connects. Side branches shall be connected with a radius of curve as large as practicable. All inverts shall be troweled to a smooth, clean surface.

B. Connecting Piping

1. The space between connecting pipes and the wall of precast sections shall be completely filled with non-shrink grout, except where resilient connectors are provided.

2. When resilient connectors are used, the connecting pipe shall be carefully adjusted to proper line and grade, and the bedding material shall be compacted under the haunches and to the spring line of the pipe for a distance of at least 6 feet from the manhole wall and to at least the minimum trench width. The pipe shall be installed in the resilient connector prior to backfilling outside the manhole and shall be resealed after completion of the manhole and backfill. All visible leakage shall be eliminated.

3. The connecting pipe for installation with resilient connectors shall be plain-end, square cut spigots and shall not protrude more than 1 inch inside the manhole wall. A clear distance of at least 1 inch from the end of each connecting pipe and around the pipe shall be provided when the concrete invert fill is installed. After completion of the manhole, the boxout shall be filled with mastic filler material, completely filling the space beneath the pipe and extending to at least the spring line. The filler material shall provide a smooth, uniform surface between the inside diameter of the pipe and the manhole invert.

4. At each special manhole, rubber joint filler shall be provided around connecting piping. The filler shall be securely fastened in place with suitable wires or straps.

3.3 EXTERIOR COATING

A. Damproofing

1. Before backfilling is started, the outside surfaces of each manhole shall be coated with one heavy coat of dampproofing as specified in the dampproofing section. Surfaces to receive coating shall be dry. Dampproofing may be applied to precast units in the shop. If the shop coating is damaged during construction, a touchup coat shall be applied and allowed to dry prior to backfilling.

3.4 CASTING COATING

A. Prior to installation, one coat of coal tar epoxy shall be applied to all castings. Before coating, castings shall be thoroughly cleaned and properly supported. All loose rust shall be removed by wire brushing. Castings shall not be handled until the coating is dry and hard.

End of Section

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SECTION 02618 - CONCRETE SEWER PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers bar-cage reinforced concrete pipe with rubber and concrete joints to be furnished for the lines listed in the Concrete Sewer Pipe Schedule 02618 -S01.

B. Pipe shall be furnished complete with all jointing materials and other appurtenances.

C. Pipe trenching, bedding, and backfill are covered in the trenching and backfilling section.

1.2 GOVERNING STANDARDS

A. Except as modified or supplemented herein, concrete sewer pipe shall comply with ASTM C76 and C655. For metric equivalent pipe, ASTM C76M and C655M shall be used.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Drawings, specifications, schedules, and other data showing complete details of the fabrication and construction of pipe and fittings, together with complete data covering all materials proposed for use, shall be submitted in accordance with the Submittals Procedures section.

B. Drawings and Data – Each Size and Class of Pipe

1. The drawings and data shall include, but shall not necessarily be limited to, the following for each size and class of pipe:

a. Data on reinforcement.
b. Details of joints.
c. Gasket certificate, certifying that the gasket material is suitable for service intended.
d. Details of fittings and specials.
e. Test reports.
f. Laying schedule.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Concrete pipe and fittings shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint surfaces. Use of lifting holes is not acceptable.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

A. Concrete pipe shall be designed to withstand the design loads listed in the Concrete Sewer Pipe Schedule 02618 -S01 or as otherwise specified herein.

B. Wall thickness shall be not less than Wall B.

C. The absorption of concrete pipe shall not exceed 5.5 percent.

D. The minimum concrete cover over circumferential reinforcement, except under the spigot groove of pipe with concrete spigots, shall be at least 3/4 inch for 54 inch and smaller pipe, and 1 inch for 60 inch and larger pipe.

E. In preparation of concrete pipe layouts, the maximum joint opening shall not exceed 3/8 inch .

2.2 MATERIALS

A. Unless otherwise specified, all materials used in the manufacture of pipe, fittings, and accessories shall conform to ASTM C76.

Fine Aggregate	ASTM C33.
Cement	ASTM C150, Type I Water-to-cementitious materials ratio of the mortar coating shall not exceed 0.40.
Gaskets	ASTM C361, Section 6.9, standard gasket. Hardness shall be 40 for concrete joints and 60 for steel joints when measured by ASTM D2240, Type A durometer. Polymer shall be synthetic rubber. Natural rubber will not be acceptable. Gaskets shall be furnished by the pipe manufacturer.
Joint Lubricant	Vegetable based lubricant; petroleum or animal based lubricants will not be acceptable.
Rubber Joint Filler	Synthetic.
Hardness	40 ± 5 as measured by ASTM D2240, Type A durometer.
Tensile Strength	1,200 psi minimum.

2.3 LENGTH

A. Except for fittings and closure pieces, each piece of pipe shall be at least 7'-6" long.

2.4 JOINTS

A. Except as modified herein, joints shall conform to Section 8 of ASTM C361 and shall consist of a formed concrete bell and spigot and a rubber gasket. Gaskets shall have a circular cross section and shall be confined in a groove in the pipe spigot. Pipe with collars instead of integral bells will not be acceptable.

B. Each concrete pipe joint shall be designed to withstand the gasket compression, plus a differential load across the joint equal to 4,000 pounds per foot of internal diameter, without cracking.

C. The distance from the face of the spigot to the shoulder of the spigot shall be at least 3/8 inch greater than the joint depth (the distance from the face of the bell to the seat of the bell) for 42 inch and smaller pipe, and at least 1/2 inch greater than the joint depth for pipe larger than 42 inches in diameter.

D. Pipe sections connecting to manholes shall have a joint in each line within 4 feet of the inside face of each manhole or other structure.

2.5 REINFORCEMENT

A. Circumferential reinforcement shall be full-circle type. Elliptical or part-circle reinforcement will not be acceptable. The total area of longitudinal steel shall be at least 0.2 percent of the concrete cross-sectional area of the pipe. Longitudinal steel shall be spaced uniformly around the pipe and shall consist of at least eight continuous or lap spliced wires or bars (20 bar diameters for deformed bars or 40 bar diameters for smooth bars) in each cage; splices shall not be welded. For pipe larger than 72 inches in diameter, longitudinal bars shall be spaced not more than 30 inches apart.

B. At least three circumferential bars shall be provided in each pipe bell. The bars shall be placed within 1-1/2 times the socket depth from the end of the pipe and shall be equal in area to an equivalent length of the outside cage in the pipe barrel. The end circumferential bar shall be placed 1 inch from the face of the bell. The inside cage (or the single cage) in the pipe barrel shall be extended to within 1 inch of the end of the spigot on 24 inch and larger pipe, and to within 1/2 inch of the gasket groove on pipe smaller than 24 inches in diameter.

2.6 FITTINGS

A. All bends, tees, closure pieces, wall fittings, and other fittings which are indicated on the Drawings or are necessary to complete the work shall be furnished. Except as modified or otherwise provided herein, the design and manufacture of fittings shall be governed by the same requirements as the connecting piping.

B. Bends

1. Bends for concrete sewer pipe shall be fabricated in accordance with this paragraph and shall be provided at the locations indicated on the Drawings. Bends shall be fabricated from segments of a steel cylinder, with concrete or mortar lining and reinforced concrete

exterior covering. The deflection angle between adjacent segments shall not exceed 30 degrees .

2. Steel cylinders for bends shall be at least USS 10 gage and shall be lined with at least 3/4 inch of mesh-reinforced concrete or mortar. Bends fabricated from steel cylinders shall be designed for the same three-edge bearing loads as the adjacent piping.

C. Wall Fittings

1. Wall fittings shall be bell type, and shall be provided at the locations indicated on the Drawings. Wall fittings shall be of the required length, shall have bells to match the joints on the concrete pipe, and shall be fabricated by the manufacturer of the pipe to which they connect.

D. Outlets

1. Fabricated outlet branches shall be provided as indicated on the Drawings.

E. Closure Pieces, Rubber and Concrete Joints

1. Shop fabricated closure pieces are not required for pipe with rubber and concrete joints. Closure pieces shall be cut in the field after the pipe, fittings, and specials indicated on the Drawings have been installed. The alignment indicated on the Drawings shall be maintained by deflecting joints and by adding fittings if necessary. The length between structures and PI locations shall be adjusted in the field if required.

2. Closure pieces shall be field cut from full-length pipe sections. At the option of Contractor, field cuts may be made with a masonry saw, or may be chiseled and neatly trimmed. Field-cut ends shall be encased in reinforced collars at least 8 inches thick and extending 18 inches on each side of the field cuts.

2.7 MARKING

A. Each pipe or fitting shall have the following information plainly and permanently marked thereon:

1. Pipe class.

2. Date of manufacture.

3. Manufacturer's name or trademark.

4. On bends, the angle of the bend.

B. Markings shall be indented in the pipe or painted on the pipe with waterproof paint.

2.8 CURING

A. Prior to delivery to the Site, concrete pipe and fittings shall be cured in the manufacturer's facilities until concrete control cylinders representing such pipe have attained a compressive strength of at least 80 percent of the specified minimum 28 day strength.

2.9 PRELIMINARY TESTS

A. All preliminary tests shall be made at Contractor's expense. Reports covering the following joint leakage and shear tests on each size of pipe, and the three-edge bearing and absorption tests on each size and class of pipe, shall be submitted to Engineer for review as indicated.

Joint Leakage	ASTM C443, Section 10.
[Joint Shear	Suitable arrangement to apply the specified loads.**]**
Three-Edge Bearing	ASTM C497, indicating load required for 0.01 inch crack.
Absorption	ASTM C497.

2.10 CONTROL TESTS

A. Control tests to determine strength and absorption shall be made during the manufacture of the pipe. The tests shall be made by an independent testing laboratory at the expense of the Contractor.

B. At the option of Contractor, strength tests may be made on cores or on standard concrete cylinders. A set of two cores or four cylinders shall be taken from each day's production and each time the concrete mix is changed. One-half of the samples shall be tested at 7 days or earlier to determine when the pipe has attained sufficient strength for delivery. The remainder shall be tested at 28 days.

C. Absorption tests shall be made on cores taken from the pipe barrel. Cores shall be at least 2 inches in diameter and shall be taken with a diamond drill. One core shall be tested from each of the first three lengths of pipe of each size and class. Additional cores shall be tested from 5 percent of the pipe produced, but not less than one from each day's production.

D. Core holes shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to Engineer.

E. Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation and testing will be in accordance with the Sewer Pipe Installation and Testing section.

End of Section

Schedule 02618-S01

Concrete Sewer Pipe Schedule

Size in.	Service	Class or Line Number	D-Load lb/ft/ft dia.
15	Storm Drain	Class III	1,500
24	Storm Drain	Class III	1,400
24	Culverts	Class III	1,350
30	Storm Drain	Class III	1,400

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Schedule 02618-S01

Concrete Sewer Pipe Schedule

Size in.	Service	Class or Line Number	D-Load lb/ft/ft dia.
15	Storm Drain	Class III	1,500
24	Storm Drain	Class III	1,400
24	Culverts	Class III	1,350
30	Storm Drain	Class III	1,400

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SECTION 02628 - POLYVINYL CHLORIDE (PVC) SEWER PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing polyvinyl chloride (PVC) gravity sewer pipe and fittings, complete with all jointing materials and appurtenances. Ribbed pipe or open profile pipe will not be acceptable.

B. The following pipe may be permitted as an alternate to PVC sewer pipe:

1. Ductile Iron Pipe

2. Reinforced Concrete Pipe

C. Specifications for alternate pipe materials are covered in other sections.

D. Pipe trenching, bedding, and backfilling are covered in the Trenching and Backfilling section.

1.2 SUBMITTALS

A. General Submittals.

1. Drawings and data shall be submitted in accordance with the Submittals Procedures section. Drawings and data shall include, but shall not be limited to, the items listed in this Section.

B. Details of joints.

C. Gasket material.

D. Pipe length.

E. Certifications

1. Certification in accordance with ASTM D3034, Section 11; ASTM F679, Section 10; ASTM F1803, Section 12.

1.3 DELIVERY, STORAGE AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Pipe, fittings, and accessories shall be handled in accordance with Chapter 6 of AWWA Manual M23, to ensure installation in sound, undamaged condition. Pipe shall not be stored uncovered in direct sunlight.

PART 2 - PRODUCTS

2.1 MATERIALS

Pipe and Fittings.

Solid wall 4 through 15 inches .	ASTM D3034, Minimum SDR 35, Minimum Cell Classification 12354.
18 through 48 inches .	ASTM F1803, or ASTM F679, Minimum Pipe Stiffness of 46 psi, Minimum Cell Classification 12354.

Jointing Materials.

Bell-and-Spigot Joints.	ASTM D3212, integral bell push-on type elastomeric gasket joints.
Gaskets.	ASTM F477, synthetic rubber. Natural rubber will not be acceptable.
Field-Cut Joints and Connections to Other Piping Materials.	Fernco "Flexible Couplings" or Mission "Eastern Standard Band-Seal Couplings" with stainless steel shear rings.
For Grouted Connections to Cast-in-Place Concrete Manholes	Rubber ring water stop.
Tracer	Detection tape, 3 inches wide; aluminum foil core, 0.5 mil thick, encased in a protective inert plastic jacket; 5,000 psi min tensile strength; 2.5 lbs per inch per 1,000 feet min mass; color coded in accordance with APWA Uniform Color Code; Lineguard "Type III", or Reef Industries "Terra Tape D".

PART 3 - EXECUTION

A. INSTALLATION AND TESTING

1. Pipe shall be installed and tested in accordance with the Sewer Pipe Installation and Testing section.

2. A conductive tracer shall be buried above PVC pipe, not more than 18 inches below the ground surface.

End of Section

SECTION 02675 - CLEANING AND DISINFECTION OF WATER PIPELINES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers cleaning of potable and non-potable water pipelines and disinfection of all potable water pipelines installed under this Contract.

B. Pipeline pressure and leakage testing is covered in the Pipeline Pressure and Leakage section.

1.2 GENERAL

A. Coordination

1. Large volumes of water required for cleaning, disinfection, and filling of pipes will not be available through the Owner until the 60" Treated Water pipeline from the existing WTP is constructed and placed into service by others. Alternatively, Contractor may purchase water from Springdale Water Utility through a temporary connection to perform the cleaning, disinfection, and filling work prior to the 60" Treated Water pipeline connection. The 60" Treated Water pipeline contractor will require access to the site to perform the cleaning, disinfection, and filling operations for the pipeline. Contractor shall coordinate with the pipeline contractor to facilitate cleaning, disinfection, and filling of the 60" Treated Water pipeline.

2. Contractor shall coordinate cleaning and disinfection work with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.

3. Water for cleaning and disinfection work will be provided as stipulated in the Temporary Facilities section..

4. In all cases where it is necessary to interrupt service, permission of Owner shall be obtained at least two days before the service will be interrupted. In all cases where it is necessary to interrupt service to water customers, permission of the Owner shall be obtained and each customer affected shall be notified of the proposed service interruption and its possible duration in accordance with the Project Requirements section.

5. Unless otherwise specified, final cleaning and disinfection work shall not be performed until after hydrostatic testing of the pipelines and any resulting repair work completed.

6. Contractor shall notify Owner and Engineer prior to the work to allow their representatives to be present during cleaning and/or disinfection of the pipelines.

B. Related Work

1. Other sections directly related to work covered in this section are the Pipeline Pressure and Leakage Testing section.

C. Governing Standard

1. All disinfection work shall conform to the requirements of ANSI/AWWA C651, and the requirements of Arkansas Department of Health (ADH), except as modified herein. If any state or local requirements conflict with the provisions of this section, the state and local requirements shall govern.

2. Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of neutralized or diluted chlorinated water from the final flushing of pipelines and to identify acceptable locations for disposal of the flushing water. All requirements and costs associated with notification and obtaining any discharge permits shall be the responsibility of the Contractor.

D. Experience

1. The disinfection work shall be performed by a subcontractor specialized in such work, or with the permission of Engineer, Contractor may provide the necessary equipment and do the work with his own personnel. In either case, all work shall be done under the direct supervision of a competent and experienced specialist in such work.

2. Personnel performing the disinfection shall demonstrate a minimum of 5 years experience in the chlorination and dechlorination of similar pipelines.

E. Special Cleaning and Disinfection Requirements

1. Special cleaning and disinfections requirements include the following:

a. Unless otherwise acceptable to Owner and Engineer, the general sequence of work for each pipeline, or valved or bulkheaded section thereof shall be as follows:
   1) Initial flushing and cleaning of pipeline.
   2) Filling pipeline.
   3) Hydrostatic pressure and leakage testing.
   4) Disinfection.
   5) Final cleaning, flushing, and neutralization of heavily chlorinated water.
   6) Fill with potable water from transmission main. Allow 24 hours before first bacteriological test.
   7) Bacteriological tests, first set.
   8) Bacteriological tests, second set (24 hours after first bacteriological test)
   9) Final test results will be available 48 hours after second bacteriological tests, unless that time falls on a weekend or holiday, in which case the final results will be available on the next business day.
   10) Redisinfection, if required.

b. The cleaning and disinfection work shall be completed before connection to any portion of new lines installed under this Contract that have been put into service.

1.3 SUBMITTALS

A. Cleaning and Disinfection Plan

1. Unless otherwise specified, Contractor shall submit a detailed cleaning and disinfection plan to Engineer 30 days prior to starting any cleaning and disinfection work. The plan shall cover the method and procedure proposed, necessary coordination, qualification of personnel performing the disinfection work, sequence of operations, the limits of the pipelines to be cleaned and disinfected, the positions of all valves, location of temporary bulkheads, materials and quantities of each to be used, equipment to be used, manner of filling and flushing the pipelines, chlorine injection points, sample points, bacteriological testing location and schedule, potable water source, method of metering the water if required, neutralization and disposal of wasted water, and all other methods and procedures to be followed in performing the cleaning and disinfection work.

B. Testing

1. Bacteriological testing shall be performed by Owner's staff.

2. Contractor shall provide all items of equipment, piping, and other facilities necessary to assist with the collection of the samples as required. Locations for bacteriological sampling shall be in accordance with the governing standards or as acceptable to the Owner.

3. The chlorine residual tests shall be performed by Contractor. The test logbook shall be made available to Owner or Engineer upon request and shall be submitted to Engineer upon completion of all chlorine residual testing.

1.4 QUALITY ASSURANCE

A. Chlorine Residual Tests

1. Contractor shall provide the necessary apparatus for making the chlorine residual tests by the drop dilution method in Appendix A of ANSI/AWWA C651. Test results shall be recorded in a logbook that includes for each test: the location, date, time, test results, and test kit manufacturer.

B. Bacteriological Tests

1. Sampling and testing of water in the pipelines shall be performed after final flushing in accordance with Section 5 of ANSI/AWWA C651. Two consecutive sets of acceptable samples, taken at least 24 hours apart, shall be collected and standard heterotrophic plate counts measured for each sample.

C. Redisinfection

1. Should the bacteriological tests indicate the presence of coliform organisms at any sampling point, the pipelines shall be reflushed, resampled and retested in accordance

with Section 5 of ANSI/AWWA C651. If check samples show the presence of coliform organisms, then the pipelines shall be rechlorinated until acceptable results are obtained.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials furnished by Contractor shall conform to the requirements of ANSI/AWWA C651 and shall be clean and free of debris which could infer questionable test results.

B. Liquid Chlorine

1. Liquid chlorine shall conform to AWWA B301.

C. Calcium Hypochlorite (Dry)

1. Calcium hypochlorite shall conform to AWWA B300.

D. Sodium Hypochlorite (Solution)

1. Sodium hypochlorite shall conform to AWWA B300.

E. Chlorine Residual Test Kit

1. Chlorine residual concentration shall be measured using an appropriate range, drop count titration kit or an orthotolidine indicator comparator with wide range color discs. The color disc range shall be selected to match chlorine concentration limits. Test kits shall be maintained in good working order and available for immediate test of residuals at point of sampling. Test kits manufactured by Hach Chemical or Orbeco-Hellige are acceptable.

PART 3 - EXECUTION

3.1 APPLICATION

A. Cleaning

1. Pipelines, including all associated valves and fittings, shall be cleaned to the satisfaction of Owner and Engineer.

2. Small pipelines shall be cleaned by flushing with water at the maximum velocity which can be developed, but not less than 3.0 feet per second, unless otherwise permitted by Engineer. Flushing shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

3. Large pipelines (36-inch or larger) shall be cleaned with a hose or cleaned by other methods acceptable to Engineer in accordance with ADH requirements. Cleaning

methods shall continue until the pipeline is free of dirt, debris, and other foreign materials. Cleaning shall precede disinfection.

4. Flushing shall be accomplished through the installed valves or fittings, blow-offs or through temporary flushing connections installed for that purpose and in accordance with any details indicated on the Drawings. Contractor shall provide all temporary piping and fittings required to supply, and dispose of, flushing water. Drainage of flushing water to building drainage system is not acceptable.

5. Booster pumps shall be used if needed to obtain the necessary volume or velocity of water. Pumping equipment installed under this Contract shall not be used for flushing, nor shall the flushing water be passed through them or other installed equipment; temporary bypass piping at each pump or installed equipment shall be provided as needed.

B. Disinfection Procedure

1. The pipelines shall be disinfected by the slug method. Potable water shall be used in conjunction with the chlorination agent.

2. For the continuous feed or slug method, the chlorination agent shall be injected into the line at the supply end of each new pipeline or valved section thereof.

3. Admission of disinfectant solution into or the flushing thereof through existing piping shall be held to the minimum possible, and then only after adequate measures have been taken to prevent any such solution of chlorinated wastewater from entering branch service connections to water customers or other piping systems.

4. During disinfection, all valves and hydrants shall be operated to ensure that all appurtenances are disinfected. Valves shall be operated such that the chlorine solution in the pipeline being chlorinated will not flow back into the supply line. Check valves shall be used if needed.

5. Existing pipelines which may become contaminated during work requiring connections to the new pipeline, involving either tapping or cutting into operations, shall be flushed and disinfected in accordance with Section 4 of ANSI/AWWA C651.

C. Final Flushing

1. Upon completion of chlorination, but before sampling and bacteriological testing, all heavily chlorinated water shall be removed from the lines by flushing with potable water until the chlorine residual in the lines is not higher than that generally prevailing in the adjacent existing system or as acceptable to the Owner.

2. Final flushing shall be accomplished as specified for cleaning of pipelines.

D. Disposal of Chlorinated Wastewater

1. All chlorinated wastewater to be discharged shall be neutralized by chemical treatment and disposed in accordance with Section 4 of ANSI/AWWA C651, ANSI/AWWA C655 and the requirements of the governing agency specified herein. Schedule, rates of flow,

and locations of discharge of disinfection and flushing water shall be coordinated with Engineer and in accordance with all applicable rules and regulations.

End of Section

SECTION 02702 - SEWER PIPE INSTALLATION AND TESTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation and testing of all sewer pipe furnished under the following specification sections:

1. Concrete Sewer Pipe

2. Polyvinyl Chloride (PVC) Sewer Pipe

B. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1.2 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Pipe, fittings, and appurtenances shall be transported, stored, and handled in a manner which prevents damage. Hooks shall not be permitted to come in contact with joint surfaces. Plastic pipe shall be shaded if necessary to prevent curvature due to thermal expansion. Damaged pipe and fittings shall be removed from the site.

1.3 Submittals

A. Laying Schedule

1. The Contractor shall submit a laying schedule to the Engineer. The schedule shall be updated as needed to provide at least one week notice on all pipeline installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Sewer pipe materials are specified in the pipe sections.

PART 3 - EXECUTION

3.1 ALIGNMENT

A. Piping shall be laid to the lines and grades indicated on the Drawings. Laser beam equipment or surveying instruments shall be used to maintain alignment and grade. At least one elevation measurement shall be made on each length of pipe.

B. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

3.2 LAYING PIPE

A. Pipe shall be protected from lateral displacement by embedment material installed as specified in the Trenching and Backfilling section. Pipe shall not be laid in water or under unsuitable weather or trench conditions.

B. Pipe laying shall begin at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Engineer.

C. Foreign material shall be kept out of the pipe during installation. No debris, tools, clothing, or other foreign objects shall be placed in the pipe.

D. Whenever pipe laying is stopped, the open end of the pipe shall be closed with a tight-fitting end board to keep out soil. The end board shall have perforations to admit water and prevent flotation of the pipe in the event the trench becomes flooded.

E. Core holes and handling holes in concrete pipe shall be repaired by cementing a properly shaped concrete plug in place with epoxy cement or by other methods acceptable to Engineer. Plugs shall be provided by the pipe manufacturer and shall be sized and designed to match the pipe supplied.

3.3 JOINTING

A. All joint preparation and jointing procedures shall comply with the instructions and recommendations of the manufacturer.

B. Rubber Gasketed Joints

1. Rubber gaskets shall be positioned on the joint in accordance with the manufacturer's recommendations. Immediately before joints are pushed together, all joint surfaces shall be thoroughly cleaned and coated with the lubricant furnished with the pipe. The gasket shall be lubricated and positioned in the spigot groove so that the gasket is distributed uniformly around the pipe circumference. The position of the rubber gasket shall be checked with a feeler gauge after each joint is completed. If the gasket is not in the

proper position, the joint shall be pulled apart, the gasket removed and discarded, and the joint re-assembled using a new, properly lubricated gasket.

2. Joint lubricant shall be stored in closed containers and shall be kept clean. When installing pipe in cold weather, the joint surfaces and gaskets shall be kept warm and the joint lubricant shall be protected from freezing.

3. For rubber and steel joints, each exterior joint recess shall be filled with joint grout. A diaper shall be used to prevent foreign material from entering the joint recess before grouting and to serve as a form for the grout. Each diaper shall be of sufficient length to encircle the pipe, leaving enough space between the ends to allow the grout to be poured. Joint grout shall be poured between the diaper and the pipe and shall be allowed to run down to the bottom of the pipe. The grout shall be rodded while being poured, using a stiff wire curved to the approximate shape of the pipe. Each joint recess shall be completely filled with grout for the full circumference of the pipe.

4. Not less than two lengths of pipe shall be in final position in advance of exterior joint grouting. If placing of pipe embedment is resumed before the grout has attained initial set, care shall be taken to prevent damage to the grout while placing and compacting embedment material.

5. After trench backfilling has been completed, the interior joint recess of pipe with rubber and steel joints shall be filled with mortar following the recommendations of the pipe manufacturer. Joint surfaces shall be damp, but free from standing water, when the mortar is placed. Mortar shall be thoroughly compacted to completely fill the recess and shall be finished smooth. All excess mortar shall be removed from the pipe.

C. Flexible Sealant Joints

1. Joints made with flexible joint sealant shall be coated with adhesive as directed by the sealant manufacturer, and the joint sealant shall be positioned in accordance with the manufacturer's installation instructions. The pipe sections forming the joint shall be pulled together with sufficient force to uniformly fill and seal the annular space in the joint. Joints shall not be made when adverse weather conditions may prevent proper sealing, nor when the temperature of the pipe and sealing materials is too low to achieve proper sealing.

D. Mastic Joints

1. Surfaces of pipe to be joined with mastic joints shall be primed, if recommended by the mastic manufacturer. Immediately before joining the pipes, a uniform layer of mastic shall be applied to the joint surfaces. After the pipes are in final position, the mastic shall completely fill and seal the annular space in the joint. Joints shall not be made when weather conditions may interfere with obtaining a satisfactory seal.

E. Field Cut Joints or Connections Between Dissimilar Pipe Materials

1. Where indicated on the Drawings or required to facilitate installation of field cut joints in PVC or composite sewer pipe, or connections between PVC or composite sewer pipe and pipe of other materials, couplings may be used in accordance with the instructions of the coupling manufacturer and pipe manufacturer.

3.4 SERVICE CONNECTIONS

A. Service connections shall not be installed as vertical risers but shall be laid on a slope not to exceed 2 vertical to 1 horizontal. Each service connection pipe shall have a solid bearing on undisturbed earth.

3.5 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed where indicated on the Drawings. A pipe joint shall be provided within 12 inches of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section. All pipe which is to be encased shall be suitably supported and blocked in proper position and shall be anchored against flotation.

3.6 ACCEPTANCE TESTS

A. Each reach of sewer shall meet the requirements of the following acceptance tests. All defects shall be repaired to the satisfaction of Engineer.

B. Lamping

1. Unless otherwise indicated on the Drawings, each section of sewer line between manholes shall be straight and uniformly graded. Each section will be lamped by Engineer. Contractor shall furnish suitable assistants to assist Engineer.

C. Exfiltration

1. An exfiltration test shall be conducted, accordance with the requirements of ASTM C969, on each reach of sewer between manholes. The first line between manholes shall be tested before backfilling and before any additional sewer pipe is installed. Thereafter, exfiltration testing shall be done after backfilling, and individual or multiple reaches may be tested at the option of Contractor.

2. Exfiltration tests shall be conducted by blocking off all manhole openings except those connecting with the reach being tested, filling the line, and measuring the water required to maintain a constant level in the manholes. Each manhole shall be subjected to at least one exfiltration test.

3. During the exfiltration test, the water depth above the pipe invert at the lower end shall be at least to the elevation of the ground surface, unless otherwise specified. The maximum depth of the water at the lower end shall not exceed 25 feet , and the minimum depth of the water at the upper end shall be at least 5 feet above the crown of the pipe or 5 feet above groundwater elevation, whichever is higher.

4. The total exfiltration shall not exceed 100 gallons per inch of nominal diameter per mile of pipe per day for each reach tested. For purposes of determining maximum allowable leakage, nominal diameter and depth of manholes shall be included. The exfiltration tests shall be maintained on each reach for at least 2 hours and shall be longer if necessary, in the opinion of Engineer, to locate all leaks.

5. Contractor shall provide, at his own expense, all necessary piping between the reach to be tested and the source of water supply, and all labor, equipment, and materials required for the tests. The methods used and the time of conducting exfiltration tests shall be acceptable to Engineer.

D. Low Pressure Air Testing

1. With prior approval by Engineer, low pressure air testing may be used in lieu of exfiltration testing for 24 inch diameter and smaller pipe. Air testing shall not be used for manholes, or for pipe larger than 24 inch in diameter.

2. Low pressure air testing shall comply with ASTM C828 for PVC, and composite pipe, and shall comply with ASTM C924 for concrete pipe. The schedule of testing shall be submitted to Engineer prior to starting the tests. The time of conducting the tests shall be acceptable to Engineer.

3. The time elapsed for a 1 psi drop in air pressure shall be not less than, nor shall the air loss exceed, the limits set forth in the governing standard.

4. If the length of sewer to be tested is fully or partially submerged in groundwater, the test pressure shall be increased if necessary to overcome the actual static pressure exerted by the groundwater. If a test pressure greater than 8 psi results, air testing shall not be used, and exfiltration testing will be required.

5. Leaks shall be located by testing short sections of pipe. Leaks shall be repaired and the reach of sewer retested.

E. Infiltration

1. If, at any time prior to expiration of the correction period stipulated in the General Conditions, infiltration exceeds 100 gallons per inch of nominal diameter per mile of sewer per day, Contractor shall locate the leaks and make repairs as necessary to control the infiltration.

F. Deflection

1. After backfilling is completed, and before acceptance of the work, each reach of PVC and composite sewer pipe shall be checked for excessive deflection by pulling a mandrel through the pipe, or by other methods acceptable to Engineer. Pipe with diametrical deflection exceeding 5 percent of the inside diameter shall be uncovered, and the bedding and backfill replaced to prevent excessive deflection. Repaired pipe shall be retested.

3.7 CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until the work has been accepted. All joint contact surfaces shall be kept clean until the joint is completed.

End of Section

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SECTION 02704 - PIPELINE PRESSURE AND LEAKAGE TESTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers field hydrostatic pressure and leakage testing of piping. The term "piping" shall be used in this section to refer to piping systems, pipelines, or sections thereof.

B. Testing of other piping is covered in the Sewer Pipe Installation and Testing section and Miscellaneous Piping and Accessories Installation section. Cleaning and disinfection of piping is covered in the Cleaning and Disinfection of Water Pipelines section.

1.2 GENERAL

A. Contractor shall coordinate pressure and leakage testing with adjacent work as necessary to preclude work interferences or duplication of effort and to expedite the overall progress of the work.

B. Contractor shall provide all necessary piping, piping connections, temporary valves, backflow preventers, and all other items of equipment or facilities necessary to complete the pressure and leakage testing.

C. In all cases where it is necessary to interrupt service, permission of Owner shall be obtained at least two days before the service will be interrupted. In all cases where it is necessary to interrupt service to water customers, permission of the Owner shall be obtained and each customer affected shall be notified of the proposed service interruption and its possible duration in accordance with the Project Requirements section.

D. Contractor shall notify federal, state, and local regulatory agencies to determine if any special procedures or permits are required for disposal of water used for pressure and leakage testing and to identify acceptable locations for disposal of the water. All requirements and costs associated with notifications and obtaining any discharge permit or approvals shall be responsibility of Contractor.

E. Engineer or Engineer's representative shall be present during testing and shall be notified of the time and place of testing at least 3 days prior to commencement of testing. All testing shall be performed to the satisfaction of Engineer, and in accordance with all governing standards and regulations.

F. Testing Schedule and Procedure

1. A testing schedule and procedure shall be submitted to Engineer for review and acceptance not less than 21 days prior to commencement of testing. The schedule and procedure shall include, but not be limited to the following information for each pipe section to be tested:

a. limits of each pipe test section;
b. proposed time and sequence;
c. physical locations and set positions of all valves;
d. locations of temporary bulkheads, stops, caps, restraints, supports, and other temporary equipment needed;
e. manner of filling and source of water;
f. method and location of metering volumes;
g. method and location of gauging pressures; and
h. method and location of disposal of test water.

G. Special Testing Requirements

1. Special testing requirements include the following:

2. Unless otherwise acceptable to Engineer, the general sequence of work for each pipeline, or valved or bulkheaded section thereof, shall be as follows:

a. Initial cleaning and flushing of pipeline.
b. Filling pipeline.
c. Hydrostatic pressure and leakage testing.
d. Disinfection.
e. Final flushing and neutralization of heavily chlorinated water.
f. Bacteriological tests.

3. Unless otherwise acceptable, during testing of the pipeline, all valves, except for auxiliary hydrant valve(s), shall be in the open position.

4. Unless otherwise acceptable, temporary bulkheads shall be provided during testing so that the test pressure is not applied to existing or new valves and hydrants, or to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

5. Unless otherwise acceptable, a temporary pressure gauge shall be installed at each end of the limits of the pipeline to be tested.

6. Unless otherwise acceptable, tests shall be conducted before connections are made to existing water lines, or to any portion of water lines installed under this Contract that have already been put into service.

7. Unless otherwise acceptable, upon completion of testing and disinfection, connections made to existing water lines or to any portion of water lines installed under this Contract that have already been put into service, and any other portion of the pipeline not subject to the pressure test, shall be visually inspected for leakage after placing the water line into service and before backfilling the connection.

H. Water

1. Water for testing shall be furnished as stipulated in the Temporary Facilities section. Following completion of testing, the water shall be disposed of in accordance with the requirements of regulatory agencies and in a manner acceptable to Engineer.

1.3 SUBMITTALS

A. Test Procedures and Plans

1. Test plans and procedures shall be submitted as outlined in the GENERAL section of this specification.

B. Test Results and Reports

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. All necessary connections between the piping to be tested and the water source, together with pumping equipment, water meter, pressure gauges, backflow prevention, and all other equipment, materials, and facilities required to perform the specified tests, shall be provided. All required blind flanges, valves, bulkheads, bracing, blocking, and other sectionalizing devices shall also be provided. All temporary sectionalizing devices shall be removed upon completion of testing. Vents shall be provided in test bulkheads where necessary to expel air from the piping to be tested.

B. Test pressure shall be applied by means of a force pump sized to produce and maintain the required pressure without interruption during the test.

C. Water meters and pressure gauges shall be accurately calibrated and shall be subject to review and acceptance by Engineer.

D. Permanent or temporary gauge connections shall be installed at each location where test gauges are connected to the piping during the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent gauge connection shall be fitted with an isolation valve and a permanent gauge, and each temporary gauge connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.

E. Permanent or temporary fill and vent connections shall be installed as needed for the required test. Drilling and tapping of pipe walls will not be permitted. Upon successful completion of testing, each permanent fill and vent connection shall be fitted with the permanent fill or vent piping, and each temporary fill and vent connection, if used, shall be fitted with a permanent sealed plug or cap acceptable to the Engineer.

PART 3 - EXECUTION

3.1 FILLING AND VENTING

A. Before filling the piping with water, care shall be taken to ensure that all air release valves and other venting devices are properly installed and operating properly. Hand-operated vent valves shall not be closed until an uninterrupted stream of water is flowing from each valve. The rate

of filling the piping with water must not exceed the venting capacity of the installed air vent valves and devices.

3.2 BLOCKING AND BACKFILLING

A. Piping shall be adequately blocked, anchored, and supported before the test pressure is applied. Underground piping identified in the Test Pressure Schedule shall be tested before the joints are covered. All other piping may be tested after backfilling.

3.3 PRESSURE TESTING

A. After the piping to be tested has been filled with water, the test pressure shall be applied and maintained without interruption within plus or minus 5 psi of test pressure for 2 hours plus any additional time required for Engineer to examine all piping being tested and for Contractor to locate any defective joints and pipe materials. The test pressure shall be in accordance with the requirements specified for pipeline or plant piping.

B. Plant Piping Test Pressure

1. Piping shall be subjected to the test pressure as indicated in the Plant Piping Test Pressure Schedule.

3.4 PLANT PIPING LEAKAGE TESTING

A. All plant piping shall be watertight and free from leaks. Each leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

End of Section

Schedule 02704-S02 - Plant Piping Test Pressure Schedule

Piping Designation		Test Pressure psig
60	Treated Water Transmission Main	100
48	Finished Water to Springdale	200
48	Finished Water to Fayetteville	250
48	Finished Water to Bentonville	150
36	Finished Water to Rogers	200
24	Treated Water	200
20	Finished Water	200
16	Surge Tank Pipe	200
8	Private Fire Water	150
-	All others	1.5 times working pressure

End of Section

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SECTION 02740 SEPTIC SYSTEM

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the septic system as indicated on the drawings, including furnishing and installation of a septic tank with manway, distribution boxes, laterals, and drain field.

1.2 GENERAL.

A. The contractor is responsible for design of the septic system and obtaining Onsite Wastewater permits for construction of septic system. The design and construction of the septic system shall be in accordance with the requirements of all state and local codes pertaining to this work. Septic system design and installation shall be in accordance with Arkansas Department of Health Act 402 of 1977 and local codes. The septic system installer shall be certified in the State of Arkansas for such work. Permit fees for septic system design and installation shall be paid by Contractor.

B. The non-dwelling facility flows are anticipated to be approximately 85 gallons per day.

1.3 SUBMITTALS.

A. Complete detailed drawings, permits, and engineering data for the septic system materials shall be developed and submitted by the Contractor. The Contractor shall receive approval of design drawings from City Project Manager before beginning construction. Data submitted shall include, but not be limited to, the following:

1. Design Drawings
2. Manufacturer's descriptive product data.
3. Installation instructions.
4. Approved permits.

PART 2 - PRODUCTS

2.1 SEPTIC TANK.

A. The septic tank shall be as required by state and local codes. Unless otherwise required by state and local codes, the septic tank shall have a minimum capacity of 1,000 gallons.

B. The septic tank shall be constructed of precast concrete and shall be in accordance with ADH Act 402 Section 10.

2.2 DRAIN FIELD COMPONENTS.

A. Piping shall meet the requirements of Section 02628. All drain field components shall meet the requirements of ADH Act 402 Section 10.

PART 3 - EXECUTION

3.1 GENERAL.

A. The installation and inspection of the septic system shall be as required by ADH Act 402 and local codes. In addition, installation and testing of piping shall be as specified in Section 02702.

3.2 AS-BUILT SURVEY.

A. All four corners of the septic tank and all beginning and end points of distribution piping and lateral piping shall be surveyed after installation. Coordinates, elevations, and descriptions of each point along with a to scale as-built drawing with points labeled shall be provided.

End of Section

SECTION 02832 - CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers chain link fencing and gates. Fencing shall be provided in the alignment indicated on the Drawings and for the following locations:

1. Pump Station perimeter

2. Connection to Electrical substation fencing

1.2 SUBMITTALS

A. Drawings and Data

1. Complete detail drawings and specifications for the fence, gates, and accessories shall be submitted in accordance with the Submittals Procedures section.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 FENCE TYPES

A. Fencing shall conform to the details indicated on the Drawings and unless otherwise specified shall be of the following general types.

Location	Fabric	Height
Pump Station perimeter	Galvanized steel with extension arms with barbed wire.	6 ft

B. Fence posts shall be directly driven into the earth, supported by concrete cast into drilled holes, set into sleeves set in concrete structures or cast into concrete structures as detailed on the Drawings.

2.2 MATERIALS

A. Steel Fencing

1. All steel or malleable iron parts and accessories shall be hot-dip galvanized, PVC coated or aluminum coated after fabrication.

Fabric	9 gauge thick, 2 inch mesh. Galvanized per ASTM A392, Class 1, or aluminum coated per ASTM A491
Fabric Finish	Knuckled both edges for fabric widths of 60 inches or less. Knuckled one edge and twisted one edge for fabric widths of 72 inches or more.
Posts, Frames, and Rails	SS 40 or Schedule 40 Steel pipe, ASTM F1043, Group IC, with ASTM F1043, Type B or D interior and Type B exterior protective coating.
Line Posts	
For 6 foot fencing	2-3/8 inch OD pipe
Terminal Posts (End, Corner and Pull Posts)	
For 6 foot fencing	2-3/8 inch OD pipe
Gate Posts	
For gate or leaf 6 feet or less	2-7/8 inch OD pipe.
For gate or leaf wider than 6 feet	4 inch OD pipe.
For gate or leaf wider than 13 feet	6-5/8 inch OD pipe.
Top Rails	1-5/8 inch OD pipe
Rail Couplings	Sleeve type, 6 inches long, ASTM F626.
Bracing, required when fence height is greater than 6 feet.	Pipe brace same as top rail, with 3/8 inch diameter steel rod truss and tightener.
Post Tops (with barbed wire)	Pressed steel, malleable iron with pressed steel extension arm, or one-piece aluminum casting, ASTM F626.
Post Tops (without barbed wire)	Pressed steel, malleable iron, or cast aluminum, ASTM F626.
Barbed Wire	Each strand shall consist of two 12.5 gage steel wires with four-point barbs; galvanized per ASTM A121, Class 3, or aluminum coated per ASTM A121.
45 degree extension arms	Three strands of barbed wire mounted on extension arms, upper strand of barbed wire approximately 18 inches out from the fence and 18 inches above the top of the fabric.

Stretcher Bars	Steel, ASTM F626, 3/16 by 3/4 inch, or equivalent area.
Fabric Ties	Aluminum bands or wire, ASTM F626, #9 wire or thicker.
Gate Frames	Steel tubing, 1-7/8 inch OD.
Tension Wire	ASTM A824, galvanized or aluminum coated coil spring wire, 7 gauge.
Handrail-Setting Cement (posts set into concrete structures)	Minwax "Super Por-Rok Cement" or BASF MasterEmaco T 545DOT.
Hog rings	9 gauge steel wire
Coal tar epoxy paint	In accordance with Protective Coatings section

B. Padlocks

1. Owner will provide padlocks at required locations. Contractor shall provide temporary padlocks during construction.

2.3 GATES

A. Gates shall be swing type, hinged to swing an angle of 180 degrees from closed to open, complete with frames, latches, hinges and braces. Stops, keepers, and padlocks shall be provided where specified.

B. Gate leaves shall have intermediate members and diagonal truss rods where necessary for rigid construction and shall be free from sag or twist. When adjacent fence is topped with barbed wire, gates shall be fitted with vertical extension arms or shall have frame end members extended to carry barbed wire. Joints between frame members shall be made by welding or by means of heavy fittings, and shall be rigid and watertight. Gate fabric shall be same as fence fabric and shall be attached to frame ends by stretcher bars, bolt hooks, or other mechanical means.

C. Hinges shall be of heavy pattern, with large bearing surfaces, and shall not twist or turn under the action of the gate. Latches shall be plunger bar type, full gate height, and arranged to engage the gate stop, except single gates less than 10 feet wide shall be provided with a forked latch. Latches shall be arranged for padlocking, with the padlock accessible from both sides of the gate unless detailed on Drawings.

D. Stops shall consist of a roadway plate with anchor set in concrete and arranged to engage the plunger. Stops shall be installed as directed by Owner.

E. Keepers shall consist of mechanical devices for securing and supporting the free end of the gates when in the fully open position. Keepers shall be installed as directed by Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installed fence shall conform to the alignment and finished grade indicated. All posts shall be plumb. Unless otherwise indicated on the drawings, posts shall be spaced approximately 10 feet apart for pump station perimeter. Where necessary, the fence grade shall be adjusted to fit the ground contour by slipping the fence fabric links. Ground surface irregularities shall be graded to maintain not more than 2 inch clearance below the bottom of the fence fabric.

B. Where posts are set in earth, concrete foundations 36 inches deep shall be provided. If bedrock is encountered, post excavation shall be continued to the 36 inch depth or 18 inches into the rock, whichever is less. Concrete foundations shall be circular in horizontal section, not less than 10 inches in diameter for line posts, and with a diameter not less than the post OD plus 9 inches for terminal and gate posts, except that foundations in bedrock shall be at least 6 inches larger than the outside dimension of the post. Foundations shall extend above the ground surface and shall be crowned approximately 1 inch. Concrete for foundations shall conform to the Cast-in-Place Concrete section using at least a 3000 psi concrete mix. Each foundation shall be cured for at least 72 hours before further work is done on the post.

C. Top rails and bottom tension wires shall be installed before the fabric. Top rails shall be furnished in at least 18 foot lengths and shall be securely connected to gate and terminal posts. Tension wires shall be installed approximately 6 inches above grade and shall be attached to each post and securely anchored at terminal and gate posts. Straight runs between braced posts shall not exceed 1,500 feet. A terminal post shall be provided at each change in slope or each change in direction greater than 10 degrees.

D. Fabric shall be attached to the top rail at 24 inch centers. Fabric shall be attached to the bottom tension wire at 12 inch centers with 9 gauge hog rings. Fabric shall be attached to the line posts at 15 inch centers. Barbed wire, when necessary, shall be fastened to each extension arm by internal clips or external fabric ties. Stretcher bars shall be provided at each gate post and terminal post. Each stretcher bar shall be threaded through the fabric and anchored to the post at 15 inch centers by positive mechanical means.

E. When necessary, each gate and terminal post shall be braced by a horizontal pipe brace and an adjustable truss extending to an adjacent line post. Corner posts to be braced in both directions.

F. Fabric shall be stretched taut and anchored so that a pull of 150 lbs at the middle of a panel will not lift the bottom of the fabric more than 6 inches.

G. Gates shall be installed so that they cannot be removed without disassembly of the hardware. Hardware attachment bolts shall be peened so that removal will be difficult.

H. Interior and exterior surfaces of aluminum which will be in contact with concrete, mortar, or dissimilar metals shall be given a heavy coat of coal tar paint. The end of each aluminum post to be set in concrete shall be dipped in a container of coal tar paint before installation.

End of Section

SECTION 02930 - SEEDING AND SODDING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers seeding and sodding to be performed after backfilling and final grading are complete. All areas disturbed by construction operations shall be treated as specified herein.

B. All lawn, ditch, and street shoulder areas within street right-of-way and temporary construction easements that are damaged during the Work shall be restored, after completion of construction, to the complete satisfaction of Owner. All areas disturbed by Contractor outside the temporary construction easements shall be restored, at Contractor's expense, to the satisfaction of the property owner, except that if the temporary construction easement through the ownership is sodded all disturbed areas outside the construction easement shall also be sodded. Occupying areas outside temporary construction easements, street right-of-way, and utility easements for any purpose shall be done only with the written approval of the property owner.

1.2 GENERAL

A. Governing Standard

1. The governing standard for the seeding and sodding Work shall be Arkansas State Plant Board.

B. Experience

1. All Work shall be performed by a licensed landscaping Contractor who is licensed in the State of Arkansas.

2. Work shall be performed by a contractor acceptable to the Engineer, with at least four years seeding and sodding experience.

C. Completion

1. Seeding Work shall be completed during the period of March 15 to August 31. At Owner's option, a portion of the final payment not to exceed one (1) percent of the contract price may be retained until an acceptable stand for all grass/ground cover is established. Seeding requirements are as follows:

a. Locations to be seeded. Areas disturbed by construction and as indicated on the Drawings,

D. Sodding shall be completed during the period of March 15 to August 31. Sodding requirements are as follows:

1. Locations to be sodded. Areas within 20’ of asphalt or concrete pavement, waterways, and locations with a finished slope of 4:1 or steeper.

1.3 SUBMITTALS

A. Soil Test

1. Soil shall be tested to determine nutrient needs by the state Extension Service or an independent agricultural soil testing lab. Composite sample(s) shall be collected and submitted in accordance with lab instructions. Lab report and nutrient recommendations shall be provided to the Engineer.

B. Invoices and Analysis Labels

1. A copy of supplier’s invoices for all seed, mulch, and fertilizer which shows the quantity by weight purchased for the project and representative labels bearing the manufacturer’s or vendor’s guaranteed statement of analysis shall be submitted to Engineer for review and approval to assure compliance with specified requirements for quality and application rates.

1.4 GUARANTEE

A. Seeding

1. Contractor shall guarantee a uniform stand of seeding, free of weeds to the extent practical, and acceptable to Owner.

B. Sodding

1. Contractor shall guarantee the sodding Work to the extent that all transplanted sod shall be uniform in color, leaf texture, shoot density, and reasonably free of visible imperfections at acceptance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Prior to use, all products shall be kept dry and in a weatherproof location so that their effectiveness will not be impaired.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall conform to the requirements of the Governing Standard, except where otherwise specified.

B. Starter Fertilizer

1. Fertilizer shall be a complete pelleted or granulated fertilizer. The analysis in percent by weight shall be as follows:

	Seeded Areas
Nitrogen	10%
Phosphorus	20%
Potassium	10%

C. Seed

1. The seed species and the mixture shall be as follows, in accordance with the Governing Standard.

	Seed Type	LB/AC
March 15- June 15	Turf Fescue	250
	Bermuda Grass (common) unhulled	10
	Annual Rye	50
June 15- August 31	Turf Fescue	200
	Bermuda Grass (common) hulled	5
	Bermuda Grass (common) unhulled	10
August 31 – March 15	Turf Fescue	250
	Annual Rye	50

D. Sod

1. Sod shall have been planted on cultivated agricultural land and grown specifically for sod purposes and shall conform to the quality standards of Nursery Grown Sod as defined by the Turfgrass Producers International. Sod shall be free of objectionable grassy and broad leaf weeds. Sod shall be considered free of such weeds if less than five such plants are found per 100 square feet of area. The sod species shall be Bermuda, Zoysia, or St. Augustine grass.

E. pH Adjustment

1. If laboratory soil testing indicates the need for increased soil pH the Contractor shall add agricultural lime as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer. If laboratory soil testing indicates the need for decreased soil pH the Contractor shall add agricultural sulfur, aluminum sulfate or iron sulfate as a soil amendment. Addition rate(s) shall be determined by analysis of soil sample(s) subjected to laboratory testing. Addition rate(s) shall be as recommended by state Extension Service guidelines and/or local horticultural agencies and as approved by Engineer

F. Topsoil

1. Topsoil shall be fertile, natural soil, typical of the locality, free from stones, roots, sticks, clay, peat, weeds, and sod, and obtained from naturally well drained areas. It shall not be excessively acidic or alkaline nor contain toxic material harmful to plant growth. Stockpiled topsoil may be used but the Contractor shall furnish additional topsoil at his own expense if required.

G. Mulch

1. Mulch shall be a specially processed cellulose fiber containing no growth or germination inhibiting factors, or shall consist of straw from hay and shall include a tackifier. Mulch for hydroseeding operation shall be a wood mulch or combination wood and paper mulch in accordance with the Governing Standard.

PART 3 - EXECUTION

3.1 GENERAL

A. Execution of seeding and sodding Work shall conform to the Governing Standard, or shall be as specified herein, whichever is the most stringent.

B. Clearing

1. Prior to finish grading, areas to be seeded or sodded shall be cleared to remove stumps, stones larger than 3 inches , roots, cable, wire, debris or other materials that might hinder seeding and/or sodding and future turf maintenance.

C. Finish Grading

1. Seeding and/or sodding shall not be started until all earthwork has been substantially completed. Backfills and fills shall be allowed to settle, the topsoil spread, and finish grading completed before the Work is started. Finish grading shall result in a surface conforming to the contours indicated on the Drawings.

D. Application of Fertilizer and pH Adjustment

1. After finish grading, any fertilizer or chemicals for pH adjustment specified shall be applied uniformly to areas to be seeded.

2. Fertilizer application rate shall be 43 lbs/acre. Chemicals for pH adjustment shall be applied at a rate based on a soil test for pH. The rate shall be adequate to neutralize the soil.

E. Final Preparation

1. Following application of additives and/or fertilizers the areas to be seeded and/or sodded shall be tilled to a true depth of 6 inches by disking, harrowing, or other accepted methods to thoroughly incorporate the additives and fertilizer, destroy vegetation, and pulverize the soil. After tilling, the bed shall be smoothed by dragging or floating. The surface shall be cleared of all stones, stumps or other objects larger than 1-1/2 inches in thickness or diameter; roots, wire, grade stakes, and other objects that might hinder future turf maintenance operations.

2. When results are not satisfactory because of drought, excessive moisture or other causes, the Work shall be stopped until such conditions have improved or have been corrected.

3. When possible, operations shall be performed parallel to the contour lines and operations uphill and downhill shall be avoided.

3.2 SEEDING

A. Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. Seed shall be applied with equipment designed to give uniform application. Any method or combination of methods which uniformly distributes the seed directly in contact with the soil, covers the seed, and firms the bed, may be selected. Seed shall be placed approximately 1/4 inch below the surface.

B. Mulching

1. All seeded areas shall be mulched within 24 hours following seed application. The mulching operation shall be in accordance with the Governing Standard. Mulch shall be placed at a rate of 800 lbs/acre. Mulch shall be placed to a thickness of approximately 2 inches.

3.3 HYDROSEEDING

A. Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. The wood cellulose fiber mulch shall be applied at the minimum rate of 2,000 lb/acre in two separate operations. Ten percent of the specified rate of fiber mulch shall be applied with the seed and the remainder applied after seeding.

3.4 SODDING

A. Application of Sod

1. Sod shall be placed within 72 hours after preparation of the sod bed. Sod shall be cut and moved only when the soil moisture conditions are such that favorable results can be expected. When the soil is too dry, the sod shall be cut only after Contractor has watered the sod sufficiently to moisten the soil to the depth at which the sod is to be cut.

2. Care shall be exercised at all times to retain the native soil on the roots of the sod during the process of stripping, transporting, and planting. Dumping from vehicles will not be permitted.

3. The sod shall be transplanted within 24 hours from the time of stripping, unless stored in a satisfactory manner. During delivery and while in stacks, the sod shall be kept moist and shall be protected from exposure to the air and sun.

4. Sod shall be laid smoothly, edge-to-edge, and with staggered joints. The sod shall be immediately pressed firmly into contact with the sod bed by tamping or rolling with acceptable equipment so as to eliminate all air pockets, provide a true and even surface, and assure knitting.

5. Staking is not required, except in ditch flow lines; however, Contractor will be responsible for replacing all sod that is displaced by erosion during the maintenance period. Only wooden (lath) stakes shall be used.

3.5 WATERING

A. Seeded Areas: Watering for seeded areas will not be required.

B. Sodded Areas

1. Contractor shall provide all water, labor, and equipment for watering sodded areas. Sodded areas representing one day's planting shall be watered sufficiently to wet the sod pads and at least 2 inches of the sod bed. Thereafter, in the absence of adequate rainfall, watering shall be performed daily and as often as necessary to keep the sod pads moist at all times. Watering of sod shall continue as needed until final acceptance.

3.6 REPLANTING

A. Seeded Areas

1. Unacceptably seeded areas shall be overseeded or completely reseeded as instructed by Engineer. Unless otherwise permitted by Engineer, reseeding shall be performed during the next planting season.

B. Sodded Areas

1. Prior to acceptance, sodded areas that show signs of substantial desiccation as evident by a loss of color and a distinct yellowing shall be resodded and shall continue to be resodded until an acceptable sod cover is obtained. Replanting operations shall be as specified except that fertilizer and lime shall be deleted from the operation.

3.7 MAINTENANCE

A. All areas shall be maintained until final acceptance of the project.

B. Seeded Areas

1. Maintenance shall include any necessary reseeding, repair of erosion damage, and replacement of displaced mulch until covered with seedlings. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired.

C. Sodded Areas

1. Original grades of the sodded areas shall be maintained after commencement of planting operations and until acceptance. Any damage to the finished surface shall be repaired. In the event erosion occurs from either watering operations or rainfall, such damage shall be repaired. Ruts, ridges, tracks, and other surface irregularities shall be corrected and areas resodded.

2. During the maintenance period prior to acceptance, all sodded areas shall be mowed to height of 3 inches as soon as, and each time that, the grass reaches an average height of 5 inches. Clippings shall be collected and removed from the Site.

End of Section

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SECTION 03100 - CONCRETE FORMING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers formwork for cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. All forms shall be accurately and properly placed so cast-in-place concrete may be placed as indicated on the Drawings and as specified. The forms shall produce a smooth concrete finish free from offsets or irregularities.

1.3 SUBMITTALS

A. Drawings and Data

1. All submittals of catalog data sheets, manufacturers' certificates of compliance and other data shall be in accordance with the Submittals Procedures section.

B. Certificates of Compliance

1. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

a. Form Coating
b. Form Ties

PART 2 - PRODUCTS

2.1 MATERIALS.

Forms

Prefabricated	Simplex "Industrial Steel Frame Forms," Symons "Steel Ply," or Universal "Uni-form."
Plywood	Product Standard PS1, waterproof, resin-bonded, exterior type Douglas fir, face adjacent to concrete Grade B or better.

Fiberboard	ANSI/AHA A135.4, Class 1, tempered, water-resistant, concrete form hardboard.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Chamfer Strips	Clear white pine, surface against concrete planed.
Form Coating	Nonstaining and nontoxic after 30 days. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

2.2 FORMS

A. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the Drawings. Forms shall conform to ACI 347R and the following additional requirements.

1. Stay-in-place metal formwork will not be permitted.

2. Form-facing materials shall be selected in accordance with ACI 347.3R, based upon the applicable formed concrete surface category. Formed concrete surface categories vary by structure and application, and shall be as indicated in the Concrete Finishing section. Other types of forming materials, such as steel or unlined wood, may be used where plywood or lined forms are not required, and may be used as backing for form linings. Forms for exposed surfaces shall be laid out in a regular and uniform pattern with the long dimension of panels vertical and all joints aligned. The forms shall produce finished surfaces that are free from offsets, ridges, waves, and concave or convex areas, within the tolerances specified herein.

3. All vertical concrete surfaces above footings shall be formed.

4. Flat segmented forms not more than 24 inches wide may be used for forming curved surfaces 25 feet in diameter or larger.

B. Design

1. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that permissible working stresses are not exceeded.

2. Beams and slabs supported by concrete columns shall be formed so that the column forms may be removed without disturbing the supports for the beams or slabs.

3. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations, forms shall be brought to a true line and grade, or a wooden guide strip shall be placed at the proper location on the forms so that the concrete surface can be

finished with a screed or template to the specified elevation, slope, or contour. At horizontal construction joints in walls, the forms on one side shall not extend more than 2 feet above the joint.

4. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection.

C. Form Ties

1. Form ties shall have removable end and permanently embedded body, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portion shall be at least 1 inch back from the concrete face. Form ties for walls with waterstops at joints shall be provided with water stop washers located on the permanently embedded portions of the ties at the approximate center of the wall. The ties shall be smooth at the location of the water stop washer; continuously threaded systems will not be acceptable. Permanently embedded portions of form ties without threaded ends shall be constructed so that the removable ends are readily broken off without damage to the concrete. Through-wall tapered removable ties will not be acceptable. The type of form ties used shall be acceptable to Engineer.

2. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows.

D. Edges and Corners

1. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Equipment bases shall have formed beveled salient edges for all vertical and horizontal corners, unless specifically indicated otherwise on the Drawings. Unless otherwise noted, bevels shall be 3/4 inch wide.

PART 3 - EXECUTION

3.1 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

B. Before concrete is placed, forms shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

3.2 TOLERANCES

A. Tolerances for cast-in-place concrete work shall be as indicated in ACI 347.3R, based upon the relevant formed concrete surface category.

B. Formed concrete surfaces that are to have a face-mounted flat steel or FRP member attached, including but not limited to items such as weir plates or shelf angles, shall have more stringent flatness requirements. The surface profile shall permit the installation of the flat member without grinding the concrete surface (except for removal of fins), deforming the flat member, or requiring usage of backer rods or shims.

3.3 FORM COATING

A. All concrete forms shall have form release agent applied to them before placement of concrete.

3.4 FORM REMOVAL

A. Forms shall not be removed from structures until the concrete in the structures has sufficient strength to support the weight of the structure and any superimposed load, including loads from construction operations. Contractor shall be responsible for limiting any applied loadings. There shall be no evidence of damage to concrete and no excessive deflection or distortion of members due either to the removal of forms or to loss of support.

B. Supporting formwork (soffit material only) for horizontal members shall not be removed until the concrete has attained at least 75 percent of the specified 28 day compressive strength as determined by cylinders made and cured in the field. Shoring systems for horizontal members shall not be removed until the concrete has attained the full specified 28 day compressive strength, but may be temporarily removed for the purpose of removing the soffit material as permitted above. Shoring shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.

C. When forms are removed before the specified curing is completed, measures shall be taken to immediately continue curing and to provide adequate thermal protection for the concrete.

End of Section

SECTION 03200 - CONCRETE REINFORCING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers reinforcement for cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 SUBMITTALS

A. Drawings and Data

1. All submittals of drawings, manufacturers' certificates of compliance, certification of reinforcement, reinforcement bar lists, placement drawings, test data, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

2. Bar lists and drawings for the fabrication and placing of reinforcement shall be submitted for review and shall have sufficient plans, elevations, and sections to adequately detail and label all reinforcement. The bar lists and drawings shall also include a reference to the structure in which the reinforcement will be installed and to the Drawing showing the reinforcement.

3. Reinforcement fabrication drawings shall not be submitted until Engineer has reviewed and accepted any applicable concrete placement sequence submittals, as indicated in the Concrete Placing section.

B. Manufacturer's Certificate of Compliance

1. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

a. Mechanical connectors

PART 2 - PRODUCTS

2.1 MATERIALS.

Bars, Except Weldable	ASTM A615, Grade 60, deformed. Shear bars shall be Grade 60, smooth.

Bars, Weldable	ASTM A706 or A615, Grade 60, deformed, with maximum carbon equivalent of 0.55%.
Ductile Reinforcing Bars	ASTM A706 or ASTM A615, Grade 60, if the actual yield strength based on mill tests does not exceed the specified yield strength by more than 18,000 psi (retests shall not exceed this value by more than an additional 3,000 psi) and the ratio of the actual ultimate tensile strength to the actual tensile yield strength is not less than 1.25.
Column Spirals	ASTM A1064, cold drawn wire.
Welded Wire Fabric	ASTM A1064, Grade 70.
Bar Supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected. Precast concrete bricks shall not be used without approval of Engineer.
Mechanical Connectors	Splicing system meeting Type 2 tensile requirements of ACI 318. Products shall have a current evaluation report verifying testing per ICC-ES AC 133.
Threaded Type	Dayton Superior "DBDI Splice System," nVent "LENTON Mechanical Splicing Systems", or Barsplice Products "Grip-Twist" system.
Locking Type	Dayton Superior "Bar-Lock Coupler System", nVent "LENTON Connect System", or Barsplice Products "Zap Screwlock Type 2 Mechanical Connector" system.

2.2 REINFORCEMENT

A. Reinforcement shall be accurately formed and shall be free from loose rust, scale, concrete splatter, and contaminants which reduce bond. Unless otherwise indicated on the Drawings or specified herein, the details of fabrication shall conform to ACI SP-66 and ACI 318. Reinforcement shall not be bent in the field without approval of Engineer.

B. Splices

1. Splices shall conform to the details indicated on the Drawings. Splices at locations other than those indicated on the Drawings shall be submitted to Engineer for review and concurrence.

2. The reinforcement splice locations shall be coordinated with the construction joint locations and concrete placement sequence.

C. Mechanical Connectors

1. Mechanical connectors shall be used only as indicated on the Drawings. Connections in adjacent bars shall be spaced at least 30 inches apart.

D. Welding

1. Except where indicated on the Drawings, welding or tack welding of reinforcement is not permitted. Preheating and welding shall conform to AWS D1.4. Reinforcement which has been welded improperly or without Engineer's concurrence shall be removed and replaced.

PART 3 - EXECUTION

3.1 STORAGE AND HANDLING

A. Reinforcing steel shall be carefully handled and shall be stored on supports which prevent the steel from touching the ground.

3.2 PLACEMENT

A. Reinforcement shall be accurately positioned on supports, spacers, hangers, or other reinforcement, and shall be secured in place with wire ties or suitable clips. Tolerances shall be as stipulated in ACI 117 and ACI 318 unless otherwise indicated.

B. Reinforcement at the bottom of concrete slabs and mats shall not be supported from contact with subgrade by the use of metal supports or bent reinforcement.

C. Where reinforcement in beams is placed in two or more layers, the bars in the upper layer shall be placed directly above the bars in the lower layer.

D. Reinforcement for beams or slabs which are supported by concrete columns shall not be installed until after the concrete for the column has been placed.

E. Before concrete is placed, reinforcement shall be rigidly secured in proper position. All surfaces encrusted with dried concrete from previous placements shall be cleaned and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow before concrete is placed.

3.3 PLACING CONCRETE

A. Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns.

3.4 DUCT BANKS

A. All reinforcement and other magnetic materials installed in duct banks shall be installed parallel to the individual ducts, unless they enclose all the ducts of the duct bank.

End of Section

SECTION 03520 - CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers concrete accessories including construction, contraction and expansion joints for cast-in-place concrete.

B. Dovetail anchor slots shall be as specified in the Masonry section.

C. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. All accessories shall be accurately placed and all joints shall be accurately and properly constructed so cast-in-place concrete can be placed as specified and as indicated on the Drawings.

1.3 Submittals

A. Drawings and Data

1. All submittals of manufacturers' certificates of compliance, test data, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 MATERIALS

Metal Waterstops

Carbon steel	Uncoated, 12 gage minimum thickness, size as indicated on the Drawings.
Stainless steel	ASTM A480/A666, Type 304 or 316, 14 gage minimum thickness, size as indicated on the Drawings.
PVC Waterstops	Extruded, virgin, elastomeric, polyvinyl chloride (PVC), white (no pigment), ribbed, 3/8 inch min thick, size as indicated on the drawings. Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12 inches on center entire length.
6 inches wide, at construction joints	Greenstreak "679", JP Specialties "PVC637", or Vinylex "R638."

9 inches wide, at construction joints	Greenstreak ”646”, JP Specialties “PVC937”, or Vinylex ”R938.”
6 inches wide, at control joints	“O” bulb closed center section; Greenstreak “732”, JP Spcialties “PVC638”, or Vinylex “RB638H.”
9 inches wide, at control joints	“O” bulb closed center section; Greenstreak ”735”, JP Specialties “PVC938”, or Vinylex “RB938H.”
TPV Waterstops	Extruded, virgin, thermoplastic vulcanizate (TPV), black, size as indicated on the drawings. Ribbed; center bulb. Ozone resistance – no cracking at 450 pphm per ASTM D1171.
6 inches wide	3/16 inches min thick; minimum 0.5 lbs/ft . J.P. Specialties “Earth Shield – Part No. 636” or Westec “Style 619.”
9 inches wide	3/16 inches min thick, minimum 0.8 lbs/ft . J.P. Specialties “Earth Shield – Part No. 936” or Westec “Style 620.”
Expandable Waterstops, permitted only at locations indicated on Drawings	
For concrete sections that are at least 10 inches thick and 6 feet high, and with at least two layers of reinforcement	Hydrophilic; bentonite free, chemically modified rubber. Adeka “Ultra Seal MC-2010MN” or Greenstreak “Hydrotite CJ-1020-2K.” Adhesive and sealant as recommended by the manufacturer.
For other concrete sections	Hydrophilic; chemically modified rubber. Adeka “KBA-1510FP” or Greenstreak “Swellstop.” Adhesive and sealant as recommended by the manufacturer.
Expansion joint materials	
Filler	Preformed sponge rubber, ASTM D1752, Type I.
Filler adhesive	As recommended by manufacturer.
Sealant	As specified in the Joint Sealants section.
Polyethylene film	NBS Product Standard PS17 or ASTM D4397, 6 mils or thicker.
Vapor retarder and seam tape	Polyolefin membrane, 15 mil min, ASTM E1745, Class A, with maximum water vapor permeance of 0.02 perms. Stego Industries “Stego Wrap 15 Mil,” Raven Industries “Vaporblock 15,” Reef Industries “Griffolyn 15 Mil Green,” W.R. Meadows “Perminator 15,” Insulation Solutions “Viper VaporCheck II.” Manufacturer recommended seam tape and pipe boots.
Bearing pads	Preformed cotton duck reinforced pads, at least 1/4 inch thick; JVI “Capralon” or Voss Engineering “Sorbtex.”

Epoxy bonding agent	As specified in Concrete Placing section.

PART 3 - EXECUTION

3.1 CONSTRUCTION JOINTS

A. Construction joints shall be made at locations indicated on the Drawings or where specified. Construction joints shall not be made at other locations without the concurrence of Engineer.

B. Location

1. Construction joints shall be located as follows:

a. Bottom Slabs. Slabs with a transverse reinforcement pattern shall be divided into approximately square sections not to exceed 60 feet in their longest dimension. Slabs with a radial and circumferential reinforcement patter shall be divided into circular segments not to exceed 60 feet diameter, or into pie-shaped segments not to exceed 60 feet in the longest circumferential distance.

b. Columns. Provide joints at the underside of beams, girders, haunches, drop panels, and column capitals, and at floor levels. All haunches, drop panels, and column capitals shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Column bases will not be required to be monolithic with the floor beneath.

c. Walls. Provide joints at the underside of beams, girders, haunches, drop panels, and at floor levels. All haunches and drop panels shall be considered part of the supported floor or roof and shall be placed monolithically therewith. Walls shall be divided into sections not to exceed 60 feet in length. Joints shall be located within 30 feet of corners for liquid-containing structures and within 40 feet of corners for non-liquid containing structures. Walls supporting beams shall have pockets blocked out so that the full beam cross section penetrates the full thickness of the wall. Where waterstops are required in the joint, the wall pocket shall be widened and deepened to prevent interference between the waterstop and the beam reinforcement.

d. Beams, Girders and Suspended Slabs. Provide joints within the middle third of the span, and as close as practicable to the 1/3 point of the span. If a beam intersects a girder, the joint in the girder shall be offset by at least twice the width of the beam. Integral beam and slab systems shall be monolithic and shall have identical joint locations within spans. Members shall be divided into pour sections not to exceed 60 feet in length.

2. Construction joints in all concrete elements shall be perpendicular to the planes of their surfaces.

C. Watertight Joints

1. Construction joints in the following locations shall be watertight and shall be provided with continuous waterstops.

a. For liquid-containing structures, provide in slabs below the liquid surface elevation, and in all perimeter walls to their full height.
b. For liquid-containing structures, provide in divider walls where it is possible for one side or "cell" to be out of service while the other remains liquid-containing.
c. For filters and clear water reservoirs, provide in all walls, base slabs, and top slabs.
d. Provide in other locations specifically indicated on the Drawings.

3.2 EXPANSION AND CONTRACTION JOINTS

A. Expansion joint filler shall be firmly bonded to the previously poured joint face with a suitable adhesive, and the new concrete shall be poured directly against the joint filler. Accessible edges of each expansion and contraction joint shall be sealed as specified in the caulking section.

3.3 WATERSTOPS

A. Placement

1. Each waterstop shall be continuous throughout the length of the joint in which it is installed. Waterstops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted. Waterstop embedment shall be equal on both sides of the joint.

2. Expandable waterstops shall be located as nearly as possible to the center of the joint and shall not be installed when air temperature falls outside the manufacturer's recommended range.

B. Storage and Handling

1. Expansion joint filler and elastomeric (PVC or TPV) waterstops shall be stored in a cool place protected from direct sunlight.

2. Metal waterstops shall be handled, transported, delivered, and stored in a manner which will prevent bends, dents, or corrosion.

C. Splices

1. Junctions between adjacent sections of metal waterstops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.

2. Junctions between adjacent sections of elastomeric (PVC or TPV) waterstops shall be spliced in strict conformity with the recommendations of the manufacturer. Directional changes and intersections shall be factory fabricated by the waterstop manufacturer prior to delivery to the Site. Field splices will be acceptable only in straight sections.

3. Expandable waterstops shall be contact lapped a minimum distance of 8 inches . Voids shall be filled with sealant.

4. Where an expandable waterstop is used in combination with metal or PVC water stops, the expandable water stop shall be placed in contact and shall overlap a minimum distance of 12 inches . Voids shall be filled with sealant.

3.4 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer.

3.5 EMBEDMENTS

A. Anchor bolts, castings, steel shapes, conduits, sleeves, masonry anchors, and other objects that are to be embedded in the concrete shall be accurately positioned in the forms and securely anchored.

B. Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut to be placed on the concrete side of the form or template. A second nut shall be placed on the other side of the form or template, and the two nuts shall be so adjusted that the bolt will be held rigidly in proper position.

3.6 DUCT BANK JOINTS

A. Hardened surfaces that are to receive additional concrete shall be prepared by removing all loose particles, scum, and laitance so that the aggregate is exposed. The hardened surface shall then be thoroughly wetted and a thin coating of neat cement mortar shall be spread over the entire surface just before the fresh concrete is placed. The fresh concrete shall be puddled and spaded to eliminate any honeycomb or lack of mortar near the joint.

3.7 PLACEMENT AGAINST SUBGRADE

A. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high-pressure water spray.

B. Polyethylene Film

1. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film. Joints in the film shall be lapped at least 6 inches and taped.

C. Vapor Retarder

1. Vapor retarder shall be installed at the locations indicated on the Drawings. Installation shall be in accordance with ASTM E1643 and the manufacturer's recommendations. Joints in the retarder shall be sealed with waterproof sealing tape. Care shall be exercised to avoid tearing or puncturing the retarder. Any damage shall be promptly repaired, and the retarder shall be inspected for damage immediately before the concrete is placed.

End of Section

SECTION 03300 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers procurement of all cast-in-place concrete, including concrete materials, limiting requirements, mixture design, and performance requirements, and delivery to the Site through discharge at the end of the delivery truck chute.

B. Work beyond the end of the delivery truck chute is covered in the Concrete Forming, Concrete Joints and Accessories, Concrete Reinforcing, Concrete Placing, Concrete Finishing, and Concrete Curing sections.

1.2 GENERAL

A. All cast-in-place concrete shall conform to the limiting requirements of this specification including Table 1.

B. Concrete Classifications

1. Concrete classifications shall be defined and used as indicated for the following classes:

C. Concrete Classifications

Class	Class Description
A.	Structural Concrete
A1.	Concrete for Liquid-Containing Structures. Concrete for liquid-containing environmental structures, liquid-containing tanks, interior suspended slabs in high humidity areas, headwalls, chemical storage or containment areas, below grade structures exposed to groundwater under normal conditions, and all other concrete not otherwise indicated.
A2.	Small Aggregate Concrete; Congested Areas. Structural small aggregate concrete shall be used in all areas (including liquid-containing structures) where the clear distance between reinforcement, conduit, or embedded items is less than the largest dimension of coarse aggregate particles in the structural concrete.
A3.	Concrete for Non-Liquid-Containing Structures. Concrete for footings, foundations, manholes, catch basins, pan-formed joists, and all other structural concrete other than for liquid-containing structures.
A4.	Mortar Puddle. Placed in a lift 2 inches or more deep at the bottom of forms for walls and columns immediately before structural concrete is placed.
B.	Exterior Flatwork Concrete. Concrete for exterior slabs on grade, plant pavement, sidewalks, curbs and gutters, and small equipment pads.

Class Class Description

C. Architectural Concrete. Not used.

D. Miscellaneous Concrete

D1. Ductbanks, Pipe Blocking, Concrete Fill, and Pipe Encasement Concrete. Concrete used in ductbanks, pipe blocking, concrete fill and pipe encasements.

D7. Lean Concrete. Used as a fill material for over-excavations or for mud slabs below foundations. Controlled Low-Strength Material (CLSM) used as an easily removable fill material is covered in the Excavation and Fill for Structures section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. All data shall be submitted in accordance with the Submittal Procedures section, unless otherwise specified herein.

B. Drawings and Data – Required Items

1. The required submittal data for each Class of concrete shall be as indicated in Tables 2A, 2B, and 2C.

C. Preliminary Review of Materials

1. Reports covering the source and quality of concrete materials proposed for the work shall be submitted to Engineer for review within 30 days after the preconstruction conference.

2. The submittal shall include Submittal Cover Page #1, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

3. A manufacturer's certificate of compliance, which includes copies of independent test results confirming compliance with specified requirements, shall be submitted for the following materials:

a. Cement.
b. Admixtures.
c. Fly Ash.
d. Slag Cement.

D. Proposed Mixture Proportions

1. Data indicating the proposed material quantities in each Class of concrete shall be submitted to Engineer for review within 30 days after the preconstruction conference.

2. The submittal shall include Submittal Cover Page #2, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

E. Mixture Test Results

1. Concrete mixture test results shall be submitted to Engineer for review and acceptance.

2. The submittal shall include Submittal Cover Page #3, provided in the Appendix of this section. The cover page shall indicate the page numbers in the submittal where the respective data may be found during Engineer review.

3. Compressive strength shall be qualified by field test record data only for the Classes of concrete indicated as such in Table 2C. Compressive strength shall be qualified by laboratory testing for other Classes.

4. Laboratory trial mixture testing shall not begin until materials and proposed mixture proportions have been reviewed and are acceptable to Engineer.

1.4 STORAGE AND HANDLING

A. Cement, slag cement and fly ash shall be stored in suitable moistureproof enclosures. Cement, slag cement and fly ash which have become caked or lumpy shall not be used.

B. Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Unless otherwise specified, each concrete mixture shall be designed and controlled, within the following limits, to provide a dense, durable concrete suitable for the expected service conditions.

B. Concrete materials shall be selected and concrete shall be proportioned, batched, mixed, and delivered in a manner that will minimize shrinkage and cracking as specified herein, and in accordance with Chapters 3 and 8 of ACI 224R. Concrete temperatures shall be controlled before and until delivery at the end of the delivery truck chute to minimize cracking. Any rise in concrete temperature caused by environmental conditions that will be conducive to excessive shrinkage shall be controlled.

C. For each class of concrete, each concrete mixture shall be designed and concrete shall be controlled within the limits in the specification and in Table 1.

D. Cementitious Material Content Limits

1. The minimum quantity of Portland cement in the concrete shall be as indicated in Table 1.

2. The cementitious material content shall not be increased beyond the Table 1 values more than necessary to achieve the required f'_{cr}.

3. Contractor may substitute fly ash for Portland cement within the percentage ranges indicated in Table 1, on the basis of 1.0 lbs of fly ash added for each lb of Portland cement reduction.

4. Contractor may substitute slag cement for Portland cement within the percentage ranges indicted in Table 1 on the basis of 1.0 lbs of slag cement added for each lb of Portland cement reduction.

5. Mixtures using slag cement in combination with fly ash will not be acceptable.

E. Maximum Water-Cementitious Material Ratio

1. The maximum water-cementitious material ratio shall be on a cement mass basis, or, if fly ash or slag cement is used, the combined mass of cement plus fly ash or slag cement shall be used to determine the water-cementitious materials ratio. Limiting maximum water-cementitious material ratios are indicated in Table 1.

F. Aggregates

1. Aggregates shall comply with ASTM C33 except as specified herein. Fine aggregate shall be clean natural sand. Artificial or manufactured sand shall not be used unless acceptable to Engineer. Coarse aggregate shall be crushed rock, washed gravel, or other inert granular material, meeting Class 4S requirements, except that clay and shale particles shall not exceed values indicated in Table 1.

2. Gradation of coarse aggregate shall conform to maximum nominal size grading requirements of ASTM C33. When a combination of two or more sizes is used, the combined gradation shall meet ASTM C33 requirements.

3. Aggregates used in concrete shall have a combined aggregate distribution similar to the aggregates used in the concrete trial mixtures. Reports of individual aggregates shall include sieve sizes 1-1/2 inch, 1 inch, 3/4 inch, 1/2 inch, 3/8 inch, No. 4, No. 8, No. 16, No. 30, and No. 50 in accordance with ASTM E11.

4. Specified sand equivalent for fine aggregate shall be not less than indicated in Table 1 for an average of 3 samples tested in accordance with ASTM D2419.

5. To comply with the specified concrete shrinkage test requirements, the clay and shale content of the aggregates may need to be reduced by washing the aggregate.

G. Ratio of Fine to Total Aggregates

1. The ratio of fine to total aggregates, based on solid volumes (not weights), shall be as follows:

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
3/8 inch	0.45	0.60
1/2 inch	0.40	0.55
3/4 inch	0.35	0.50

Maximum Nominal Coarse Aggregate Size	Minimum Ratio	Maximum Ratio
1 inch	0.30	0.46
1-1/2 inch	0.25	0.40

H. Slump

1. Concrete slump shall be kept as low as possible, consistent with proper handling and thorough consolidation. Prior to the addition of admixtures, slump shall be at least 2 inches and shall not exceed the maximum slump as indicated in Table 1.

2. When superplasticizer is dispensed at the ready-mix plant, the concrete mixture design shall be based on a maximum slump as indicated in Table 1. When superplasticizer is dispensed at the Site, the slump of the concrete delivered shall not exceed the maximum slump as indicated in Table 1 before superplasticizer is added.

I. Initial Set

1. The initial set, as determined by ASTM C403, shall be attained 5-1/2 hours ±1 hour after the water and cementitious materials are added to the aggregates for each concrete mixture. The quantity of retarding admixture shall be adjusted to compensate for variations in temperature and job conditions.

J. Total Air Content

1. The total volumetric air content of concrete after placement shall be as indicated in Table 1, and within ±1.5 percent. Air-entraining admixture may be omitted from concrete for interior floor surfaces which are to be steel trowel finished.

K. Admixtures

1. Only approved or specified admixtures shall be used.

2. Unless otherwise acceptable to Engineer, all admixtures shall be from one manufacturer and shall be compatible. Admixtures that are compatible with other admixtures and concrete materials shall not have an adverse effect on the required properties of the concrete nor the specified limiting requirements. The admixture content, batching method, and time of introduction to the mixture shall comply with these specifications and with the manufacturer's recommendations for minimum shrinkage. The admixture manufacturer shall provide qualified field services as necessary, at no additional cost to Owner.

3. Admixtures used in the concrete shall be reviewed and accepted by Engineer prior to conducting the laboratory trial mixture testing and the shrinkage testing. No calcium chloride nor admixture containing chloride from sources other than residual impurities in admixture ingredients will be permitted.

4. Combination of admixtures which cause premature or local dehydration or post-compaction settlement of the concrete surface shall not be used. If any such undesirable

characteristics are observed, the use of the mixture shall be discontinued and an alternate mixture design used.

5. All liquid-containing (Class A1) concrete, and small aggregate (Class A2) concrete that is placed in liquid-containing structures, shall include a high-range water reducing admixture (superplasticizer). Water-reducing admixtures are not required for Classes D1 and D7, but may be included at Contractor's option. For all other non-liquid-containing concrete, a water-reducing admixture shall be used.

6. Superplasticizer may be dispensed into the concrete at the plant or on the Site and shall be mixed in accordance with the admixture manufacturer's recommendations. Each superplasticizer dose, when dispensed at the Site, shall be easily verifiable and recorded on the delivery ticket. The superplasticizer for each load shall be accurately proportioned into a separate container prior to dispensing the admixture into the concrete. When truck-mounted dispensers are used, the system shall not be flushed or cleaned with water until after the entire load of concrete has been discharged. When permitted by Engineer, redosing of concrete with superplasticizer shall be done only once. Redosing procedures shall be as recommended by the admixture manufacturer.

7. A shrinkage reducing admixture may be added to Class A1 concrete. It shall replace an equal volume of mixing water or as otherwise recommended by the admixture manufacturer. The quantity of air entrainment admixture shall be adjusted as required by the admixture manufacturer to keep mixture air content within specified limits.

L. Strength

1. In addition to the other limiting requirements to achieve durability and minimize shrinkage, the minimum acceptable compressive strengths of concrete tested at the end of the delivery truck chute, as determined by ASTM C39, shall be as indicated in Table 1.

2. Adequate test cylinders taken at the point of placement shall also be made to verify that Contractor's concreting procedures comply with applicable industry standard procedures.

M. Pumped Concrete

1. Coarse aggregate size for pumped concrete mixtures shall be limited to a nominal maximum of 1-1/2 inch.

N. Water-Soluble Chloride

1. Maximum water-soluble chloride ion concentrations in hardened concrete at an age of 28 days shall not exceed the limits expressed as a percentage of mass of cementitious materials as indicated in Table 1.

2. Test results shall be reported as the percentage of water-soluble chloride ions in the concrete and as a percentage of chloride ion relative to the mass of cementitious materials in the concrete.

3. Testing of the concrete components for water-soluble chloride ions may be done at the discretion of Contractor. Copies of the reports on such tests shall be furnished to Engineer.

4. The hardened concrete and each gradation of aggregate used in the concrete shall be tested each time a chloride ion test is conducted on a concrete mixture.

O. Laboratory Shrinkage Limits

1. Based on the modified ASTM C157 test procedures as specified herein, the shrinkage limits of concrete shall be the average drying shrinkage of each set of three test specimens cast in the laboratory from a trial mixture as measured at the 21 days drying age, and shall not exceed the values in Table 1.

P. Cold Weather Concrete

1. Except as modified herein, cold weather concrete shall comply with ACI 306.1. The temperature of concrete at the point of delivery at the end of the delivery truck chute shall be not less than that indicated in ACI 306.1 for corresponding outdoor temperature (in shade) at the time of placement.

2. When delivered, heated concrete shall be not warmer than 80°F.

Q. Hot Weather Concrete

1. Except as modified herein, hot weather concrete shall comply with ACI 305.1. At air temperatures of 90° F or above, concrete shall be kept as cool as possible before and during delivery. The temperature of the concrete at the time of delivery at the end of the delivery truck chute shall not exceed the values indicated in Table 1.

2.2 MATERIALS

Cement	ASTM C150, Type II or Type I/II. Low Alkali. Or ASTM C595, Type IL 10 MS, with equivalent alkalis ($Na_2O + 0.658\ K_20$) maximum % of 0.60 per ASTM C114.
Fly Ash	ASTM C618, except that loss on ignition shall not exceed 4 percent. Class F or Class C are acceptable, but Class C shall also be qualified for moderate sulfate resistance as described in ASTM C618, Table 3, Procedure A. The test for sulfate resistance shall be in accordance with ASTM C1012.
Slag Cement	ASTM C989, Grade 100 or Grade 120.
Aggregates, Fine and Coarse	As specified in Limiting Requirements paragraph.
Water	Potable. Water from concrete production operations shall not be used.
Admixtures	
Water Reducing/Normal Set	ASTM C494, Type A, except as otherwise specified herein.
Water Reducing/Retarding	ASTM C494, Type D, except as otherwise specified herein.

Air-Entraining	ASTM C260.
High Range Water Reducing/Normal Set	ASTM C494, Type F, extended slump life type, except as otherwise specified herein.
High Range Water Reducing/Retarding	ASTM C494, Type G, extended slump life type, except as otherwise specified herein.
Shrinkage Reducing Admixture	GCP Applied Technologies (Grace) "Eclipse 4500," Euclid "Eucon SRA," or Master Builders Solutions "MasterLife SRA 035." These admixtures shall not be used when NSF/ANSI 61 certification is required.

2.3 MIXTURE DESIGN AND TESTING

A. As stipulated in the Quality Control section, all reports and tests required for preliminary review of materials and for laboratory trial mixtures shall be made by an independent testing laboratory at the expense of Contractor. Mixtures shall be adjusted in the field as necessary, within the limits specified, to meet the requirements of these specifications. If the source of any concrete materials is changed during the contract, concrete work shall pause until the new materials and the new mixture design are tested in accordance with the specified requirements.

B. Preliminary Review of Materials

1. The tests and reports required shall be as indicated in Table 2A. Review of these reports shall be for general acceptability only, and continued compliance with all contract provisions shall be required.

2. Aggregate reports and cement mill test reports shall be no more than 90 days old at time of submittal.

3. Alkali-aggregate reactivity potential shall be determined by one of the following procedures. Field performance history as described in ASTM C1778 will not be an acceptable method for qualifying aggregates.

   a. Test fine and coarse aggregates in accordance with ASTM C1260. Aggregates which are classified as innocuous may be used without further testing.
   b. Test fine and coarse aggregates in accordance with ASTM C1567, using a single aggregate with all cementitious materials selected for the Project. The fine and coarse aggregates shall not be combined and used in a single test. This test may only be used for mixtures that contain slag cement or fly ash, and those products shall not have an alkali content greater than 4.0 percent sodium oxide equivalent. Combinations of cementitious materials and aggregate which do not indicate a potential for alkali reactivity may be used without further testing. Mixture combinations which indicate a potential for alkali reactivity shall have the ingredients and/or proportions modified and then the test shall be repeated.
   c. Test fine and coarse aggregates in accordance with ASTM C1293. Concrete mixtures containing only portland cement (without pozzolan or slag cement) shall be tested accordingly and have a measured expansion of 0.04 percent or less at one year duration. Concrete mixtures containing pozzolan or slag cement shall be

tested with those ingredients in proportions matching that of the proposed mixture, and shall have a measured expansion of 0.04 percent or less at two years duration.

4. At the discretion of Engineer, testing in addition to that indicated herein or in ASTM C1778 may be performed on potentially reactive aggregates. Nonreactive aggregates shall be imported if, in the opinion of Engineer, local aggregates exhibit unacceptable potential reactivity.

C. Proposed Mixture Proportions

1. Proposed proportions for each Class of concrete shall meet the limiting requirements indicated herein.

D. Mixture Testing

1. Test results on each Class of concrete shall be submitted for review and shall be acceptable to Engineer before concrete work is started. The reports shall include the information indicated in Table 2C.

2. Field Test Record Data

a. If indicated as acceptable in Table 2C, concrete mixtures may be qualified based upon field test record performance data in lieu of laboratory trial mixtures. Field test data records shall be from the production facility being used on the current Project and shall have been performed in the past 24 months. Field test records shall represent a single group of at least 10 consecutive strength tests for one mixture, using the same materials, under the same conditions, and encompassing a period of not less than 45 days.

3. Laboratory Trial Mixture Testing

a. Trial mixtures shall be tested in the laboratory for each size and combined gradation of aggregates and for each consistency as indicated and intended for use on the work and as specified.
b. Concrete ingredients shall be measured and mixed in the laboratory. Concrete test specimens shall be made, cured, and stored in accordance with ASTM C192 and tested in accordance with ASTM C39.
c. Concrete proportions shall be established based on laboratory trial mixtures that meet the following requirements:
    1) The combination of materials shall be as proposed for use in the work.
    2) Mixtures shall conform with the limiting requirements specified herein.
    3) The required average compressive strength, f'_{cr}, of the trial mixture shall exceed the specified minimum acceptable compressive strength, f'_{cr}, as required in Table 1.
    4) Trial mixtures of the proportions and consistencies specified for the work shall be prepared. When a three point curve is required by Table 2C, the three concrete trial mixtures shall reflect the cement content proposed for the Project and for the indicated concrete class at three water-cementitious material ratio contents at or lower than indicated in Table 1. The compressive strength of the cylinders made from the three trial mixtures

shall produce a range of compressive strengths exceeding or encompassing the f'_{cr} required for the work.

5) For each proposed concrete mixture that is required to be tested as indicated in Table 2C, compressive strength test cylinders shall be made for each testing age. Each change in the water-cementitious materials ratio shall be considered a new concrete mixture. Each mixture shall be tested at the ages of 7 days and 28 days.

6) When a three point curve is required in Table 2C, the results of the cylinder tests for each water-cementitious materials ratio at each age shall be plotted as a curve showing the relationship between compressive strength (along y-axis) and the water-cementitious materials ratio (along x-axis). The water-cementitious materials ratio and the associated average compressive strength for the Project concrete mixture shall be selected from the 28 day curve. The maximum water-cementitious materials ratio specified in the limiting requirements shall still apply even if the curve indicates that the concrete strength would be adequate at a higher ratio. The cement content and mixture proportions to be used shall be such that the selected water-cementitious materials ratio will not be exceeded at specified maximum slump. These concrete mixture proportions shall be submitted for review in accordance with the Submittals Procedures section.

7) When a shrinkage reducing admixture is proposed, trial mixtures shall be prepared with and without the shrinkage reducing admixture.

4. Testing Procedures

a. Concrete mixture testing procedures shall be as specified herein, and reports for these tests shall be prepared specifically for this Project.

b. Aggregates shall be sampled and tested in accordance with ASTM C33. The bulk specific gravity of each aggregate shall be determined in accordance with ASTM C127 and ASTM C128.

c. Slump shall be determined in accordance with ASTM C143. Unit weight (mass) shall be determined in accordance with ASTM C138. Total air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138. Concrete temperature shall be determined in accordance with ASTM C1064.

d. Initial set tests shall be made at ambient temperatures of 70° F and 90° F to determine compliance with the specified time for initial set. The test at 70° F shall be made using concrete containing the specified normal set/water-reducing admixture and, when required, air-entraining admixture. The test at 90° F shall be made using concrete containing the specified retarding/water-reducing admixture and, when required, air-entraining admixture. Initial set shall be determined in accordance with ASTM C403.

e. Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch. The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular class of concrete shall be performed using the same sized cylinders for the duration of the work.

f. Water-soluble chloride ion shall be determined in accordance with ASTM C1218.

g. A drying shrinkage test shall be conducted on the trial mixture with the maximum water-cementitious materials ratio used to qualify each proposed concrete mixture design using the concrete materials, including admixtures, that are proposed for the Project. Three test specimens shall be prepared for each test. Drying shrinkage specimens shall be 4 inch by 4 inch by 11 inch prisms with an effective gauge length of 10 inches, fabricated, cured, dried, and measured in accordance with ASTM C157 except with the following modifications:

1) Specimens shall be removed from the molds at an age of 23 hours ±1 hour after batching, shall be placed immediately in water at 73°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in lime-saturated water as specified in ASTM C157. Measurement to determine expansion expressed as a percentage of original length shall be taken at age 7 days. The length at 7 days shall be the base length for drying shrinkage calculations ("zero" days drying age). Specimens then shall be stored immediately in a humidity controlled room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as a percentage of the base length shall be reported separately for 7, 14, and 21 days ±4 hours of drying from "zero" days after 7 days of moist curing for a total of 28 days from the date of casting.

2) Drying shrinkage deformation for each specimen shall be computed as the difference between the base length (at "zero" days drying age) and the length after drying at each test age. Results of the shrinkage test shall be reported to the nearest 0.001 percent. If drying shrinkage of any specimen deviates from the average for that test age by more than 0.004 percent, the results for that specimen shall be disregarded.

3) The average drying shrinkage of each set of 4 inch by 4 inch by 11 inch test specimens made in the laboratory from a trial mixture shall not exceed the values required in Table 1.

PART 3 - EXECUTION

3.1 BATCHING, MIXING, AND DELIVERY

A. Concrete shall be furnished by an acceptable ready-mixed concrete supplier, and shall conform to ASTM C94 except as indicated otherwise in this specification.

B. Delivery Tickets

1. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be handed to Engineer by the truck operator at the time of delivery. Tickets shall indicate the name and location of Contractor, the project name, the mixture identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cementitious materials were added, and the numerical sequence of the delivery.

C.

D. Mixing Water

1. Mixing water shall not be added in transit. Any amount of water withheld from the truck mixer shall be clearly indicated on the delivery ticket. Water added at the site shall not exceed the amount withheld, and shall not be added without oversight by Owner's on site inspector.

E. Consistency

1. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall flow uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

3.2 CONTRACTOR'S ON GOING MATERIAL CONTROL TESTING

A. The following tests and test reports are required during the progress of the work and shall be made at the expense of Contractor. The frequency specified herein for each field control test is approximate and subject to change as determined by Engineer.

B. Aggregate Gradation

1. Each 200 tons of fine aggregate and each 400 tons of coarse aggregate shall be sampled and tested in accordance with ASTM D75 and C136, for verification that the gradations continue to meet ASTM C33 requirements. If lesser quantities of aggregates are used, the sampling and testing shall occur at least once every 6 months.

C. Sand Equivalent

1. The sand equivalent test shall be conducted each time the sand gradation tests are conducted.

D. Fly Ash

1. Each 400 tons of fly ash shall be sampled and tested in accordance with ASTM C618 and C311. Contractor shall supply Engineer with certified copies of supplier's (source) test reports showing chemical composition and physical analysis for each shipment delivered to Contractor and certifying that the fly ash complies with the specifications. The certificate shall be signed by the fly ash supplier.

E. Cement

1. Each 1500 tons of cement shall be sampled and tested in accordance with ASTM C150. Contractor shall supply Engineer with certified copies of supplier's (source) test reports showing chemical composition and physical analysis, and certifying that the cement complies with ASTM C150 and these specifications. The certificate shall be signed by the cement manufacturer.

F. Slag Cement

1. Each 800 tons of slag cement shall be sampled and tested in accordance with ASTM C989. Contractor shall supply Engineer with certified copies of supplier's (source) test reports showing chemical composition and physical analysis, and certifying that the slag cement complies with ASTM C989 and these specifications. The certificate shall be signed by the slag cement manufacturer.

3.3 OWNER'S FIELD CONTROL TESTING

A. Field control tests, including slump, air content, and making compression test cylinders, shall be performed by Engineer or Owner's testing laboratory personnel, at the expense of Owner. Contractor shall provide access to all facilities and the services of one or more employees as necessary to assist with the field control testing.

B. The frequency specified herein for each field control test is approximate and subject to change as determined by Engineer.

C. Engineer may require field testing prior to the addition of superplasticizer at the Site to determine compliance with the specifications. Field testing after the addition of superplasticizer shall be conducted as specified and as needed to determine that the concrete is in compliance with the specifications. Air content tests shall be conducted whenever field tests are conducted.

D. Slump

1. A slump test shall be made for each 100 cubic yards of concrete. Slump shall be determined in accordance with ASTM C143.

E. Air Content

1. An air content test shall be made on concrete from one of the first three batches mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. Air content shall be determined in accordance with ASTM C231 and verified in accordance with ASTM C138.

F. Unit Weight

1. A unit weight test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Unit weight shall be determined in accordance with ASTM C138.

G. Concrete Temperature

1. A concrete temperature test shall be made on concrete from the first batch of concrete mixed each day and on concrete from each batch of concrete from which concrete compression test cylinders are made. During hot or cold weather concreting operations, temperature shall be checked not less than once per hour. Concrete temperature shall be determined in accordance with ASTM C1064.

H. Water-Soluble Chloride Ion

1. Water-soluble chloride ion testing shall be performed once for each 1,000 cubic yards of concrete in accordance with ASTM C1218.

I. Compression Tests

1. One set of concrete compression test cylinders shall be made not less than once each day concrete is placed, not less than once for each 100 cubic yards of each class of concrete, and not less than once for each 5000 square feet of surface area for slabs or walls. Half of the cylinders of each set shall be tested at an age of 7 days and the remaining cylinders shall be tested at an age of 28 days.

2. Test cylinders shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and tested in accordance with ASTM C39.

3. Cylinders shall be 6 inches diameter by 12 inches high for concrete mixes using a maximum nominal aggregate size of 1 inch or larger. Cylinders may be either 6 inches diameter by 12 inches high, or 4 inches diameter by 8 inches high for concrete mixes using a maximum nominal aggregate size of less than 1 inch. The average compressive strength shall be determined from the results of at least three cylinders when using 4 inch diameter cylinders, and at least two cylinders when using 6 inch diameter cylinders. All tests for a particular mixture class shall be performed using the same sized cylinders for the duration of the work and shall match the cylinder size used for the trial mixtures.

4. Each set of compression test cylinders shall be marked or tagged with the date and time of day the cylinders were made, the location in the work where the concrete represented by the cylinders was placed, the number of the delivery truck or batch, the air content, the slump, the unit weight, and the concrete temperature.

J. Shrinkage Tests

1. Concrete shrinkage tests shall be performed once for each 1,000 cubic yards of concrete with controlled shrinkage that is placed and shall be made on concrete from a batch of concrete from which concrete compression test cylinders are made. Shrinkage testing shall be conducted as specified for the preliminary trial mixtures.

2. The average drying shrinkage of each set of test specimens cast in the field from concrete delivered to the Site and sampled at the end of the delivery truck chute, as measured at the 21 days drying age, shall not exceed the values indicated in Table 1.

K. Test Reports

1. Five copies of each test report shall be prepared and distributed by the testing laboratory to the Owner, Resident Project Representative (two copies), Engineer, and Contractor, in accordance with the Quality Control section.

3.4 EVALUATION AND ACCEPTANCE OF CONCRETE

A. Concrete will be evaluated for compliance with all requirements of the specifications. Concrete strength will be only one of the criteria used for evaluation and acceptance of the concrete. The results of all tests performed on the concrete and other data and information concerning the procedures for handling, placing, and curing concrete will be used to evaluate the concrete for compliance with the specified requirements.

B. Compression tests will be evaluated in accordance with ACI 318 and as specified herein. A strength test shall be the average of the compressive strengths of two 6 inch diameter cylinders or three 4 inch diameter cylinders, made from the same concrete sample tested at 28 days.

C. Compression Test Evaluation

1. Compressive strength test results will be evaluated for compliance with the specified strength requirements. The strength level of the concrete will be considered satisfactory when the averages of all sets of three consecutive strength tests equal or exceed the specified compressive strength, f'_c, and no individual strength test result falls below the specified compressive strength by more than 500 psi.

D. Inspection of Concrete Supplier

1. Both scheduled and unscheduled visits by inspectors on days of concrete pours shall be accommodated. Inspectors shall be allowed access to delivery tickets and mixture proportions.

TABLE 1 – LIMITING REQUIREMENTS															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1.	Minimum Cement Content, lbs/cubic yard; based on maximum slump and maximum water-cementitious material ratio.														
	Maximum Nominal Aggregate Size, ASTM C33 aggregate														
	Size No. 467 (1-1/2")	---	---	489	---	440	464	---	---	600*	**	---	---	---	380
	Size No. 57 (1")	536	---	514	---	460	489	514	460	620*	**	---	---	---	400
	Size No. 67 (3/4")	564	---	526	---	480	514	526	480	640*	**	---	---	526	420
	Size No. 7 (1/2")	---	601	555	---	500	526	555	500	660*	**	---	584	555	440
	Size No. 8 (3/8")	---	636	564	---	520	555	564	520	680*	**	636	601	564	460
	Fine Aggregate, (Sand)	---	---	---	750	---	---	---	---	---	---	---	---	---	---
2.	Compressive Strength, minimum; psi														
	Field, 7 days;	3375	3375	3375	3000	3000	3000	3000	2250	3000	**	3000	3000	3000	1500
	Field, 28 days; f'_c	4500	4500	4500	4000	4000	4000	4000	3000	4000	**	3000	4000	4000	2000
	Laboratory, 28 days; f'_{cr}	5700	5700	5700	5200	5200	5200	5200	3200	5200	**	4200	5200	5200	2000
3.	Maximum water-cementitious material ratio	0.42	0.42	0.45	0.45	0.45	0.48	0.45	0.65	0.45	**	0.45	0.45 0.40[a]	0.42	0.75
4.	Maximum nominal coarse aggregate size, inches	1	1/2	1-1/2	Sand	1-1/2	1-1/2	1	1	1-1/2	**	3/8	1/2	3/4	1-1/2
5.	Maximum slump, inches														
	Slump before super-plasticizer added	3	3	4	6	6	4	3	5	6	**	4	4	4	6
	Slump after adding superplasticizer	8	8	8	8	8	8	8	8	9	**	8	8	8	10
6.	Total air content, percent, (± 1.5 %)	6	6	6	6	6	6	6	---	---	**	---	6	6	---
7.	Fly ash replacement, percent range	15-25	15-25	15-25	15-25	15-30	15-25	15-25	15-30		**	15-30	15-35	15-25	15-30

TABLE 1 – LIMITING REQUIREMENTS														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
8.	Slag cement replacement, percent range	25-50	25-50	25-50	0	25-50	25-30	0	25-50	0	**	0	0	25-50	25-50
9	Testing limits														
	Sand equivalent, min. percent	75	75	75	75	75	75	75	---	75	**	75	75	75	---
	Chloride ion, max. percent	0.08	0.08	0.15	0.08	0.30	0.15	0.10	0.30	0.30	**	---	0.15	0.15	---
	Shrinkage, max. percent; based 4 x 4 x 11 inch specimen														
	Laboratory	0.036	0.036	0.048	---	---	0.048	0.048	---	0.048	**	---	---	0.048	---
	Field	0.048	0.048	0.064	---	---	0.064	0.064	---	0.064	**	---	---	0.064	---
	Coarse Aggregate: Clay and shale combined particles shall not exceed, max. percent	1	1	1	1	1	3	2	10	1	**	3	1	2	3
10	Concrete temperature at time of delivery and placement, max. ° F	85	85	90	85	90	95	85	95	95	**	90	85	85	95

NOTES:

* "D2" (Underwater concrete) - Limit aggregate to 3/4" for reinforced concrete, up to 1-1/2" for unreinforced concrete.

** "D3" (Mass Concrete) limiting requirements shall be as indicated in the Mass Concrete section.

[a] "D5" Wash water trough top edge water-cementitious ratio, 100 percent sand passing No. 8 sieve.

TABLE 2A – SUBMITTAL REQUIREMENTS (PRELIMINARY REVIEW OF MATERIALS)														
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
1	Aggregate reports														
	Fine aggregate														
	Source and type	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Gradation	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Deleterious materials	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Fineness modulus	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	X	X	X	X	X	X	**	---	X	X	X
	Sand equivalent	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Coarse aggregate														
	Source and type	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Gradation	X	X	X	---	X	X	X	X	X	**	X	X	X	X
	Deleterious materials	X	X	X	---	X	X	X	X	X	**	X	X	X	---
	Abrasion loss	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Soundness test	X	X	X	---	X	X	X	---	X	**	X	X	X	---
	Alkali-aggregate reactivity	X	X	X	---	X	X	X	X	X	**	---	X	X	X
	Combined aggregate gradation	X	X	X	---	X	X	X	X	---	**	X	---	---	---
2	Cement, mill report	X	X	X	X	X	X	X	X	X	**	X	X	X	X
3	Cementitious material, type, data sheet, and test report (fly ash, slag cement)	X	X	X	X	X	X	X	X	X	**	X	X	X	X
4	Admixtures														
	Data sheets and certifications	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Manufacturer's approval letter	X	X	X	X	X	X	X	X	X	**	X	X	X	X
5	NSF/ANSI 61 compliance, for each proposed concrete constituent, where applicable	---	---	---	---	---	---	---	---	---	**	---	---	---	---

TABLE 2B – SUBMITTAL REQUIREMENTS (PROPOSED MIXTURE PROPORTIONS)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
6	Mixture proportions, reports	X	X	X	X	X	X	X	X	X	**	X	X	X	X

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
7	Type of testing														
	Field test records acceptable	---	---	---	---	---	---	---	X	---	**	X	X	X	X
	Trial mixtures required	X	X	X	X	X	X	X	---	X	**	---	---	---	---
8	Test Reports Required														
	Confirmation of materials tested														
	Cement brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Fly ash brand, type, composition, quantity	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Specific gravity of each aggregate	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Ratio of fine to total aggregates	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Water content	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Water-cementitious materials ratio	X	X	X	X	X	X	X	X	X	**	X	X	X	---
	Slump	X	X	X	X	X	X	X	---	X	**	X	X	X	---
	Unit weight	X	X	X	---	X	X	X	---	X	**	---	X	X	---
	Air content	X	X	X	---	X	X	X	---	---	**	---	X	X	---
	Temperature	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Time of initial set at 70° F and 90° F.	X	X	X	X	X	X	X	---	X	**	---	---	---	---
	Three point curves	X	X	X	---	---	---	X	---	X	**	---	---	---	---
	Compressive strength at 7 and 28 days	X	X	X	X	X	X	X	X	X	**	X	X	X	X
	Water-soluble chloride ion	X	X	X	X	X	X	X	X	X	**	---	X	X	---
	Drying shrinkage	X	X	X	---	---	X	X	---	X	**	---	---	X	---

TABLE 2C – SUBMITTAL REQUIREMENTS (MIXTURE TESTING)															
	Concrete Class	**A1**	**A2**	**A3**	**A4**	**A5**	**B**	**C**	**D1**	**D2**	**D3**	**D4**	**D5**	**D6**	**D7**
	NSF/ANSI 61 compliance evaluations where applicable	---	---	---	---	---	---	---	---	---	**	---	---	---	---

NOTES:

** "D3" (Mass Concrete) submittal requirements shall be as indicated in the Mass Concrete section.

Appendix – Submittal Cover Pages

Submittal Cover Page #1 – Preliminary Review of Materials	
Subject	Insert Submittal Page Number(s)
FINE AGGREGATE REPORTS	
Source and Type	
Gradation	
Deleterious Materials	
Fineness Modulus	
Alkali-Aggregate Reactivity	
Sand Equivalent	
COARSE AGGREGATE REPORTS	
Source and Type	
Gradation	
Deleterious Materials	
Abrasion Loss	
Soundness Test	
Alkali-Aggregate Reactivity	
Combined Aggregate Gradation	
CEMENTITIOUS MATERIAL REPORTS	
Cement Mill Report	
Fly Ash Report	
Slag Report	
ADMIXTURES	
Data Sheets and Certifications	
Manufacturer's Approval Letter	

Submittal Cover Page #2 – Proposed Mixture Proportions																
	Insert Submittal Page Number(s)															
Subject	A1	A2	A3	A4	A5	A6	A7	B	C	D1	D2	D3	D4	D5	D6	D7
Water-Cementitious Material Ratio																---
Ratio of Fine-to-Total Aggregates				---						---	---		---			---

Submittal Cover Page #3 – Mixture Test Results														
	Insert Submittal Page Number(s)													
Subject	A1	A2	A3	A4	A5	B	C	D1	D2	D3	D4	D5	D6	D7
Slump (pre HRWR)								---						---
Slump (after HRWR)								---						---
Unit Weight				---				---			---			---
Air Content				---				---			---			---
Temperature								---			---	---	---	---
Time of Set								---			---	---	---	---
Lab Compressive Strength (7 days)								---			---	---	---	---
Lab Compressive Strength (28 days)								---			---	---	---	---
Three point curves				---	---	---		---			---	---	---	---
Field Compressive Strength (28 days)	---	---	---	---	---	---	---		---	---				
Water-soluble chloride											---			---
Shrinkage				---	---			---			---	---		---
ANSI/NSF 61			---	---	---	---	---		---		---	---	---	---

End of Section

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SECTION 03330 - CONCRETE PLACING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers placing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly placed as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. Drawings and Data

1. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittal Procedures section.

B. Manufacturer's Certificate of Compliance

1. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

a. Epoxy bonding agent.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Concrete shall be handled and placed in a manner that will minimize shrinkage and cracking as specified herein. Concrete temperatures shall be controlled both before and after placement to minimize cracking.

2.2 MATERIALS

Epoxy Bonding Agent	ASTM C881, Type V, moisture insensitive, 100 percent solids; Dayton Superior "Sure Bond J58," Euclid "Dural 452 MV," Prime Resins "Prime Bond 3900 High Mod LPL," or SpecChem "SpecPoxy 2000."

PART 3 - EXECUTION

3.1 RECEIVING

A. Contractor shall check each delivery ticket to verify the concrete class delivered to the jobsite is in compliance with the concrete requested and is suitable for Contractor's handling, placing, finishing, and curing procedures. Engineer will collect the delivery tickets from the truck operator.

3.2 PLACEMENT

A. The limits of each concrete pour shall be determined by Contractor and shall be acceptable to Engineer. All concrete within the predetermined limits shall be placed in one continuous operation.

B. Before concrete is placed, forms, reinforcement, water stops, anchor bolts, and embedments shall be rigidly secured in proper position; all dirt, mud, water, and debris shall be removed from the space to be occupied by concrete; all surfaces encrusted with dried concrete from previous placements shall be cleaned; and the entire installation shall be acceptable to Engineer. Remove all frost, ice, and snow from within the formwork before concrete is placed.

C. Contractor shall inform Engineer at least 24 hours in advance of any concrete placement.

D. Bonding to Hardened Concrete

1. The surface of hardened concrete upon which fresh concrete is to be placed shall be rough, clean, sound, and damp. Before placement of plastic concrete, the hardened surface shall be cleaned of all laitance and foreign substances (including curing compound), washed with clean water, wetted thoroughly, and the surface made free of standing water. Surface profile of the hardened concrete after surface preparation shall be as required for good bond.

2. Epoxy bonding agent shall only be required where specifically indicated on the project drawings or specifications. Fresh concrete shall be applied when bonding agent is still tacky. Bonding agent material that has exceeded the manufacturer's recommended pot life shall be removed.

3. Coarse aggregate shall be omitted from the first batch or batches of concrete placed on hardened concrete in wall or column forms. The mortar puddle, Class A4 concrete, shall cover the hardened concrete by at least 2 inches at every point.

E. Conveying Concrete

1. Methods of conveying concrete to the point of final deposit shall prevent segregation or loss of ingredients. After placement in the forms, concrete shall not be moved laterally more than 5 feet . Concrete's free fall should not exceed 4 feet .

F. Pumping Concrete

1. The slump of concrete, with or without a superplasticizer, which is discharged into the pump may exceed the specified maximum slump value by the amount of slump loss in the pumping system, up to a maximum of 1 inch . The slump loss shall be determined by tests made at each end of the pumping system. If tests indicate a slump loss greater than 1 inch in the pumping system, Contractor shall modify the pumping system as required to reduce the slump loss to 1 inch or less.

G. Placing Concrete

1. For proper compaction, concrete shall be placed in approximately horizontal layers not to exceed 24 inches . Each layer of concrete shall be plastic when covered with the following layer, and the rate of vertical rise of the concrete in the forms shall not be less than 24 inches per hour. Vertical construction joints shall be provided as necessary to comply with these requirements.

2. Concrete shall be placed and compacted in wall or column forms before any reinforcement is placed in the system to be supported by such walls or columns. The height of any portion of a wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet . Concrete in walls or columns shall be in place at least 2 hours before concrete is placed in the structural systems to be supported by such walls or columns.

3. Concrete shall be thoroughly settled in wall forms before top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has settled, the excess shall be screeded off.

H. Compaction

1. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Mechanical vibrators shall maintain at least 14,000 cycles per minute when immersed in the concrete. The number and type of vibrators shall be acceptable to Engineer. The use of “jitterbug” tampers to compact concrete flatwork will not be permitted.

I. Cold Weather Concreting

1. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

2. When placed, heated concrete shall not be warmer than 80° F .

J. Hot Weather Concreting

1. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

2. At air temperatures of 90° F or above, concrete shall be kept as cool as practicable during placement. The temperature of the concrete when placed in the work shall not exceed the values indicated in the Cast-in-Place Concrete section.

3. Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented. Concrete shall not be placed when the evaporation rate (actual or anticipated) equals or exceeds 0.2 lb per square foot per hour , as determined using the nomograph in Appendix A of ACI 305.1.

K. Duct Banks

1. Duct bank concrete shall be compacted by rodding or spading only. Mechanical vibrators shall not be used. Concrete shall be worked around reinforcement and embedments and into the corners of the forms.

3.3 CLEANING EMBEDMENTS

A. Embedments shall be clean when installed.

End of Section

SECTION 03350 - CONCRETE FINISHING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers finishing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly finished as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. Drawings and Data

1. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittal Procedures section.

B. Manufacturer's Certificate of Compliance

1. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

a. Floor sealer.

PART 2 - PRODUCTS

2.1 MATERIALS

Concrete Surface Coloring/Hardener	Mineral aggregate dry-shake colored hardener for concrete flatwork. ChemSystems, Inc. "CSI Color Hardener," Euclid "Surflex," or Dayton Superior "Quartz Tuff."
Evaporation Reducer	Dayton Superior "AquaFilm Concentrate J74," Euclid "Eucobar," L&M Chemical "E-Con," Master Builders Solutions "MasterKure ER50," or Sika "SikaFilm."
Nonslip Aggregate	Aluminum oxide aggregate, L&M Chemical "Grip It," Master Builders Solutions "MasterTop 120SR," or Dayton Superior "Emery Non-Slip."

Floor Sealer	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3.1 FINISHING UNFORMED SURFACES

A. Buried and permanently submerged concrete blocking and encasement will require no finishing except as necessary to obtain the required surface elevations or contours. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating, and troweling where required.

B. Screeding

1. Screeding shall produce a concrete surface conforming to the proper elevation and contour, with all aggregates completely embedded in mortar.

C. Application of Evaporation Reducer

1. Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight shall be protected with an evaporation reducer. The evaporation reducer shall form a continuous film on the surface of fresh, plastic concrete to reduce evaporation.

2. Immediately following screeding, evaporation reducer shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon , in accordance with the manufacturer's recommendations. The spray equipment shall have sufficient capacity to continuously spray the product at approximately 40 psi with a suitable nozzle as recommended by the manufacturer.

3. The sprayable solution shall be prepared as recommended by the manufacturer.

4. Under severe drying conditions, additional applications of evaporation reducer may be required following each floating or troweling, except the last finishing operation.

D. Floating

1. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.

2. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color, and unless additional

finishing is specifically required, shall produce the completed finish for unformed surfaces.

3. Floating shall be done with hand floats or suitable mechanical compactor-floats.

E. Finishing Surfaces for Bonding

1. All surfaces to be covered with concrete or topping shall be float finished. All laitance, surface mortar, and unsound material shall be removed by brushing or air blasting at the time of initial set. Surfaces shall be rough, clean, and sound. Floors and other flat surfaces to receive composite topping (Class D6) shall be given a broom finish or raked finish with at least a 1/4 inch profile.

F. Troweling

1. Interior floor surfaces which will be exposed after construction is completed; surfaces to be covered with resilient floor coverings, thinset terrazzo, or seamless floor covering; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the Drawings shall be steel trowel finished. Surfaces to be covered with elastomeric deck covering shall be lightly troweled but not burnished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

2. Air-entraining admixture may be omitted from concrete for interior floor surfaces which are to be steel trowel finished.

G. Edging

1. Unless specified to be beveled, exposed edges of floated or troweled surfaces shall be edged with a tool having at least a 1/8 inch corner radius.

H. Broom Finish

1. Concrete surfaces indicated below shall be given a light broom finish to produce a nonslip surface. Brooming shall be done after the second floating and at right angles to the normal direction of traffic.

2. Broom finish shall be provided at the following locations:

a. exterior docks
b. exterior stairs

I. Pavement Finishing

1. The surface of pavements shall not vary more than 1/8 inch under a 10 foot straightedge placed parallel to the center line.

2. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be drag finished, using a seamless strip of damp burlap over the

full width of the surface. The burlap drag shall consist of sufficient layers of burlap and shall have sufficient length in contact with the concrete to slightly groove the surface. The drag shall be moved forward with a minimum bow of the lead edge. The drag shall be kept damp, clean, and free of particles of hardened concrete. When acceptable to Engineer, carpet, artificial turf, or cotton fabric may also be used.

3. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be broom finished with a broom acceptable to Engineer. The broom shall be not less than 18 inches wide and made from good quality bass or bassine fibers not more than 5 inches long. The broom finishing shall produce regular corrugations not over 1/8 inch deep. The broom shall be pulled square across the surface, from edge to edge, with adjacent strokes slightly overlapped, and shall not tear the concrete surface.

4. Following placement and consolidation, and the disappearance of bleed water, the concrete surface shall be grooved in the transverse direction, using a wire broom or comb with a single row of tines. Unless otherwise permitted by Engineer, the grooving shall be at least 1/8 inch wide at 3/4 inch centers and the groove depth shall be approximately 1/8 inch . The transverse grooving shall terminate approximately 1 foot from the gutter line at the base of the curb. The area adjacent to the curb shall be given a light broom finish longitudinally.

J. Sidewalk Finishing

1. Concrete surfaces shall be screeded to the proper elevation and contour. All aggregates shall be completely embedded in mortar. Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface. Initial floating shall be followed by a second floating at the time of initial set.

2. Floated surfaces shall be given a light broom finish, using a horsehair broom, to provide a nonslip surface. Brooming shall be done at right angles to the length of the walk.

3. Sidewalks shall be edged using a 3 or 4 inch wide edging tool with a 1/8 inch corner radius. Edger lap marks at corners of each slab shall be carefully removed. False joints shall be provided at right angles to the length of the walk, using a grooving tool with 1/8 inch radius. The finished edge on each side of the joint shall be the same width as the edging tool used. False joints shall divide each sidewalk into square sections.

4. The finished surface of all sidewalks shall be neat in appearance, shall be sloped to drain, and shall not pond water.

3.2 CONCRETE SURFACE COLORING/HARDENER

A. Where concrete surface coloring/hardener is required, a dry-shake coloring material shall be worked into the freshly screeded concrete surface.

B. Duct Bank Finishing

1. After screeding and before final floating, a red concrete surface coloring shall be dusted onto the fresh concrete surface at the rate recommended by the manufacturer.

3.3 FLOOR SEALER

1. All concrete floors in interior locations which are to remain as exposed concrete or will be covered with carpet shall be given two coats of clear floor sealer in addition to any which may have been applied as a membrane curing compound. Floor sealer shall not be applied to concrete floors that are to be stained or etched, covered with chemical resistant linings, covered with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material. Prior to application of each coat of sealer, the floor shall be thoroughly cleaned of dirt, grease, and other foreign matter. The first coat shall be applied at the end of the curing period. The second coat shall be applied in preparation for substantial completion of the work. Floor sealer shall be applied in accordance with the manufacturer's recommendations.

3.4 REPAIRING DEFECTIVE CONCRETE

A. Defective concrete shall be defined as any surface with undesirable visible effects in excess of that permitted by the relevant formed concrete surface category (CSC), except as indicated otherwise herein.

B. Defects in formed concrete surfaces shall be repaired to the satisfaction of Engineer within 24 hours of form removal. Surface repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of the surrounding concrete. Surface repair material shall be adequately cured.

C. Defects in concrete that are more than 3 inches deep shall be brought to the attention of Engineer prior to any repair work. Contractor shall submit a proposed repair material and procedure for review by Engineer. The repair material and procedure required by Engineer may be more extensive than the process described in Article 5.3.7 of ACI 301.

3.5 FINISHING FORMED SURFACES

A. Formed concrete surfaces shall meet all criteria of the relevant formed concrete surface category (CSC), as defined in ACI 347.3R, except as indicated otherwise herein. Surfaces shall be assigned to CSCs as indicated.

B.

Formed Concrete Surface Category	Applicable Surfaces	Mockup Required
CSC1	Formed concrete surfaces that will be in permanent contact with earth backfill.	No
CSC2	All other formed concrete surfaces not designated otherwise.	No
CSC3	None.	Yes

Formed Concrete Surface Category	Applicable Surfaces	Mockup Required
CSC4	None.	Yes

C. Fins, form seams, and construction joints shall be ground flush on all surfaces in formed concrete surface categories CSC2, CSC3, and CSC4, and in CSC1 surfaces that are required to be dampproofed.

D. All tie holes in formed surfaces, regardless of the relevant CSC, shall be cleaned, wetted, and filled with patching mortar. The patches shall be finished flush and cured and shall match the texture and color of the adjacent concrete.

E. Concrete surfaces to be dampproofed shall have fins removed and tie holes filled, but no additional finishing will be required.

F. Concrete surfaces to be painted or grout cleaned shall have sharp edges and projections removed to provide an acceptable condition for painting or grout cleaning. The concrete surfaces shall have bug holes filled per the Protective Coatings section.

3.6 TOLERANCES

A. Tolerances for cast-in-place concrete work shall be as stipulated in ACI 117, unless otherwise indicated.

3.7 CLEANING EMBEDMENTS

A. After placement of concrete, surfaces of embedments not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

End of Section

SECTION 03390 - CONCRETE CURING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers curing of cast-in-place concrete.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values in inch-pound units govern.

1.2 GENERAL

A. All cast-in-place concrete shall be properly cured as indicated on the Drawings and as specified herein.

1.3 SUBMITTALS

A. Drawings and Data

1. All submittals of test data, manufacturers' certificates of compliance, reports, catalog data sheets and other data shall be in accordance with the Submittals Procedures section.

B. Manufacturer's Certificate of Compliance

1. A manufacturer's certificate of compliance, which includes the name of the project and, when requested, copies of independent test results confirming compliance with specified requirements, shall be submitted to Engineer for the following materials:

a. Membrane curing compound.

C. Curing Plan

1. A curing plan shall be submitted for review, indicating the planned method of curing for each individual structure on the project.

PART 2 - PRODUCTS

2.1 LIMITING REQUIREMENTS

A. Concrete shall be cured in a manner that will minimize shrinkage and cracking as specified herein.

2.2 MATERIALS

Membrane Curing Compound	ASTM C1315, Type I, Class A, minimum 25 percent solids, acrylic, non-yellowing, unit moisture loss 0.40 kg/m^2 maximum in 72 hours. Product shall not exceed VOC limits established by the federal, state, or local regulatory agency having jurisdiction over the project site.

PART 3 - EXECUTION

3.1 GENERAL

A. Cold Weather Concreting

1. Except as modified herein, cold weather concreting shall comply with ACI 306.1.

2. The concrete surface shall be maintained at a temperature of at least 50° F for 5 days or 70° F for 3 days, after placement. Concrete temperature shall be recorded at least six times for each 24 hour period. Concrete and adjacent form surfaces shall be kept continuously moist. Sudden cooling of concrete shall not be permitted.

B. Hot Weather Concreting

1. Except as modified herein, hot weather concreting shall comply with ACI 305.1.

2. At air temperatures of 90° F or above, concrete shall be kept as cool as practicable during curing.

3. Plastic shrinkage cracking due to rapid evaporation of moisture shall be prevented.

3.2 CURING

A. Concrete shall be protected from loss of moisture for at least 7 days after placement unless indicated otherwise. Curing of concrete shall be done by methods which will keep the concrete surfaces adequately wet for the specified curing period.

B. Water Curing

1. Water curing shall be performed for concrete in liquid-containing structures and for all concrete containing slag cement. Other forms of curing will not be acceptable in these applications. Water curing shall be in accordance with ACI 308.1 except as modified herein.

2. Water saturation of concrete surfaces shall begin as soon as possible after initial set. The rate of water application shall be regulated to provide complete surface coverage with a minimum of runoff. The application of water to walls may be interrupted for grout cleaning only over the areas being cleaned at the time, and the concrete surface shall not be permitted to become dry during such interruption.

3. Water curing shall continue for 14 days for concrete containing slag cement, and for 7 days for other types of concrete. However, when concrete is being protected from low temperatures, the duration of water curing may be shortened to 1 day less than the duration of cold weather protection.

4. When forms are removed before the specified curing duration is completed, measures shall be taken to immediately continue water curing and to provide adequate thermal protection for the concrete.

C. Membrane Curing

1. Unless otherwise specified, membrane curing compound may be used instead of water curing on concrete in non-liquid-containing structures which will not be stained or etched, covered with chemical resistant linings, covered with additional concrete, or indicated in the Architectural drawings to be covered with a finish flooring material.

2. Membrane curing compound shall be evenly sprayed at a coverage rate of not more than 300 square feet per gallon . The spray equipment shall have sufficient capacity to continuously spray curing compound at approximately 40 psi with a suitable nozzle as recommended by the manufacturer. Unformed surfaces shall be covered with the first coat of curing compound within 30 minutes after final finishing. A second coat of curing compound shall be applied when the first coat has become tacky to the touch and shall be applied at right angles to the first coat.

3. Curing compound shall be suitably protected against abrasion during the curing period.

D. Film Curing

1. Unless otherwise specified, film curing with white polyethylene sheeting may be used instead of water curing on concrete in nonliquid-containing structures which will be covered later with mortar or additional concrete, or which will otherwise not be exposed to view.

2. Film curing shall begin as soon as possible after initial set of the concrete. The concrete surfaces shall be completely covered with polyethylene sheeting. Sheeting shall overlap the edges of the concrete for proper sealing and anchorage, and joints between sheets shall be sealed. All tears, holes, and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and as necessary to prevent billowing on the surface.

End of Section

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SECTION 03600 – GROUTING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers procurement and installation of grout. Unless otherwise specified, only nonshrink grout shall be furnished.

B. Epoxy grouting and adhesive anchoring of anchor bolts, threaded rod anchors, and reinforcing bars is covered in the Anchorage in Concrete and Masonry section. Grouting of masonry is covered in the Masonry section.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete manufacturers' data and product information shall be submitted in accordance with the Submittal Procedures section.

B. Certification Letter

1. A letter of certification indicating the types of grout to be supplied and the intended use of each type shall be submitted in accordance with the Submittals Procedures section.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2.1 MATERIALS

Nonshrink Grout	Precision cementitious grout with demonstrated non-shrinking properties, minimum 28 day compressive strength of 9000 psi; L&M "Crystex," Master Builders Solutions "Masterflow 928," Sika "SikaGrout 328," Euclid "Hi-Flow Grout," Dayton Superior "Sure-Grip High Performance Grout," or SpecChem "SC Precision Grout."
Water	Clean and free from deleterious substances.

2.2 CEMENTITIOUS GROUT

A. Cementitious grout shall be furnished factory premixed so that only water is added at the jobsite.

2.3 EPOXY GROUT

A. Epoxy grout shall be used in lieu of cementitious grout when required by the equipment manufacturer for performance or warranty requirements. Epoxy grout shall be a three component system consisting of a Part A (resin), Part B (hardener) and Part C (aggregate). All three components shall be products of the same manufacturer and be compatible. Epoxy grout products and installation procedures shall be submitted to Engineer for approval.

PART 3 - EXECUTION

3.1 CEMENTITIOUS GROUT INSTALLATION.

A. Preparation

1. The concrete foundation to receive cementitious grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

B. Mixing

1. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout, nor shall water content exceed the amount recommended by the manufacturer.

C. Temperature Restrictions

1. Grout shall be placed in accordance with the manufacturer's published temperature restrictions. Ambient temperature and grout temperature shall be a minimum of 40 degrees F and rising at time of placement. Grout shall not be placed on frost covered surfaces. Grout shall be protected from freezing until it has reached a minimum strength of 4,000 psi. Grout shall not be placed when the ambient or grout temperature exceeds 90 degrees F.

D. Placement

1. Unless otherwise specified or indicated on the Drawings, grout under baseplates shall be 1-1/2 inches thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

E. Edge Finishing

1. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

F. Curing

1. Grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

3.2 EPOXY GROUT INSTALLATION

A. Epoxy grout shall be installed in accordance with ACI 351.5.

End of Section

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SECTION 03930 - CONCRETE CRACK REPAIR

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the repair of concrete and shotcrete cracks and joints.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

C. General Crack Repair

1. General crack repair is applicable only to new construction, and shall include the following:

a. Sealing of all cracks and crack networks that are wider than 10 mils (0.01 inch) as measured at the exposed surface.
b. All necessary repairs to structures that have failed a tightness test, including sealing of construction joints.

2. All costs for general crack repair shall be included in the Contract Price. General crack repair work is expected to be necessary due to cracks that commonly develop during concrete construction.

D. Engineer-Directed Crack Repair

1. Engineer-directed crack repair is applicable only to new construction, and shall only be performed when instructed by Engineer. The work shall include, but is not limited to, the following:

a. Sealing of construction joints that are not otherwise required to be sealed as the result of a failure of a leakage test.
b. Sealing of cracks and crack networks with a width of 10 mils (0.01 inch) or less as measured at the exposed surface.

2. Contractor shall include 150 linear feet of Engineer-directed crack repair in the Contract Price. The Engineer-directed crack repair may be either epoxy resin or foam resin, as determined by Engineer.

1.2 SUBMITTALS

A. Specifications and data covering physical properties, mixtures, application procedures, and curing procedures of the materials proposed shall be submitted in accordance with the Submittals Procedures section. Submittals shall include the approvals from the material manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer's Field Services

1. The material manufacturer shall provide engineering field services to review the Work and the material application prior to any preparation; to approve the applicator, the material used, and the procedure to be used; to observe surface preparation; to approve surface preparation; and to observe application. The field representative of the material manufacturer shall submit, in writing through Contractor, approvals of proposed material, application procedures, applicator, and surface preparation. The field representative shall be an employee of the material manufacturer.

B. Applicator

1. The applicator shall submit through Contractor a satisfactory experience record including references from previous application of the specified materials to structures of similar design and complexity.

C. Pre-Construction Meeting

1. At least 30 days prior to concrete crack repairs, Contractor shall conduct a meeting to review the detailed requirements for rehabilitation work. Site conditions, surface preparation, proposed equipment, procedures, material mixing, placing procedures, and curing methods shall be discussed and approved by Engineer and by the manufacturer's field representative. Contractor shall require the attendance of all involved parties, including but not limited to Contractor's superintendent, repair contractor, manufacturer's field representative and proposed equipment supplier representative. Minutes of the meeting shall be recorded, typed and printed by Contractor and distributed to all parties within 5 days after the meeting.

D. Quality Assurance Certification

1. Material manufacturers shall be ISO 9001/9002 registered or shall provide proof of documented quality assurance. The documented quality assurance system shall be obtained through an independent auditing registrar.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless otherwise specified or authorized, repairs shall conform to the requirements specified herein. Types of repairs not specified herein shall be as specified in other sections, as indicated on the Drawings, or, in the absence of any definite requirement, as recommended by the

manufacturer's representative and subject to acceptance by Engineer. The following types of repairs shall be performed as required.

B. Epoxy Resin

1. Unless indicated otherwise on the drawings, epoxy resin shall be used to seal construction joints and cracks. Epoxy resin shall be pressure-injected for vertical and overhead applications. Epoxy resin may be applied by gravity feed in lieu of pressure injections for cracks in floors, using a very low-viscosity material.

C. Foam Resin

1. Foam resin shall be used to seal expansion joints. Otherwise, foam resin shall only be used to seal crack and joints when indicated on the drawings or when permitted by Engineer in lieu of epoxy resin. Foam resin shall be pressure-injected.

2.2 ACCEPTABLE PRODUCTS

A. Repair products/materials shall be as specified herein. Equivalent products of other manufacturers regularly producing high quality concrete crack repair products/materials, providing engineering field services, and meeting the specified quality assurance requirements may be furnished subject to review and acceptance by Engineer.

2.3 MATERIALS

A. Materials shall be approved by the manufacturer for the type of application, including temperature and moisture conditions encountered.

Epoxy Resin	ASTM C881, Type I or Type IV, moisture tolerant or moisture insensitive.
Crack Sealant	As recommended by the manufacturer of the epoxy resin product.
Foam Resin	Hydrophilic polyurethane foam; Prime Resins “Prime-Flex 900 XLV”, DeNeef "Sealfoam PURe", Euclid “Dural Aqua-Fil”, or Avanti “AV 333 Injectaflex”.
Foam Resin Accelerator	As recommended by foam resin manufacturer.
Water	Clean and free from deleterious substances.

PART 3 - EXECUTION

3.1 INSPECTION

A. Prior to the placement of the repair materials, the crack to be repaired shall be inspected by the material manufacturer to assure that preparation and conditions are correct for the type of repair and the product/material being used as specified herein.

3.2 PREPARATION

A. All cracks and surfaces around the cracks shall be free of objectionable substances and shall conform to the requirements of the material manufacturer. Concrete and shotcrete to be repaired shall be cleaned by methods acceptable to the material manufacturer so that the cracks are free of dirt, oil, grease, laitance, and other foreign matter. All loose and deteriorated existing concrete and shotcrete shall be removed down to sound materials. All concrete and shotcrete surfaces shall be checked for delamination to ensure that all surfaces are sound. All edges shall be square cut to avoid feather edges.

B. Any other preparation recommended by the material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

C. Concrete and shotcrete surfaces in the area of a crack to be repaired shall be cleaned by wire brushing, blasting, or other acceptable methods.

D. Wall surfaces shall be sandblasted clean to expose crack networks and construction joints. If there is active water seepage in the repair area, the seepage shall be stopped as recommended by the injection material manufacturer and as acceptable to Engineer. Injection ports shall be installed, when recommended by the injection material manufacturer.

E. Injected Epoxy Resin

1. Preparation for injected epoxy resin shall include sealing the surface at the crack, on both sides when possible, with crack sealant as recommended by the material manufacturer and as acceptable to Engineer for the pressure injection work. Injection ports for epoxy resin shall penetrate through the crack sealant into the cracks at spacings recommended by the material manufacturer.

F. Injected Foam Resin

1. Preparation for injected foam resin shall include drilling offset injection holes at an angle that will intersect the crack, joint, or crack network at approximately one-half the thickness of the concrete or shotcrete up to a thickness of 36 inches. Spacing of injection ports shall be determined as recommended by the injection material manufacturer and as acceptable to Engineer. When the injection material manufacturer certifies, in writing, that spacing of injection ports and installation procedures are acceptable, the injection ports may be installed directly into the crack, subject to review by Engineer.

3.3 APPLICATION

A. Concrete and shotcrete repair work shall be performed in accordance with the following requirements.

B. Crack Sealant

1. Crack sealant shall be trowel-applied to a minimum dried thickness of 1/8 inch , or thicker if directed by manufacturer's literature. The concrete surface where the sealant is applied shall be smooth, uniform, and free from irregularities. Crack sealant shall be removed after the injection of resin is completed, except for portions of wall faces that will be at least 12 inches below the finished grade.

C. Pressure-Injected Resin

1. The injected areas shall be prepared as specified and as recommended by the manufacturer.

2. After the joints and cracks are prepared and before the injection of the resin, the joints shall be flushed with water. The water flush shall be terminated when the turbidity of the expelled water is equal to that of the flush water. Unless otherwise acceptable to resin manufacturer and Engineer, cracks shall be dry prior to injecting resin.

3. The pumping equipment used for the pressure injection of resin shall have pressure metering. Written procedures for use and quality control of the injection equipment shall be furnished to Engineer for review and acceptance. The pump shall be electric. The material and process used for the pressure injection of the resin shall have been in use a minimum of 5 years.

4. The joints and crack networks shall have a minimum of 90 percent penetration of resin into the joint or crack network. Core samples may be taken at Engineer's discretion.

5. Epoxy Resin

a. Epoxy resin shall be injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Epoxy resin shall be injected until the resin appears at the next injection port.

6. Foam Resin

a. Foam resin shall be premixed and injected into the structure in accordance with the material manufacturer's recommendations and as acceptable to Engineer. Foam resin shall be injected into the structure until the resin appears at the next injection port.
b. Surfaces of cracks and joints may need to be sealed with crack sealant.

D. Gravity Fed Resin

1. A bead of the epoxy resin shall be placed over the entire surface of the crack. Enough resin shall be applied so that there is a visible heaping above the floor surface.

2. The applicator shall periodically inspect the resin to verify that it has penetrated the crack and flattened against the floor surface.

3. After the resin has flattened, another bean shall be applied, and the process repeated until the crack cannot receive additional resin.

E. Cold Weather

1. When ambient temperatures below 40° F are expected during the curing period, the repair materials shall be maintained at a temperature of at least 50° F for 14 days or 75° F for 7 days after placement. Sudden cooling of the repair materials shall not be permitted.

3.4 PROTECTION

A. Post-placement curing and protection shall be as specified herein and in accordance with the manufacturer's recommendations.

3.5 CLEANING

A. Work areas shall be cleaned each day in accordance with the Project Requirements section. Upon completion of the final cleanup, Contractor shall restore all areas affected by the repair procedures to their original condition, leaving no trace of material piles or other wasted materials.

End of Section

SECTION 04200 - MASONRY

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installing of building masonry.

1.2 GENERAL

A. Building masonry shall be constructed of units of the types, dimensions, arrangements, and coursing indicated on the Drawings and specified herein, complete with all materials, accessories, and appurtenances indicated and specified.

B. All work shall be in accordance with TMS 602 except as modified herein.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. All masonry units shall be handled in a manner which will prevent soiling, chipping, or damage of any kind. Broken, discolored, chipped, or otherwise damaged facing units will be rejected and shall be replaced with undamaged units.

C. Masonry units shall be stored on pallets, shall be protected against contamination and staining, and shall be kept covered and dry at all times. Lime and cement shall be stored under cover in a dry place.

D. Sand shall be stored so that the inclusion of foreign materials is prevented. Whenever sand is piled directly on the ground, the surface beneath the sand shall be smooth, well drained, and free from dust, mud, and debris. The bottom 6 inches of each pile shall not be used in mortar.

E. Insulation shall be stored under cover in a dry place and shall be protected from the weather at all times.

1.4 SUBMITTALS

A. Drawings, Data and Samples.

1. Before masonry construction is begun, the following drawings, data, specimens, and samples shall be submitted in accordance with the Submittals Procedures section. Additional data shall be submitted as needed. If the source of a material is changed during the course of the work, the tests and reports required for preliminary review of that material shall be resubmitted.

a. Samples of all masonry units and mortar. At least two samples of each type of unit required shall be submitted.
b. Color selection sample kits for integral mortar colors.
c. One sample, at least 6 inches long, of each type of non-masonry joint material required.
d. Control joint locations in the CMU wall.
e. Shop drawings or manufacturers' literature showing details of anchors, ties, and metal accessories to be used in masonry construction.
f. Bar lists and drawings for the fabrication and placement of reinforcement with sufficient elevations and sections to adequately detail and label all reinforcement.
g. Setting drawings covering marble, granite or cut stone.
h. Cold and hot weather construction procedures.
i. Certificates for the following materials used in masonry construction, indicating compliance with the standards herein.
    1) Masonry units.
    2) Mortar and grout materials, including manufacturer data for any admixture, mortar coloring, or other product added to the grout or mortar.
    3) Reinforcement.
    4) Anchors, ties, fasteners, and metal accessories.

j. For each mortar mix, submit one of the following:
    1) For preblended (bagged) mortar mixes, qualification shall be by the property specifications of ASTM C270. Compressive strength test results submitted shall have been performed within the previous 12 months. All ingredients in the mortar mix shall be identified.
    2) For mortar mixes where materials are blended on site (non-bagged), qualification shall be by the proportion specifications of ASTM C270. Types and proportions of all ingredients shall be submitted.

k. For each grout mix, submit mix designs indicating type and proportions of ingredients in compliance with the specified compressive strength method of ASTM C476. Strength test results shall be from testing performed within the preceding 12 months.

1.5 COLOR SELECTION AND SAMPLE PANELS

A. Colors of masonry units and native stone veneer will be selected from manufacturer's data and samples after the award of the contract.

B. Masonry Units

1. Colors for masonry units, or integral colored masonry units shall be selected from manufacturer's standard commercial color selections. At least five manufacturer's color lines shall be submitted for selection. Different colors may be required for each type of masonry unit or for different locations of the same type of masonry unit. Special color patterns shall be as indicated on the Drawings. General color selections shall be made from manufacturer's data. After general color selections are made, sample masonry boards shall be submitted to Engineer for preliminary color selections. These boards shall be of sufficient size to show the proposed shade distribution and shall be submitted in as many different colors, textures, arrangements, and shade combinations as may be required for

making a proper selection. The preliminary color and texture selections shall be made prior to submitting the full size units and constructing the sample panels specified herein. All color, shade, and texture selections shall not be final until the field constructed sample panel has been accepted.

C. Sample Panels

1. Before the installation of any masonry materials, sample panels shall be constructed at the Site incorporating each type of masonry material. Unless otherwise indicated or detailed on the Drawings, sample panels shall be 6'-8" long by 4'-0" high. Sample panels shall show the proposed color range, texture, bonding patterns, mortar joints, mortar color, and workmanship for masonry materials. Each panel shall be of the thickness indicated on the Drawings for building walls of similar construction. The panels shall be representative of each typical exterior and interior masonry wall construction indicated on the Drawings complete with, as applicable, masonry units, bonding patterns, joint reinforcement, wall ties, wall insulation, vertical steel, a typical bond beam, mortar color, mortar tooling, weeps, and flashings. Each sample panel shall include a typical control or expansion joint, as applicable, for each wythe of masonry, complete with filler strips and caulking as indicated on the Drawings. The sample panels shall not be incorporated into the work. No masonry work shall progress until Engineer has accepted the sample panels. The panels shall then become the standard of comparison for all masonry work built of the same materials. The panels shall not be destroyed or moved until all masonry work is completed.

2. At least one exterior wall panel shall include an exterior corner condition and an intersecting interior wall constructed as detailed on the Drawings.

3. Sample panels shall include over masonry backup, and masonry veneer over masonry backup, as applicable for each wall. Non-masonry backup construction shall include framing, sheathing, wall ties, insulation, and flashing as applicable.

1.6 COMPRESSIVE STRENGTH DETERMINATION

A. The compressive strength of CMU shall be determined by the unit strength method specified in TMS-602.

B. The design compressive strength of CMU, f'_m, for this project is 2500 psi.

C. CMU construction shall not begin until Engineer has reviewed the applicable submittals for strength of masonry units, grout, and mortar.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All acceptable masonry products are indicated below. Products necessary for the work are as specified or as indicated on the Drawings. Sizes of masonry units are nominal, the actual size being slightly smaller to allow for mortar joints.

Concrete block	ASTM C90, normal weight, 8 inch x 16 inch face dimensions, sizes with special shapes as indicated on the Drawings; aggregate conforming to ASTM C33.
Regular type	Standard gray color, sizes, special shapes, and face pattern as indicated on the Drawings. Standard weight aggregate units.
Rubble Native Stone	Hard, tough, durable, native stone, with no triangular or lens-shaped stones, and free from soft or spongy pieces. Minick Materials (minickmaterials.com) "Rustic Rubble" or approved equal.
Bonding pattern	Random webwall
Finish	Natural face
Color ranges	Blend
Mortar	ASTM C270, cement-lime, Type S. Preblended (bagged) dry mortar mix shall conform to ASTM C1714 and shall contain no additives or admixtures.
Sand	Natural sand in accordance with ASTM C144. Gradation shall be adjusted as indicated below.
For Stone Mortar	Gradation in accordance with ASTM C144 except that 95 percent shall be passing the No. 16 sieve.
Portland Cement	ASTM C150, Type I.
White Cement	Atlas White, Medusa White, or Trinity White.
Hydrated Lime	ASTM C207, Type S.
Quicklime	ASTM C5, pulverized.
Lime Putty	Quicklime, thoroughly slaked and stored for one day; kept moist until used.
False Joint Mortar	ANSI A118.4, Type S, Portland cement mortar with latex admixture, color to match mortar color.
Integral Waterproofing	Aluminum stearate, ammonium stearate, or calcium stearate, 2 percent of weight of cement; W. R. Grace "Dry Block Mortar Admixture," A. C. Horn "Hydratite," or Sonneborn "Hydrocide."
Grout	ASTM C476, conventional coarse grout. Grout may be self-consolidating type. Compressive strength shall be the larger of f'_m or 2500 psi.
Portland Cement	ASTM C150, Type I.
Sand	ASTM C404, natural sand.
Pea Gravel	ASTM C404.

Water	Clean and free from deleterious substances.
Prepared Joint Filler	ANSI A118.6 Sanded tile grout. Laticrete Series 500 joint filler, Bonsal "Sanded Grout" or Bostik "Hydroment Joint Filler."
Joint Reinforcement	Hohmann and Barnard; stainless steel, ASTM A580 Type 304; type as indicated on the Drawings with prefabricated corners and tees.
Without Veneer	Ladder type, two-rods.
Standard Weight	9 gage side rods and cross rods.
Heavy-Duty	3/16 inch side rods and 9 gage truss rods.
Thin Joint	11 gage side rods and cross rods.
With Stone Facing	Truss type, heavy-duty weight, with extended tabs, 3/8 inch vertical rods, and 3 x4-1/2 x 3/16 inch wire ties; Hohmann & Barnard "Tie-HVR-195V" Extra Heavy anchor system.
Anchors and Ties	Alternate manufacturers and products may be submitted in lieu of the ones listed below. Alternates shall include published manufacturer's data for out-of-plane load capacities
Masonry Veneer to CMU Wall Backup (Seismic Design Categories A and B)	Hook attached to adjustable type horizontal joint reinforcement; Hohmann & Barnard 2X-Hook. 2X-Hook shall be 3/16" diameter embedded portion, ASTM A580 Type 304 stainless steel. Joint reinforcement as indicated above.
Masonry Veneer to CMU Wall Backup (Seismic Design Categories C, D, E, and F)	Seismic hook and continuous wire attached to adjustable type horizontal joint reinforcement; Hohmann & Barnard SH-Seismic Hook. SH-Seismic Hook shall be 3/16" diameter embedded portion, ASTM A580 Type 304 stainless steel. Continuous wire shall be 9 gauge, AISI Type 304 stainless steel. Joint reinforcement as indicated above
CMU Wall Ends to Structural Steel	Slotted channel anchors; Heckman or Hohmann & Barnard, stainless steel, ASTM A580 Type 304.
Channels	16 gage steel channels; weld-on, built-in, or screw on type as necessary.

Anchors	12 gage x 1 inch wide anchor straps punched or notched for mortar grip, 16 inches long unless otherwise required.
CMU Wall Ends to Structural Steel	Adjustable wire anchors fabricated from 1/4-inch wire, galvanized in accordance with ASTM A153, Class B-2; continuous weld-on anchor rods, with 1/4 inch wire anchors where indicated on the Drawings.
Cast Stone Copings	Cramp anchors; stainless steel, ASTM A580 Type 304, 1/4 x 1-1/4 inches , at least 6 inches long, with bent-up ends.
Cut Stone Veneer	Stone anchors; stainless steel, ASTM A580 Type 304, 1/4 x 1-1/4 inches , length as necessary.
Reinforcing Steel	ASTM A615, Grade 60, deformed.
Rebar Positioner	9 gage wire, sized for block thickness, single or double bar type, galvanized ASTM A153, Class B-2.
Rigid Insulation	ASTM C578, Type X; extruded closed-cell polystyrene foamboard, Dow Styrofoam "Cavitymate." "R" value of 5.0 minimum at 75° F mean temperature and water vapor transmission factor of 1.1 perm-in. , thickness as indicated on the Drawings.
Insulation Adhesive	Rubber-based mastic adhesive as recommended by the insulation manufacturer.
Veneer Control and Expansion Joint Material	ASTM D1056, Class 2A1, closed-cell neoprene with pressure-sensitive adhesive back; Hohmann & Barnard "NS- Closed Cell Neoprene Sponge."
Structural Wall Preformed Control Joint Material	
Rubber	ASTM D2000, extruded rubber, Hohmann & Barnard "#RS Series"
PVC	ASTM D2287, PVC, Hohmann & Barnard "VS Series."
Drainage Mat	Extruded polypropylene non-woven lightweight fabric mat, to provide drainage and ventilation between exterior sheathing and adhered masonry plaster. ASTM E2273-18. Keene Building products "Driwall" Rainscreen or approved equal. Size: 3/8" (10 mm).

Weep Screed	Description: Perforated sheet metal drainage device. Performance: Weeps the bottom edge of the weather resistant barrier applied to the exterior face of wall sheathing and creates a bottom of drainage plane and mortad bed of adhered masonry veneer. Material: 26-gauge galvanized steel, sheet metal bent into "V" shaped channel, with long vertical leg and short leg at 70-degree angle out from other leg and slots punched into bottom edge. Product: Masonry Technology, “L & R Weep Screed LR 3501” or approved similar.
Weep Vents	High density polyethylene (HDPE) weep vents measuring 2 5/8”x3 ½”x ½”, color to match mortar color; Mortar Net “Weep Vent” or approved equal.

B. Wall flashings are covered in the Sheet Metal section.

2.2 MORTAR

A. Mortar shall be cement-lime type; the use of masonry cement or mortar cement will not be acceptable.

B. Masonry Mortar

1. Masonry mortar that is preblended shall be qualified in accordance with the properties specifications of ASTM C270. Mortar that is site blended shall be qualified in accordance with the proportion specifications of ASTM C270.

2. Integral waterproofing shall be added to each mortar mixture.

3. White cement shall be substituted for Portland cement for stone mortar.

2.3 GROUT

A. Grout shall be proportioned in accordance with ASTM C476 by the specified compressive strength method. Only enough water shall be added to produce a mixture which is flowable, but which will not show an excess of water when placed. Unless otherwise specified, grout shall have a slump ranging from 8 to 11 inches .

B. Self-consolidating grout shall have a slump flow of 24 to 30 inches in accordance with ASTM C1611, and shall have a Visual Stability Index of not greater than 1 as determined by ASTM C1611 Appendix X1.

PART 3 - EXECUTION

3.1 MORTAR

A. Mixing

1. The method of measurement of all mortar ingredients shall be accurate and shall ensure definite and uniform proportions. Mortar shall be machine mixed for at least 5 minutes and shall be used within 90 minutes after mixing. Mortar left when work is stopped shall be discarded. Remixing of mortar more than 90 minutes old with additional water, cement, or other materials will not be acceptable.

2. The integral mortar color manufacturer's mixing instructions and proportions shall be strictly adhered to. Following the addition of integral mortar color, the mortar shall be mixed in a powered mixer until a uniform color is obtained, but not less than 5 minutes.

B. Jointing

1. General

a. Masonry shall be laid in straight, level, uniform courses, with mortar joints of uniform width. Head joints shall approximately equal the horizontal joints in width.
b. Joints in masonry surfaces which are to be covered or not exposed shall be struck flush.
c. All exterior and exposed interior mortar joints, except joints in glazed materials, joints in walls which are to be covered, and joints which are to be raked, shall be tooled to a smooth uniform surface and shall be finished free of voids using a rounded tool. Mortar joints specified to be caulked shall be raked to a depth of 1/2 inch . Tooling of joints shall be regulated so that the mortar for each wall space has a uniform appearance.
d. The filling of masonry joints shall mean that the entire space between abutting surfaces of units is full, and that the body of the mortar is forced against and into the porous surface of each unit.

2. Concrete Block

a. Abutting surfaces of head joints shall be completely and solidly cemented together with mortar.
b. Solid masonry units, starter courses for hollow units with vertical cells, hollow units with horizontal cells, and all units in masonry columns or pilasters shall be laid on a full bed of mortar.
c. All hollow CMU with vertical cells (above the starter course) shall be laid with face shell mortar bedding. In partially grouted walls, web joints of all cores which will be subsequently filled with grout fill shall be fully mortared. In fully grouted walls, web joints are not required to be mortared. All collar joints in multiwythe masonry walls, except cavity walls, shall be completely filled.

3. Veneer Stone

a. Arrange stones in, random-range rubble pattern with random course heights, random lengths (interrupted coursed), and uniform joint widths. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance. Maintain uniform joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 3/8 inch at narrowest points or more than 5/8 inch at widest points.
b. All voids shall be slushed full, and all joints shall be completely filled.
c. Joints in fieldstone masonry shall be slightly raked and finished with a flat tool.

3.2 BONDING AND REINFORCING

A. Bonding

1. Except where otherwise indicated on the Drawings, all concrete blocks shall be laid in running bond. Special bonding patterns shall be as indicated on the Drawings. Stone shall be laid in the pattern indicated on the Drawings.

B. Joint Reinforcing

1. Joints in horizontal masonry units shall be reinforced as specified, unless otherwise indicated on the Drawings.

2. The width of joint reinforcement (side rod to side rod) shall be approximately 2 inches less than the nominal overall thickness of the wall in which it is placed. All joint reinforcement shall be fully embedded in mortar and shall be covered with at least 5/8 inch of mortar on the exterior face.

3. Joint reinforcing shall be discontinuous at control and expansion joints. The ends of sections of joint reinforcement shall be lapped at least 8 inches with the next section. At corners and intersections, prefabricated corner and tee reinforcing pieces shall be used.

4. Concrete Block

   a. Mortar joints in concrete block shall be reinforced with continuous ladder type joint reinforcement spaced not more than 16 inches apart vertically. The joint reinforcement shall have one longitudinal rod at each face shell of the masonry units.
   b. Except where a top bond beam is indicated on the Drawings, the top three courses of all CMU walls, including backup, shall have continuous joint reinforcement placed in each joint 8 inches on centers. Openings in CMU walls shall have joint reinforcement placed in the two courses immediately above lintels and in the two courses immediately below all sills. Joint reinforcement shall extend 24 inches past openings on each side.
   c. Cavity wall mortar joints shall be reinforced by means of continuous standard weight ladder type joint reinforcement spaced at 16 inches vertically. The reinforcement shall bridge the gap between the wythes of masonry.

5. CMU With Stone Facing

a. CMU faced with stone shall have joint reinforcement spaced 16 inches apart vertically for single-faced walls and 8 inches apart vertically for double-faced walls. Vertical rods spaced 16 inches apart horizontally shall be inserted and wire-tied into the extended tabs of the joint reinforcement. Facing stones shall be anchored to the backup CMU with individual metal ties placed at each vertical rod of the backup wall reinforcement and spaced not more than 12 inches apart vertically.
b. Stone shall be well bonded with broken joints. Through-bond stone shall occupy at least 20 percent of the wall area and shall have a maximum spacing of 3 feet vertically and horizontally.

C. Masonry Anchorage

1. Masonry anchorage to an abutting structure or to backup construction shall be as specified herein, unless indicated otherwise on the Drawings.

2. CMU Walls to Overhead Beams

a. Tops of CMU walls which abut the underside of steel or concrete beams shall be anchored to the beams as indicated on the Drawings.

3. CMU Wall Ends Terminating at Steel

a. Unless indicated on the drawings to be unconnected, ends of CMU walls which terminate at steel columns shall be securely anchored to the steel member with slotted channel anchors. Channels shall be welded to webs or flanges of columns, spaced and located to provide an adjustable anchor for each 16 inches of CMU wall height. Anchors shall also be placed in each bond beam and in the course above and below each bond beam.
b. Alternatively, CMU may be anchored by adjustable wire anchors. Anchor rods shall be welded to columns, spaced not more than 32 inches apart horizontally, and located to provide adjustable anchors at not more than 16 inches apart vertically in the CMU. Anchors shall also be placed in each bond beam and in the course above and below each bond beam.

4. Stone Veneer to CMU or Concrete Backup

a. Each piece of stone facing shall be anchored to CMU backing with at least two stone anchors.

5. Cast Stone Copings

a. Corner coping stones shall be anchored to adjacent stones with cramp anchors extending across the joints.

D. Reinforcing Steel

1. Concrete block bond beam units shall be installed and reinforced as indicated on the Drawings. Bond beam units shall be filled with grout fill as specified herein. Reinforcing steel shall be continuous around corners. At expansion joints, all bond beam reinforcing shall be discontinuous. At control joints, all bond beam reinforcing shall be discontinuous

through the joint, except reinforcement shall be continuous at control joints where bond beams are located at roof and floor joist bearings.

2. Vertically reinforced concrete block cores shall be provided as indicated on the Drawings. Reinforcing shall be accurately placed and securely tied to prevent shifting during core filling. Bar positioners shall be used for alignment. Positioners shall be placed in the bottom and top courses of walls and at not more than 4 feet centers between. Mortar fins which project into cores more than 1/2 inch , and all loose mortar and debris, shall be removed before filling the cores. Cores shall be filled with grout fill as specified herein.

E. Grout

1. Unless otherwise acceptable to Engineer, grout shall be placed in lifts not to exceed 5 feet . Lifts exceeding 12 inches in height shall be consolidated by mechanical vibration and reconsolidated after initial water loss and settlement. Bond beam grout shall not be mechanically vibrated. Grout shall be placed in reinforced block cores, bond beams, lintels, and in other locations indicated on the Drawings. If the cells beneath a bond beam are not required to be grouted, wire mesh material may be used in the joint to retain the grout.

3.3 LAYING MASONRY UNITS

A. All masonry units shall be free from dust, dirt, and surface moisture when laid. Concrete blocks shall be dry when laid.

B. All masonry shall be laid to a line. Walls shall be plumb and straight and in level courses. At no time shall any part of masonry construction project more than 8 feet above adjacent work. When work is suspended, the tops of exterior masonry walls shall be covered and protected from the weather.

C. Care shall be taken in corner construction and at jambs to maintain uniformity of appearance and to ensure that only whole, undamaged units are used. All patterned masonry units shall have special corner units installed at exposed corners to maintain consistency of patterns. Masonry units shall be selected and laid so that the exposed face of each unit is free of broken corners, chipped edges, or other defects which would be detrimental to the appearance of the wall surface.

D. Units laid in stack bond or soldier coursing shall be carefully plumbed, so that vertical joints will form uniform, continuous vertical lines of uniform width, texture, and general appearance. Units shall be of uniform length and shall be trimmed as necessary. Short closure pieces shall not be used in stack bond.

E. Masonry units laid in running bond shall be so constructed that vertical joints in alternate courses lie in the same vertical lines, midway between the vertical joints in adjacent courses to provide a regular and uniform joint pattern. All custom scored units shall be aligned as detailed on the Drawings.

F. Masonry units shall be saw-cut to provide openings and to accommodate embedded items. Anchors shall be securely embedded in mortar. Door and window frames shall be maintained plumb and true. Masonry shall be built tightly against interior door frames. A caulking space shall be provided between exterior door frames and masonry in accordance with the details

indicated on the Drawings. The jambs of built-in hollow metal door frames shall be completely filled with grout fill.

G. Lintels shall be provided over all CMU wall openings wider than the length of a masonry unit. Lintels shall be of the types and sizes indicated on the Drawings, and shall be acceptable to Engineer. Lintels longer than 3 feet shall bear on solid concrete masonry units or on grout-filled cells of hollow units at least one masonry course in height, unless otherwise indicated on the Drawings.

H. All embedded items shall be set and securely anchored in the masonry work as indicated on the Drawings or as acceptable to Engineer. Joints between masonry and embedded items shall be pointed.

I. Multi-wythe cavity walls shall be carefully constructed to the dimensions indicated on the Drawings. On the cavity face of both facing brick or other veneer and concrete block, glazed block or structural glazed tile, all mortar extruded from the joints shall be struck off flush with the masonry surface. The cavity shall be kept free of mortar droppings.

J. Where indicated on the Drawings, rigid insulation shall be installed in the cavity between brick or other veneer material and concrete block, glazed block or structural glazed tile; and in the air space behind veneer facing cast-in-place concrete. The rigid insulation shall be installed in horizontal blocks sized to fit neatly between joint reinforcement or dovetail anchors, with joints butted as closely as possible. The insulation shall be secured to the face of the cast-in-place concrete or the backup masonry with mastic adhesive applied as recommended by the manufacturer and shall be kept from contact with the facing veneer.

K. Where indicated on the Drawings, the unfilled cores of concrete block or glazed block walls shall be filled with loose insulation. The insulation shall be poured into the space as the work progresses, with care taken to fill all spaces and voids.

L. The entire back surfaces of all stone abutting other masonry, and concrete block masonry to be faced with stone, shall be dampened and plastered with mortar to a thickness of at least 1/2 inch immediately before the backing or facing stone is laid. Mortar shall not be splashed on exposed stone surfaces, and any spills or drippings shall be immediately removed with a sponge and clear water.

M. Stones showing pronounced cleavage shall be laid on natural beds. Each stone shall be lowered carefully into its proper place in a well-prepared bed of mortar and brought to a solid bed so that it will bear evenly and not only on the front edge. Each stone shall be laid plumb, level, and true to line and bond. Stones for corners and openings shall be carefully selected for squared faces. Edges of stones at jambs shall be field cut as needed to secure a clean, plumb opening.

3.4 THROUGH-WALL FLASHINGS

A. Through wall total flash flashing system shall be installed where and as indicated on the Drawings. Flashings in horizontal joints shall be in the bottom of the joints, and the stainless steel drip shall extend past the face of the wall unless otherwise indicated on the Drawings. Flashings shall drain toward the exterior surface of the wall. Lap joints shall be caulked and termination bars shall be screwed and caulked as per manufacturer's recommendations. The manufacturer's installation instructions shall be followed.

B. Flashings over lintels and sills shall extend 8 inches past each jamb and shall have end dams. Joints in wall flashings shall overlap and shall be caulked as per manufacturer's recommendations.

3.5 EXPANSION AND CONTROL JOINTS

A. Expansion and control joints in masonry walls and veneer shall be constructed as indicated on the Drawings. Joint material shall be placed tightly in the wall as construction proceeds.

B. Veneer joint filler strips shall have a thickness not less than the nominal width of the joint. The filler strips shall be firmly bonded to one joint face by the adhesive backing, and shall be of required width to be held back 1/2 inch from each face for caulking, and placed under compression by the abutting masonry. All joints in filler strips shall be tightly butted.

3.6 ANCHORS, INSERTS, AND OTHER PENETRATIONS

A. All necessary ties, anchors, bolts, inserts, bucks, flashings, sleeves for piping, conduits of every kind, window and door frames, and other work shall be accurately set and securely held in the masonry work as indicated on the Drawings or in a manner acceptable to Engineer. Sleeves shall be provided where small piping passes through the masonry.

B. Structural shapes, joists, and decking passing through or over the masonry, but not bearing on the masonry, shall be isolated from the masonry by a minimum of 1 inch on all sides, unless indicated otherwise on the Drawings.

3.7 LOW TEMPERATURES

A. When the temperature of the surrounding air is below 40° F , the cold weather construction procedures of TMS-602 shall be followed except as modified below.

1. In addition to the weather protection specified for ordinary conditions, masonry materials shall also be kept from contact with snow, ice, or dampness of any kind.

2. The temperature of the mixed mortar shall be between 70° and 120° F . Mixing water shall be warm, but not above 165° F . If necessary, sand shall be heated also. Mortar mixing equipment shall be heated before it is used. The use of salt or calcium chloride is not acceptable.

3. Masonry units shall be above freezing when laid. If the outdoor temperature is below 30° F . units shall be heated to at least 40° F . If the temperature is below 0° F -, units shall be heated to at least 60° F . Heating shall be done so that the units are not damaged.

4. Masonry shall be kept warm for at least 72 hours after laying. The air temperature at the masonry surface shall be kept between 45° F and 90° F , using heating methods that will not unduly dry out or otherwise damage the masonry. Masonry surfaces inside enclosures shall not be exposed to carbon dioxide gases emitted from heaters. Heat shall be applied to both sides of the wall, with provisions for proper circulation of air. The masonry shall be suitably housed or covered.

3.8 HIGH TEMPERATURES

A. When the ambient air temperature exceeds 100° F , or exceeds 90° F with a wind velocity greater than 8 mph , the hot weather construction procedures of TMS-602 shall be followed.

3.9 FINISH TUCK POINTING

A. On completion of the work, all exposed masonry shall be pointed where necessary and all voids and holes in the mortar shall be filled to match adjacent joint surfaces. Defective joints shall be cut out and repointed with mortar. Care shall be taken to produce a uniform overall appearance. Spottiness due to variations in either materials or workmanship will not be acceptable.

3.10 PROTECTION FROM DAMAGE

A. Masonry and all embedded or built-in items shall be carefully protected from damage. Masonry walls discolored by paint, mortar, or concrete shall be rebuilt with new materials.

B. Where concrete is placed adjacent to or on top of previously constructed masonry, the masonry shall be adequately protected against damage and against splashing of concrete paste.

3.11 CLEANING

A. Following finish pointing, all exposed masonry surfaces shall be cleaned to remove all surface stains and smears. If stains and smears cannot be removed by the specified methods, Contractor may propose alternative methods or cleaning products. These alternatives shall be acceptable to Engineer before they are used.

B. Mortar smears and other stains shall be removed from stone by scrubbing with soap and water and, where necessary, using a cleaning compound recommended by the masonry unit manufacturer. On stone, clean fine sand may be used as a scouring agent where necessary.

C. Mortar smears or droppings on concrete blocks shall be removed with a steel trowel after they have hardened to the extent that removal will not cause additional smearing. Any remaining mortar shall be removed to the extent possible by rubbing with a small piece of block. All surfaces shall then be thoroughly brushed.

3.12 OWNER'S FIELD CONTROL TESTING

A. Field control tests will be performed by Engineer or a testing laboratory. Contractor shall provide testing personnel with access to all material stockpiles and shall provide the services of one or more employees as necessary to assist with the collection of samples and construction of prisms. Contractor shall provide material samples in sufficient quantity to conduct the specified tests.

B. As stipulated in the Quality Control section, tests required during the progress of work will be made at the expense of Owner.

C. The frequency specified for each field control test is approximate and subject to change as determined by Engineer.

D. Concrete Masonry Units

1. Concrete masonry units from worksite stockpiles will be tested once per 5,000 square feet of wall. Sampling and testing will be in accordance with ASTM C140.

E. Grout

1. Grout will be field sampled during placement and will be tested once per 5,000 square feet of wall. Sampling and testing will be in accordance with ASTM C1019. Compressive strength tests shall be conducted at 28 days after sample collection. Grout strength shall equal or exceed the specified f'_m.

F. Masonry Prism Tests

1. If the design compressive strength of masonry, f'_m, is determined prior to construction based on prism testing, then prism testing will be required for field verification in lieu of the preceding individual material tests. Prisms representative of the Project masonry will be constructed on Site using worksite stockpiles, and will be tested in accordance with ASTM C1314.

End of Section

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SECTION 05210 - STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers design, fabrication, and erection of joists, joist girders, bridging and bracing, and other accessories and appurtenances as required or indicated on the Drawings.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 GENERAL

A. Unless otherwise noted, all materials, design, fabrication, erection, and end anchorage of open web steel joists shall conform to applicable provisions of the Steel Joist Institute (SJI) specifications.

1.3 SUBMITTALS

A. Drawings and Data – General

1. All submittals shall be submitted in accordance with the Submittals Procedures section.

B. Approved Fabricator Confirmation

1. Submit written confirmation from the Authority Having Jurisdiction (AHJ) that the manufacturing plant qualifies as an approved fabricator that does not require in-plant special inspection, as indicated in the International Building Code (IBC) Chapter 17, and in the Code Required Special Inspections and Procedures section.

C. Drawings and Data – Detailed

1. Submit detailed steel joist placement plans, which shall be independently checked by both the joist manufacturer and Contractor. Any drawings submitted without evidence of checks by both parties will be returned without review. Placement plans shall include the following as a minimum.

a. Listing of all applicable loads used in the design of the steel joists and joist girders.
b. Profiles for non-standard joist and joist girder configurations.
c. Connection requirements for joist and joist girder supports, and field splices.
d. Deflection criteria for live load and total loads for non-SJI standard joists.
e. Size, location, and connections for all bridging.
f. Joist headers.
g. Mark numbers, type, sizes and locations of joists, and joist girders.

D. Certificate of Compliance

1. At completion of manufacture, submit a certificate of compliance in accordance with the Code Required Special Inspections and Procedures section. The statement shall certify that the work was performed in accordance with the Drawings, this specification section, and SJI standard specifications. Copies of the certificate shall be provided to Owner, Engineer, and the AHJ.

E. Items Requiring Professional Seal

1. When requested by Engineer, submit the following items bearing the seal of an engineer registered in the state of the project.

a. Joist calculations.
b. Non-SJI standard bridging details (e.g., for cantilevered conditions, net uplift, etc.)
c. Connection details for non-SJI standard connections (e.g., flush-framed or framed connections).
d. Connection details for field splices.
e. Connection details for joist headers.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged units shall be promptly replaced. Materials shall be stored off the ground, with one end elevated to provide drainage. Stored materials shall be protected with a waterproof covering and ventilated to prevent condensation.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Design Criteria

1. Joists, joist girders, and appurtenant materials shall be designed and fabricated in accordance with the applicable requirements of the SJI specifications, except as otherwise specified or indicated on the Drawings.

2. All welds, welding, and related operations for steel joists shall be in conformity with the SJI requirements for welding steel joists.

3. All welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of the Structural Welding Code as issued by the American Welding Society (AWS). Qualification shall be in written form and shall be submitted to Engineer for review if requested.

4. Joists and joist girders shall be designed for the loadings indicated on the drawings, using the load combinations indicated in the applicable building code. The joist manufacturer shall check the joist and joist girder sizes indicated on the drawings, and shall modify the

selections when appropriate. The indicated joist or joist girder depth shall not be changed without prior approval of Engineer. If web clearance diagrams for ductwork and other utilities are indicated on the Drawings, the web member locations shall be adjusted as needed from the standards.

B. Defective Material and Improper Workmanship

1. Any defective joist material or improper workmanship, wherever found, at the mill, shop, or Site, at any time, will be rejected regardless of all previous inspection and regardless of load tests. Contractor shall remove and replace rejected steel joist and joist girder material at no additional cost to Owner and pay all expense because of delay caused by such rejections and replacements.

C. Fabricator Approval

1. All fabricating plants providing steel joists and joist girders shall be qualified by the SJI plant certification program.

2.2 MATERIALS

A. Materials used in the manufacture and installation of steel joists and joist girders shall be as follows:

Steel	Comply with SJI specifications.
Unfinished Threaded Fasteners	ASTM A307, Grade A, regular Hexagon type, low carbon steel.
Prime Paint	Comply with SJI specifications.

2.3 ACCESSORIES

A. Sloped End Bearing

1. Sloped end bearing of joists shall be provided where indicated, complying with manufacturer's standards and requirements of applicable SJI specifications.

B. Extended Ends

1. Extended ends of joists shall be provided where indicated, complying with manufacturer's standards and requirements of applicable SJI specifications.

C. End Anchorages

1. End anchorage of joists to the adjacent construction shall be in accordance with the Drawings and applicable SJI specifications, unless otherwise noted.

D. Bridging and Bracing

1. Horizontal or diagonal type bridging shall be provided for joists, and bracing shall be provided for joist girders, complying with manufacturer's standards, SJI specifications, and as indicated on the Drawings.

2. Horizontal bridging for joists shall consist of two continuous steel members, one of which is attached to the top chord and the other attached to the bottom chord. The bottom chord bridging for the joists shall be of sufficient strength to properly resist any lateral force exerted by the bottom chord of the joist.

3. Diagonal cross type bridging for joists shall be provided when required by the manufacturer's standard or the SJI specifications.

4. Bracing shall be provided for joist girder bottom chords when girder is designed for uplift, as indicated in the SJI specifications.

E. Headers

1. Headers shall be provided where indicated or required, complying with manufacturer's standard and SJI specifications. Headers are not allowed for LH Series (longspan) and DLH Series (deep longspan) joists.

2.4 PAINTING

A. Loose scale, heavy rust, and other foreign materials shall be removed from fabricated joists, joist girders and accessories before application of shop paint.

B. One shop coat of primer paint shall be applied to steel joists, joist girders and accessories by spraying, dipping, or other method to provide a continuous dry paint film thickness of not less than 0.50 mil .

PART 3 - EXECUTION

3.1 GENERAL

A. Steel joists and joist girders shall be installed in accordance with the recommendations of the manufacturer.

3.2 INSTALLATION

A. Placing Steel Joists and Joist Girders

1. Placing of steel joists and joist girders shall not begin until supporting work is in place and secured. Joists and joist girders shall be placed on the support work, and shall be adjusted and aligned in accurate locations and spacing before permanently fastening.

B. Bridging and Bracing

1. Bridging and bracing shall be installed simultaneously with joists and joist girders before construction loads are applied. Anchor ends of bridging and bracing lines where terminating at walls or beams.

C. Field Welding

1. Joists and joist girders shall be welded to supporting steel framework as indicated on the Drawings and in accordance with SJI specifications for type of joists and joist girders used. Welding sequence and procedure shall be coordinated with placing of joists and joist girders. Shop paint shall be removed from the joists in the vicinity of field welding prior to the weld being performed.

D. Touchup Painting

1. Damaged or inadequate paint films of shop-primed steel joists and joist girders, all accessible surfaces of field welds, and ungalvanized field connection bolts shall be cleaned and touchup painted using the same materials as used for shop painting.

E. Joist Girders, Longspan Joists and Deep Longspan Joists

1. The installation of joist girders, longspan joists and deep longspan joists shall strictly conform with manufacturer's recommendations and SJI specifications.

End of Section

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SECTION 05312 - STEEL DECKING

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the fabrication and erection of steel decking, including flashings, fastening devices, and other accessories and appurtenances as required and as indicated on the Drawings.

1.2 DELIVERY, STORAGE, AND HANDLING.

A. Materials shall be handled, transported, delivered, and stored in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged deck units shall be promptly replaced.

1.3 SUBMITTALS.

A. General

1. Detailed fabrication and erection drawings covering the steel deck shall be submitted in accordance with the Submittals Procedures section.

2. Drawings shall indicate locations of framing supports and the depths, profiles, thicknesses, locations, lengths, and markings of decking units to correspond with the sequence of installation. Drawings shall indicate fastening methods for decking units, accessories, closure pieces, fittings, and auxiliary supports.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Except as modified or supplemented herein, or as otherwise indicated on the Drawings, steel decking work shall in accordance with the following standards.

Steel Roof Decking	ANSI/SDI-RD1.0.
Steel Form Decking (non-composite concrete slabs)	ANSI/SDI-NC1.0.

B. Joints in the decking shall be centered on supporting members, with typical lengths extending over a minimum number of spans as indicated on the Drawings.

2.2 MATERIALS.

A. Materials used in the manufacture and installation of steel roof deck shall be as follows.

Steel Deck (galvanized)	ASTM A653, min F_y = 50,000 psi, depth and gauge as indicated on the Drawings. Canam Steel Corporation, or Nucor.
Steel Deck (prime painted)	ASTM A1008, min F_y = 50,000 psi, depth and gauge as indicated on the Drawings. Canam Steel Corporation, or Nucor.
Galvanizing	ASTM A653, thickness as indicated on the Drawings.
Prime Painting	Baked-on acrylic primer, manufacturer's standard.
Fasteners at Supports	Products shall have a current manufacturer's research report confirming testing per ICC-ES AC43 or IAPMO UES EC 007.
Screws	Size shall be #12. Self-drilling, self-tapping screws with hexagonal washer head and corrosion resistant finish. Acceptable products: Hilti "S-MD 12-24" or "S-RT5+ M9", as appropriate for support member thickness. Simpson "XM #12 Screw" or "XL #12 Screw", as appropriate for support member thickness.
Power-Actuated	Knurled shank, minimum 1/2 inch diameter steel washer. Pin diameter and length to suit deck type and flange thickness of steel support member. Acceptable products: Hilti "X-ENP 19" or "X-HSN 24", as appropriate for support member thickness. Pneutek "K66075", "K64075", "SDK61075", or "SDK63075", as appropriate for support member thickness.
Punched	Verco "PunchLok" system.
Fasteners at Sidelaps	Products shall have a current manufacturer's research report confirming testing per ICC-ES AC43 or IAPMO UES EC 007.
Screws	Size shall be #10. Self-drilling, self-tapping screws with hexagonal washer head and corrosion resistant finish. Acceptable products: Hilti "S-SLC 01 M HWH" or "S-SLC 02 M

	HWH".
	Simpson "XM #12 Screw" or "XL #12 Screw"
Punched	Verco "PunchLok" system. VSC2 connections shall be made using the PunchLok tool.
Compressible Filler	Preformed soft rubber.

2.3 ACCESSORIES.

A. All accessories, such as flashings and closure pieces and other items as indicated or required, shall be fabricated of the same material and finish as decking units, in the thicknesses indicated or recommended by the deck manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Steel decking shall be installed in accordance with the following standards.

Steel Roof Decking	ANSI/SDI-RD1.0.
Steel Form Decking (non-composite concrete slabs)	ANSI/SDI-NC1.0.

B. Steel decking shall be secured to the supporting steel, including miscellaneous framing around openings and at side joints as follows.

C. Fasteners at Supporting Members.

1. Decking panels shall be secured to each supporting member as indicated on the Drawings.

D. At Side Joints.

1. Decking panels shall be secured to each other at supporting members and between supports as indicated on the Drawings.

E. Finishing.

1. The installed roof deck shall be smooth, unbroken, and free of unnecessary openings, holes, or crevices which might allow leakage of adhesive or bitumen. Any such openings shall be repaired to the satisfaction of Engineer.

2. Field-cut openings for piping or other projections shall be neatly cut and adequately flashed. Openings larger than three ribs in width shall be supported by structural members or otherwise reinforced.

3. Unless otherwise indicated on the Drawings, steel decking shall not be used to support ceilings, light fixtures, ducts or other utility devices.

3.2 CLEANUP.

A. At the completion of installation, all surplus materials, rubbish, and other debris shall be removed from the surface of the roof deck.

End of Section

SECTION 05400 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers cold-formed (light gage) metal framing, which may also be referred to on the drawings as structural studs. This section includes all accessories indicated on the drawings, specified herein, and needed for a complete and proper installation of metal studs, joists, rafters, ceiling drops, soffits, fascias, false roofs, dormers and miscellaneous framing as indicated on the drawings.

1.2 CODES AND SPECIFICATIONS.

A. Cold-formed metal framing systems shall conform to AISI "Specifications for the Design of Cold Formed Steel Structural Members" and ML/SFA (Metal Lath/Steel Framing Association) "Lightweight Steel Framing Systems Manual". Requirements of local codes, manufacturer's instructions, trade standards, and specifications may differ. In such event, the most stringent requirements shall govern.

B. All cold-formed metal framing is structural and shall be designed, detailed, fabricated, installed, and connected to meet the structural requirements of the applicable codes. Cold-formed metal framing shall be designed by a professional engineer licensed in the state of the project.

1.3 DESIGN REQUIREMENTS.

A. Cold-formed metal framing shall be designed in accordance with the requirements of the 2021 International Building Code; local codes, manufacturer’s instructions, trade standards, and specifications which may differ. In such event, the most stringent requirements shall govern.

B. Cold-formed metal framing design loads shall be based on estimated weights of supplied materials and based on the criteria indicated in the Meteorological and Seismic Design Criteria Section, unless otherwise indicated on the drawings.

C. At locations where the cold-formed metal framing abuts face brick and requires a structural connection, the framing connection shall be made to the backup concrete masonry or structural steel framing, and not to the face brick.

D. Cold-formed metal framing design shall be coordinated with the structural design of the windows.

E. Cold-formed metal framing shall be designed and detailed to meet dimensional restrictions indicated on the drawings and specified herein.

F. Standing seam metal roof covering shall not be considered as a bracing element for design of cold-formed metal framing.

1.4 SUBMITTALS.

A. Drawings and Data.

1. Complete data and drawings covering work in this section, including but not limited to the following, shall be submitted in accordance with the Submittal Procedures section:

a. Detailed framing plans including loading diagrams sealed by a professional engineer licensed in the state of the project.
b. Complete materials list of all items proposed to be furnished and installed under this section.
c. Manufacturers' specifications and other data required to demonstrate compliance with the specified requirements.
d. Manufacturer’s recommended installation details.

1.5 STORAGE AND HANDLING.

A. All materials shall be delivered to the jobsite in their original unopened containers, with all labels intact and legible at time of use. Storage of framing material shall be in strict accordance with the manufacturer's recommendations.

B. Materials shall be protected before, during, and after installation. Handling and lifting of prefabricated assemblies shall be done in a manner not to cause distortion in any manner.

1.6 ALTERNATE MATERIALS.

A. Contractor may propose alternate materials to those specified herein. Proposed alternates shall be submitted during the submittal review process for Engineer’s review. All substitutions shall meet specifications as detailed herein and quality of materials shall be equal or greater than those specified. All deviations from the listed manufacturers shall be noted in the submittal.

PART 2 - PRODUCTS

2.1 MATERIALS.

Steel Sheet, Galvanized, 18 Gauge and Lighter	ASTM A653, SS Grade 33.
Steel Sheet, Galvanized, 16 Gauge and Heavier	ASTM A653, SS Grade 50.
Galvanizing	ASTM A653, G-60.
Studs and Tracks	ASTM C645.
Bracing, Bridging, Gussets, or Clips	Formed sheet steel, manufacturer's standard shapes.

Screws	Galvanized, self-drilling, or self-tapping with hardened points suitable for fastening cold-formed metal framing, ASTM C1002.

2.2 METAL STUDS, JOISTS, FRAMING, AND ACCESSORIES.

A. Studs, framing, track, and accessories shall be 18 gauge minimum thickness. Studs and framing shall be channel or "C" shapes with minimum 2 inch wide flanges and 5/8 inch flange returns, of the sizes indicated on the drawings. Members shall have no less than the following minimum properties:

Section	Size	Gage	I_x(in.^{4})	I_y(in.^{4})
8" stud	8 x 2	18	5.223	0.276
6" stud or joist	6 x 2	18	2.640	0.255
4" stud or joist	4 x 2	18	1.031	0.223
8" track	8 x 1-1/4	18	3.692	0.046
6" track	6 x 1-1/4	18	1.810	0.043
4" track	4 x 1-1/4	18	0.687	0.040

B. All properties are calculated in accordance with the latest AISI specification.

C. Where non-load bearing partitions are secured to a structural element above, the connection shall be designed and detailed to allow a minimum of 3/4 inch free vertical movement of the structural element.

D. Floor and ceiling runner tracks shall be per manufacturer's recommendation, but no lighter than 18 gauge. Top tracks where partitions are secured to structural element above shall be nested pair with flanges on inner track not less than 1 inch longer than outer track flanges, and outer track flanges not less than 1 inch.

E. Bridging shall be at least 3/4 inch cold-rolled channel, with framing clips screwed to each stud flange. Bridging shall be provided where indicated and where required to provide lateral support. Bridging sections shall be attached within the stud cavity.

F. Connectors for cold-formed metal framing shall be provided as indicated on the drawings or recommended by the framing manufacturer and shall be clearly detailed on the submitted framing plans.

PART 3 - EXECUTION

3.1 FABRICATION.

A. Framing components may be preassembled into panels prior to erecting. Prefabricated panels shall be square with components attached in a manner as to prevent racking.

B. All framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.

3.2 INSTALLATION.

A. Areas and conditions under which work will be performed shall be examined, and conditions detrimental to the proper and timely completion of the work shall be corrected.

B. Installation.

1. All construction shall be accurately laid out to the dimensions indicated on the drawings. All metal studs, rafters, joists, ceiling drops, soffits, fascias, false roofs, dormers and accessories shall be installed in strict accordance with ASTM C754, ASTM C1007, and the manufacturer's recommendations. All components shall be anchored firmly into position with anchors as recommended or specified.

2. Spacing of studs, joists, and rafters shall be 16 inches on center, unless otherwise indicated or required by applicable codes, and shall give proper support for covering materials. Splicing of load bearing studs is prohibited.

3. Walls shall be constructed with the top track secured to structure above, and an inner track secured to the studs, nested inside the top track to allow a minimum of 3/4 inch vertical movement, unless specific dimensions or details are indicated on the drawings. At track butt joints, abutting pieces of track shall be securely anchored to a common structural element, or they shall be butt-welded or spliced together. Runners at corners shall be butted and shall not be mitered.

4. Unless otherwise indicated, all framed openings shall have double studs on both sides and triple studs at corners and at junctions with adjoining framing. Stud tracks shall be installed on each side of opening, at frame head height, and between studs and adjacent studs.

5. Joists and rafters shall be set parallel and level, with end bearing, lateral bracing, and bridging in accordance with manufacturer's recommendations.

6. Provisions shall be made for erection stresses. Temporary alignment and bracing shall be provided.

7. Metal framing members for soffits, fascias, ceiling drops, and enclosures shall be accurately aligned and assembled. Members shall be set parallel and in a true plane. Assemblies shall be adequately braced as required for rigid installation.

8. All required backing and other support of items to be mounted on the finished wall, soffit, or ceiling shall be provided and coordinated as required. Location and installation of bucks, anchors, blocking, and electrical and mechanical work placed in or behind framing shall be coordinated as required. All requirements for pipes and other items designed to be housed within or to penetrate the partitions and wall systems shall be coordinated.

C. Fastening.

1. Stud-to-stud and stud-to-track connections shall be made with self-drilling screws or welding as recommended by the manufacturer and accepted by Engineer. Metal stud framing shall be welded to, or attached with clip angles and screws, to structural frame members unless otherwise indicated on the drawings, specified herein, or recommended by the stud manufacturer and accepted by Engineer. Connections for cold-formed metal framing not specifically called out shall be as required by the applicable building code.

2. Welded connections may be substituted where Contractor has submitted evidence that proposed welds are equal in capacity to screwed fasteners and when prior written approval has been received from Engineer.

3. Runner tracks shall be securely attached to the structure with fasteners as follows:

   a. To concrete slabs using power-actuated fasteners, expansion anchors, or adhesive anchors.
   b. To concrete masonry walls using square-cut nails or power-actuated fasteners.
   c. Runners shall be secured with fasteners placed at corners and at runner ends, and shall be spaced not to exceed the stud spacing on floor runner and 16 inches on center on ceiling runners unless detailed otherwise.
   d. To structural steel using self-drilling screws or power-actuated fasteners at 16 inches on center.

4. Tolerances.

   a. All partitions, wall assemblies, and soffits shall be aligned to a tolerance of 1:200 horizontally and 1:500 vertically.

5. Leveling.

   a. Continuous bearing under all portions of the floor runner members of steel stud walls shall be provided by use of grout as specified in the Grouting section. Walls shall be leveled in a manner to provide uniform interfaces with ceilings and other overhead construction.

6. Welding.

   a. Welds shall conform to the requirements of AWS D1.1, AWS D1.3, and AISI Manual, Section 4.2. Where galvanized studs are welded, the surfaces to be welded shall be thoroughly cleaned by wire-brushing prior to the welding activity. After welding, the welded surfaces and any nearby damaged galvanized surfaces shall be completely coated with zinc-rich paint.

7. ZINC COATING REPAIR.

a. Damaged galvanizing, cut edges and uncoated areas shall be repaired in accordance with ASTM A780. Repair shall be accomplished with an organic paint that provides a minimum of 90 percent zinc dust in the dried film. Surface preparation shall be in accordance with Annex A2 of ASTM A780.

End of Section

SECTION 05530 - METAL GRATINGS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the fabrication and installation of metal grating.

B. Both inch-pound (English) and SI (metric) units of measurement are specified herein; values expressed in inch-pound units shall govern.

1.2 GENERAL.

A. Fabricated items which are indicated on the Drawings but not mentioned specifically herein shall be fabricated in accordance with the applicable requirements of this section.

1.3 SUBMITTALS.

A. Items listed in this article shall be submitted for review by Engineer.

1. Detailed fabrication and erection drawings, indicating location of grating supports, profiles, thicknesses, piece lengths and widths, markings of panels, and fastening methods.

2. Clips and anchorage devices information.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damage of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Design Criteria.

1. Except as modified herein, the manufacture and fabrication of metal grating shall comply with NAAMM MBG 531 "Metal Bar Grating Manual", and NAAMM MBG 532 “Heavy-Duty Metal Bar Grating Manual”. Grating depth shall be as indicated on the Drawings.

B. Carbon Steel Grating.

1. Carbon steel grating shall be the welded type. Bearing bars shall be at least 3/16 inch thick with center to center spacing of 1 3/16 inch. Cross bar center to center spacing shall be 4 inches. Grating shall be galvanized with a coating weight of at least 1.8 oz/sq. ft of coated surface.

2.2 MATERIALS.

Carbon Steel Grating	ASTM A1011.
Grating Stair Treads	Grating stair treads shall match the material and finish of grating in adjacent platforms and floors. Treads shall have a permanently attached or integral non-skid nosing.
Grating Fasteners	Manufacturer's standard, AISI Type 316 stainless steel.
Clips, Bolts, Nuts, Washers	Manufacturer's standard, AISI Type 316 stainless steel.
Welded Threaded Steel Studs	ASTM A108 fully threaded studs automatically welded with compatible nuts and washers; TRW Nelson Type CFL or equal.
Stepped Locking Fasteners	Non-penetrating, non-welded mechanical fasteners, with stainless steel clips and bolts, galvanized cast iron body; Lindapter "Grate-Fast" or Grating Specialty Co. "G-Clip".

2.3 FABRICATION.

A. Grating shall be fabricated in panels that can be easily handled by plant personnel. Unless otherwise indicated on the Drawings, the weight of individual panels shall not exceed 150 lbs. Cross bars and edge bars of adjacent panels shall align. After installation, there shall be not more than 1/4 inch clearance between panels. All bearing bars shall be parallel. Bands and toeplates shall align within 1/8 inch tolerance, vertical and horizontal.

B. Angular, circular, and re-entrant cuts in steel grating may be made by flame cutting. All other cuts in steel grating shall be sawed or sheared. Cuts shall be clean and smooth, without fins, beads, or other projections. Any damaged protective coating shall be fully restored.

C. Grating panels shall be arranged so that openings are centered on a joint between panels. Toeplates extending the full depth of the grating and four inches above the top shall be provided around openings. Toeplates shall be welded to each bearing bar. The ends of bearing bars need not be banded unless required by the Drawings. Bands shall be welded to the first, the last, and every fourth intermediate bar. Bands and toeplates shall be 3/16 inch thick. Crossbars shall be cut off flush with the outside face of side bars.

D. Steel frames anchored to or cast in concrete to support grating shall be stainless steel or hot-dip galvanized after fabrication.

2.4 SHOP COATING.

A. Finish painting of grating, if required, is covered in the Protective Coatings section.

B. Galvanizing.

1. All galvanizing shall be done by the hot-dip process after fabrication, in conformity with the requirements of ASTM A123, A153, and A385.

PART 3 - EXECUTION

3.1 GENERAL.

A. All grating shall lie flat, with no tendency to rock when installed. Poorly fitting or damaged grating shall be rejected. Grating openings may be field cut with the approval of Engineer, provided that no more than four adjacent bearing bars are cut. If the grating is cut or modified in the field, affected surfaces shall be repaired or sealed to assure restoration of the corrosion resistance of the grating. Field cut openings must be spaced so that there are at least as many continuous bars between each opening as there are cut bars at the opening.

3.2 ATTACHMENTS TO SUPPORTING STRUCTURE.

A. All grating supported on steel or aluminum structures shall be attached. Grating shall be attached to the supporting structure in accordance with the grating manufacturer's recommendations and submittals. Single span grating over openings in concrete may rest unattached in recesses constructed for that purpose.

B. Prime Painted Steel Supports.

1. Unless otherwise required or indicated on the Drawings, clip or flange block fasteners or stepped locking fasteners shall be used to attach grating to prime painted steel supports. Clip fasteners shall be secured to the supporting steel with through bolts in drilled holes. Through bolts shall be stainless steel. Fusion welded threaded studs may be utilized if the primer is removed before welding or if a suitable weldable primer is used. Welded studs shall be cleaned and prime painted to match the support steel prior to finish painting.

C. Galvanized Steel Supports.

1. Unless otherwise indicated on the Drawings, stepped locking fasteners shall be used to attach grating to galvanized steel supports. The galvanized coating shall not be damaged.

3.3 FINISH TOUCHUP.

A. After erection, all grating shall be cleaned. Damaged coatings shall be touched up in accordance with the grating manufacturer's recommendations to fully restore the corrosion resistance of the grating.

End of Section

SECTION 05550 - ANCHORAGE IN CONCRETE AND MASONRY

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design and installation of anchors in concrete and masonry. It includes cast-in-place anchor bolts and anchor rods, adhesive anchors for both threaded rods and reinforcing bars, expansion anchors, and undercut anchors.

1.2 GENERAL

A. Anchors Designed by Engineer

1. Cast-in-place and post-installed anchors that are fully detailed on the Drawings have been designed by Engineer and may not be changed to a different type without written approval of Engineer.

B. Anchors Designed by Contractor's Suppliers

1. Contractor's material suppliers shall be responsible for design of anchors for railings, ladders, equipment, pre-engineered structures, and other manufactured items, as indicated in the Drawings and Specifications. Anchors shall be designed for all operating conditions, including wind and seismic loadings when indicated in the Meteorological and Seismic Design Criteria section.

2. Cast-in-place anchors shall be used unless post-installed types are indicated on the Drawings or accepted by Engineer. Post installed anchors into concrete or masonry shall be designed in accordance with the anchor manufacturer's research report.

3. Adhesive anchors used in vibrating applications shall only be used if the anchor manufacturer submits documentation indicating that the product is suitable for the anticipated service conditions.

4. Seismic anchorage design for non-structural components shall include the overstrength factors indicated in ASCE 7, Tables 13.5-1 and 13.6-1, when applicable.

5. Design of anchorage into concrete shall be in accordance with ACI 318 Chapter 17, shall consider concrete to be cracked, and shall not include the strengthening effects of supplementary reinforcement or anchor reinforcement unless approved by Engineer.

6. Design of anchorage into masonry shall be in accordance with TMS 402.

7. Shop drawings for anchor bolts, anchor rods, and post-installed anchors shall include full details and shall be sealed by a professional engineer licensed in the state of the project. Calculations shall be furnished when requested by Engineer.

C. Materials

1. Unless otherwise indicated, anchors of structural steel members connected to concrete shall have a diameter of at least 3/4 inch, and structural members connected to masonry shall have a diameter of at least 5/8 inch. Anchors for ladders and equipment shall have a diameter of at least 1/2 inch. Anchors for pedestrian railing systems shall have a diameter of at least 3/8 inch.

2. Unless otherwise indicated on the Drawings, anchors used in the following locations and applications shall be of the indicated materials.

Cast-In-Place Anchor Bolts and Anchor Rods	
Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Galvanized steel.
Other exterior locations	Galvanized steel.
Interior locations not subject to corrosion	Carbon steel.
Adhesive, Expansion, and Undercut Anchors	
Submerged locations	Stainless steel.
Locations subject to splashing	Stainless steel.
Buried locations	Stainless steel.
Anchorage of structural steel columns	Stainless steel.
Other exterior locations	Stainless steel.
Interior locations not subject to corrosion	Carbon steel.

1.3 SUBMITTALS

A. Drawings and Data

1. Data, catalog cuts, and manufacturer's research reports (from independent organizations such as ICC-ES or IAPMO UES) indicating the manufacturer and types of adhesive anchors, expansion anchors, and undercut anchors to be supplied shall be submitted in accordance with the Submittal Procedures section.

B. Calculations

1. If Contractor requests use of products other than those indicated herein, calculations may be required as part of the submittal package. Calculations shall be prepared by a professional engineer licensed in the state of the project, using methods and procedures required by the building code. Contractor shall demonstrate that the proposed substitute anchors are equivalent in all necessary criteria, including strength, spacing and edge distance limitations, embedment depth limitations, temperature limitations, and any other criteria required by Engineer.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent damage or corrosion. Damaged materials shall be promptly replaced. Materials shall be shipped and stored in original manufacturer's packaging.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated on the drawings, materials shall be as indicated below.

Cast-In-Place Anchor Bolts and Anchor Rods	
Carbon steel	ASTM F1554, Grade 36 with compatible nuts.
Galvanized steel	ASTM F1554, Grade 36 with compatible nuts; hot-dip galvanized, ASTM F2329.
Stainless steel	Bolts, ASTM F593, Alloy Group 1 or 2 (minimum yield strength of 45 ksi); nuts, ASTM F594, Alloy Group 1 or 2.
Flat Washers	ANSI B18.22.1; of the same material as anchor bolts and nuts.
Expansion Anchors in Concrete	Products shall be single component anchors tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces. Hilti "Kwik-Bolt TZ2" Simpson "Strong-Bolt 2", or DeWalt "Power-Stud+SD2" (carbon steel), "Power-Stud+SD4" (304 stainless steel), and "Power-Stud+SD6" (316 stainless steel).
Expansion Anchors in Grouted Concrete Masonry Units	Products shall be single component anchors tested in accordance with ICC AC01, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "Kwik-Bolt 1," Simpson "Wedge-All," or DeWalt "Power-Stud+ SD1."
Undercut Anchors in Concrete	Products shall be tested in accordance with ICC AC193, and shall have a manufacturer's research report in compliance with the applicable building code. Hilti "HDA Undercut Anchor" (carbon steel) and "HDA-R Undercut Anchor" (stainless steel), or DeWalt "Atomic+ Undercut Anchor" (A36 carbon steel).
Adhesive Anchors in Concrete	Products shall be tested in accordance with ICC AC308, and shall have a manufacturer's research report in compliance with the applicable building code. The anchors shall be approved for use in cracked concrete, and for resisting seismic forces.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.

Threaded Rods and Nuts (Stainless Steel)	ASTM F593, CW.
Reinforcing Bars	ASTM A615, Grade 60, deformed.
Reinforcing Bars, weldable	ASTM A706, Grade 60, deformed.
Adhesive	Hilti “HIT-HY 200,” or DeWalt “Pure 110+.”
Adhesive Anchors in Grouted Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer’s research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti "HIT-HY 270,” DeWalt “AC100+ Gold,” or Simpson “SET XP.”
Adhesive Anchors in Hollow Concrete Masonry Units	Products shall be tested in accordance with ICC AC58, and shall have a manufacturer’s research report in compliance with the applicable building code.
Threaded Rods and Nuts (Carbon Steel)	ASTM A307 or ASTM F1554 Grade 36.
Threaded Rods and Nuts (Stainless Steel)	ASTM F593 CW (Hilti or Powers systems), or ASTM A193 Grades B6, B8, or B8M (for Simpson system).
Adhesive	Hilti “HIT-HY 270,” DeWalt “AC100+ Gold,” or Simpson “SET XP.”
Screen Tubes	As recommended by the manufacturer.

2.2 ANCHORS

A. Cast-in-Place Anchor Bolts and Anchor Rods

1. Cast-in-place anchor bolts and anchor rods shall have forged heads or embedded nuts and washers. Anchors shall be delivered in time to permit setting prior to the placing of structural concrete or masonry grout. Anchor sleeves shall not be used unless acceptable to Engineer. Unless installed in sleeves, anchor bolts and anchor rods shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the concrete form or the supporting template. Two nuts, a jam nut, and a washer shall be furnished for cast-in-place anchor bolts and anchor rods indicated on the Drawings to have locknuts; two nuts and a washer shall be furnished for cast-in-place anchor bolts and anchor rods without locknuts.

B. Adhesive, Expansion, and Undercut Anchors

1. When adhesive, expansion, or undercut anchors are indicated on the Drawings, only acceptable systems shall be used. Acceptable systems shall include only those systems

and products specified or specifically indicated by product name on the Drawings. Alternative anchoring systems may be used only when specifically accepted by Engineer.

2. Unless otherwise noted, single nuts and washers shall be provided with adhesive anchors, expansion anchors, and undercut anchors. Adhesive anchors shall be free of coatings that would weaken the bond with the adhesive.

3. Adhesive anchors in hollow CMU masonry and unreinforced brick masonry shall utilize screen tubes as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 GENERAL

A. Anti-seize thread lubricant shall be liberally applied to projecting, threaded portions of stainless steel anchors immediately before tightening of the nuts.

B. Compliance with Manufacturer's Instructions

1. Post-installed anchors shall be installed in accordance with the manufacturer's printed installation instructions and all applicable requirements of the manufacturer's research report for the specific anchor system. If conflicts are found between the Drawings, the manufacturer's printed installation instructions, and the manufacturer's research report installation requirements, Contractor shall notify Engineer for resolution.

C. Special Inspection

1. Special inspection requirements for cast-in-place and post-installed anchors shall be as indicated in the Code-Required Special Inspections and Procedures section. Anchorage work shall be performed in a manner that allows the inspections to take place without adversely impacting the schedule.

3.2 CAST-IN-PLACE ANCHOR BOLTS AND ANCHOR RODS

A. Cast-in-place anchor bolts and anchor rods shall be carefully positioned with templates and secured in the forms prior to placing concrete, or in masonry bond beams prior to placing grout. Contractor shall verify that anchorage devices are positioned in accordance with the Drawings and with applicable equipment or structure submittal drawings.

B. Threads, bolts, and nuts spattered with concrete or masonry grout during placement shall be cleaned prior to final installation of the bolts and nuts.

C. Sleeves shall be filled with non-shrink grout.

3.3 ADHESIVE ANCHORS

A. Adhesive shall be statically mixed in the field during application. All proportioning and mixing of the components shall be in accordance with the manufacturer's recommendations.

B. Anchors or bars shall be installed in holes hammer drilled into hardened concrete or masonry. Drill shall be set to rotation-only mode when drilling into hollow CMU or into brick. Diameter of holes shall be 1/16 inch larger than the outside diameter of the rod or bar unless recommended otherwise by the anchor system manufacturer. Holes shall be prepared by removing all dust and debris using procedures recommended by the adhesive manufacturer.

C. Adhesive anchors and holes shall be clean, dry, and free of grease and other foreign matter at the time of installation. The adhesive shall be placed and the rods or bars shall be set in accordance with the recommendations of the manufacturer. Care shall be taken to ensure that all spaces and cavities are filled with adhesive, without voids.

D. Concrete Installation

1. Unless indicated otherwise on the Drawings, reinforcing bars shall be embedded to a depth of 15 bar diameters, and threaded rods shall be embedded to a depth that will develop the yield strength of the rod.

2. Adhesive anchors in concrete shall be installed under the following conditions.

Minimum Age of Concrete Prior to Anchor Installation	21 days.
Concrete Temperature Range	Maximum short-term temperature 162° F, maximum long-term temperature 110° F.
Moisture Condition	Dry concrete.
Type of Lightweight Concrete	N/A
Hole Drilling and Preparation	Hammer drill only.

3. Installation of adhesive anchors into concrete that are either horizontal or upwardly inclined shall be performed only by personnel certified by the ACI/CRSI Adhesive Anchor Installation Certification Program.

E. Masonry Installation

1. Anchors shall be installed to meet all criteria in the manufacturer’s installation instructions and ICC-ES reports, including but not limited to minimum compressive strength at time of installation, minimum edge distances, minimum clearances from mortar joints, minimum anchor spacing, and use of screen tubes.

3.4 EXPANSION AND UNDERCUT ANCHORS

A. Expansion and undercut anchors shall be installed using all procedures and accessory devices recommended by the anchor manufacturer.

End of Section

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SECTION 05590 - STRUCTURAL METALS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the fabrication and erection of structural metal items.

B. Except as otherwise specified or indicated on the Drawings, all work shall conform to the applicable provisions of the AISC "Steel Construction Manual" (15th edition) with the exception of the "Code of Standard Practice for Steel Buildings and Bridges"; and the Aluminum Association "Specification for Aluminum Structures."

C. Special inspection during the fabrication and erection of structural steel, if required by the local building code, is addressed in the Code-Required Special Inspections and Procedures section.

D. Both inch-pound (English) and SI (metric) units of measurement are specified herein; the values expressed in inch-pound units shall govern.

1.2 SUBMITTALS

A. Drawings and Data - General

1. Complete data, fabrication drawings, and setting or erection drawings covering all structural and miscellaneous metal items shall be submitted in accordance with the Submittals Procedures section.

B. Connection and Weld Data

1. All bolted connections and welds shall be properly identified on the shop drawings. Welding procedures, welding procedure qualification records and welder qualifications shall be submitted.

C. Bolts and Washer Data

1. Submittals for high strength bolts, tension control bolts and load indicator washers shall include statements from the bolt and washer manufacturers certifying satisfactory compliance with the governing standards and the specified tests.

D. Drawings and Data – Design

1. Submittals for items that are designed by the fabricator shall include drawings sealed by a professional engineer registered in the state of the project. Data shall include confirmation that the design meets all applicable code requirements. Calculations shall be submitted when requested by Engineer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, significant coating damage, or corrosion. Damaged materials shall be promptly replaced. Structural metal work shall be stored on blocking so that no metal touches the ground and water cannot collect thereon. The material shall be protected against bending under its own weight or superimposed loads.

B. Bolting materials shall be stored indoors. Weld rod shall be stored in accordance with the supplier's instructions and AWS D1.1.

1.4 FABRICATOR QUALIFICATION

A. All fabricating plants providing structural steel shall be qualified fabricators who participate in the AISC Certification program and are designated an AISC Certified Plant, Category BU.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials needed for both shop and field assembly shall be furnished.

2.2 MATERIALS

Steel

Shapes (W, WT)	ASTM A992.
Shapes (S, M, HP, C)	ASTM A36 or ASTM A572 Grade 50.
Other Shapes (angles)	ASTM A36.
Plates and Bars	ASTM A36.
Sheets	ASTM A1008 CS Type B or A1011 CS Type B.
Pipe	ASTM A53, Type E or S, Grade B (F_y = 35 ksi).
Round Structural Tubing	ASTM A500, Grade C (F_y = 46 ksi).
Square and Rectangular Structural Tubing	ASTM A500, Grade C (F_y = 50 ksi).
Bolts and Nuts	
Bolts, High Strength	ASTM F3125, Grade A325.
Bolts, Tension Control Type (Twist off)	ASTM F3125, Grade 1852.
Bolts, unfinished	ASTM A307.
Nuts, Heavy-Hex	ASTM A563, grade and finish compatible with bolts.

Nuts, Self-Locking	Prevailing torque type; IFI-100, Grade A.
Washers	
Flat, Hardened	ASTM F436, Type 1.
Lock	ANSI/ASME B18.21.1, helical spring type.
Beveled	ASTM F436.
Load Indicator	ASTM F959, compressible-washer-type direct tension indicator; type compatible with bolts tested in accordance with Article 10.2 of ASTM F959.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A36. Threaded rods shall have sufficient threading to permit the maximum adjustment available. Continuously threaded rod is not acceptable for rods over 12 inches in length.
Forged Steel Sleeve Nuts	AISI C-1018, Grade 2.
Stainless Steel	
Shapes	ASTM A1069 or A276, Type 316L.
Plates	ASTM A240, Type 316L.
Pipe	ASTM A312, Grade TP316L.
Tube	ASTM A269, Grade TP316L.
Bolts	ASTM F593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Nuts	ASTM F594, Alloy Group shall match that of the bolts. Nuts shall have a minimum proof stress equal to or greater than the minimum full-size tensile strength of the bolts.
Washers	
Flat	ANSI/ASME B18.22.1, Type 316.
Lock	ANSI/ASME B18.21.1, helical spring type, Type 316.
Threaded Rods (Including Hanger Rods for Pipe Supports)	ASTM A593, Alloy Group 1 or 2, minimum yield strength of 45 ksi.
Weld Metal (Steel Connections)	ANSI/AWS D1.1, Table 3.1, filler metal with minimum 70 ksi tensile strength unless otherwise required.
Rails	
Crane	ASTM A1.
Railroad	ASTM A1.
Shop Coatings	
Universal Primer	As indicated in the Protective Coatings section.

Bituminous Paint	Metal fabricator's standard product.
Galvanizing	ASTM A123, A153, A385, and F2329 as applicable.

2.3 CRANE SYSTEMS

A. Steel beams used as underhung crane or hoist runways shall be straight and level. The upper surface of the lower flange of each beam shall be smooth, with all projections ground off. Joints shall be close-fitting and free from unevenness. The beams shall be rigidly supported in exact alignment. A section of each runway beam shall not be installed until after the crane or hoist has been installed.

B. Stops as recommended by the crane or hoist manufacturer shall be bolted in place on each end of each runway beam to limit the travel of the crane or hoist. Stops shall be so located that the crane or hoist does not come into contact with any part of the structure or piping. If the crane or hoist is required to be powered, at the power feed end of the runway the stops shall be designed so that the cable trolleys will pass beneath the stops. The stops shall be so located that there is sufficient room on the runway for storage of the cable trolleys beyond the stops. Secondary stops shall be provided for the cable trolleys.

C. Crane Rails

1. Rails on which a traveling, top running crane is to travel shall be furnished complete with clamps or hook bolts, splice plates, stops, anchor bolts and nuts, and other accessories necessary to complete the installation indicated on the Drawings.

2.4 STRUCTURAL STEEL BOLTED CONNECTIONS

A. Bolt holes shall have a diameter nominally 1/16 inch larger than the nominal bolt diameter. Bolt holes for one ply of vertical diagonal bracing connections may be oversized to a diameter nominally 3/16 inch larger than the nominal bolt diameter.

2.5 SHOP COATING

A. All items shall be shop coated as specified herein. The requirements for field painting are covered in the Protective Coatings section.

B. Contact surfaces of structural steel slip critical bolted connections shall not be shop coated. Contact surfaces of structural steel bearing type bolted connections may be shop coated.

C. Cleaning

1. Surfaces shall be dry and of proper temperature when coated, and shall be free of grease, oil, dirt, dust, grit, rust, loose mill scale, weld flux, slag, weld spatter, and other objectionable substances. Articles to be galvanized shall be pickled before galvanizing. All other ferrous metal surfaces shall be cleaned by solvent, high-speed power wire brushing or by blasting to the extent recommended by the paint manufacturer and as required in the Protective Coatings section.

D. Edge Grinding

1. Sharp projections of cut or sheared edges of ferrous metals which will be submerged in operation, except for items specified to be hot-dip galvanized, shall be ground to a radius as needed to ensure satisfactory paint adherence and as required in the Protective Coatings section.

E. Prime Painted Steel

1. Unless otherwise specified or indicated on the Drawings, all ungalvanized steel shall be given a shop coat of universal primer after fabrication. The dry film thickness of the universal primer shall be at least 5 mils. Steel surfaces shall be prime-coated as soon as practicable after cleaning. Steel shall not be moved or handled until the shop coat is dry and hard.

F. Galvanizing

1. Steel materials required to be galvanized are indicated on the Drawings. All galvanizing shall be done by the hot-dip process after fabrication. An approved zinc-rich paint shall be used to touch up minor coating damage, in accordance with ASTM A780. Materials with significant coating damage shall be regalvanized or replaced.

2. Bolts, nuts, and washers shall be galvanized when connected materials are galvanized or where indicated on the Drawings. The use of zinc-plated bolts will not be acceptable.

G. Stainless Steel

1. Unless otherwise specified, all items fabricated from stainless steel shall be thoroughly cleaned and degreased after fabrication. Pickling or a light blast cleaning shall produce a modest etch and remove all embedded iron and heat tint. Surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron and shall be retreated as needed to remove all traces of iron contamination. Surfaces shall be adequately protected during shipping and handling to prevent contact with iron or steel objects or surfaces.

PART 3 - EXECUTION

3.1 STRUCTURAL STEEL ERECTION

A. Structural steel shall be erected so that individual pieces are plumb, level, and aligned within a tolerance of 1:500. The elevations of the top of floor and roof members shall be within 1/16 inch of the elevations indicated on the Drawings. The faces of girts and other supporting members for rigid wall panels shall be in vertical planes within a maximum variation of 1/8 inch.

B. All members and parts, as erected, shall be free of warps, local deformations, and unauthorized bends. All parts shall be assembled accurately as indicated on the Drawings. Light drifting will be permitted to draw parts together, but drifting to match unfair holes will not be permitted. Any enlargement of holes necessary to make connections in the field shall be done by reaming with

twist drills and only with the approval of Engineer. Enlarging holes by burning will not be permitted.

C. Baseplates shall be set level in exact position and grouted in place.

D. Inspection and Testing

1. Special inspection will be performed as indicated in the Code Required Special Inspections and Procedures section. The erector shall provide access as needed to facilitate all inspections and shall provide timely notification during erection when inspection milestones are approaching.

E. Crane Rails

1. Crane rails shall be installed level and in accurate alignment and shall form a continuous, smooth track. Rail installation tolerances shall be in accordance with CMAA Specification 70.

3.2 STRUCTURAL STEEL BOLTED CONNECTIONS

A. Unless otherwise indicated on the Drawings, bolted connections for structural steel, as defined in the AISC manual, shall be made with ASTM F3125 high strength bolts conforming to the "Specification for Structural Joints Using High-Strength Bolts" as approved by the Research Council on Structural Connections. The method of installation, pretensioning procedures, bolting equipment and tools shall likewise conform to the above referenced standard.

B. When assembled, all joint surfaces, including those adjacent to the bolt heads, nuts, or washers, shall be free of loose mill scale, dirt, burrs, oil, and other foreign material that would prevent solid seating of the parts.

C. Beveled washers shall be used when the bearing faces of bolted parts have a slope of 1:20 or greater with respect to a plane perpendicular to the bolt axis. Bolt length shall be increased as needed to accommodate the beveled washers.

D. Tightening of each connection assembly shall progress systematically from the most rigid part of the joint toward the free edges until all have been sufficiently rotated or the load indicator washers on all bolts have been closed to the average gap stipulated by the load indicator washer manufacturer.

E. Except as otherwise indicated on the Drawings or specified herein, bolted connections shall be bearing type with threads excluded from the shear plane. Slip critical connections shall be used in diagonal bracing connections, where oversize holes or slotted holes parallel to the direction of the load are used, and where indicated on the Drawings.

F. Bolts in all structural steel connections, both bearing and slip critical, shall be fully pretensioned in accordance with the AISC standards unless specifically noted otherwise on the Drawings. The calibrated wrench method of pretensioning bolts will not be acceptable. Acceptable pretensioning methods are as follows:

Connection Type	Acceptable Pretensioning Method

Bearing	Turn of the nut method and load-indicator washers are acceptable. Tension control (twist-off) type bolts may be used only if approved by Engineer.
Slip-Critical	Load indicator washers.

G. Turn of the Nut Method

1. The bolt, nut, and material shall be match marked. A wax lumber marker or paint shall be used to clearly mark the assembly.

H. Load-Indicator Washers

1. Load indicator washers shall be installed in accordance with the manufacturer's recommendations, as supplemented herein. To facilitate proper tightening of fastener assemblies with load indicator washers, a hardened flat washer shall be installed under the turned element (bolt head or nut) and between the turned element and the load indicator washer protrusions, in all cases. Whenever possible, the load indicator washer shall be installed on the head end of the bolt. If the bolt head will not be visible for inspection of the indicator washer after installation, or if the bolt head must be turned to tighten the assembly, the load indicator washer may be installed on the nut end of the bolt.

I. Tension Control (Twist-off) Bolts

1. Patented tension control bolts shall be of equivalent size and strength to the indicated high strength bolts, and shall be installed in strict accordance with the manufacturer's instructions. Load-indicator washers are not required on tension control bolts.

3.3 STRUCTURAL AND STAINLESS STEEL WELDING

A. Welding and related operations shall conform to applicable provisions of AWS D1.1 for steel and AWS D1.6 for stainless steel. All welding shall be performed in accordance with written procedures, using only those joint details which have prequalified status. All welding shall be performed by welders qualified in accordance with the American Welding Society.

B. Welds not dimensioned on the Drawings shall be sized to develop the full strength of the least strength component of the connection.

C. All butt and miter welds shall be continuous and, where exposed to view, shall be ground smooth. Intermittent welds shall have an effective length of at least 2 inches and shall be spaced not more than 6 inches apart.

D. Surfaces within 2 inches of a weld shall be free from loose or thick scale, slag, rust, moisture, grease, paint and other foreign materials that would prevent proper welding or release objectionable fumes.

E. Only shielded metal arc, gas metal arc, flux cored arc, submerged arc, and gas tungsten arc welding are permitted. For flux cored arc welding, only E70xx one (1) or five (5) wire electrodes with supplemental gas shielding shall be permitted. Use of electroslag or electrogas

welding processes or the short-circuiting transfer mode of the gas metal arc process will not be acceptable.

F. Field welded connections shall not be substituted for field bolted connections indicated on the Drawings.

End of Section

SECTION 07160 - DAMPPROOFING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing and installation of dampproofing for concrete.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications and data covering the dampproofing materials furnished under this section shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials to be used shall be as follows:

Waterborne Emulsified Asphalt — BASF "Masterseal 615 (formerly Hydrocide 700B)", or approved equal.

2.2 SURFACES TO BE DAMPPROOFED

A. Exterior wall surfaces which are poured against sheeting or undisturbed earth need not be dampproofed. The following concrete surfaces that are not in contact with treated or potable water shall be dampproofed:

1. All exterior concrete wall surfaces forming a part of an interior room or dry pit which will be in contact with earth backfill below finished grade and above the top of the footings or bottom slabs.

2. All exterior wall surfaces of cast-in-place and precast concrete electrical manholes and handholes below finished grade and above the top of the footings or bottom slabs.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. When dampproofing is applied, concrete surfaces shall be clean and dry. Except where membrane is applied, new concrete shall cure at least 28 days before dampproofing material is applied. Concrete shall be allowed to cure in accordance with the membrane manufacturer's recommendation before membrane damproofing is applied. Concrete shall be prepared to receive the damproofing material as recommended by materials manufacturer.

B. All dirt, dust, sand, grit, mud, oil, grease, and other foreign matter shall be removed in accordance with ASTM D4258 and the surface abraded when recommended by the manufacturer of the dampproofing material. Abrading shall be done in accordance with ASTM D4259. Prior to application of the coating, the surfaces shall be thoroughly washed, or cleaned by air blasting, to remove all dust and residue.

3.2 APPLICATION

A. Dampproofing materials shall not be thinned unless recommended by the manufacturer.

B. Surfaces not intended to be dampproofed shall be protected from contamination, discoloration, or other damage. Such surfaces shall be masked as necessary to protect uncoated areas and to confine the dampproofing to the intended limits.

C. Surfaces shall be dry and at recommended temperature when dampproofing is applied. Unless properly protected, coatings shall not be applied in wet, damp, or foggy weather or when windblown dust, dirt, or debris, or insects would collect on the coating. Dampproofing, other than low temperature membrane dampproofing, shall not be applied when the temperature of the air or the surface is below 50° F , unless approved by manufacturer. Low temperature membrane dampproofing may be applied at air and surface temperatures as low as 25° F if approved by manufacturer and acceptable to the Engineer.

D. Dampproofing shall be applied by brush, high pile rollers, or spray equipment complying with the manufacturer's recommendations. If blistering occurs, all blisters larger than 1/4 inch in diameter shall be broken before the subsequent coat is applied.

E. Emulsified asphalt shall be installed in accordance with manufacturer's recommendations and at the maximum coverage rate recommended by manufacturer that is acceptable to Engineer.

F. Membrane shall be installed in accordance with manufacturer's recommendations including the recommended primer.

End of Section

SECTION 07200 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers thermal insulation and associated items not covered in other sections.

1. Insulation to be installed under the roofing is specified in the Standing Seam Metal Roofing and Soffit Panels section. Mechanical ductwork insulation is specified in the Heating, Ventilating, and Air Conditioning section. Piping insulation is specified in the Miscellaneous Piping and Accessories Installation section. Sound insulation is specified in the Acoustical Wall Panel Systems section.

1.2 GENERAL

A. Thermal insulation shall be furnished and installed as specified herein and as indicated on the Drawings. Thermal insulation shall be rigid type or batt type. Safing insulation shall be furnished and installed as specified herein and as indicated on the Drawings.

1.3 SUBMITTALS

A. Complete specifications covering the materials furnished shall be submitted in accordance with the Submittals Procedures section.

1. A sample of each type of thermal insulation shall be submitted in accordance with the Submittals Procedures section, and such samples will be held to be representative of the properties and characteristics of the finally installed insulation.

2. Provide printed statement of VOC content and chemical components for insulation installed inside the weatherproofing barrier.

1.4 STORAGE AND HANDLING

A. All materials shall be delivered in the original unopened packages bearing the name of the manufacturer and the brand. Insulation shall be stored under cover in a dry place, and shall be protected from the weather at all times. Good fire safety practices shall be observed at all times during storage and installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials to be used shall conform to the following:

Batt Type Insulation

Standard	ASTM C665, mineral or glass fiber, Type II, Class C (nonreflective membrane, one face), 3-5/8 inch thick with R value of 13, 6 inch thick with R value of 19, or 9 inch thick with R value of 30, formaldehyde-free; Owens-Corning, Manville or equal.
Safing	ASTM C665, mineral fiber, Type I, 4 inch, 4 pound density; formaldehyde-free; USG "Thermafiber Safing", Dow Chemical or equal.

2.2 LOCATION FOR INSTALLATION

A. Standard Batt Insulation. Standard batt insulation shall be installed in exterior wall assemblies and soffits at the locations indicated on the drawings.

B. Safing. Safing insulation shall be installed where required for separation closures and at other locations as indicated on the drawings.

PART 3 - EXECUTION

3.1 INSTALLATION OF BATT INSULATION

A. Soffits. Batt type insulation shall be installed between metal framing members where indicated on the drawings. Insulation shall be laid in as large a batt as practical for the specific location. Nonreflective membrane covering shall be installed on the inside (warm) face of the assembly. The insulation shall be secured in place to prevent sagging or slipping within the assembly.

B. Safing Type. Safing insulation shall be neatly stuffed to completely fill all voids between the metal deck and walls. Manufacturer's standard safing clips shall be provided as required.

End of Section

SECTION 07415 - STANDING SEAM METAL ROOFING AND SOFFIT PANELS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and erection of standing seam metal roofing, including trim, flashings, clips, under-layment, insulation and appurtenances, as indicated on the Drawings and as specified herein.

1.2 GENERAL.

A. The materials to be furnished and installed under this section include, but are not limited to, the following:

Standing seam metal roof panels.

Soffit panels

Flashings, trim, and closures.

Gutters and downspouts.

Clips, spacers, and shims.

Caulking and sealing materials.

Fasteners/anchors.

Underlayment (Weather Barrier)

Rigid Board Insulation

Snow guards

1.3 SUBMITTALS.

A. Product data, detailed fabrication, erection shop drawings, and material samples shall be submitted in accordance with the Submittals Section. Submittals shall include jointing, trim, and flashing details, including termination and penetrations.

1. Product Data. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of panel and accessory.

2. Shop Drawings. Include fabrication and installation layouts of metal panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details.

3. Accessories. Include project specific details of the gutters and downspouts, flashing, trim, and anchorage systems, at a scale of not less than 1-1/2 inches per 12 inches (1:10).

4. Samples. Provide samples as follows:

   a. Samples for Initial Selection. For each type of metal panel indicated with factory-applied color finishes. Include similar samples of trim and accessories involving color selection.
   b. Samples for Verification. For each type of exposed finish required, prepare on samples of size indicated below:
   c. Metal Panels. 12 inches long by actual panel width. Include clips, fasteners, closures, and other metal panel accessories.

1.4 INFORMATIONAL SUBMITTALS. As follows:

1. Qualification Data: For roofing installer.

2. Test Reports: For each product, for tests performed by a qualified testing agency.

3. Manufacturer's Technical Representative: Field quality-control reports.

4. Sample Warranties: For special warranties.

1.5 QUALITY ASSURANCE. Provide installer qualifications certifying that Installer is an entity that employs installers and supervisors who are trained and approved by manufacturer. Provide names of certified personnel and designate which certified individual will be on-site during installation.

1. Pre-Installation Conference: Conduct on-site conference with Engineer, Contractor and certified Installer to review/discuss complete roofing installation process.

1.6 HANDLING AND STORAGE. Handling and storage shall be in accordance with the Products, Materials, Equipment and Substitutions Section. The roofing materials shall be handled in a manner which will prevent bending, dents, scratches, or damage of any kind. Damaged units and accessories will be rejected, and shall be replaced by and at the expense of the Contractor promptly after rejection. Materials shall be stored under cover at all times.

1.7 FINISH. Roof and soffit panels, gutters, downspouts, trim, seam corners, flashings, snow guards and all exposed appurtenances shall have a 70 percent "Kynar 500" fluoropolymer oven-baked coating conforming to AAMA 2605.2; both prime coat and finish coat shall be oven baked.

1.8 COLOR SELECTION. The finishes will be selected after the award of contract from the manufacturer's full range of standard and custom colors. Contractor shall be responsible for purchase of the entire minimum amounts of all materials required to obtain the selected color including custom colors that may be subject to required minimum quantities by the manufacturer. Samples shall be submitted for color verification.

1.9 WARRANTY. The manufacturer/installer of the metal roof systems shall furnish to the Owner special warranties/guarantees covering materials, finish, weathertightness and workmanship, as follows.

A. Materials/Workmanship Warranty. Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within a three (3) year warranty period, dated from the date of acceptance.

B. Failures include, but are not limited to, structural failures including rupturing, cracking, or puncturing, and deterioration of metals and other materials beyond normal weathering.

C. Panel Finish Warranty. Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within a 20-year warranty period, dated from the date of Substantial Completion.

1. Deterioration to "exposed panel finish" includes, but is not limited to, the following: color fading more than 5 Hunter units when tested according to ASTM D 2244; chalking in excess of a No. 8 rating when tested according to ASTM D 4214; and cracking, checking, peeling, or failure of paint to adhere to bare metal.

D. Weathertightness Warranty. Manufacturer's "original cost" warranty form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within a 20-year warranty period dated from the date of Substantial Completion.

E. Extent of Warranty for metal roof panel "assemblies" shall include the roof panels, and their support system, flashings, and accessories, and shall further include all piping/venting penetrations, and related flashings.

F. Extent of Coverage by the metal roof manufacturer shall include repair or replacement, in accordance with the original project requirements, any/all leaks, structural failures, ruptures or perforations, and including any defects due to faulty material and workmanship, at no additional cost to the Owner.

G. Installer Warranty/Guarantee. The certified installer/applicator shall provide a three (3) year installation and workmanship guarantee.

PART 2 - PRODUCTS

2.1 PERFORMANCE DATA.

A. Structural Performance.

1. Provide metal panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 1592.

Wind Loads	As indicated on Drawings.
Other Design Loads	As indicated on Drawings.
Deflection Limits	For wind loads, no greater than 1/240 of the span.

B. Air Infiltration.

1. Air leakage of not more than 0.06 cfm/sq. ft. when tested according to ASTM E 1680 or ASTM E 283 at the following test-pressure difference of 6.24 lbf/sq. ft.

C. Water Penetration under Static Pressure.

1. No water penetration when tested according to ASTM E 1646 or ASTM E 331 at the following test-pressure difference of 6.24 lbf/sq. ft.

D. Wind-Uplift Resistance.

1. Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.

Uplift Rating	UL 90

2.2 STANDING SEAM METAL ROOF PANELS

A. General.

1. Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.

2. Unless more stringent requirements are indicated, steel panel systems shall comply with ASTM E 1514.

2.3 Steel Sheet Material.

A. Zinc-coated (galvanized) steel sheet complying with ASTM A 653/A 653M, G90 coating designation, designation; structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

2.4 Metal Roof Panels.

A. Vertical-Rib, Seamed-Joint Standing-Seam Roof Panels shall be formed with vertical ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

Panel design criteria shall be as follows:

Gage	24 gage.
Panel Coverage	16 inches.
Panel Height	2 inches.
Exterior Finish	Two (2) coat fluoropolymer.
Clips	Concealed anchorage system, standard with the roofing manufacturer, designed to permit thermal movement and to assure positive and negative loading in compliance with UL90 rating.

2.5 Soffit Panels.

A. Shop formed, Flush Surface Soffit Panel, smooth faced; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.

Panel design criteria shall be as follows:

Gage	24 gage.
Panel Coverage	11 inches.
Panel Height	1 inches.
Exterior Finish	Two (2) coat fluoropolymer.

Clips	Concealed anchorage system, standard with the roofing manufacturer, designed to permit thermal movement and to assure positive and negative loading in compliance with UL90 rating.

2.6 Fascia, Trim, Flashing, and Seams.

A. Same material, finish, and color as the roof or soffit panels.

2.7 Gutters and Downspouts.

A. Prefinished, 26 gage steel. Gutters and downspouts shall be provided where and as detailed on the Drawings. Gutters and downspouts shall be constructed of the material specified. Gutters shall be configured as indicated with fully welded seam construction. All details and construction shall be as recommended by the SMACNA "Architectural Sheet Metal Manual".

2.8 Snow Guards.

A. 16 gage steel snow guard, laser-cut machined grade 304 stainless steel; painted to match roof color as defined herein. Snojax SnowCatcher, or similar.

2.9 Underlayment (Weather Barrier).

A. Provide self-adhering, cold-applied, sheet underlayment, a minimum of 30 mils thick, consisting of slip-resistant, polyethylene-film top surface laminated to a layer of butyl or SBS-modified asphalt adhesive, with release-paper backing, Provide primer when recommended by underlayment manufacturer.

B. Thermal Stability: Stable after testing at 240 deg F: ASTM D 1970.

C. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.

D. Product Reference: Carlisle Residential WIP 300 HT or equal.

2.10 Roof Board Insulation.

A. Composite insulation board with closed cell polyisocyanurate composite insulation board with foam core board insulation (which is CFC and HCFC free) and compliant with ASTM C 1289, Type V; bonded to 7/16" APA/TECO rated OSB on the top, and glass fiber-reinforced felt facer on the bottom.

B. Manufacturer/Product Reference: Atlas Roofing Corp./ ACFoam Nail Base Insulation or equal.

PART 3 - EXECUTION

3.1 EXAMINATION.

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal panel supports, and other conditions affecting performance of the Work. Installer shall notify Engineer, in writing, if the substrate surfaces are not suitable to receive the composite deck and metal roof system. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine primary and secondary roof framing to verify that all structural support members, metal deck, and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

C. Examine metal roof deck to verify that joints are supported by framing members and that installation is within flatness tolerances required by metal roof panel manufacturer.

D. Examine roughing-in for components and systems penetrating metal panels to verify actual locations of penetrations relative to seam locations of metal panels before installation.

3.2 ROOF BOARD INSULATION.

A. Install composite roof board insulation in full compliance with insulation manufacturer's written instructions, and with the project specifications and submittals.

B. Secure composite insulation panels to metal deck/roof structure in accordance with roof panel manufacturer's requirement, using fasteners required by the insulation manufacturer. Mechanical fasteners shall be of sufficient size and number, and in the required pattern to resist the displacement of the insulation by wind uplift forces.

C. Stagger/offset panel joints as required by insulation manufacturer.

3.3 UNDERLAYMENT INSTALLATION.

A. Install underlayment over the entire roof surface as recommended by the underlayment manufacturer.

B. Install self-adhering sheet underlayment complying with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlay side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.

C. Extend underlayment into gutter.

3.4 METAL PANEL INSTALLATION.

A. Install metal panels according to manufacturer's written instructions in orientation, sizes, and locations indicated. Metal panels shall be installed in full length panels only – no splices.

B. Anchor metal panels and other components securely in place, with provisions for thermal and structural movement. Flash and seal metal panels at perimeter of all openings. Fasten with self tapping screws. Do not begin installation until air- or water-resistive barriers and flashings that will be concealed by metal panels are installed. Install screw fasteners (where required) in predrilled holes. Locate and space fastenings in uniform vertical and horizontal alignment.Install flashing and trim as metal panel work proceeds. Provide weathertight escutcheons for pipe- and conduit-penetrating panels.

C. Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.

D. Metal Protection: Where dissimilar metals contact each other or corrosive substrates, protect against galvanic action as recommended in writing by metal panel manufacturer.

3.5 Standing-Seam Metal Roof Panel Installation:

A. Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended in writing by manufacturer.

B. Install clips to supports with self-tapping fasteners.

C. Install pressure plates at locations indicated in manufacturer's written installation instructions.

D. Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

E. Provide watertight panel installation as follows:

1. Apply a continuous ribbon of sealant or tape to seal joints of metal panels, using sealant or tape as recommend in writing by manufacturer as needed to make panels watertight.

2. Provide sealant or tape between panels and protruding equipment, vents, and accessories.

F. Install accessories with positive anchorage to building and weathertight mounting, and provide for thermal expansion. Coordinate installation with flashings and other components.

G. Install components required for a complete metal panel system including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items. Provide types indicated by metal roof panel manufacturers; or, if not indicated, types recommended by metal roof panel manufacturer.

H. Flashing and trim shall comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without buckling and tool marks, and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and achieve waterproof and weather-resistant performance.

2. Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection.

I. Gutter sections shall be joined with riveted, or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more that 24 inches o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

J. Downspout shall be joined with telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch away from walls; locate fasteners at top and bottom and at approximately 60 inches o.c. in between.

1. Provide metal boot/spout at face of concrete sidewalls to direct water into concrete splash-block and away from building.

2. Connect downspouts to underground drainage system, or to PVC pipe at elevated walks where indicated, using PVC caps with top (cut-out) opening to match downspout size.

K. Install flashing around bases of roof curbs where they meet metal roof panels. Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.6 ERECTION TOLERANCES. Shim and align metal panel units within installed tolerance of ¼ inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.7 FIELD QUALITY CONTROL.

A. Engage a factory-authorized service representative to test and inspect metal roof panel installation, including accessories. Report results in writing.

B. Remove and replace applications of metal roof panels where tests and inspections indicate that they do not comply with specified requirements.

C. Additional tests and inspections, at Contractor's expense, are performed to determine compliance of replaced or additional wark with specified requirements.

D. Prepare test and inspection reports.

3.8 CLEANING AND PROTECTION.

A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

End of Section

Section 07421

FORMED METAL WALL PANELS

PART 1 – GENERAL

1-1. SCOPE: Section includes the furnishing and installation of formed metal wall panels system and associated materials. Materials listed under this include, but are not limited, to the following:

1. Formed Metal Wall Panels
2. Flashing, Trim, and Closures
3. Sub-framing and Furring
4. Clips, Spacers, and Shims
5. Fasteners
6. Sealants

1-2. SUBMITTALS: Before fabrication, detailed fabrication and erection drawings of formed metal wall panel system shall be submitted in accordance with the Submittal Procedures Section. Submittals shall include jointing, trim, and flashing details, including terminations and penetrations.

1-2.01. Shop Drawings: Include fabrication and installation layout of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorage, attachment system, trim, flashings, closures, and accessories; and special details.

1-2.02. Samples: For each type of metal wall panel indicated.

1-2.03. Warranties: Samples of special Warranties

1-3. HANDLING AND STORAGE: Handling and storage shall be in accordance with the Handling and Storage Section. Formed wall panel material shall be handled in a manner which will prevent bending, dents, scratches, or damage of any kind. Damaged units and accessories will be rejected and shall be replaced by and at the expense of Contractor promptly after rejection. Materials shall be stored under cover at all times.

1-4. WARRANTY: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory applied finishes, and repair or replace metal wall panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.

1-4.01. Warranty Period: 20 years from date of Substantial Completion.

PART 2 – PRODUCTS

2-1. PERFORMANCE REQUIREMENTS:

2-1.01. Structural Performance: Formed metal wall panel systems to be capable of withstanding effects of loads indicated and in accordance with ASTM E1592:

1. Wind Loads: As indicated on Drawings.
2. Other Design Loads: As indicated on Drawings.
3. Deflection Limits: For winds loads, no greater than 1/180 of the span.

2-1.02. Air Infiltration: Air leakage of not more than 0.06 cfm/sq.ft. (0.3 L/s per sq.m.) when tested in accordance with ASTM E283 at the following test-pressure difference of 1.57 lbf/sq.ft.(75 Pa)

2-1.03. Water Penetration under Static Pressure: No water penetration when tested in accordance with ASTM E331 at the following test-pressure difference of 2.86 lbf/sq.ft.(137 Pa)

2-1.04. Wind Uplift Resistance: Metal wall panel assemblies are to comply with UL 580 and have an uplift rating of UL 90.

2-1.05. Thermal Movements: Panels are to be designed to allow for thermal movement from ambient and surface temperature changes so bucking, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other harming effects do not occur.

2-2. FORMED METAL WALL PANELS: Aluminum-zinc coated steel per ASTM A792, Grade 50B with AZ50 coating when painted Panels shall be ribbed to minimize “oil canning” effect.

2-2.01. Panel Thickness: 24 gauge.

2-2.02. Panel Width: 16 inches wide panels.

2-2.03. Batten Height: 2-inch vertical height

2-2.04. Products:

1. ATAS International, Inc., Monarch MRB160.
2. Or approved equal.

2-2.05. Concealed Anchor Panel Clips: Fasten metal wall panels to support substrate with concealed anchor clips eliminating all through fastener penetrations.

:

2-3. MISCELLANEOUS MATERIALS:

2-8.01. Metal Sub-framing and Furring: ASTM C645; G90 hot-diped galvanized cold-formed metallic coated steel sheet, ASTM A653/A653M unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal wall panel system.

2-8.02. Panel Accessories: Where required, provide the necessary components to ensure a weathertight installation including trim, copings, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match materials to finish of metal roof panels system unless otherwise indicated.

1. Closures: Provide closures at corners and sills.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from materials recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber, or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1 inch (25 mm) thick, flexible closure strips; cut or pre-molded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight installation.

2-8.03. Flashing, Trims and Closures: Provide flashing and trim formed from the same material as metal wall panels as required to seal against weather and to provide a finished appearance. Locations include, but are not limited to, corners, bases, framed openings, and fillers. Finish flashing and trim with same finish system as metal wall panel system.

2-8.04. Fasteners: Use only high-quality fasteners as recommended or approved by wall panel system manufacturer.

2-8.05. Sealants: Use only high-quality sealants as recommended or approved by the wall panel system manufacturer. Sealants must not contain oils, asbestos, or asphalts.

2-4. FINISHES: Metal wall panels, flashings, and all other exposed appurtenances shall have the following finish system:

2-9.01. Two-Coat Fluoropolymer: AAMA 2605. Two-coat system consisting of a corrosion inhibitive primer on both sides with a Fluoropolymer finish

containing not less than 70 percent Kynar 500/Hylar 5000 polyvinylidene fluoride (PVDF) resin by weight in color coat.

1. Color Selection: Coating system shall have been tested in accordance with ASTM standard test methods for factory color finish. Exterior color shall be chosen from manufacturer's standard colors, minimum 20 colors.

2-9.02. Concealed Finish: White or light-colored acrylic or polyester backer finish.

Texture: Panels shall have a smooth finish per manufacturer's standards.

PART 3 – EXECUTION

3-1. PREPARATION:

3-1.01. Miscellaneous Supports: Sub-framing, furring, and other miscellaneous panel support members and anchorage are to be installed in accordance with ASTM C754 and by manufacturer's written recommendations.

3-2. INSPECTION:

3-2.01. Applicator shall examine the surfaces on which wall panels are to be applied and shall obtain and verify all field measurements prior to fabrication of wall panels. If surfaces are not suitable for receiving metal wall panels, applicator shall notify Engineer in writing. Roofing, fascia and soffit work shall be completed before wall panel work is started.

3-3. FABRICATION:

3-3.01. Metal wall panels shall be field assembled. Wall panels, flashings, trim, and accessories shall be fabricated in accordance with the details on the Drawings to tolerances which will ensure proper fit, appearance, and weathertightness when erected.

3-3.02. Metal wall panel side joints shall be of interlocked panel construction, shall be sealed full or gasketed at the factory, and shall be completely resistant to moisture and air infiltration when erected. Panels shall be fabricated in lengths which will eliminate vertical joints in the completed construction.

3-3.03. Metal wall panel systems shall be fabricated so that no fasteners are exposed after erection, except where exposed fasteners are

incorporated into the design or are required for securing flashing and trim.

3-3.04. Sheet Metal Flashing and Trim: Flashing and trim to be fabricated to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of items indicated.

3-4. INSTALLATION:

3-4.01. Workmanship shall conform to standards set forth in the Architectural Sheet Metal Manual published by SMACNA.

3-4.02. Materials shall be installed by experienced mechanics who are directly employed by the wall panel manufacturer or by an erector currently franchised by the panel manufacturer and who has experience in installing projects of similar or greater complexity.

3-4.03. Metal wall panels shall be installed complete with all hold-down clips, fasteners, flashings, and accessories, in accordance with the manufacturer's instructions. All horizontal lines shall be true and vertical lines shall be plumb and in alignment.

3-4.04. All trim, closure panels, and flashings shall be installed to provide watertight joints. All penetrations shall be coordinated with the work of other trades. Any damaged materials shall be replaced; only minor scratches and abrasions may be touched up.

3-5. CLEANING AND PROTECTIONS: After installation is complete, all exposed surfaces of the wall panel system, including flashings and accessories, shall be cleaned of all dust, dirt, grease, and other foreign material to the satisfaction of the Engineer.

END OF SECTION

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SECTION 07600 - SHEET METAL

PART 1 - GENERAL

1.1 SCOPE

A. This section covers sheet metal for flashings and moisture protection. The following sheet metal items are covered in other sections:

1. Ductwork, louvers, and other sheet metal for the heating, ventilating, and air conditioning system.

2. Steel roof deck.

1.2 GENERAL

A. Installation of wall and roof flashings, gutters and downspouts shall be as indicated on the drawings and as specified in the building masonry and roofing sections.

1. Flashing members to be built into masonry, concrete, or roofing shall be delivered at the proper time for incorporation into the work.

2. When installing sheet metal items, care shall be taken to avoid marring and improper bending. All components shall be stored in clean, dry storage areas. Contact with corrosive or staining materials shall be prevented. All damaged sections shall be replaced, and only undamaged units shall be installed.

1.3 SUBMITTALS

A. Complete specifications, data, and catalog cuts or drawings covering the items furnished under this section shall be submitted in accordance with the Submittals Procedures section.

1.4 HANDLING AND STORAGE.

A. Adequate protection shall be provided during shipment, site storage, and installation to prevent damage to materials or finished work.

PART 2 - PRODUCTS

2.1 MATERIALS

Galvanized Steel	ASTM A366 or A569; hot-dip galvanized in accordance with ASTM A525, G90 minimum.

Sheet Aluminum	ASTM B209, Alloy 3003-H14, mill finish.
Extruded Aluminum	ASTM B221, Alloy 6053 or 6063.
Lead	Fed Spec QQ-L-201, Grade B.
Stainless Steel	ASTM A167, Type 302 or 304, AISI 2B finish unless otherwise specified.
Solder	ASTM B32, Alloy Grade 50A (50-50). Soldering
Flux	
For Stainless Steel	Zinc chloride type, Fed Spec 0-F-506, Type II.
For Other Metals	Acid type, Fed Spec O-F-506, Type I, Form A.
Fasteners	Same metal as sheet metal being fastened.
Plastic Cement	Asphalt roof cement, asbestos free; ASTM D4586, Type 1.
Acrylic Sealant	Pecora "Unicrylic" or Tremco "Mono".

2.2 FLASHINGS

A. All exposed or contacting flashings shall be of the same material.

B. Types.

Through-Wall flashing	Stainless steel, 32 gage, dead soft, fully annealed; ribbed; Architectural Steel “Rib –Bond”, Cheney “3-Way Saw-tooth Flashing”, or Keystone “Interlocking Type”
Cap Flashing	Stainless steel, 26 gage.
Counterflashings	Stainless steel, 26 gage; Architectural Steel, Cheney, or Keystone, with wall flat and hook dam for masonry wall installation, with vertical receivers for surface-mounted installation, or with snap lock for reglet installation as indicated.
Miscellaneous Hidden	Stainless steel, 26 gage. Flashings
Miscellaneous Exposed	Prefinished metal flashing, 22 gage Flashing steel.

Reglets	Stainless steel, 26 gage, designed to retain counterflashing by snap action or friction fit; Architectural Steel "Friction Reglet", Cheney "Type A", or Keystone "Simplex".
Gutters	Field formed prefinished 0.032 inch aluminum with an oven baked 70 percent “Kynar 500” fluoro-polymer coating; flush surface, 5” style f shape, continuous lengths, complete with hangers and roof apron.
Downspouts	Shop formed, prefinished 0.027 inch aluminum with an oven baked 70 percent “Kynar 500” fluoro-polymer coating; flush surface, 4” X 4”, complete with strap hangers.

2.3 CONFIGURATIONS

A. Through-wall flashing. Through-wall flashings shall be provided as indicated on the drawings. Flashings under copings shall be continuous. Flashings over lintels and sills shall extend 8 inches past each jamb and shall have ends turned up ¼ inch. Joints in wall flashings shall overlap and shall be interlocked.

1. Where multiple bends are required for through-wall installation, as indicated on the drawings, flashings may be provided in single-bend sections with vertical legs overlapped to drain to the outside face of the wall.

B. Cap Flashings. Cap flashings shall be provided at all roof ventilators and elsewhere as indicated on the drawings. Cap flashings shall be fabricated in sections not exceeding 10 feet in length; sections shall overlap at least 3 inches and shall form a slip joint, but shall not be interlocked. All corners and all joints other than slip joints shall be closed watertight as specified herein.

C. Counterflashings. Counterflashings shall be provided, at the locations indicated on the drawings, to overlap roof membrane base flashings and fit intoflashing reglets or receivers. Counterflashings shall be fabricated in sections not exceeding 10 feet in length; sections shall overlap at least 3 inches and shall form a slip joint but shall not be interlocked. End joints between counterflashing sections shall be offset from underlying joints between reglet or receiver sections. Corners in counterflashings shall be closed watertight as specified herein.

D. Reglets. Reglets shall be provided at all locations indicated on the drawings to receive counterflashings as shown. Reglets shall be fabricated in lengths not to exceed 10 feet and shall overlap at least 3 inches.

E. Hoods. Counterflashing hoods shall be provided for all conduits and pipes which pass through the roof, as indicated on the drawings. Hoods shall be fabricated of 24 gage stainless steel or 22 gage galvanized steel, and shall conform to the details indicated on the drawings.

F. Prefinished Metal Copings. Not used.

G. Pitch Dams. Not used.

H. Roof Drain Flashings. Not used.

I. Gutters and Downspouts. All gutters and downspouts shall be well constructed, watertight, properly secured to the structure, and installed according to the design drawings and per SMACNA recommendations. Gutters shall be supported at 2'-0" maximum spacing. Downspouts shall be supported at the top and bottom and at 6'-0" maximum intermediate spacing. Connection shall in no way interfere with the watertightness of the roofing, siding, gutter, or downspout. Screw fasteners shall penetrate though the plywood sheathing. Suitable expansion joints shall be provided wherever necessary to allow for proper expansion and contraction – 1/8 per 10 feet.

J. Miscellaneous Metal Flashings. Metal flashings shall be provided for vents, sleeves, and similar projections through the roof.

1. Unless otherwise indicated on the drawings, all flashings for such projections shall be fabricated from 4 pound sheet lead and shall extend at least 8 inches above the roof.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Watertight Joints. Joints in sheet metal work shall be closed watertight unless slip joints are specifically required. Watertight joints shall be mechanically interlocked and then thoroughly soldered for metals other than aluminum. Joints in aluminum or between aluminum and other metals shall be sealed with acrylic sealant.

1. All joints shall be wiped clean of flux after soldering. Acid flux shall be neutralized by washing the joints with sodium bicarbonate.

B. Through-Wall Flashings. Not used.

C. Cap Flashings. Cap flashings shall be installed after membrane base flashings have been completed. Cap flashings shall be anchored in place as indicated on the drawings.

D. Counterflashings. Counterflashings shall be installed after membrane base flashings have been completed. Counterflashings shall be fitted into reglets or receivers and securely locked in place in accordance with the manufacturer's recommendations.

E. Reglets. Reglets to be set in concrete to receive counterflashings shall be nailed into the forms in accordance with the manufacturer's recommendations, with care being taken to maintain precise alignment of abutting sections. After the forms are stripped, the temporary form filler strip shall be removed from the reglet and the form securing nails shall be clipped flush.

F. Hoods. Counterflashing hoods shall be installed as specified in the roofing section.

G. Prefinished Metal Copings. Not used.

H. Pitch Dams. Not used.

I. Roof Drain Flashings. Not used.

J. Gutters and Downspouts. The gutters and downspouts shall be as indicated on the Drawings and specified herein. All joints in gutters and downspouts shall be watertight. Downspouts shall have bottom terminations canted outward away from the wall for discharging onto splash blocks or other suitable wear surfacing.

K. Miscellaneous Metal Flashings. Metal flashings shall be installed as specified in the roofing section.

3.2 PROTECTION

A. Adequate protection shall be provided during shipment, site storage, and installation, to prevent damage to materials or finished work.

B. Aluminum to be placed in contact with concrete, mortar, or dissimilar metals shall be given a heavy coat of coal tar paint.

End of Section

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SECTION 07840 - FIRESTOPPING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the through penetration firestop systems for penetrations through fire-resistance rated assemblies, including both blank openings and openings containing penetrating items such as walls and partitions. Fire-resistive joint assemblies for linear voids where fire-rated floor, roof, or wall assemblies abut one another, and head-of-wall joints where a fire-rated wall or partition intersects a roof or floor assembly.

1.2 GENERAL.

A. Firestop systems shall be constructed and provided of the types and arrangements as indicated on the Drawings and specified herein, complete with all materials, accessories, and appurtenances indicated and specified.

1. Contractor shall be responsible for selecting systems which, when installed, will maintain required fire separations. Firestopping systems and materials shall be compatible with each other and the substrates forming openings, including penetrating items under conditions of service and application. Contractor shall provide components for each firestopping system that is needed to install fill materials. All materials shall be provided by a single firestopping products manufacturer.

2. For fire-resistive joint assemblies, where joint will be exposed to the elements, fire-resistive joint sealant must be approved by Manufacturer for use in exterior applications and shall comply with ASTM C920.

3. For Head-of-Wall assemblies, use at top of fire-rated walls and partitions where they abut floor and roof structures above. Fire stopping system shall accommodate deflection of structure above and shall have a “D” designation rated for dynamic movement capability.

4. Where walls are non-fire rated, or Smoke tight (with no fire resistive requirement), top of wall condition shall be sealed with acoustical sealant.

5. Minimum Fire (F) Rating for Firestop assemblies in walls shall equal that of the wall, but not less than 1 hour.

6. Minimum Temperature (T) Rating of Firestop assemblies in walls may equal 0.

1. Firestop Systems shall be based on barrier type, fire-resistive rating, and penetrant type. Each system shall comply with Building Code and Fire Code as locally adopted.

1.3 THROUGH PENETRATION FIRESTOP SYSTEMS

A. Requirements for acceptable through penetration fire systems shall be based on barrier type, fire- resistive rating, and penetrant type. Each system must comply with Building Code and Fire Code as locally adopted and amended.

1. Requirements for "single-membrane" penetrations and through penetration firestops shall be identical. Unless otherwise noted, penetrants which pass through a single membrane, shall be treated the same if it passed through the entire fire- resistive assembly.

2. Select each fire-stop system based on actual field conditions, including penetration type, shape, size(s), quantities and physical position within opening.

3. Refer to Drawings for indication of the required ratings of fire-resistive wall, floor and roof assemblies.

4. The minimum Fire (F) and Temperature (T) Ratings of firestop assemblies used in floors or roofs shall equal the hourly rating of the floor or roof being penetrated, but not less than 1 hour. Exception 1: The T-rating may equal 0 when the portion of the penetrant which is above the floor is contained within a wall. Exception 2: Firestops are not required for floor penetrations that are within a 2 hour rated shaft enclosure.

5. Non-rated smoke and air tight walls with no fire-resistant requirement shall be saled with acoustical sealant.

6. Where voids in wall with no penetrating items to be filled with approved through penetration firestopping system. Patch void in wall with like construction and complete by sealing gaps between patch and wall with approved firestopping.

7. When penetrating ducts and dampers, use only firestop materials which are included in the damper's classification. Do no install firestop systems that might hamper the performance of fire dampers.

8. Cable trays and similar devices: Openings within walls and floors designed to accommodate voice, data and video cabling shall be provided with re-enterable products (e.g. Firestop Pillows) specifically designed for removal and re-installation.

9. For electrical and electrical devices recessed in to face of rated walls such items including switches, receptacles, j-boxes, medical gas outlets, and similar items recessed into the face(s) of fire rated walls. Where such devices are placed on opposite sides of wall, and are less than 12 inches apart measured horizontally, install intumescent pads over back of device as approved.

1.1 QUALITY ASSURANCE

A. Provide Firestop Systems that comply with the following requirements: Firestopping tests shall be performed by a qualified testing and inspection agency UL or another agency acceptable to local authorities having jurisdiction; Firestop system products shall bear the classification marking of the qualified testing and inspection agency.

1. Installer shall be certified, license, or otherwise qualified by a Firestopping Manufacturer as having the necessary training to install firestop products per specified requirements. Installer shall be licensed by the state or local authority, where applicable and shown to have successfully completed not less than 5 comparable scale projects. Installer shall have FM approval in accordance with FM Standard 4991 - Firestop Contractors.

2. Firestop systems shall be performed by a single manufacturer for each type of penetration and construction condition.

3. Fire test requirements shall be in accordance with Underwriters Laboratories, Inc.: UL 1479, “Fire Tests of Through Penetration Firestops”, UL 2079 “Tests for Fire Resistance of Building Joint Systems”, and UL 263 “Fire Test of Building Construction and materials”. American Society of Testing and Materials: ASTM-E814 “Fire Tests of Through Penetration Fire Stops”, ASTM-E1966 “Test Method for Fire Resistive Joint Systems, ASTM-E119 “Fire Tests of Building Construction and materials, ASTM-E84 “Surface Burning Characteristics of Building Materials”, and ASTM-E1399 “Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.

1.2 PERFORMANCE REQUIREMENTS

A. Provide products that upon curing do not re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or otherforms of moisture during or after construction.

1. Firestop sealants shall be sufficiently flexible to accommodate motion such as pipe vibration, water hammer, thermal expansion and building movement without damage to the seal.

2. Pipe insulation shall not be removed, cut away or otherwise interrupted through wall or floor openings. Products should be tested for the thickness and type of insulation utilized.

1. Cabling (i.e. voice, data and video cabling, etc) where frequent cable moves, add-ons, and changes are likely to occur in the future: Where cable trays are used to convey such cabling, utilize re-enterable products (e.g. removable intumescent pillows) specifically designed for retrofit. Where cable trays are not utilized, usefire-rated cable pathway devices. Where not practicable, re-enterable products specifically designed for retrofit may also be used.

2. Provide fire-resistive joint sealants sufficiently flexible to accommodate movement such as thermal expansion and other normal building movement without damage to the seal. Fire-resistive joint sealants shall be designed to accommodate a specific range of movement and shall be tested for this purpose in accordance with a cyclic movement test criteria as outlined in Standards, ASTM-E1399, ASTM-E1966 or UL 2079. Provide fire-resistive joint systems subjected to an air leakage test conducted in accordance with Standard, UL 2079 with published L-Ratings for ambient and elevated temperatures as evidence of the ability of the fire-resistive joint system to restrict the movement of smoke.

1.3 APPROVALS

A. All firestopping materials must meet UL approval for the designated fire-resistance rated systems. Use only products that have been tested for specific fire-resistance rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, void width, movement capabilities, and fire-rating involved for each separate instance.

1.4 SUBMITTALS

A. Specifications and data covering the materials proposed for use, together with samples showing the manufacturer's firestopping systems shall be submitted in accordance with the Submittals Procedures section. Additional data shall be submitted as needed. If the firestopping system is changed during the course of the work, the tests and reports required for preliminary review of that material shall be resubmitted.

1.5 DELIVERY, STORAGE AND HANDLING

A. Shipping shall be in accordance with the Shipping section. Handling and storage shall be in accordance with the Handling and Storage section.

1. All products shall be handled in a manner which will prevent soiling, or damage of any kind. Damaged products will be rejected and shall be replaced with undamaged products.

2. Products shall be protected against contamination so that the inclusion of foreign materials is prevented. Store and handle materials to prevent deterioration due to moisture, temperature changes or other causes. Products shall be delivered to project site in original, unopened containers.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide only Firestopping sealing products that have a low volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No. 1168. Systems which are not UL approved for conditions, will not be accepted.

B. Acceptable Manufacturers: Hilti, Specified Technologies, Inc (STI), and Tremco

Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less.	Floors and Masonry Walls: UL Design No. "CAJ 1109", "CAJ 1088" F Rating 2 hour. Other interior partitions: UL Design No. "WL 1046, WL 1169", F Rating 1 hour.
Firestopping at Nonmetallic Penetrations of diameter 4 inches or less.	Floors and Masonry Walls: UL Design No. "CAJ 2171", F Rating 2 hour. Other interior partitions: UL Design No. "WL 2166", F Rating I hour.
Firestopping at Cable Tray Penetrations.	Floor: UL Design No. "CAJ 4027", F Rating 2 hour. Masonry Walls: UL Design No. "WJ 4019, F Rating 2 hour.
Firestopping at Cable Penetrations, Not in Conduit or Cable Tray: caulk or putty	Floors and Masonry Walls: UL Design No. "CAJ 3016", F Rating 2 hour.

Firestopping at Joints without penetrations.	Between top of fire rated walls and bottom of slab above: UL Design No. “HWD 0110, F Rating 2 hour. Between top of fire rated walls and bottom of unrated roof above: Smoke seal; UL Design No. “HWD 0110, F Rating 0 hour. Floors: UL Design No. “FWD 1024, F Rating 3 hour.
Latex Sealants Single component latex formulations that upon cure do not re-emulsify during exposure to moisture.	Hilti Through Penetration Firestop Systems: “FS-ONE”, “CP604”, and “CP606”. STI “SpecSeal Series SSS and LCI Intumescent Sealants”, “SpecSeal Series LC Endothermic Sealant”, and SpecSeal Series AS Elastomeric Spray”. Hilti Fire-resistive joints “CP606” and CP672”. STI “SpecSeal Series ES and AS Elastomeric Sealants”.
Firestop Devices Factory assembled steel collars lined with intumescent material sized to fit specific outside diameter of penetrating item.	STI “SpecSeal Series SSC and LLC Firestop Collars”.
Intumescent Pads (Wall opening protective materials) Intumescent, non curing pads or inserts for protection of electrical switch and receptacle boxes, and other items recessed into face of fire rated walls.	Hilti “FS-ONE” and “CP643N”. STI “SpecSeal Series EP PowerShield Insert Pads.

Fire-Rated Cable Pathways Cables passing through fire-rated floors or walls shall pass through Fire-Rated Cable pathway devices made from an intumescent material that adjusts automatically to cable additions or subtractions. Product description and requirements: Pathway device modules comprised of steel raceway and intumescent foam pads. F Rating shall be equal to the rating of the barrier in which the device penetrates. Pathway devices shall be capable of allowing a 0 to 100% fill of cables. Size shall accommodate the quantity and size of electrical wires and data cables indicated plus 100% expansion. Wire devices to be provided with steel wall plates allowing for single or multiple devices to be ganged together.	STI “EZ-PATH Fire rated pathway”.
Firestop Putty Intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds.	Hilti “CP618” and “CP619”. STI “SpecSeal Series Firestop Putty”.
Wrap Strips Single component intumescent elastomeric strips faced on both sides with a plastic film.	Hilti “CP645” and “CP648”. STI “SpecSeal Series RED Wrap Strip” and “SpecSeal Series BLU Wrap Strip”.
Firestop Pillows Re-enterable, non-curing, mineral fiber core encapsulated with an intumescent coating contained in a flame retardant poly bag.	Hilti "CP647". STI "SpecSeal Series SSB Firestop Pillows".

Mortar Portland cement based dry-mix product formulated for mixing with water at project site to form a non-shrinking, water resistant homogeneous mortar.	Hilti “CP637”. STI “SpecSeal Series SSM Firestop Mortar.
Silicone Sealants Moisture curing, single component, silicone elastomeric sealant for horizontal surfaces (pourable or nonsag) or vertical surface (nonsag).	Hilti “FS-ONE” and “CP601S”. STI “Pensil 300 Silicone Sealant” and “Pensil 300 SL Self-Leveling Silicon Sealant”.
Silicone Foam Multi-component, silicone-based, liquid elastomers, that when mixed, expand and cure in place to produce a flexible, non-shrinking foam.	Hilti “CP620”. STI “Pensil 200 Silicone Foam”.
Metal Stud & Drywall Walls	UL HW-D-0000 Series.
Concrete and Masonry Walls	UL HWD-D1000 Series.

2.2 COLORS

A. Colors of sealants shall be as selected by Engineer from the manufacturer's standard line of colors. Different colors may be required for different locations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellents, and any other substances that may inhibit optimum adhesion. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials. Do not proceed until satisfactory conditions have been corrected.

3.2 INSTALLATION

A. Do not install when ambient or substrate temperatures are outside the limitations recommended by the manufacturer. Do not install when the substrates are wet due to rain, frost, condensation or other causes, and do not use materials that contain flammable solvents.

1. Coordinate construction of openings and penetrating items to ensure that firestopping systems are installed according to specified requirements. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate through penetration firestop systems. Schedule installation of firestopping after completion of penetrating item installation, but prior to covering or concealing of openings.

2. Install firestop systems in accordance with "Performance Requirements" Article and in accordance with the conditions of testing and classification as specified in the published design. Seal openings or voids made by penetrations to ensure an air and water resistant seal. Install firestopping in accordance with manufacturer's instructions, to maintain fire separations per UL listing. Apply a suitable bond breaker to prevent three-sided adhesion in applications where this condition might occur such as the intersection of a gypsum wallboard/steel stud wall to floor or roof assembly where the joint is backed by a steel ceiling runner or track. Protect materials from damage on surfaces subject to traffic and use labels to identify each through penetrating firestop assembly as defined in the Quality Assurance.

3.3 FIELD QUALITY CONTROL

A. Keep area of work accessible until inspection by authorities having jurisdiction. Where deficiencies are found, repair or replace assemblies so they comply with requirements.

3.4 CLEANING

A. Remove equipment, materials, and debris, leaving area in undamaged, clean condition. Clean surfaces adjacent to seal openings to be free of excess materials and soiling as work progresses. Perform patching and repair of firestopping systems damaged by other trades.

End of Section

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SECTION 07900 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers caulking and sealing. Fire rated caulking is covered in the Firestopping section.

1.2 GENERAL

A. The terms "caulking" and "sealing," as used on the Drawings and in these Specifications, are synonymous. Both terms indicate the materials specified herein. Oil-base caulking shall not be used on this Project.

1.3 APPROVALS

A. All caulking shall meet the requirements of the standards specified herein. All caulking and sealing to be used in contact with potable water shall meet the requirements of ANSI/NSF Standard 61.

1.4 SUBMITTALS

A. Drawings and Data

1. Specifications and data covering the materials proposed for use, together with samples or color cards showing the manufacturer's full line of sealant colors, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 MATERIALS

Thiokol Sealants (polysulfides)	Fed Spec TT-S-00227E, Class A or ASTM 920 Type M; polysulfide rubber, two-component.
Nonsag	
Submerged Service, Non potable water	Pecora "Synthacalk GC-2+."
Nonsubmerged Service	Pecora "Synthacalk GC-2+"; Polymeric Systems "PSI-350."
Self-Leveling, nonsubmerged	C. Horn "Hornflex Traffic Grade"; Polymeric Systems "PSI-350."

Urethane Sealants (Polyurethanes)	Fed Spec TT-S-00227E, Class A, Type 2 and ASTM C920, Type M, Grade NS, two- component.
Nonsag	
Submerged Service	
Potable Water	Polymeric Systems “RC-270”; Sika “Sikaflex-2cNS.
Nonpotable Water	Polymeric Systems “RC-270.”
Nonsubmerged Service	Bostik “Chem-Calk 500”; Tremco “Vulkem 227”; Pecora “Dynatrol II”; Tremco “DYmeric 240”; Sika “Sikaflex-2cNS.”**]**
Self-Leveling, Nonsubmerged Service	Bostik “Chem-Calk 550”; Tremco “Vulkem 245”; Pecora “Urexpan NR-200”; Polymeric Systems “RC-2SL”; Tremco “THC-900.”**]]**
Acrylic Sealant	Fed Spec TT-S-230; ASTM C834.
	Bostik “Chem-Calk 600”; Pecora “AC20”; Tremco “Mono 555.”
Primer	As recommended by the sealant manufacturer.
Backup Material	Polyethylene or polyurethane foam as recommended by the sealant manufacturer; Dow “Ethafoam SB” or Plateau “Denver Foam.”
Bondbreaker Tape	Adhesive-backed polyethylene tape as recommended by the sealant manufacturer.

2.2 COLORS

A. Colors of sealants shall be as selected by Engineer from the manufacturer’s standard line of colors. Different colors may be required for different locations.

2.3 LOCATIONS TO BE CAULKED

A. With Thiokol or Urethane Sealant (Nonsag) - Submerged Service

1. All joints requiring caulking in submerged locations.

B. With Thiokol or Urethane Sealant (Nonsag) - Nonsubmerged Service

1. Entire perimeter of frames for exterior metal doors.

2. Entire perimeter of metal louvers.

3. Entire perimeter of metal dampers and metal shutters.

4. Entire perimeter of aluminum windows.

5. Control joints in masonry walls.

6. Perimeter of aluminum entrances and assemblies, except exterior side of exterior sills.

7. Around service sinks.

8. Joints between masonry and cast-in-place concrete, where indicated on the Drawings.

9. Other locations where caulking is indicated on the Drawings, specified in other sections, or required for weatherproofing.

C. With Thiokol or Urethane Sealant (Self-Leveling)

1. Horizontal joints in walks or drives.

2. Horizontal joints in traffic-bearing decks and slabs.

3. Annular space around handrail posts set in sleeves**.**

D. With Acrylic Sealant

1. Watertight joints in sheet metal work.

PART 3 - EXECUTION

3.1 JOINT PREPARATION

A. All surfaces to receive sealant shall be clean, dry, and free from dust, grease, oil, or wax. Concrete surfaces which have been contaminated by form oil, paint, or other foreign matter which would impair the bond of the sealant to the substrate shall be cleaned by sandblasting. All surfaces shall be wiped with a clean cloth saturated with xylol or other suitable solvent, and shall be primed before the sealant is applied.

B. Unless otherwise recommended by the sealant manufacturer and permitted by the Engineer, the depth of sealant in a joint shall be equal to the width of the joint, but not more than 1/2 inch. Backup material shall be provided as necessary to control the depth of sealant and shall be of suitable size so that, when compressed 25 to 50 percent, the space will be filled. Backup material shall be rolled or pressed into place in accordance with the manufacturer's installation instructions, avoiding puncturing and lengthwise stretching. If depth of the joint does not permit use of backup material, bondbreaker tape shall be placed at the bottom of the joint to prevent three-sided adhesion.

3.2 SEALING

A. Sealing work shall be done before any field painting work is started. The air temperature and the temperature of the sealed surfaces shall be above 50° F when sealing work is performed.

B. Upon completion of the sealing work, each sealed joint shall have a smooth, even, tooled finish, flush with the edges of the sealing recess, and all adjacent surfaces shall be clean. Sealant shall not lap onto adjacent surfaces. Any sealant so applied as to prevent the painting of adjacent surfaces to a clean line, or with an excess of material outside the joint and feathered onto surfaces, shall be removed and the joint resealed.

End of Section

SECTION 08110 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of hollow metal doors and frames. Unless otherwise indicated or specified, all steel doors shall be flush type.

B. Structural steel door frames and finish hardware are covered in the Structural and Miscellaneous Metals section and the Finish Hardware section, respectively.

1.2 GENERAL

A. Doors, frames, and appurtenances shall be furnished and installed as specified herein and in accordance with the details and arrangements indicated on the Drawings.

B. Doors, frames, and appurtenances furnished under this section shall be fabricated and assembled and erected, in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

1.3 SUBMITTALS

A. General Submittals:

1. Complete detail drawings of all items specified herein shall be submitted in accordance with the Submittals Procedures section. Drawings shall show elevations of each door type; details of each frame type; location or identification of each item; typical and special details of construction; methods of assembling sections; location and installation requirements for hardware; size, shape, and thickness of materials; joints; connections; and finish.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Deliver Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Governing Standard

1. Except as modified or supplemented herein, all steel doors and frames shall conform to the requirements of ANSI/SDI 100, Level 2, Model 2.

B. Metal Thicknesses

1. Metal thicknesses and gages of steel sheet metal specified herein are the minimum required. Gages refer to US Standard gage.

C. Nomenclature

1. The nomenclature used herein conforms to ANSI/SDI A250.8.

2.2 ACCEPTABLE PRODUCTS

A. Internally reinforced doors and accompanying frames shall be equivalent to the following or approved equal:

1. The Ceco Corporation “Trio” with minimum 58% recycled steel content.

2. Curries Manufacturing Company “Series 777” with minimum 58% recycled steel content.

B. Flush panel doors with foamed-in-place polyurethane or rigid urethane core and accompanying frames shall be equivalent to the following or approved equal:

1. The Ceco Corporation “Imperial”

2. Pioneer Industries “CHT Series”

C. Fire Doors

1. Fire doors shall be of the same construction as internally reinforced doors, except where building codes require that certain fire doors meet a specific maximum temperature rise requirement. Fire doors and frames listed on the Drawings requiring a 450° F maximum temperature rise in first 30 minutes of exposure shall be equivalent to the following or approved equal:

    a. The Ceco Corporation “Trio” with minimum 58% recycled steel content.
    b. Curries Manufacturing Company “Series 777” with minimum 58% recycled steel content.

2.3 MATERIALS

A. Materials used in the manufacture of steel doors and frames shall be as follows:

Doors and Frame	ASTM A1008/A1008M or A1011/A1011M, stretcher leveled, commercial quality sheet steel with smooth, clean surface; galvanized, per ASTM A653/A653M with G90 minimum coating.
Internal Reinforcing	ASTM A1008/A1008M, cold-rolled steel.
Fillers for Internally Reinforced Doors	Injected polyurethane foam, CFC and HCFC free.
Thermal Characteristics	R Factor: 11.0 (ASTM C518).
Anchoring Devices	Zinc-plated where exposed; zinc- plated or galvanized where concealed; non-corrosive.
Expansion Anchors	As specified in the Anchorage in Concrete and Masonry section.
Tape Sealant	PVC or neoprene closed-cell foam, black, 1/2 inch wide by 1/4 inch thick strip with pressure-sensitive adhesive back; Williams "Everlastic NN-1" or approved equal.

2.4 FRAMES

A. Frames for doors, transoms, sidelights, mullions, and interior glazed panels shall be formed of steel to the sizes, 14gage, and shapes required.

B. Workmanship

1. The finished work shall be strong, rigid, neat, and free from defects. Molded members shall be fabricated straight and true, with corner joints well formed, and with fastenings concealed where practicable.

C. Joints

1. Joints for frames shall be mitered or butted and continuously welded on the reverse side to produce rigid joints which are invisible on the face of the frame. Frame bottoms shall be held rigidly in position by spreader bars to maintain proper alignment during shipment and erection.

D. Hardware Provisions

1. Frames shall be prepared at the factory for the specified hardware. Frames shall be mortised, reinforced, drilled, and tapped for mortised hardware, and shall be reinforced for surface-applied hardware. Cover boxes shall be provided in back of all hardware cutouts. Frames for all doors except weatherstripped doors shall be punched to receive silencers, three holes on the lock side of single door frames and one hole for each leaf in heads of double door frames. Lock strikes shall be set out and adjusted to provide clearance for silencers.

2. Concealed metal reinforcements shall be provided for hardware in at least the following thicknesses:

Hinge reinforcement	10 gage
Strike reinforcement	14 gage
Closer reinforcement	12 gage
Other reinforcement	14 gage

E. Mullions and Transom Bars

1. Mullions and transom bars shall be of reinforced tubular construction, connecting neatly with heads and jambs and secured in place by concealed interlocking joints or by welding. Removable transom bars shall be connected to frames at jambs by concealed fasteners. Cutouts or removable plates shall be provided for access to fasteners.

F. Reinforcing

1. Where structural steel members are indicated at mullions, transoms, or other locations, and are required to be built into hollow metal frames, the structural steel shapes shall be provided as part of the frame assembly.

G. Wall and Floor Anchors

1. Metal anchors of the sizes and shapes required for the adjoining type of wall construction shall be provided. Jamb anchors shall be fabricated from steel, of at least the same thickness as the frames. Anchors shall be located near the top and bottom of each frame and at intermediate points spaced not more than 32 inches apart.

2. For frames set in masonry, jamb anchors shall be at least 10 inches long, adjustable, and corrugated or other deformed type.

3. For frames set in metal stud partitions, anchors shall be welded to the backs of frames. Anchors shall be fastened to steel studs with 1/4 inch diameter machine bolts, or by welding.

4. Door frames shall be provided with a 16 gage thick base clip at each jamb for floor anchorage. Clips shall be sized and drilled for at least two 3/8 inch diameter anchoring devices. Where floor fill occurs at a door opening, the bottom of the frame shall terminate at the indicated finished floor level and shall be supported by adjustable extension clip angles anchored to the structural slab.

H. Stops and Beads

1. Metal glazing beads shall be furnished with hollow metal frames at transoms, sidelights, interior glazed panels, and other locations where glazed frames are indicated on the Drawings. Glazing stops shall be formed as an integral part of the frames, and the frames shall be prepared to receive the glazing beads. Where frames are exposed to weather, the integral stops shall be located on the exterior side of the frames. Beads having a molded shape shall be mitered at comers. Rectangular beads may be either mitered or butted at corners.

2.5 DOORS

A. Doors indicated on the Drawings as hollow metal, including doors with glazed and louvered openings, shall be as specified herein. Doors shall be prepared to receive the hardware specified in the Finish Hardware section.

B. Workmanship

1. Doors shall be rigid, neat in appearance, and free from defects. Molded members for glazed doors shall be formed straight and true, with joints coped or mitered, well formed, and in true alignment. All welded joints on exposed surfaces shall be dressed smooth so that they are invisible after finishing.

C. Sizes and Clearances

1. Doors shall be of 1-3/4 inchthickness, and type indicated on the Drawings, of the sizes and design indicated. Clearances for doors, except fire doors, shall be 1/8 inch at jambs and heads, 1/4 inch at meeting stiles of pairs of doors, and 3/4 inch at bottom, unless otherwise indicated. Clearances for fire doors shall be as indicated by NFPA 80 or by the authority having jurisdiction.

D. Construction

1. Doors shall have 18 gage thick seamless outer sheets. Side edges of doors shall be flush and closed watertight. All seams shall be continuously welded and ground smooth. Doors shall be prepared at the factory for hardware, for glazing, and for louvers as indicated on the Drawings. Door edges shall be beveled or rounded.

2. Flush internally reinforced doors shall have fillers placed in the spaces between reinforcing members and shall be reinforced by 22 gage thick or thicker vertical steel stiffeners installed on 6 inch centers and welded to face sheets.

3. Flush foam-filled doors shall have all internal spaces completely filled with foamed-in-place polyurethane core or rigid urethane core chemically bonded to the interior surfaces of the door.

4. Outswinging exterior doors shall be finished flush at the top, with all seams and joints closed watertight as specified for side edges.

E. Hardware Provisions

1. Doors shall be mortised, reinforced, drilled, and tapped for mortised hardware. Reinforcing units shall be provided for locksets. Reinforcing plates shall be provided for mortised and surface-applied hardware in at least the following thicknesses:

Hinge reinforcement	10 gage
Surface-applied closers and hold-open arms	12 gage
Other reinforcement	14 gage

2. Where concealed overhead door closers are required, the necessary cutouts, reinforcement, and provisions for fasteners shall be made in the heads of doors.

3. The locations of hardware items shall be in accordance with DHI "Recommended Locations for Builders' Hardware for Standard Steel Doors and Frames."

F. Stops and Beads

1. Metal glazing beads shall be furnished with hollow metal doors where glazed doors are indicated on the Drawings. Glazing stops may be formed as an integral part of the doors, or separate glazing beads provided for both sides of the glass. Doors shall be prepared to receive the glazing beads. Beads shall be snapped into place, or shall be fastened with oval-head machine screws spaced at 9 inch centers maximum. Beads having a molded shape shall be mitered at comers. Rectangular beads may be either mitered or butted at corners.

2. Where glazed doors are exposed to weather, all seams and joints on all sides of the glass panel, except joints in removable beads, shall be closed watertight as specified for side edges.

G. Astragals

1. The meeting edges of all exterior double doors, of interior double doors scheduled to be weatherstripped, and fire doors shall be provided with astragals. Fire doors shall be equipped with solid, bar type astragals. Astragals shall be applied to the active leaf unless otherwise indicated. When the astragal is attached to the inactive leaf, the active leaf shall be prepared for a lockset with a 3-3/4 inch backset.

H. Louvers

1. Louvers shall be stationary, sight proof, fixed slat or fixed grid type, with a minimum of 60 percent of free air area.

I. Transom Panels

1. The construction of transom panels shall be as specified for hollow metal doors. Panels shall be set into frames with tape sealant all around for weatherproofing.

2.6 FIRE DOORS AND FRAMES

A. Fire doors and frames shall be provided at the locations and of the ratings indicated on the Drawings. Doors and frames shall be labeled, constructed, and installed in accordance with the requirements of an Underwriters' Laboratories and shall have a maximum transmitted temperature end point of not more than 450° F above ambient at the end of 30 minutes of standard fire test exposure or a rating as indicated on the Drawings. Door of a corresponding classification by Factory Mutual or Warnock Hersey will be acceptable. For doors exceeding the Underwriters' Laboratories size limitations for labeling, the UL "Certificate for Oversize Construction" shall be provided. Authorized construction details and requirements for labeling shall take precedence over these specifications, except when these specifications require a greater metal thickness.

2.7 SHOP FINISH

A. A primer shall be applied to all surfaces of ferrous metal fumished under this section. Metal surfaces shall be cleaned and given a phosphate or equivalent treatment to ensure maximum corrosion protection and paint adherence. A dip or spray coat of synthetic resin, rust-inhibitive metallic oxide, or rust-inhibitive zinc chromate primer shall be applied to all surfaces, then baked or oven-dried. Finished surfaces shall be smooth and free from irregularities.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Frames shall be set in position, plumbed, aligned, and braced securely until permanent anchors are set. Frames shall be anchored to floors with expansion anchors or as indicated on the Drawings. Jamb anchors shall be built into walls and secured to adjoining construction. Spreader bars shall remain in place until frames have been built into the walls.

B. Transom Panels

1. Transom panels, when provided, shall be fastened to frames with oval-head machine screws or with 1 inch long intermittent welds spaced at 9 inch centers maximum and located on the interior side of the panels.

C. Glazing Beads

1. Glazing beads, when provided, shall be fastened to frames with oval-head machine screws spaced at 9 inch maximum centers.

End of Section

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SECTION 08331 OVERHEAD COILING ALUMINUM DOORS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and installation of insulated rolling aluminum doors. Doors shall be overhead coiling type, of the sizes indicated on the Drawings, complete with necessary guides, hoods, hardware, fastenings, mechanisms, and accessories as specified or as indicated on the Drawings.

B. Motor operated doors shall be installed complete and in proper operating condition in the openings indicated on the Drawings. Electrical conduit and wiring from the power source to the door control equipment, to motors, and to disconnect switches will be furnished and installed under the electrical sections.

1.2 GENERAL.

A. Equipment furnished under this section shall be fabricated, assembled, and installed in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Details of doors, guides, hoods, and accessories shall be as indicated on the Drawings and as specified herein. Doors shall be the product of a manufacturer who is regularly engaged in manufacturing the items specified.

C. General Equipment Stipulations.

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements.

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Power Supply.

1. Power supply to electric operators will be 480 volts, 60 Hz, 3 phase, unless otherwise indicated on the Drawings.

F. Metal Thicknesses.

1. Metal thicknesses and gauges of sheet metal specified herein are the minimum required. Gauges refer to American or B&S gauge.

1.3 SUBMITTALS.

A. Complete detail and installation drawings shall be submitted in accordance with the Submittals Procedures section. Drawings shall indicate construction details, clearance requirements, metal thicknesses, finish, counter balancing, and method of anchoring, locations of guides, motors, switches, controls, power requirements, and wiring diagrams.

B. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

C. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

1.4 DELIVERY, STORAGE AND HANDLING.

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Doors shall be protected from damage during transportation, at the Site, and during construction. Damaged items will be rejected and shall be replaced.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS.

A. Rolling aluminum doors shall be of the types, models, and operation specified herein and indicated on the Drawings.

B. Uninsulated Rolling Doors.

1. Not used.

C. Insulated Rolling Doors.

1. Insulated rolling doors shall be Atlas "Insulated Thermal Door Series T", Overhead "Stormtite Insulated Series 625", or Wayne Dalton "Thermotite Series 800C".

2.2 MATERIALS.

A. Materials used in rolling aluminum doors shall be as follows:

Curtain and Hood	Aluminum; Sheet - ASTM B209, Alloy 5005-H154; Extrusions - ASTM B221, Alloy 6063-T5.
End Locks	Manufacturer's standard.

Bottom Bar and Guides	Aluminum angles or channels at least 3/16 inch thick.
Bottom Weather Seal	Rubber or vinyl.
Roller Shaft	Steel pipe or tubing.
Roller Ends	Cast iron, ASTM A48.
Spring	Oil-tempered steel.
Brackets and Gearing	Cast iron or steel.
Slat Insulation	Polyurethane, foamed in place.
Anchor Bolts	As specified in the anchorage in concrete and masonry section.

2.3 ROLLING DOOR FABRICATION.

A. Mounting.

1. Doors shall be fabricated for installation on the face of the wall, with the hood mounted above the opening as indicated on the Drawings.

B. Insulated Door Curtain.

1. The curtain for insulated doors shall be formed of interlocking insulated slats and shall be designed to resist a 35 psf wind pressure. The curtain shall roll up on a drum supported at the head of the opening and shall be balanced by helical springs. Slats shall be 3/4 inch thick, formed of an outside face and inside face of .050 aluminum totally enclosing foamed-in-place polyurethane insulation.

2. The ends of each slat in the insulated curtain shall be equipped with a combination end lock and wind lock. Combination end locks shall have a flat surface engaging a seal of metal or of other suitable material mounted on or in the guides, in a manner which will provide an effective seal against wind and water.

3. Each insulated curtain shall be provided with a bottom bar attached in a manner to suit sill construction. Each exterior insulated door shall be furnished with a replaceable, compressible weather seal fastened to the bottom bar.

C. Vision Panels.

1. Not used.

D. Guides.

1. Guides shall form a pocket of sufficient depth to retain the curtain in place under the specified maximum wind pressure. Guides shall be attached to adjacent construction with 3/8 inch non-corroding bolts spaced at not more than 30 inches and near each end.

E. Roller Shaft.

1. The roller shaft shall be designed so that deflection does not exceed 0.03 inch per foot of span. Ends of the roller shall be closed with plugs machined to fit and fastened with pins or screws. Welding will not be acceptable. The counterbalancing spring installed inside the roller shall be capable of producing sufficient torque to permit easy operation of the curtain from any position. The spring tension shall be adjustable from outside the bracket without removing the hood, except for manual push-up doors, which may have the spring adjusting device inside the hood.

F. Brackets.

1. Brackets shall close the ends of roller-shaft housing and shall support the hood. Ends of the roller shaft shall be journaled into bracket hubs. The shaft shall be fitted with self-lubricating, sintered bronze bearings or double sealed, grease lubricated ball bearings.

G. Hood.

1. The hood shall be fabricated of at least 20 gauge (0.032 inch) aluminum, shall be formed to fit the contours of the brackets, and shall be reinforced with rods, rolled beads, or a stiffening flange at top and bottom edges. Hoods at openings larger than 12 feet wide shall be fitted with intermediate supporting brackets. A flexible weather baffle, mounted internally or externally, shall be provided to prevent airflow around the coil, and provisions shall be included in the design of the hood to prevent the ingress of birds.

H. Locking Device.

1. Not used.

I. Door Operation.

1. Doors indicated on the Drawings to be motor operated, shall be provided with electric motor operators and auxiliary chain gear operation.

J. Finish.

1. Curtain slats, hood, and bottom rails shall be given an anodic finish conforming to Aluminum Association (AA) requirements in the shop. Color will be selected from the manufacturer's standards, unless otherwise indicated on the Drawings. All other exposed metal parts of the door and accessories, except bearings and chains, shall be shop-primed.

2. Galvanizing shall comply with ASTM A653 for commercial steel sheets and ASTM A123 for assembled steel products. Galvanized surfaces shall be phosphatized before painting.

2.4 ELECTRIC MOTOR OPERATORS.

A. Electric motor operators shall be of a type recommended by the door manufacturer and shall be complete with an electric motor, reduction gearing, magnetic brake, brackets, push-button controls, limit switches, magnetic reversing starters, and other accessories required for proper operation. Each operator shall be designed so that the motor may be removed without disturbing the limit switch adjustment and without affecting the emergency auxiliary operators. Provisions shall be made for immediate manual operation of the door in case of electric power failure. The emergency operating mechanism shall be arranged to be activated and deactivated from the floor, and its use shall not affect the adjustment of the limit switches. Whenever the mechanism is engaged, the motor shall be disconnected from the manual operating mechanism. Electric motor operators shall be wall-mounted near the head of the door, unless indicated on the Drawings.

B. Motors.

1. Motors shall be of sufficient horsepower to move doors in either direction from any position at a rate between 0.5 foot and 1 foot per second when operating under full wind load conditions.

2. Motors shall be of open drip proof construction and rated 460 volts, 60 Hz, 3 phase.

C. Control System.

1. Each door shall be equipped with an automatic control system arranged to control the opening, closing, and stopping of curtain travel, and to automatically reverse closing travel when the lower edge of the door curtain meets an obstruction. The control system shall be mounted in a NEMA Type 4 enclosure, or as indicated on the Drawings.

D. Motor Controller.

1. The motor controller shall be a full voltage, reversing, magnetic type, with 480 volt, 60 Hz, 3 phase contactors; automatically reset thermal overload relays; 120 volt ac operating coils; and 480 to 120 volt dry-type control transformer complete with one secondary lead fused and the other secondary lead grounded. Starters shall not be smaller than NEMA Size 1.

2. Reversing starters shall be mechanically interlocked so that only one set of contacts can be closed at any one time.

3. Three thermal overload relays, rated to protect the motor from damage due to overload, shall be furnished with each motor starter.

4. The motor controller enclosure shall be sized and arranged to house the control power transformer and fuses, relays if required, and a marked terminal block on which all control wiring from all devices shall be terminated. The terminal block shall be located for easy installation and maintenance. All control wiring shall be 14 AWG or larger.

E. Control Switches.

1. Remote control switches shall be located on the interior or exterior of the openings as indicated on the Drawings. Each switch control station shall be of the three-button,

momentary contact type, with the buttons marked "Open", "Close", and "Stop". When the door is in motion and the "Stop" button is pressed, the door shall stop instantly and remain in the stopped position until the "Open" or "Close" button is pushed. Push buttons shall be of the fully guarded type to prevent accidental operation. Control switches located on the building exterior shall be mounted in NEMA Type 4 enclosures. Exterior control switches shall be provided with a key-operated locking device, unless indicated otherwise on the Drawings. Limit switches shall automatically stop the doors in their fully open and fully closed positions. The limit switches shall be readily adjustable.

F. Safety Device.

1. Each motor operated door shall be equipped with safety edges complying with UL 325, Usage Class III. The primary and secondary entrapment protection devices provided shall be a combination of Type A, Type B1, or Type B2 per UL 325. All safety edges shall be monitored. Entrapment protection requiring a constant pressure actuating device to operate the door motor will not be acceptable. Upon sensing an obstruction, the door operator shall respond as prescribed in UL 325. The safety device shall be connected with the "closed" limit switch to prevent opening a closed door by tripping the safety device. The safety device shall not serve as a substitute for a limit switch. Type S cable equipped with a spring-loaded automatic take-up reel, or an equivalent device, shall be provided between the safety device and the fixed cable supports.

2. The bottom edge of each electric motor operated door shall be equipped with a safety device, unless indicated otherwise on the Drawings, which will immediately stop the door upon contact with an obstruction in the door opening and reverse its downward travel. The safety device shall be connected with the "closed" limit switch to prevent opening a closed door by tripping the safety device. The safety device shall not serve as a substitute for a limit switch. Type S cable equipped with a spring-loaded automatic take-up reel, or an equivalent device, shall be provided between the safety device and the fixed cable supports.

G. Electrical Work.

1. All manual or automatic control devices necessary for proper operation of the doors shall be provided. Motors and accessories shall be prewired at the factory to the extent practicable, with connections brought to terminal strips in the controller enclosure.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Doors shall be installed in accordance with details, drawings, and manufacturer's directions. All anchors and inserts for guides, brackets, motors, controls, switches, and other devices shall be accurately located. After installation, doors shall be free from warp, twist, or distortion, and shall be lubricated and properly adjusted to operate freely and smoothly.

3.2 CLEANING.

A. After installation, factory finished metal surfaces shall be thoroughly cleaned and touched-up as recommended by the manufacturer. Abrasive, caustic, or acid cleaning agents shall not be used.

End of Section

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SECTION 087100 DOOR HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Mechanical door hardware for the following:

a. Swinging doors.
b. Other doors to the extent indicated.

2. Cylinders for door hardware specified in other Sections.

3. Electrified door hardware.

B. Related Requirements:

1. Section 08110 "Steel Doors and Frames" for astragals provided as part of labeled fire-rated assemblies.

2. Section 16721 “Fire Detection and Alarm System: for connections to building fire alarm system.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.

2. Inspect and discuss preparatory work performed by other trades.

3. Inspect and discuss electrical roughing-in for electrified door hardware.

4. Review sequence of operation for each type of electrified door hardware.

5. Review required testing, inspecting, and certifying procedures.

B. Keying Conference: Conduct conference at Project site to comply with requirements in Division 1 sections.

1. Conference participants shall include Owner, Owner’s Representative, Construction Manager, Contractor, Architect, Installer's Architectural Hardware Consultant and Owner's security consultant.

2. Incorporate conference decisions into keying schedule after reviewing door hardware keying system including, but not limited to, the following:

    a. Function of building, flow of traffic, purpose of each area, degree of security required and plans for future expansion.
    b. Preliminary key system schematic diagram.
    c. Requirements for key control system.
    d. Requirements for access control.
    e. Address for delivery of keys.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: Details of electrified door hardware, including the following.

1. System Block Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring. Include the following for each unique electrified opening:

    a. Details of interface of electrified door hardware and building safety and security systems.
    b. Schematic diagram of systems that interface with electrified door hardware.
    c. Point-to-point system wiring and riser diagrams.
    d. Elevation diagram of each door.
    e. Operational description.

C. Samples for Verification: For exposed door hardware of each type required, in each finish specified, prepared on Samples of size indicated below. Tag Samples with full description for coordination with the door hardware schedule. Submit Samples concurrent with submission of door hardware schedule. Samples will be reviewed by the Owner's Representative for design, color and texture only.

1. Sample Size: Full-size units or minimum 2-by-4-inch Samples for sheet and 4-inch long Samples for other products.

    a. Full-size Samples will be returned to Contractor. Units that are acceptable and remain undamaged through submittal, review, and field comparison process may, after final check of operation, be incorporated into the Work, within limitations of keying requirements.

2. Tag Samples with full product description to coordinate Samples with door hardware schedule.

D. Door Hardware Schedule: Prepared by or under the supervision of Installer, detailing fabrication and assembly of door hardware, as well as installation procedures and diagrams. Coordinate door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Submittal Sequence: Submit door hardware schedule concurrent with submissions of Product Data, Samples, and Shop Drawings. Coordinate submission of door hardware schedule with scheduling requirements of other work to facilitate the fabrication of other work that is critical in Project construction schedule.

2. Format: Use same scheduling sequence and format and use same door numbers as in door hardware schedule in the Contract Documents.

3. Content: Include the following information:

    a. Identification number, location, hand, fire rating, size, and material of each door and frame.
    b. Locations of each door hardware set, cross-referenced to Drawings on floor plans and to door and frame schedule.
    c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function, and finish of each door hardware product.
    d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.

        1) Sequence of Operation: Include description of component functions that occur in the following situations: normal secured/unsecured state of door; authorized person wants to enter; authorized person wants to exit; unauthorized person wants to enter; unauthorized person wants to exit, fire alarm and loss of power conditions.

    e. Fastenings and other installation information.
    f. Explanation of abbreviations, symbols, and designations contained in door hardware schedule.
    g. Mounting locations for door hardware.
    h. List of related door devices specified in other Sections for each door and frame.

E. Keying Schedule: Prepared by or under the supervision of Installer, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents. Owner to approve submitted keying schedule prior to ordering of permanent cylinders.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and Architectural Hardware Consultant.

B. Product Certificates: For each type of electrified door hardware.

1. Certify that door hardware for use on each type and size of labeled fire-rated doors complies with listed fire-rated door assemblies.

C. Product Test Reports: For compliance with accessibility requirements, for tests performed by manufacturer and witnessed by a qualified testing agency, for door hardware on doors located in accessible routes.

D. Sample Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For each type of door hardware to include in maintenance manuals.

B. Schedules: Final door hardware and keying schedule.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Supplier of products and an employer of workers trained and approved by product manufacturers and of an Architectural Hardware Consultant who is available during the course of the Work to consult Contractor, Architect, and Owner about door hardware and keying.

1. Scheduling Responsibility: Preparation of door hardware and keying schedule.

2. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.

C. Deliver keys to manufacturer of key control system for subsequent delivery to Owner’s Representative.

1.8 COORDINATION

A. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

B. Security: Coordinate installation of door hardware, keying, and access control with Owner’s security consultant.

C. Electrical System Roughing-In: Coordinate layout and installation of electrified door hardware with connections to power supplies and building safety and security systems.

D. Existing Openings: Where hardware components are scheduled for application to existing construction or where modifications to existing door hardware are required, field verify existing conditions and coordinate installation of door hardware to suit opening conditions and to provide proper door operation.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of doors and door hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

2. Warranty Period: Three years from date of Substantial Completion unless otherwise indicated below:

a. Mechanical Exit Devices: Three years from date of Substantial Completion.
b. Manual Closers: 30 years from date of Substantial Completion.

1.10 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.

B. Maintenance Service: Beginning at Substantial Completion, furnish six months' full maintenance by skilled employees of door hardware and integrated access control systems suppliers and installers. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Furnish parts and supplies as used in the manufacture and installation of original products.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of door hardware from single manufacturer.

1. Provide electrified door hardware from same manufacturer as mechanical door hardware unless otherwise indicated. Manufacturers that perform electrical modifications and that are listed by a testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.

2.2 PERFORMANCE REQUIREMENTS

A. Fire-Rated Door Assemblies: Where fire-rated doors are indicated, provide door hardware complying with NFPA 80 that is listed and labeled by a qualified testing agency, for fire-

protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.

B. Smoke- and Draft-Control Door Assemblies: Where smoke- and draft-control door assemblies are required, provide door hardware that complies with requirements of assemblies tested in accordance with UL 1784 and installed in compliance with NFPA 105.

1. Air Leakage Rate: Maximum air leakage of 0.3 cfm/sq. ft. at the tested pressure differential of 0.3-inch wg of water.

C. Electrified Door Hardware: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Means of Egress Doors: Latches do not require more than 15 lbf to release the latch. Locks do not require use of a key, tool, or special knowledge for operation.

E. Accessibility Requirements: For door hardware on doors in an accessible route, comply with the USDOJ's "2017 ADA Standards for Accessible Design" and ICC A117.1.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf.

2. Comply with the following maximum opening-force requirements:

a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf applied perpendicular to door.
b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch high.

4. Adjust door closer sweep periods so that, from an open position of 90 degrees, the door will take at least 5 seconds to move to a position of 12 degrees from the latch.

2.3 SCHEDULED DOOR HARDWARE

A. General: Furnish door hardware for each door as scheduled in Part 3 "Door Hardware Schedule" Article to comply with requirements in this Section and the Door Hardware Schedule indicated in Architectural drawings.

1. Door Hardware Sets: Furnish quantity, item, size, finish or color indicated for named products listed in Hardware Sets.
2. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.

B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Schedule" Article. 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.
2. References to BHMA Designations: Provide products complying with these designations and requirements for description, quality and function.

2.4 HINGES

A. Hinges: BHMA A156.1. Provide template-produced hinges for hinges installed on hollow-metal doors and hollow-metal frames.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allegion plc; Ives 5BB Series or a comparable product by one of the following:

    a. Bommer Industries, Inc.
    b. Hager Companies.
    c. McKinney Products Company; an ASSA ABLOY Group company.

B. Quantity: Provide the following, unless otherwise indicated:

1. Two Hinges: For doors with heights up to 60 inches.

2. Three Hinges: For doors with heights 61 to 90 inches.

3. Four Hinges: For doors with heights 91 to 120 inches.

C. Hinge Weight: Unless otherwise indicated, provide the following:

1. Entrance Doors: NRP – five knuckle ball bearing heavy-weight hinges.

2. Hinges for Fire-Rated Assemblies: NRP – five knuckle ball bearing heavy-weight hinges.

3. Doors with Closers: five knuckle ball bearing standard-weight hinges.

4. Interior HM Doors: five knuckle plain bearing standard-weight hinges.

D. Hinge Base Metal: Unless otherwise indicated, provide the following:

1. Exterior Hinges: Stainless steel, with stainless-steel pin.

2. Interior Hinges for HM Doors and Frames in non-classified: Steel, with steel pin, unless otherwise indicated.

3. Interior Hinges for HM or FRP Doors and Frames in classified areas: Stainless steel, with stainless-steel pin.

E. Hinge Options: Where indicated in door hardware sets or on Drawings:

1. Hospital Tips: Slope ends of hinge barrel.

2. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed.

F. Fasteners: Comply with the following:

1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.

2. Screws: Phillips flat-head; machine screws (drilled and tapped holes) for metal doors. Finish screw heads to match surface of hinges.

3. Welded to Frame: Fully weld hinges to stainless steel doors and frames. Welding to be ground smooth, refinished, and re-polished to match the finish of the door and frame.

2.5 ELECTRIC POWER TRANSFER

A. Electrical Power Transfer: Furnish EPT where it is required per exit device manufacturers requirements and warranty for more than 1 amp of inrush for latch retraction of exit device bolt. Furnish prep in door, frame, and continuous hinge. Furnish a secure and unobtrusive means of channeling electrical wiring from the door frame into the door itself by concealing internal wires for low voltage electrified door hardware. Furnish an electrical Power Transfer fully manufactured with metal.

1. Products: Subject to compliance with requirements, provide the following:

a. Allegion plc; Von Duprin: EPT-10 Series
b. ABH PT1000
c. Securitron CEPT-10

B. Furnish mortar guard enclosure on frames at each electrical hinge/ EPT location specified.

2.6 MECHANICAL LOCKS AND LATCHES

A. Electrified Locking Devices: BHMA A156.25.

B. Lock Functions: As indicated in Hardware Sets.

C. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:

1. Bored Locks: Minimum 1/2-inch latchbolt throw, 3/4” latchbolt throw at fire-rated pairs.

2. Mortise Locks: Minimum 3/4-inch latchbolt throw.

3. Deadbolts: Minimum 1-inch bolt throw.

D. Lock Backset: 2-3/4 inches unless otherwise indicated.

E. Lock Trim:

1. Lockset Design: Schlage (SCH) 17A.

2. Levers: Cast.

3. Dummy Trim: Match lockset.

F. Strikes: Provide manufacturer's standard strike for each lock bolt or latchbolt complying with requirements indicated for applicable lock or latch and with strike box and curved lip extended to protect frame; finished to match lock or latch.

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Rabbet Front and Strike: Provide on locksets for rabbeted meeting stiles.

3. Strikes for Bored Locks and Latches: BHMA A156.2.

4. Strikes for Mortise Locks and Latches: BHMA A156.13.

5. Strikes for Interconnected Locks and Latches: BHMA A156.12.

6. Dustproof Strikes: BHMA A156.16.

G. Mortise Locks: BHMA A156.13; Security Grade 1; stamped steel case with steel or brass parts; Series 1000.

1. Basis-of-Design Product: Subject to compliance with requirements, furnish products by the following:

a. Allegion plc; Schlage L Series.
b. ASSA Abloy; Sargent 8200 Series.
c. Best; 45K Series.

2.7 MANUAL FLUSH BOLTS

A. Manual Flush Bolts: BHMA A156.16; minimum 3/4-inch throw; designed for mortising into door edge.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allegion plc; IVES FB458 or a comparable product by one of the following:

a. Burns Manufacturing, Inc.
b. Don-Jo Mfg., Inc.
c. Hager.

2.8 AUTOMATIC AND SELF-LATCHING FLUSH BOLTS

A. Automatic Flush Bolts: BHMA A156.3, Type 25; minimum 3/4-inch throw; with dust-proof strikes; designed for mortising into door edge. Include wear plates.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allegion plc; IVES FB31P or a comparable product by one of the following:

    a. Burns Manufacturing, Inc.
    b. Don-Jo Mfg., Inc.
    c. Hager.

2. Provide 12-inch steel or brass rods at doors up to 90 inches in height. For doors over 90 inches in height increase top rods by 6 inches for each additional 6 inches of door height. Provide dust-proof strikes at each bottom flush bolt.

2.9 EXIT DEVICES AND AUXILIARY ITEMS

A. Exit Devices and Auxiliary Items: BHMA A156.3. Grade 1 and UL listed for Panic Exit or Fire Exit Hardware.

1. Products: Subject to compliance with requirements, furnish products by the following:

    a. Allegion plc; Von Duprin 98/35A Series.
    b. ASSA Abloy; Sargent 8000 Series.
    c. Detex; Apex Series.

B. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf to release the latch.

1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 15 lbf.

C. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

D. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.

E. Outside Trim: Lever; material and finish to match locksets and latchsets, unless otherwise indicated.

F. Through Bolts: For exit devices and trim on metal doors.

G. Concealed Vertical Rod: For exit devices and trim on metal doors in GMP areas.

H. Electrified Options: As indicated in hardware sets, furnish electrified exit device options including: electric latch retraction, electric dogging, outside door trim control, exit alarm, delayed egress, latchbolt monitoring, lock/unlock status monitoring, touchbar monitoring and request-to-exit signaling. Unless otherwise indicated, furnish electrified exit devices standard as fail secure on lever or trim side, always free egress on push side.

1. If exit device requires over 1 amp of in-rush then furnish manufactures power supply to comply with warranty requirements, one power supply per two door leafs. Furnish power

supply with applicable relay and control boards for complete operation and integration of associated hardware with opening which may require: auto operator, card access, fire alarm, delayed egress and alarmed control boards devices.

2. If exit devices require over 1 amp of in-rush then furnish Electric Power Transfer (EPT), coordinate preps of door, frame and continuous hinges; unless exit device manufacture has approved listed through wire products with standardized connectors.

2.10 LOCK CYLINDERS

A. Lock Cylinders: Tumbler type, constructed from brass or bronze, stainless steel, or nickel silver. Provide cylinder from same manufacturer of locking devices.

B. Interchangeable Lock Cylinders: BHMA A156.5; Grade 1 permanent cores; face finished to match existing building.

C. Provide cylinders in the below-listed configuration(s), distributed throughout the Project as indicated.

1. Conventional Patented Restricted: cylinder with interchangeable core with patented, restricted keyway.

D. Patent Protection: Cylinders/cores requiring use of restricted, patented keys, patent protected.

E. Construction Master Keys: Provide cylinders with feature that permits voiding of construction keys without cylinder removal. Provide 10 construction master keys.

F. Construction Cores: Provide construction cores that are replaceable by permanent cores. Provide 10 construction master keys.

2.11 KEYING

A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, appendix. Provide one extra key blank for each lock. Incorporate decisions made in keying conference.

1. Provide a factory registered keying system, complying with guidelines in ANSI/BHMA A156.28, incorporating decisions made at keying conference.

2. New Grand Master Key System: Cylinders are factory keyed operated by a change key, master key, and a grand master key. Conduct keying meeting with End User to define and document keying system instructions and requirements prior to ordering any material on project.

3. Forward bitting list and keys separately from cylinders, by means as directed by Owner.

B. Keys: Nickel silver.

1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:

a. Identification stamping provisions must be approved by the Architect and Owner.
b. Stamp cylinders/cores and keys with Owner's unique key system facility code as established by the manufacturer; key symbol and embossed or stamped with "DO NOT DUPLICATE" along with the "PATENTED" or patent number to enforce the patent protection.

2. Quantity: In addition to one extra key blank for each lock, provide the following:

a. Cylinder Change Keys: Four
b. Master Keys: Five
c. Construction Control Keys: Two
d. Permanent Control Keys: Two

3. Key Registration List: Furnish keying transcript list to Owner's Representative for lock cylinders.

2.12 OPERATING TRIM

A. Operating Trim: BHMA A156.6; stainless steel unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. IVES, Allegion plc.
b. Hager Companies.
c. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
d. Trimco.

2.13 ACCESSORIES FOR PAIRS OF DOORS

A. Coordinators: BHMA A156.3; consisting of active-leaf, hold-open lever and inactive-leaf release trigger; fabricated from steel with nylon-coated strike plates; with built-in, adjustable safety release.

1. Referenced Product: IVES; COR X FL Series with Carry Bar CB1.

B. Carry-Open Bars: BHMA A156.3; prevent the inactive leaf from opening before the active leaf; provide polished brass or bronze carry-open bars with strike plate for inactive leaves of pairs of doors unless automatic or self-latching bolts are used.

C. Astragals: BHMA A156.22. Flat metal bar, surface mounted on face of door with screws; minimum 1/8 inch thick by 2 inches wide by full height of door. BHMA A156.22.

2.14 SURFACE CLOSERS

A. Surface Closers: BHMA A156.4; rack-and-pinion hydraulic type with adjustable sweep and latch speeds controlled by key-operated valves and forged-steel main arm. Comply with manufacturer's written instructions for size of door closers depending on size of door, exposure

to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force. Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allegion plc; LCN 4040XP or a comparable product by one of the following:

    a. SARGENT Manufacturing Company; ASSA ABLOY.

2. Through bolt all closers using sex-bolt fasteners.

3. Furnish all brackets, drop plates and any other necessary hardware required to insure proper installation.

4. Finish for Closer Cylinders, Arms, and Adapter Plates: Powder coating finish which has been certified to exceed 100 hours salt spray testing as described in ANSI Standard A156.4 and ASTM B117.

B. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.

2.15 MECHANICAL STOPS AND HOLDERS

A. Wall- Mounted Stops: BHMA A156.16.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. IVES; Allegion plc.
    b. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
    c. Trimco.

2. Provide door stops at each door leaf:

    a. Provide wall stops wherever possible. Provide concave type where lockset has a push button of thumbturn.
    b. Where a wall stop cannot be used, provide overhead stop.

2.16 SILENCERS

A. Silencers: Provide "push-in" type silencers for hollow metal frames.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. IVES; Allegion plc.
    b. Burns Manufacturing Incorporated.

c. Trimco.

B. Requirements: Provide one silencer per 30 inches of height on each single frame, and two for each pair frame. Omit where gasketing is specified.

2.17 ELECTROMAGNETIC STOPS AND HOLDERS

A. Electromagnetic Door Holders: BHMA A156.15, Grade 1; wall-mounted electromagnetic single unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire-alarm system for labeled fire-rated door assemblies.

1. Basis-of-Design Product: Subject to compliance with requirements, provide LCN SEM Series; or a comparable product by one of the following:

a. Rixson Company; ASSA ABLOY.

2.18 OVERHEAD STOPS AND HOLDERS

A. Overhead Stops and Holders: BHMA A156.8.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Architectural Builders Hardware Mfg., Inc.
b. Glynn-Johnson. Scheduled Manufacturer.
c. Rixon.

2. Requirements: Provide overhead stop at any door where conditions do not allow for a wall stop.

a. Provide friction type at doors without closer and positive type at doors with closer.

2.19 DOOR GASKETING

A. Door Gasketing: BHMA A156.22; with resilient or flexible seal strips that are easily replaceable and readily available from stocks maintained by manufacturer.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. National Guard Products, Inc.
b. Pemko; an ASSA ABLOY Group Company.
c. Reese Enterprises, Inc.
d. Zero International; an Allegion brand.

B. General: Furnish continuous weatherstrip seal on exterior doors and smoke, light, or sound gasketing on interior doors where specified. Furnish non-corrosive fasteners for exterior applications.

1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. Install header seal before mounting door closer arms.

2. Meeting Stile Astragals: Fasten to meeting stiles, forming seal when doors are closed.

3. Door Sweep: Apply to bottom of door, forming seal with threshold when door is closed.

C. Seals: Provide continuous adjustable perimeter seals on doors where indicated or scheduled. Provide noncorrosive fasteners.

1. Perimeter Seals: Apply to head and jamb, forming seal between door and frame; use adjustable type, stainless steel with silicone gasket.

2. Door Sweeps: Silicone gasket material held in place by flat stainless steel housing or flange; surface mounted to face of door with screws.

3. Meeting Stile: Silicone gasket material held in place by flat stainless steel housing or flange; surface mounted to face of door with screws.

D. Maximum Air Leakage: When tested in accordance with ASTM E283 with tested pressure differential of 0.3-inch wg, as follows:

1. Smoke-Rated Gasketing: 0.3 cfm/sq. ft. of door opening.

2. Gasketing on Single Doors: 0.3 cfm/sq. ft. of door opening.

3. Gasketing on Double Doors: 0.50 cfm per ft. of door opening.

2.20 METAL PROTECTIVE TRIM UNITS

A. Metal Protective Trim Units: BHMA A156.6; fabricated from 0.050-inch-thick stainless steel; beveled four edges as scheduled with manufacturer's standard machine or self-tapping screw fasteners.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ives; an Allegion brand.
b. Burns Manufacturing Incorporated.
c. Rockwood Manufacturing Company; an ASSA ABLOY Group company.
d. Trimco.

2. Requirements:

a. Sizes plates 2 inches less width of door on single doors, pairs of doors with a mullion, and doors with edge guards. Size plates 1 inch less width of door on pairs without a mullion or edge guards.
b. At fire rated doors, provide protection plates over 16 inches high with UL label.

B. Fasteners: Manufacturer's standard machine or self-tapping screws.

C. Coordinate stainless steel hinges, door edges, kickplates and armor plates with less than .09375 inches between meeting edges, regardless of specified sizes in hardware sets.

D. At fire rated openings with protection plates ensure they are listed by third party, plates to be embossed with listing agency approval. Ensure wood door and hollow metal door manufactures are accepting of protection plates prior to quoting and submitting bid.

2.21 AUXILIARY ELECTRIFIED DOOR HARDWARE

A. Wire Harness, Cable, and Connectors: Hardwired Electronic Access Control Lockset and Exit Device Trim.

1. Where scheduled in the hardware sets, provide each item of electrified hardware and wire harnesses with sufficient number and wire gauge with standardized Molex plug connectors to accommodate electric function of specified hardware. Provide Molex connectors that plug directly into connectors from harnesses, electric locking and power transfer devices. Provide through-door wire harness for each electrified locking device installed in a door and wire harness for each electrified hinge, electrified continuous hinge, electrified pivot, and electric power transfer for connection to power supplies.

2.22 DOOR POSITION SWITCHES

A. Door position switch: Provide recessed or surface mounted type door position switches as specified.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Allegion plc; Schlage Series or a comparable product by one of the following:

a. GE-Interlogix.
b. Sargent.

B. Requirements: Coordinate door and frame preparations with door and frame suppliers. If switches are being used with magnetic locking device, provide minimum of 4 inches between switch and magnetic locking device.

2.23 POWER SUPPLIES

A. Power supplies to be provided as approved by manufacturer of supplied electrified hardware.

1. Products: Subject to compliance with requirements, provide the following:

a. Allegion plc; Schlage/Von Duprin PS900.
b. Securitron: BPS.

2.24 FABRICATION

A. Base Metals: Produce door hardware units of base metal indicated, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.

B. Fasteners: Provide door hardware manufactured to comply with published templates prepared for machine, wood, and sheet metal screws. Provide screws that comply with commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.

2. Furnish manufacturer's templated and approved stainless steel screws and fasteners for stainless steel hardware specified in the hardware sets.

3. Fire-Rated Applications:

a. Wood or Machine Screws: For the following:

1) Hinges mortised to doors or frames.
2) Strike plates to frames.
3) Closers to doors and frames.

b. Steel Through Bolts: For the following unless door blocking is provided:

1) Surface hinges to doors.
2) Closers to doors and frames.
3) Surface-mounted exit devices.

4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.

5. Gasketing Fasteners: Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

C. Mounting Accessories: Furnish drop plates, filler brackets, extended length screws, through bolts, and accessories for complete mounting with door, frame, light kits, applied molding and special applications as part of the base bid with complete installation per manufactures recommendations.

1. Unless otherwise noted, install surface mount magnetic locks on the pull side of the doors when specified in hardware sets and located on openings in corridors. Furnish all mounting brackets with finish and beauty covers.

2.25 FINISHES

A. Provide finishes complying with BHMA A156.18 as indicated in door hardware schedule.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Furnish 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.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

E. Furnish clear powder coat finish at exit devices located on exterior openings.

F. BHMA Designations: Comply with base material and finish requirements indicated by the following:

1. BHMA 600: Primed for painting, over steel base metal.

2. BHMA 626: Satin chromium plated over nickel, over brass or bronze base metal.

3. BHMA 628: Satin aluminum, clear anodized, over aluminum base metal.

4. BHMA 630: Satin stainless steel, over stainless-steel base metal.

5. BHMA 652: Satin chromium plated over nickel, over steel base metal.

6. BHMA 689: Aluminum painted, over any base metal.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

D. Notify Owner's Representative and 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. Steel Doors and Frames: For surface-applied door hardware, drill and tap doors and frames in accordance with ANSI/SDI A250.6.

B. Electrified Openings: Furnish steel doors and frames and wood doors prepared to receive electrified hardware connections specified in Door Hardware Sets without additional modification.

3.3 INSTALLATION

A. Mounting Heights: Mount door hardware units at heights to comply with the following unless otherwise indicated or required to comply with governing regulations.

1. Standard Steel Doors and Frames: ANSI/SDI A250.8.

B. Install each door hardware item to comply with manufacturer's 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. Do not install surface-mounted items until finishes have been completed on substrates involved.

1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.

2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

C. Hinges: Install types and in quantities indicated in door hardware schedule, but not fewer than the number recommended by manufacturer for application indicated or one hinge for every 30 inches of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.

D. Lock Cylinders: Install construction cores to secure building and areas during construction period.

1. Replace construction cores with permanent cores as indicated in keying schedule.

E. Boxed Power Supplies: Locate power supplies as indicated or, if not indicated, above accessible ceilings or in equipment room. Verify location with Owner's Representative and Architect.

1. Configuration: Provide least number of power supplies required to adequately serve doors with electrified door hardware.

F. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they will impede traffic.

G. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame. Seal is to be continuous and uninterrupted. Install seals prior to soffit mounted hardware. Provide mounting brackets if needed.

1. Do not notch perimeter gasketing to install other surface-applied hardware.

H. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.

I. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.

3.4 FIELD QUALITY CONTROL

A. Independent Architectural Hardware Consultant: Owner will engage a qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Independent Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

3.5 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.

1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

2. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.

B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer's Architectural Hardware Consultant shall examine and readjust each item of door hardware, including adjusting operating forces, as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.6 CLEANING AND PROTECTION

A. Clean adjacent surfaces soiled by door hardware installation.

B. Clean operating items as necessary to restore proper function and finish.

C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes.

3.8 DOOR HARDWARE SCHEDULE

A. The hardware sets listed in the drawings 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.

Hardware set: 01
door number:

101A

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	CONT. HINGE	112XY EPT	628	IVE
2	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	HD-RX-LC-QEL-9847-EO-CON 24 VDC	630	VON
1	EA	ELEC PANIC HARDWARE	HD-RX-LC-QEL-9847-NL-OP-110MD-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	20-057	626	SCH
2	EA	90 DEG OFFSET PULL	8190HD 10"	630	IVE
2	EA	SURFACE CLOSER	4111 SCUSH	689	LCN
2	EA	MOUNTING PLATE	4110-18 SRT	689	LCN
2	EA	CUSH SHOE SUPPORT	4110-30 SRT	689	LCN
2	EA	BLADE STOP SPACER	4110-61 SRT	689	LCN
2	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	655A-223	A	ZER
4	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	SET	WEATHERSTRIP	BY DOOR/FRAME MANUF		
1	EA	LOW VOLTAGE LOCK POWER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

OPERATION: DOORS DOGGED ELECTRONICALLY VIA ACCESS CONTROL SYSTEM, OR MANUALLY BY HEX KEY. WHEN LOCKED. ENTRY BY CARD READER, MOMENTARILY RETRACTING DEVICE LATCHES. INSIDE PUSH PADS ALWAYS FREE EGRESS.

Hardware set: 02
door number:

101A	101C	111A	111C	111E	111G
112	113B	114B			

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-98-L-M996-17-FSE-CON	630	VON
1	EA	RIM CYLINDER	20-057	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A	AL	ZER
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	LOW VOLTAGE LOCK POWER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

DOOR NORMALLY CLOSED AND LOCKED. PASSAGE THROUGH DOOR REQUIRES VALID CARD PRESENTATION TO WALL MOUNT CARD READER, MOMENTARILY UNLOCKING EXIT DEVICE LEVER TRIM. INSIDE PUSH PAD ALWAYS FREE EGRESS. EXIT DEVICE TRIM IS FAIL SECURE AND REMAINS LOCKED UPON LOSS OF POWER.

Hardware set: 03
door number:

110A

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	STOREROOM LOCK	L9080R 17A	630	SCH
1	EA	LOCK GUARD	LG12	630	IVE
1	EA	SURFACE CLOSER	4111 SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A	AL	ZER
1	SET	GASKETING	429AA-S	AA	ZER
1	EA	ASTRAGAL SET	8195AA	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE

NOTE: INSTALL WEATHERSTRIP AT FRAME HEADFIRST, THEN INSTALL CLOSER PA BRACKET ON WEATHERSTRIP.

Hardware set: 04
door number:

101B

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	FIRE EXIT HARDWARE	9847-EO-F-LBR	630	VON
1	EA	FIRE EXIT HARDWARE	9847-L-F-LBR-17	630	VON
1	EA	RIM CYLINDER	20-057	626	SCH
2	EA	SURFACE CLOSER	4111 EDA	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
2	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	ASTRAGAL SET	8195AA	AA	ZER

Hardware set: 05
door number:

110C

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	CLASSROOM LOCK	L9070R 17A	630	SCH
1	EA	COORDINATOR	COR X FL	628	IVE

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
2	EA	MOUNTING BRACKET	MB1/MB2	689	IVE
2	EA	SURFACE CLOSER	4111 SHCUSH	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER
1	EA	MEETING STILE	383AA	AA	ZER

Hardware set: 06
door number:

111D 113A 114A

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5 NRP	630	IVE
1	EA	FIRE EXIT HARDWARE	98-L-BE-F-17	630	VON
1	EA	SURFACE CLOSER	4111 EDA	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware set: 07
door number:

107

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	STOREROOM LOCK	L9080R 17A	630	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware set: 08
door number:

102 105A 105B 106A 106B 108

109A 109B

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	L9010 17A	630	SCH
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
1	EA	GASKETING	488SBK PSA	BK	ZER

Hardware set: 09
door number:

104

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PASSAGE SET	L9010 17A	630	SCH
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware set: 10
door number:

102 103

each to have:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW 4.5 X 4.5	630	IVE
1	EA	PUSH PLATE	8200 4" X 16"	630	IVE
1	EA	PULL PLATE	8303 10" 4" X 16"	630	IVE
1	EA	SURFACE CLOSER	4011	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	WALL STOP	WS406/407CVX	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

Hardware set: 11
door number:

101B 110B 111B 111F 113C 114C

each to have:

QTY	DESCRIPTION	CATALOG NUMBER	FINISH	MFR

NOTE: ALL HARDWARE BY DOOR MANUFACTURER

END OF SECTION

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SECTION 08800 - GLASS AND GLAZING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers glass and glazing for windows and doors as indicated on the Drawings and as stipulated herein.

1.2 GENERAL

A. Except as modified or supplemented herein, all glazing shall be in accordance with the recommendations of the Flat Glass Marketing Association (FGMA).

1. Tempered glass and laminated glass shall conform to the requirements for glazing materials for Category II products in accordance with the Safety Standard for Architectural Glazing Materials, 16 CFR 1201, January 6, 1977, as amended.

2. Insulating glass units shall bear the certification labels of the Insulating Glass Certification Council (IGCC).

1.3 SUBMITTALS

A. Complete product data sheets and specifications covering each item furnished under this section shall be submitted in accordance with the submittals section.

1. Provide labeled samples (12 inches) square for each glass type.

1.4 LABELS

A. All glass shall be delivered to the work bearing the original manufacturer's labels. These labels shall not be removed until just prior to the final window cleaning.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall conform to the following:

Plate or Float Glass Clear	ASTM C1036, Type I, Quality Q3, Class 1. PPG or equal.

Tempered Glass	ANSI Z97.1 or ASTM C1048,Type I; Quality Q3, Class 1; comply with ASNI Z97.1. Plate or float, fully tempered.
Clear	PPG or equal.
Laminated Glass	ASTM C 1172; comply with ANSI Z97.1; 1/4-inch thickness shall be two 1/8-inch thick sheets of float glass with polyvinyl butyral interlayer.
Clear	PPG or equal.
Insulating-Laminated Glass	
Exterior Application – Tinted	ASTM E 2190; 1-inch thick insulated units, made from 1/4-inch/6.0 mm thick laminated glass with inner pane clear and outer pane tinted. Laminated glass shall be two (2) layers of 1/8-inch/3.0 mm thick glass bonded to a .030 inch/.076 mm polyvinyl butyral interlayer.
Spacers	Cork and rubber; Rhopac "Adhesive Backed Spacer Blocks."

PART 3 - EXECUTION

3.1 GLAZING

A. All glass sizes shall be obtained from measurements of the work at the site or from the manufacturer of the sash, doors, or frames in which the glass is to be set. In all cases, however, the Contractor shall be responsible for the correctness of the size of the glass.

1. Locations for each type of glass shall be as indicated in the schedules and details on the Drawings. Glazing shall conform to all local codes.

2. Setting blocks shall be provided where recommended by the FGMA.

B. Hollow Metal Doors. Glass view panels in hollow metal doors shall be set in glazing compound and held in place with the glazing stops and beads provided by the door manufacturer. Spacers held 1/4-inch below sight line shall be provided between the glass and the stops or beads if required to position the glass. Each glass panel shall be cushioned so that it is free from strain or binding due to uneven pressure at the stops.

C. Hollow Metal Frame Openings. Glass in hollow metal opening – transoms or windows, shall be set in glazing compound and held in place with the glazing stops and beads provided by the frame manufacturer. Spacers held 1/4-inch below sight line shall be provided between the glass and the stops or beads if required to position the glass. Each glass panel shall be cushioned so that it is free from strain or binding due to uneven pressure at the stops.

D. Aluminum Windows. Glazing in aluminum assemblies shall be provided by the window manufacturer, unless otherwise indicated.

E. Other Glass. All other glass shall be set as required by the glazing facilities provided and the glass embedment requirements.

3.2 PROTECTION AND CLEANING

A. All glass shall be protected against breakage during the construction period, and all broken or cracked glass shall be replaced at the completion of the work.

1. All glass shall be cleaned just before final inspection, and all stains and defects shall be removed. Care must be exercised to remove paint, labels, and glazing compound without scratching or marring the surface of the glass or metal work.

3.3 MONOLITHIC GLASS SCHEDULE

A. Glass Type GL-1: Clear 1 heat-strengthened float glass.

1. Minimum Thickness: 6 mm.
2. Safety glazing required.

B. Glass Type GL-4: Reflective-coated spandrel glass; heat-strengthened float glass. glass.

1. Basis-of-Design Product: Viracon VRE 1-46 Insulating HS/HS.
2. Coating Type: Pyrolytic or Sputter-coating (vacuum deposition process).
3. Coating Color: Warm Gray.
4. Glass: Clear float glass.
5. Minimum Thickness: 6 mm.
6. Coating Location: Fourth surface.
7. Factory apply manufacturer's standard opacifier to coated second surface of lites, with resulting products complying with Specification No. 89-1-6 in GANA's "Engineering Standards Manual".

3.4 LAMINATED GLASS SCHEDULE

A. Glass Type GL-2: Clear laminated glass with two plies of heat-strengthened float glass.

1. Minimum Thickness of Each Glass Ply: 3 mm.
2. Interlayer Thickness: 0.030 inch.
3. Safety glazing required.

3.5 INSULATING GLASS SCHEDULE

A. Glass Type GL-3: Clear insulating glass.

1. Basis-of-Design Product: Viracon VRE 1-46 Insulating HS/HS.
2. Overall Unit Thickness: 1 inch.

3. Minimum Thickness of Each Glass Lite: 6 mm.
4. Outdoor Lite: Heat-strengthened float glass.
5. Interspace Content: Air.
6. Indoor Lite: Heat-strengthened float glass.
7. Winter Nighttime U-Factor: 0.30 maximum.
8. Summer Daytime U-Factor: 0.27 maximum.
9. Safety glazing required.

End of Section

SECTION 09510 - SUSPENDED ACOUSTICAL CEILINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers lay-in acoustical panel ceilings with exposed grid suspension systems to be furnished and installed at the locations indicated on the drawings.

1.2 GENERAL

A. The ceiling work shall be coordinated with other building, electrical, heating, ventilating, air conditioning, and plumbing work.

1. Sheet metal and wire gages set forth herein are minimums and refer to US Standard gage.

1.3 SUBMITTALS

A. Complete specifications, data, and catalog cuts or drawings covering the items furnished under this section and installation drawings showing suspension and erection details shall be submitted in accordance with the Submittals Procedures section.

1.4 EXTRA PANELS

A. One unopened carton of each type of new acoustical panels shall be furnished to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall conform to the following. Locations for each type shall be as scheduled on the drawings.

Acoustical Panels (Type A)	ASTM E1264, Type III, Form 1 or 2, Fire Class A, square edge; Certainteed "Safetone Vantage 10", USG "Radar" or Armstrong "Fine Fissured".
Size, Nominal	24 inches by 24 inches by 5/8 inch, square edge.
Finish	Factory-applied, washable, white vinyl paint.

Recycled content	25 per cent, minimum.
NRC 0.55 minimum.	
Exposed Grid Suspension System	ASTM C635, intermediate duty classification; Chicago Metallic "1200 Series", Armstrong “Prelude XL”, or USG-Donn "DX" exposed tee system complete with main runner tees, main cross tees, intermediate cross tees, and hemmed edge moldings with standard prefabricated corner units for internal and external corners. All exposed metal shall have factory-applied, baked enamel finish. Color and finish shall be selected from manufacturer's standards.
Hangers	12 gage galvanized steel wire.
Powder-Actuated Anchors	Fed Spec GGG-D-777.
Masonry Nails Hardened steel, 9 gage.	
Wallboard Screws	ASTM C1002, Type S, self-tapping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Suspended acoustical ceilings shall be installed in accordance with the manufacturer's recommendations. Installation of suspension systems shall conform to the requirements of ASTM C635 and C636. Each area shall be permanently enclosed before ceiling work is started.

1. Suspended acoustical ceilings of the types indicated shall be installed in the locations indicated on the drawings.

2. The suspension systems shall be designed to support the ceiling, lighting fixtures, grilles, diffusers, and other required items without sagging. In each area, the suspension system shall be installed and leveled before acoustical panels or light fixtures are installed. Each grid system shall be leveled to within 1/8 inch in 12 feet. Unless otherwise indicated on the drawings, the layout for each suspended acoustical ceiling shall be symmetrical about the center lines of the space with equal borders on opposite sides, and shall be square and parallel to the enclosing walls.

B. Hangers. Hanger spacing shall not exceed 48 inches, with additional hangers placed at each corner of each recessed light fixture and framed opening. Hangers shall be securely anchored to overhead construction as follows:

C. To Steel Framing. Hangers shall be anchored by tying to the steel framing members. If the spacing of steel members exceeds the specified spacing of hangers, suitable additional framing members shall be provided and securely attached to the building's steel framing members.

1. Hangers shall be tied through holes in the vertical leg of main runner tees.

D. Main Runner Tees. Main runner tees shall be spaced 48 inches apart, supported with hanger wires not more than 48 inches apart. Main runner tees shall be placed with lines parallel to the bordering walls. Locations and methods of splicing shall be as recommended by the manufacturer.

E. Cross Tees. Main cross tees shall be spaced 24 inches apart, fitted between main runner tees, and clipped thereto as recommended by the manufacturer. Each line of main cross tees shall be straightened and aligned, and lines shall be perpendicular to main runner tees and parallel to each other.

1. Intermediate cross tees shall be spaced 24 inches apart, fitted between main cross tees, and clipped thereto as recommended by the manufacturer. Each line of intermediate cross tees shall be straightened and aligned, and lines shall be perpendicular to main cross tees and parallel to each other.

F. Special Framing. Additional members shall be installed as required to frame for and support all light fixtures, diffusers, grilles, and similar items.

G. Edge Molding. Edge molding shall be installed at all walls around the entire perimeter of each ceiling area and around all columns. At masonry walls, edge molding shall be anchored in place by masonry nails or powder-actuated anchors. At gypsum wallboard partitions and walls, edge molding shall be anchored to metal studs using wallboard screws. Prefabricated corner units shall be installed at all internal and external corners. Hemmed edges of moldings shall be field notched for a flush fit at the exact point where tees connect.

H. Acoustical Panels. Acoustical panels shall be neatly cut to fit the spaces, with each panel supported on all sides by main runners, cross runners, or edge moldings. No visible gaps, openings, split edges, or cracked panels will be acceptable. All panel units shall be installed with any apparent grain running in the same direction. Tegular ceiling panels shall be neatly notched and trimmed at perimeter wall intersections.

3.2 SEISMIC RESTRAINT SYSTEMS

A. Not used.

3.3 CLEANING

A. Following completion of erection work, dirty or discolored exposed surfaces of the suspension system and panels shall be cleaned and left free of all defects. Any item which is damaged or which cannot be properly cleaned shall be removed and replaced with new materials.

End of Section

SECTION 09725 – RESINOUS FLOORING

PART 1 - GENERAL

1-1. SCOPE. This section covers the furnishing and installation of seamless floor covering systems, including integral cove bases at the locations specified or indicated on the Drawings.

1-2. GENERAL. All seamless flooring systems provided shall be the product of one manufacturer. The seamless flooring systems shall be furnished complete with all hardware and appurtenances necessary for a complete and satisfactory installation.

1-3. SUBMITTALS. Complete specifications, detailed drawings, color samples, and setting and installation drawings covering seamless flooring shall be submitted in accordance with the Submittals Procedures section. The following additional information shall be required with the submittals:

The manufacturer's printed specifications for application of the flooring.

Data verifying that the applicator has been trained and licensed by the manufacturer of the seamless flooring.

Data verifying that the applicator has not less than 5 years' experience in installation of the flooring systems specified.

Listing of installations completed by the applicator in the last 5 years including project name, size, owner contact name and phone number.

1-4. COLOR SELECTION. Color selections will be made by Engineer from the complete line of manufacturer's custom and standard color formulations after the award of contract. The manufacturer's standard and custom colors shall be provided for locations as indicated on the Drawings.

After the color formulations and patterns have been selected, the following additional samples and data shall be submitted in accordance with the submittal Procedures section:

Two 6 by 6 inch samples of each color pattern of floor covering selected, showing proposed color, aggregate mix, and finish.

1-5. SAMPLE PANEL. Before the installation of any seamless flooring, a 4 foot square sample panel of each color selected shall be prepared at the Site, showing proposed color, finish, and workmanship for seamless flooring. The samples shall include cove basesif required in the finished floor system. All panels required shall consist of seamless flooring placed over a cement board 1/4 inch thick mounted on a rigid framework backing. The seamless flooring shall be applied in accordance with the recommendations of the manufacturer and as specified herein. Installation of seamless flooring shall not begin until Engineer has accepted the sample panels. The panels shall then become the standard of comparison for color, pattern, and finish of the seamless flooring. All required panels shall not be destroyed until the seamless flooring work is completed.

1-6. DELIVERY, STORAGE, AND HANDLING. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

Seamless flooring products shall be protected from damage during transportation, at the Site, and during construction. All containers and packages shall be unopened at delivery and shall contain the name and address of the manufacturer. All metal items shall be protected from rusting. Damaged items will be rejected and shall be replaced.

1-7. WARRANTY. The applicator of the flooring system shall supply, jointly with the flooring system manufacturer, a warranty covering the flooring system materials and installation for a period after installation of 5years.

PART 2 - PRODUCTS

2-1. FLOORING SYSTEM. The flooring systems shall conform to the following requirements. The flooring system shall be a broadcast system or trowel applied. Other manufacturers will be considered provided all the requirements of these specifications are met.

Flooring System Products	Sikafloor® DecoDur Quartz FX (1/8 inch). Color to be selected by Engineer from manufacturers standard and custom colors.

2-2. MATERIALS. All materials shall be blended and packaged in the factory. The addition of water or other loose or foreign matter at the Site will not be permitted.
Materials for the flooring system shall conform to the following:

Primer	As recommended by the flooring system manufacturer.
Topping Matrix and Finish Coat	Thermosetting epoxy resins of formulation recommended by the manufacturer for this installation. Emulsion materials, or those containing wax or styrene, shall not be used.
Aggregates	ASTM D451, spherical or angular, translucent quartz grains coated with a pigmented, inorganic ceramic film.
Hardness	6 1/2 - 7 range on Moh's Mineral Scale.
Moisture Content	Not to exceed 0.5 percent.
Edge and Divider Strips	Extruded aluminum, size and shape as recommended by the manufacturer.

PART 3 - EXECUTION

3-1. APPLICATION. Seamless flooring shall be applied by experienced, fully trained applicators licensed by the manufacturer of the flooring materials. Applicators shall have not less than 5 years' experience in the installation of the types of flooring systems specified. Methods of application shall be in accordance with the recommendations of the manufacturer of the materials and the following requirements:

The base material will be new concrete and shall be prepared as specified.

Seamless flooring shall be applied and completed prior to painting and the installation of plumbing fixtures, toilet compartments, cabinetry, appliances, and other objects that may obstruct the application.

3-1.01. Preparation of Surfaces. Concrete slabs shall have a trowel finish as stipulated in the cast-in-place concrete section. Concrete shall be clean and dry and at a surface temperature of at least 55°F when application is started. All contaminants and laitance shall be removed. Existing concrete surfaces shall be abraded as recommended. All bug holes and voids shall be filled and any protrusions ground off. Moisture content of concrete shall be checked by taping a 2 feet square sheet of polyethylene to the floor, covering the film with plywood, and checking for moisture on the underside of the film after 24 hours in accordance with ASTM D4263. Application can be started when no moisture has accumulated on the underside of the film.

All surfaces which are not to receive the flooring system shall be protected by masking or other similar methods.

3-1.02. Priming. Materials, method and rate of application, and the interval between priming and the application of the finish flooring shall be in accordance with the manufacturer's recommendations. Primer shall be uniformly spread and shall not be allowed to collect in surface depressions.

3-1.03. Edge and Divider Strips. Edge strips shall be set at all discontinuous edges of flooring and at all junctures with other flooring materials. Edge strips at doorways shall be centered under the door. Divider strips may be installed at the toe of cove bases and elsewhere if recommended by the manufacturer. Divider strips for pattern changes and dividing large areas of flooring shall be installed as recommended by the flooring manufacturer and where indicated on the Drawings.

Divider strips shall be installed at all structural control or expansion joints. Configuration of the control or expansion joints shall be as recommended by the manufacturer.

3-1.04. Integral Cove Bases. Cove bases at abutting vertical surfaces such as walls and curbs shall consist of a 1 inch radius cove formed of a mixture of epoxy and flint shot silica sand to be built up and overlaid with the finish flooring material. The cove base height shall be , and shall be uniform, straight, and true. Top edges of cove bases shall be finished with a slight radius to the wall, unless otherwise indicated or detailed on the Drawings.

3-1.05. Finish Flooring. Epoxy binder and aggregates shall be mixed to match the accepted standard sample. Adjacent surfaces shall be masked or protected as needed. Flooring materials shall be machine mixed and trowel-applied or broadcasting of aggregates in accordance with the manufacturer's instructions. The surface shall be tightly compacted and free from holes, depressions, and trowel marks.

The finish coat shall be applied in accordance with the manufacturer's recommendations and shall produce a uniform satin finish over the entire floor area. Surfaces shall be inspected for irregular or lumpy areas prior to application of the finish coat. All irregular, uneven, and misaligned floor, curb, and base surfaces shall be repaired as recommended by the flooring manufacturer and to the satisfaction of Engineer prior to finish coat application. The minimum installed thickness shall be 1/4 inch.

3-2. THICKNESS VERIFICATION. If requested by Engineer, prior to the application of the finish coat, Contractor shall take a minimum of four 1 inch diameter core samples through the flooring system into the substrate to verify proper system thickness. Cored areas found to have less than the specified thickness shall be removed and replaced, and additional core samples may be taken as necessary to verify the thickness of the entire floor area. Core holes shall be filled in with floor material to match the surrounding floor elevation prior to application of the seal coat.

3-3. ACCEPTANCE. The finished floor system may be rejected for any of the following reasons:

Uneven or patchy color and inconsistency in the color granular mix.

Uneven application of the seal coat or uneven application of the slip resistant coatings.

Variations in flooring system thickness.

Cracking, discoloration, blisters, unusual roughness of the floor system; or separation of the flooring system from the subbase.

3-4. PROTECTION AND FINAL CLEANING. Seamless floor covering shall be protected from damage until acceptance by Owner. Areas that are subject to traffic or over which materials or equipment are to be moved shall be temporarily covered with durable nonstaining paper, such as St. Regis "Seekure", or otherwise adequately protected.

Just before final acceptance, seamless floor covering shall be mopped clean with water and mild detergent, rinsed, and dried.

End of Section

SECTION 09940 - PROTECTIVE COATINGS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers field applied protective coatings, including surface preparation, protection of surfaces, inspection, and other appurtenant work for equipment and surfaces designated to be coated with heavy-duty maintenance coatings. Regardless of the number of coats previously applied, at least two field coats in addition to any shop coats or field prime coats shall be applied to all surfaces unless otherwise specified.

1.2 GENERAL

A. Cleaning, surface preparation, coating application, and thickness shall be as specified herein and shall meet or exceed the coating manufacturer's recommendations. When the manufacturer's minimum recommendations exceed the specified requirements, Contractor shall comply with the manufacturer's minimum recommendations. When equivalent products are acceptable to Engineer, Contractor shall comply with this Specification and the coating manufacturer's recommendations.

B. Governing Standards

1. All cleaning, surface preparation, coating application, thickness, testing, and coating materials (where available) shall be in accordance with the referenced standards of the following AWWA, ANSI, NACE, SSPC, NSF, and ASTM.

C. Delivery and Storage

1. All coating products shall be received and stored in accordance with the coating manufacturer's recommendations.

1.3 SUBMITTALS

A. General Submittals and Data

1. Contractor shall submit color cards for all coatings proposed for use, together with complete descriptive specifications, manufacturer's product data sheet and the completed Coating System Data Sheets, to Engineer for review and color selection. Each product data sheet shall include application temperature limits including recoat time requirements for the ambient conditions at the site, including temperatures up to 130° F. Requests for review submitted directly to Engineer by coating suppliers will not be considered.

B. NSF 61 Compliance

1. When the proposed products will be in contact with treated or raw water in potable water treatment facilities, Contractor shall submit certifications that the proposed systems are in compliance with ANSI/NSF 61.

C. Data Sheets

1. Contractor shall submit a Coating System Data Sheet for each separately identified surface in the Metal Surfaces Coating Schedule, Concrete and Masonry Surfaces Coating Schedule, and the Miscellaneous Surfaces Coating Schedule that will be used in the Project, using the appropriate Coating System Data Sheet forms (Figures 1- and 2-09940) at the end of this section. Each field coating system shall be acceptable to the coating material manufacturer.

D. Color Submittals

1. For the epoxy and for aliphatic polyurethane, a total of not more than 15 custom colors (excluding deeptone or highlevel colors) may be required. The manufacturer's standard colors will be acceptable for all other coatings.

2. The manufacturer's standard colors will be acceptable for all coatings.

1.4 QUALITY ASSURANCE

A. Coating System Data Sheet Certifications

1. The coating applicator and coating manufacturer shall review and approve in writing the coating manufacturer's written recommendations for the coating system and the intended service. Any variations from the Specifications or the coating manufacturers published recommendations shall be submitted in writing and approved by the coating manufacturer.

2. The coating manufacturer shall observe the surface preparation, mixing, and application of the coating systems and submit a written report of his observations and any additional recommendations.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Alternative Manufacturers

1. In addition to the coatings listed herein, equivalent products of other manufacturers that distribute globally will also be acceptable.

B. Equivalent Coatings

1. Whenever a coating is specified by the name of a proprietary product or of a particular manufacturer or vendor, it shall be understood as establishing the desired type and quality of coating. Other manufacturers' coatings will be accepted, provided that sufficient information is submitted to enable Engineer to determine that the proposed coatings are equivalent to those named. Information on proposed coatings shall be submitted for review in accordance with the Submittals Procedures section. Requests for review of equivalency will be accepted only from Contractor and will be considered only after the contract has been awarded.

2.2 MATERIALS

A. All coatings shall be delivered to the job in original, unopened containers, with labels intact. Coatings shall be stored indoors and shall be protected against freezing. No adulterant, unauthorized thinner, or other material not included in the coating formulation shall be added to the coating for any purpose.

B. All coatings shall conform to the air quality regulations applicable at the location of use. Coating materials that cannot be guaranteed by the manufacturer to conform, whether or not specified by product designation, shall not be used.

C. With the exception of heat resistant coatings, the coatings specified have been selected on the basis of the manufacturer's statement that the VOC content of the product is 2.8 lbs per gallon or less; however, it shall be the Contractor's responsibility to use only coating materials that are in compliance with the requirements of all regulatory agencies. Local regulations may require some coatings to have a lower VOC content than specified herein. The coatings specified may meet the VOC limits in the unthinned (as shipped) condition but may exceed the limits if thinned according to the manufacturer's recommendations. In such case, the coatings shall not be thinned beyond the 2.8 lbs per gallon limit, and if the product cannot be thinned to suit the application method or temperature limits, another manufacturer's coating shall be used, subject to acceptance by Engineer's coating shall be used, subject to acceptance by Engineer.

D. Contractor shall be responsible for ensuring the compatibility of field coatings with each other or with any previously applied coatings. Coatings used in successive field coats shall be produced by the same manufacturer. The first field coat over shop coated or previously coated surfaces shall cause no wrinkling, lifting, or other damage to underlying coats.

E. All coatings used on surfaces that will be in contact with potable or treated water shall be certified as being in compliance with ANSI/NSF 61. Coatings that cannot be so certified, whether or not specified by manufacturer and by product designation, shall not be used.

F. Primers

Universal Primer (tie coat)	PPG "Amerlock Sealer," Carboline "Rustbond Series," International Devoe "Devran 201H," Tnemec "Series 27 F.C. Typoxy," or Sherwin-Williams "Dura Plate 235."

G. Fillers and Surfacers

Epoxy Concrete Block Filler	PPG "Amerlock 400BF Epoxy Block Filler," Carboline "Sanitile 600," International Devoe "Devron 224V," Tnemec " Series 130 Envirofill ," or Sherwin-Williams " "
Epoxy Concrete Filler and Surfacer	Tnemec "Series 218 MortarClad," PPG Amercoat " 114A," Carboline "Carboguard 510," or Sherwin-Williams "Steel Seam FT910."

H. Intermediate and Finish Coatings

Epoxy (NSF certified systems)

Ferrous Metal Surfaces and Concrete Surfaces in Contact with Treated or Raw Water in Potable Water Facilities	PPG "Amerlock 400 High-Solids Epoxy Coating," Carboline "Carboguard 891 VOC," International Devoe "Bar-Rust 233H" Tnemec "Series N140 Pota-Pox Plus," or Sherwin-Williams "Dura Plate 235 NSF"; immersion service.
Epoxy	
Concrete Floors	PPG "Amerlock 2/400," Carboline "Carboguard 890," International Devoe "Devran 224V," Tnemec "Series N69 Hi-Build Epoxoline II," or Sherwin-Williams "Armorseal 1000HS"; nonskid.
Ferrous Metal Surfaces and Masonry or Concrete Surfaces Other Than Floors	PPG "Amercoat 385 Epoxy," Carboline "Carboguard 890," International Devoe Devran "224V," Tnemec "Series N69 Hi-Build Epoxoline II," or Sherwin-Williams "Dura Plate 235."

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. All surfaces to be coated shall be clean and dry and shall meet the recommendations of the coating manufacturer for surface preparation. Freshly coated surfaces shall be protected from dust and other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss on previously coated surfaces shall be dulled if necessary for proper adhesion of topcoats.

B. Surfaces shall be free of cracks, pits, projections, or other imperfections that would interfere with the formation of a smooth, unbroken coating film, except for concrete block construction where a rough surface is an inherent characteristic.

C. When applying touchup coating or repairing previously coated surfaces, the surfaces to be coated shall be cleaned as recommended by the coating manufacturer, and the edges of the repaired area shall be feathered by sanding or wire brushing to produce a smooth transition that will not be noticeable after the coating is applied. All coatings made brittle or otherwise damaged by heat of welding shall be completely removed.

D. Galvanized Surfaces

1. When a coating is required, galvanized surfaces shall be prepared for coating according to the instructions of the manufacturer of the epoxy. Any chemical treatment of galvanized surfaces shall be followed by thorough rinsing with clean water.

E. Ferrous Metal Surfaces

1. Ungalvanized ferrous metal surfaces shall be prepared for coating by using one or more of the following cleaning procedures specified here-in: solvents (SSPCSP1); abrasive blasting (SSPC-SP5, -SP10, -SP6, or -SP7) power tools (SSPCSP3 or -SP11); or hand tools (SSPCSP2). Oil and grease shall be completely removed in accordance with SSPCSP1 before beginning any other cleaning method. Surfaces of welds shall be scraped and ground as necessary to remove all slag and weld spatter. Tools which produce excessive roughness shall not be used.

2. All components of equipment that can be properly prepared and coated after installation shall be installed prior to surface preparation. Components that will be inaccessible after installation shall have the surfaces prepared and coated before installation. Motors, drive trains, and bearings shall be protected during surface preparation in accordance with the equipment manufacturer's recommendations.

3. All cut or sheared edges shall be ground smooth to a 1/8 inch minimum radius for all material 1/4 inch thickness and larger. For material thickness less than 1/4 inch all cut or sheared edges shall be ground smooth to a radius equal to 1/2 the material thickness. Grinding of rolled edges on standard shapes with a minimum radius of the 1/16 inch will not be required.

4. All ferrous metal surfaces shall have all welds ground smooth and free of all defects in accordance with NACE Standard SP0178, Appendix C, Designation C and sharp edges ground smooth, if not previously prepared in the shop. Instead of blending of the weld with the base metal as required by the NACE standard, it will be acceptable to furnish a welded joint that has a smooth transition of the weld to the base metal. All welds shall be ground smooth to ensure satisfactory adhesion of paint.

5. The cleaning methods and surface profiles specified herein are minimums, and if the requirements printed in the coating manufacturer's data sheets exceed the limits specified, the value printed on the data sheets shall become the minimum requirement.

6. Ferrous Metal Surfaces – Non-immersion Service

   a. Ferrous metal surfaces, including fabricated equipment, in non-immersion service shall be cleaned to the degree recommended by the coating manufacturer for surfaces to be coated with coal tar epoxy, epoxy, and heat-resistant coatings, except galvanized surfaces. Surface preparation of ferrous metal surfaces in non-immersion service shall consist of abrasive blast cleaning to SSPC-SP6, and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 2.0 mils.

7. Ferrous Metal Surfaces - Immersion Service

    a. Surface preparation of ferrous metal surfaces in immersion service shall consist of abrasive blast cleaning to at least SSPC-SP10 and the first application of coating shall be performed on the same day. If more surface area is prepared than can be coated in one day, the uncoated area shall be blast cleaned again to the satisfaction of Engineer. Surface profile shall be as recommended by coating manufacturer, but not less than 3.5 mils.

F. Concrete Surfaces

1. All concrete surfaces shall be free of objectionable substances and shall meet the coating manufacturer's recommendations for surface preparation. Concrete surfaces shall be prepared in accordance with SSPC-SP13/NACE 6. Any other surface preparation recommended by the coating material manufacturer shall be brought to Engineer's attention and may be incorporated into the work if acceptable to Engineer.

2. All concrete surfaces shall be dry when coated and free from dirt, dust, sand, mud, oil, grease, and other objectionable substances. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started.

3. New concrete shall have sufficiently cured for at least 4 weeks or reached moisture content levels at or below the material manufacturer's requirements before coating is applied. Concrete surfaces shall be tested for capillary moisture in accordance with ASTM D4263. There shall be no capillary moisture when coatings are applied on concrete.

4. All surfaces to be coated shall be cleaned and prepared in accordance with the printed manufacturer's requirements or ASTM D4258 and abraded in accordance with ASTM D4259. Surface profile shall be at least 25 percent of the dry film thickness specified for the coating system. Prior to application of the coating, the surfaces shall be thoroughly washed or cleaned by air blasting to remove all dust and residue. Spalled areas, voids, and cracks shall be repaired in accordance with the Concrete section and as acceptable to the Engineer. Fins and other surface projections shall be removed to provide a flush surface before application of coating.

5. Except where epoxy is applied as damp-proofing, the concrete surfaces, including those with bug holes less than 1 inch in any dimension, shall be prepared as recommended by the manufacturer, using an epoxy concrete filler and surfacer. Where coating with a vinyl ester the concrete filler and surfacer shall be as recommended by the manufacturer to be compatible with vinyl ester.

G. Concrete Block Surfaces

1. Voids and openings in concrete block surfaces shall be pointed. All exposed exterior surfaces and surfaces to be coated with epoxy, including the joints, shall be filled so that a continuous unbroken coating film is obtained.

H. Copper Tubing

1. All flux residue shall be removed from joints in copper tubing. Immediately before coating is started, tubing shall be wiped with a clean rag soaked in xylol.

I. Plastic Surfaces

1. All wax and oil shall be removed from plastic surfaces that are to be coated, including PVC and FRP, by wiping with a solvent compatible with the specified coating.

J. Hardware

1. Hardware items such as bolts, screws, washers, springs, and grease fittings need not be cleaned prior to coating if there is no evidence of dirt, corrosion, or foreign material.

K. Aluminum

1. When a coating system is required, remove all oil or deleterious substance with neutral detergent or emulsion cleaner or blast lightly with fine abrasive.

L. Stainless Steel

1. When a coating system is required, surface preparation shall conform to the coating manufacturer's recommendations.

3.2 MIXING AND THINNING

A. Coating shall be thoroughly mixed each time any is withdrawn from the container. Coating containers shall be kept tightly closed except while coating is being withdrawn.

B. Coating shall be factory mixed to proper consistency and viscosity for hot weather application without thinning. Thinning will be permitted only as necessary to obtain recommended coverage at lower application temperatures. In no case shall the wet film thickness of applied coating be reduced, by addition of coating thinner or otherwise, below the thickness recommended by the coating manufacturer. Thinning shall be done in compliance with all applicable air quality regulations.

3.3 APPLICATION

A. Coating shall be applied in a neat manner that will produce an even film of uniform and proper thickness, with finished surfaces free of runs, sags, ridges, laps, and brush marks. Each coat shall be thoroughly dry and hard before the next coat is applied. Each coat shall be a different color, if available. In no case shall coating be applied at a rate of coverage greater than the maximum rate recommended by the coating manufacturer.

B. Coating failures will not be accepted and shall be entirely removed down to the substrate and the surface recoated. Failures include but are not limited to sags, checking, cracking, teardrops, fat edges, fisheyes, or delamination.

C. Priming

1. Edges, corners, crevices, welds, and bolts shall be given a brush coat (stripe coat) of primer before application of the primer coat. The stripe coat shall be applied by a brush and worked in both directions. Special attention shall be given to filling all crevices with coating. When using zinc primers the stripe coat shall follow the initial prime coat.

2. Abraded and otherwise damaged portions of shop-applied coating shall be cleaned and recoated as recommended by the manufacturer of the finish coating. Welded seams and other uncoated surfaces, heads and nuts of field-installed bolts, and surfaces where coating has been damaged by heat shall be given a brush coat of the specified primer. Before the specified spot or touchup coating of metal surfaces, edges, corners, crevices, welds, and bolts in the area of the spot or touchup coating shall be given a brush coat of primer. This patch, spot, or touchup coating shall be completed, and the paint film shall be dry and hard, before additional coating is applied.

D. Epoxy

1. When used, epoxy shall be applied in accordance with the coating manufacturer's recommendations, including temperature limitations and protection from sunlight until top-coated.

2. When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

3. When applying high build epoxy coatings with a roller or brush and where a dry film thickness of at least 4-6 mils per coat is required, two or more coats shall be applied to achieve the recommended dry film thickness equal to a spray applied coating.

E. Coal Tar Epoxy

1. When used, the application of coal tar epoxy, including time limits for recoating, shall conform to the recommendations of the coating manufacturer.

2. When concrete is to be coated, coatings shall not be applied to concrete surfaces in direct sunlight or when the temperature of the concrete is rising. Preferably the coating shall be applied when the temperature of the concrete is dropping.

F. Film Thickness

1. The total coating film thickness including intermediate coats and finish coat, shall be not less than the following:

Type of Coating	Minimum Dry Film Thickness
Medium consistency coal tar	20 mils.
Coal tar epoxy (two coats)	20 mils .
Epoxy	
Floors (two coats)	10 mils.

Type of Coating	Minimum Dry Film Thickness
Surfaces with first coat of epoxy and final coat of aliphatic polyurethane	7 mils (5 mils DFT for epoxy plus 2 mils DFT for aliphatic polyurethane).
Surfaces with first and second coat of epoxy and final coat of aliphatic polyurethane	12 mils (10 mils DFT for epoxy plus 2 mils DFT for aliphatic polyurethane).
Other surfaces (two coats)	10 mils.
Immersion service (three coats)	15 mils.
Flake-filled epoxy (two coats)	30 mils.
Other (one coat)	5 mils.
Other (two coats)	10 mils.

G. Weather Conditions

1. Coatings shall not be applied, except under shelter, during wet, damp, or foggy weather, or when windblown dust, dirt, debris, or insects will collect on freshly applied coating.

2. Coatings shall not be applied at temperatures lower than the minimum temperature recommended by the coating manufacturer, or to metal surfaces such as tanks or pipe containing cold water, regardless of the air temperature, when metal conditions are likely to cause condensation. When necessary for proper application, a temporary enclosure shall be erected and kept heated until the coating has fully cured.

3. Coatings shall not be applied at temperatures higher than the maximum temperature recommended by the coating manufacturer. Where coatings are applied during periods of elevated ambient temperatures, Contractor and the coatings manufacturer shall be jointly responsible to ensure that proper application is performed including adherence to all re-coat window requirements. Precautions shall be taken to reduce the temperature of the surface application, especially for metal, at elevated temperatures above 100° F including shading application area from direct sunlight, applying coating in the evening or at night, and ventilating the area to reduce the humidity and temperature,

3.4 REPAIRING FACTORY FINISHED SURFACES

A. Factory finished surfaces damaged prior to acceptance by Owner shall be spot primed and recoated with materials equivalent to the original coatings. If, in the opinion of Engineer, spot repair of the damaged area is not satisfactory, the entire surface or item shall be recoated.

3.5 PROTECTION OF SURFACES

A. Throughout the work Contractor shall use drop cloths, masking tape, and other suitable measures to protect adjacent surfaces. Contractor shall be responsible for correcting and repairing any damage resulting from its or its subcontractors' operations. Coatings spilled or spattered on adjacent surfaces which are not being coated at the time shall be immediately removed. Exposed concrete or masonry not specified to be coated which is damaged by coatings shall be either removed and rebuilt or, where authorized by Owner, coated with two coats of masonry coating.

3.6 FIELD QUALITY CONTROL

A. The following inspection and testing shall be performed: surface profile, visual inspection, and wet and dry film thickness testing. All inspection and testing shall be witnessed by Engineer.

B. Surface Profile Testing

1. The surface profile for ferrous metal surfaces shall be measured for compliance with the specified minimum profile. The surface profile for concrete shall comply with SSPC 13/NACE 6 Table 1 for severe service.

C. Visual Inspection

1. The surface of the protective coatings shall be visually inspected.

D. Film Thickness

1. Coating film thickness shall be verified by measuring the film thickness of each coat as it is applied and the dry film thickness of the entire system. Wet film thickness shall be measured with a gauge that will measure the wet film thickness within an accuracy of ±0.5 mil. Dry film thickness shall be measured in accordance with SSPC-PA 2.

3.7 FIELD PRIMING SCHEDULE

A. In general, steel and cast iron surfaces of equipment are specified to be shop primed. Any such surfaces which have not been shop primed shall be field primed. Damaged or failed shop coatings which have been determined unsuitable by Engineer shall be removed and the surfaces shall be field coated, including prime coat (if any). Galvanized, aluminum, stainless steel, and insulated surfaces shall be field primed. Primers used for field priming, unless otherwise required for repair of shop primers, shall be:

Surface To Be Primed	Material
Equipment, surfaces to be coated with	
Epoxy	Same as finish coats.
Coal tar coating	Same as finish coats.
Steel and cast iron, surfaces to be coated with	
Epoxy	Same as finish coats or inorganic zinc.
Coal tar coating	Same as finish coats.
Aluminum	Epoxy.
Galvanized	Epoxy.
Copper	Epoxy.
Stainless steel	Epoxy.
Plastic surfaces, including PVC and FRP	Same as finish coats.
Piping Insulation	As Recommended by manufacturer of finish coats.

Surface To Be Primed	Material
Concrete, surfaces to be coated with epoxy	
For damp-proofing	Epoxy.
For all other surfaces	Epoxy concrete filler and surfacer.
Concrete block exposed in exterior locations	Epoxy concrete block filler.
Concrete block to be coated with epoxy	Epoxy concrete block filler.

B. Unless otherwise recommended by the coating manufacturer or specified herein, priming will not be required on concrete, or concrete block, nor on metal surfaces specified to be coated with coal tar epoxy, and heat-resistant coatings. Concrete surfaces to be coated with epoxy shall be filled with epoxy concrete filler and surfacer so that a continuous film is obtained, except where concrete is damp-proofed with epoxy.

3.8 FINISH COATING SYSTEMS

A. The following schedule lists coatings systems and coating surface designations. See Article 1-3 for a definition of the surface designations.

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
1.	Epoxy – One coat	x			x	x		
2.	Epoxy – Two coats	x	x	x	x	x		x
3.	Epoxy / NSF – Two coats		x	x				
4.	Epoxy – Three coats	x	x	x				
5.	Epoxy / NSF – Three coats	x	x	x				
6.	Epoxy – First coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		x
7.	Epoxy – First and second coat Aliphatic polyurethane – Finish coat	x	x	x	x	x		
8.	Universal primer – First coat Aliphatic polyurethane – Finish coat	x		x				
9.	Medium consistency coal tar – Two coats	x	x	x				
10.	Coal tar epoxy – Two coats	x	x	x				
11.	Vinyl ester – Two coats	x	x	x				
12.	Heat resistant – Two coats						x	
13.	High heat resistant – Two coats						x	
14.	Zinc primer – First coat Epoxy – Intermediate coat Aliphatic polyurethane – Final coat	x		x				
15.	Flake-filled epoxy	x		x				

No.	Finish Coating Systems	Coating Surface Designation						
		A	C	E	F	G	H	P
16.	Acrylic Latex Emulsion		x					x

B. Surfaces Not To Be Coated

1. Unless otherwise specified, the following surfaces shall be left uncoated:

   a. Exposed aluminum, except ductwork.
   b. Polished or finished stainless steel. Unfinished stainless steel, except flashings and counter flashings, shall be coated.
   c. Nickel or chromium.
   d. Galvanized surfaces, except piping, conduit, ductwork, and other items specifically noted. Hot dipped galvanized fabrications, including fabricated pipe supports, except where specifically noted.Rubber and plastics, except as specified.
   e. Exterior concrete.
   f. Surfaces specified to be factory finished.

C. Shop Finishing

1. Shop finishing shall be in accordance with the coating manufacturer's recommendations.

D. Field Coating

1. Items to be field coated include the following. Field coating shall be in accordance with the field priming schedule, the coating schedule, and the manufacturer's recommendations.

   a. Surfaces not indicated to be shop finished and surfaces where blast cleaning can be performed in the field.

3.9 METAL SURFACES COATING SCHEDULE

Surfaces to be coated shall include new work, including Owner furnished equipment and surfaces disturbed by the Work. Surfaces that are not disturbed will not require recoating unless noted otherwise on the Drawings.

Surface To Be Coated	Finish Coating System
Non-galvanized and galvanized structural and miscellaneous steel exposed to view or to the elements in exterior locations.	A7
Non-galvanized and galvanized structural and miscellaneous steel exposed to view inside buildings.	A2
Steel handrails, steel floor plates, door frames.	A8
Unless otherwise specified, pumps, motors, speed reducers, and other machines and equipment exposed to view.	E8

Surface To Be Coated	Finish Coating System
Heating and air conditioning units, convector covers, electrical equipment cabinets, and similar Items and equipment (unless factory finished) exposed to view.	E8
Surfaces of cranes and hoists exposed to view indoors.	E2
Steel yard lighting poles exposed to view or to the elements.	A8
Cast Iron and steel piping inside buildings, including piping to be insulated, valves, fittings, flanges, bolts, pipe support, hangers, and accessories and galvanized surfaces after proper priming.	A2
Pipe supports, hangers, bolts, and accessories inside buildings and galvanized surfaces after proper priming	A2
Copper pipe and tubing, including fittings and valves exposed to view in exterior locations.	F6
Miscellaneous castings, including manhole rings and covers, and manhole steps. (One coat, if not shop coated.)	E2
All metal harness anchorage for buried piping.	A10
Aluminum in contact with concrete.	F1
Boiler breeching and other surfaces which will be hot during operation.	H13
Aluminum and galvanized ductwork and conduit indoors.	F1 or G1
Aluminum and galvanized ductwork and conduit exposed to elements outdoors.	F6 or G6
Aluminum materials exposed to the elements outdoors.	F6

3.10 CONCRETE AND MASONRY SURFACES COATING SCHEDULE

Surfaces to be coated shall include new work and surfaces disturbed by the Work. Surfaces that are not disturbed will not require recoating unless noted otherwise on the Drawings.

Surface To Be Coated	Finish Coating System
Interior walls for architectural finish only	C2

3.11 MISCELLANEOUS SURFACES COATING SCHEDULE. Not used

3.12 PIPING IDENTIFICATION SCHEDULE

A. Exposed piping and piping in accessible chases shall be identified with lettering or tags designating the service of each piping system, marked with flow directional arrows, and color coded.

B. Piping scheduled to be color coded shall be completely coated with the indicated colors, except surfaces specified to remain uncoated shall include sufficiently long segments of the specified

color to accommodate the lettering and arrows. All other piping shall be coated to match adjacent surfaces, unless otherwise directed by Engineer.

C. Location

1. Lettering and flow direction arrows shall be provided on pipe near the equipment served, adjacent to valves, on both sides of wall and floor penetrations, at each branch or tee, and at least every 50 feet in straight runs of pipe. If, in the opinion of Engineer, this requirement will result in an excessive number of labels or arrows, the number required shall be reduced as directed.

D. Metal Tags

1. Where the outside diameter of pipe or pipe covering is 5/8 inch or smaller, aluminum or stainless steel tags shall be provided instead of lettering. Tags shall be stamped as specified and shall be fastened to the pipe with suitable chains. Pipe identified with tags shall be color coded as specified.

E. Lettering

1. Lettering shall be painted or stenciled on piping or shall be applied as snapon markers. Snapon markers shall be plastic sleeves, Brady "BradysnapOn B915," Seton "Setmark," or equal. Letter size shall be as follows:

Outside Diameter of Pipe or Covering	Minimum Height of Letters
5/8 inch and smaller	Metal tags -1/4 inch
3/4 to 4 inches	3/4 inch
5 inches and larger	2 inches

F. Color Coding and Lettering

1. All piping for the following services shall be color coded. Bands shall be 6 inches wide spaced along the pipe at 5 foot intervals. For services not listed, the color coding and lettering shall be as directed by the Engineer.

2. Pipe colors shall match existing at the Owner's existing site.

Piping Identification		
Service	**Color of Pipe**	**Color of Letters**
Compressed Air	Dark green	Black
Distilled Water	Light Blue with white bands	Red
Drain and Plumbing Vents	Dark gray	White
Natural Gas	Yellow with red bands	Black
Treated Water, Finished Water, Service Water	Light blue	White[1]
Sample	Light gray with green bands	Black

G. Notes:

1. Electrical conduit shall be coated to match adjacent ceiling or wall surfaces as directed by Engineer. Vent lines shall be coated to match surfaces they adjoin.

2. In addition, special coating of the following items will be required:

Item	Color
Valve handwheels and levers	Red
Hoist hooks and blocks	Yellow and black stripes

3. Numerals at least 2 inches high shall be painted on or adjacent to all accessible valves, pumps, flowmeters, and other items of equipment which are identified on the Drawings or in the Specifications by number.

End of Section

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SURFACE DESCRIPTION	SYSTEM NO.

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1
☐ Ferrous Metal Nonimmersion SSPC-SP6
☐ Ferrous Metal Immersion
☐ SSPC-SP10
☐ SSPC-SP-5
☐ Other

COATING	**DFT** mils	**MANUFACTURER AND PRODUCT**
First Coat (Primer)		
Second Coat		
Third Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:	
Coatings Manufacturer:	Initials _____
Painting Applicator:	Initials _____

BLACK & VEATCH	COATING SYSTEM DATA SHEET	Fig 1-09940

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SHOP PRIMED SURFACE DESCRIPTION SYSTEM NO. - -F

SURFACE PREPARATION DESCRIPTION
☐ Solvent SSPC-SP1 ☐ Other

COATING	DFT mils [µm]	MANUFACTURER AND PRODUCT
Shop Primer		(Identify Product/Type)
Touchup		
Intermediate Coat		
Finish Coat		
Total System		Not less than minimum thickness specified.

Notes: (Attached if needed.)

Project:	
Coatings Manufacturer:	Initials _____
Painting Applicator:	Initials _____

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SECTION 10160 METAL TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing and installation of metal toilet partitions and urinal screens as indicated on the drawings.

1.2 GENERAL.

A. The partitions and screens shall be the products of a single manufacturer. Manufacturers shall be regularly engaged in the manufacture of the types indicated and specified. The partitions shall be furnished complete with all hardware and appurtenances necessary for a satisfactory installation.

B. Provide products with average content so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

C. Materials and products shall be extracted, harvested or recovered, as well as manufactured within 500 miles of the project site.

D. Installation of toilet partitions shall be as indicated on the drawings and in accordance with manufacturer's instructions.

1.3 DELIVERY, STORAGE, AND HANDLING.

A. Shipping shall be in accordance with the Shipping section. Handling and storage shall be in accordance with the Shipping and Storage section.

B. Damaged items will be rejected and shall be replaced.

1.4 SUBMITTALS.

A. Complete specifications, detailed drawings, and setting or installation drawings covering arrangement, dimensions, hardware and accessories, details of construction, finishes, anchoring methods, and installation of the toilet compartments and the screens shall be submitted in accordance with the Submittals section.

B. Submit documentation indicting percentages by weight of post-consumer and pre-consumer recycled content; including documentation indicating location and distance from project of material manufacturer and point of extraction, harvest or recovery for each raw material.

1.5 COLOR SELECTION.

A. Colors for the toilet partitions and urinal screens will be selected by Engineer from the manufacturer's complete line of colors.

B. Procedures for selecting colors shall be as indicated in the Submittals section

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA.

A. General.

1. Toilet partitions shall be floor braced. Urinal screens shall be wall hung. Locations for different types shall be as indicated on the drawings.

2. Metal thicknesses and gages of sheet metal used herein are the minimum required. Gages refer to US Standard gage.

B. Attachment Materials.

1. The partitions and screens will be attached to gypsum board and metal studs.

C. Configuration.

1. Toilet compartments shall be of the configurations included on the drawings.

D. Finish.

1. All exposed surfaces, other than hardware, shall be thoroughly cleaned and given a coat of universal primer, followed by the manufacturer's standard baked enamel finish.

2.2 PRODUCTS.

A. Toilet Compartments.

1. Floor braced metal toilet compartments shall be Sanymetal "Normandie", Metpar "Luxor", or Global "Regal".

B. Urinal Screens.

1. Urinal screens shall be wall hung, Bobrick "1085 Series", Metpar "WH", or Global "WH".

2.3 CONSTRUCTION.

A. Doors and Partitions.

1. Doors and partitions shall be 1 inch thick, made of two sheets of steel cemented under pressure to dense, sound-deadening core insulation. The two face plates on the doors and partitions shall have formed edges, interlocked or provided with steel edge molding, and with corners welded and ground smooth. Pilasters shall be of similar construction, except thickness shall be 1-1/4 inches. Pilasters for ceiling hung partitions shall be of custom length to suit the ceiling height and mounting details as indicated on the drawings. Metal thicknesses shall be at least 22 gage for doors,

2. 20 gage for partition panels, and 16 gage for pilasters.

B. Urinal Screens.

1. Urinal screens shall be 24 inches wide by 42 inches high by 1 inch thick, and shall be of the same construction, finish, and color as the toilet partitions. The top of the screens shall be hung 60 inches above the finished floor, unless otherwise indicated on the Drawings.

C. Hardware and Fittings.

1. Wall and pilaster stirrup brackets shall be AISI Type 304 stainless steel or chromium plated nonferrous metal. Doors shall be hung on gravity hinges having antifriction or ball bearing cams, adjustable to permit the door to be set self-closing, self-opening, or ajar, with operating parts contained within the door. Each door shall be equipped with one cast alloy chromium plated coat hook and bumper, one cast alloy chromium plated concealed latch with stainless steel bolt, and one cast alloy chromium plated combination doorstop and latch keeper.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Toilet partitions and screens shall be installed straight, plumb, level, and rigid, in accordance with the manufacturer's instructions.

B. Stirrup brackets shall be bolted securely to masonry walls by means of expansion bolts or toggle bolts. Toggle bolts, molly bolts, plastic anchors, or other attachment to gypsum wallboard panels will not be acceptable. Exposed bolts and screws shall be provided with chrome plated cap nuts.

C. Pilasters for floor braced and overhead braced compartments shall be securely anchored to the floor in accordance with the manufacturer's instructions, and the connections shall be concealed with stainless steel or chrome plated shoes.

End of Section

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SECTION 10200 - LOUVERS AND VENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of stationary type weather louvers and acoustical louvers. Combination louver/dampers, control dampers, fire dampers, adjustable louvers, and smoke vents are covered in other sections.

1.2 GENERAL

A. Louvers shall be furnished and installed as specified herein and in accordance with the details, louver schedule, or arrangements indicated on the Drawings.

B. Louvers and vents shall be of the sizes required for opening sizes indicated on the Drawings. Actual opening sizes for louvers or vents scheduled for insertion within existing construction shall be field verified. Actual louver sizes shall allow for shim and caulk space.

1.3 SUBMITTALS

A. Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers and vents shall be submitted in accordance with the Submittals Procedures section.

1.4 COLOR SELECTION

A. Colors of louvers and vents will be selected from the manufacturer's full line of colors by Engineer. Custom colors shall be furnished. Procedures for selecting colors shall be as indicated in the Submittals Procedures section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Materials shall be handled, transported, and delivered in a manner which will prevent bends, dents, scratches, or damages of any kind. Damaged materials shall be promptly replaced. Materials shall be stored off the ground and protected from the weather.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Governing Standard

1. Except as modified or supplemented herein, all stationary louvers shall be certified to meet the performance criteria specified and outlined by AMCA Standard 500.

B. Finishes

1. Louvers and vents shall have a Kynar paint finish.

2. 70% Kynar paint finishes shall meet the AAMA specification 2605-11 with 1.2 mils total dry film thickness.

C. Construction

1. Louvers and vents shall be of aluminum construction and shall be the product of one manufacturer. Louvers and vents shall be furnished complete with all hardware and appurtenances necessary for a satisfactory installation. The louvers shall have extended sills as shown on the Drawings. The louvers shall be welded construction.

2. Stationary type weather louvers shall be architectural style continuous blades with concealed mullions.

D. Performance Requirements

1. Stationary Type

a. The velocity at which the beginning point of water penetration occurs for stationary type weather louvers shall be at least 790 fpm. The minimum free area for a 48 inches x 48 inches louver shall be 54 percent. The maximum static pressure loss at 600 fpm shall be 0.08 inches wc.

2. Acoustical Type

a. The velocity at which the beginning point of water penetration occurs for six inch deep acoustical type louvers shall be at least 800 fpm. The minimum free area for a 48 inches x 48 inches louver shall be 25 percent. The maximum static pressure loss at 800 fpm shall be 0.08 inches wc. The minimum noise decibel reduction shall be as follows:

Octave Band/hz	1/63	2/125	3/250	4/500	5/1000	6/2000	7/4000	8/8000
NR, db	9	7	8	9	10	16	16	19

2.2 ACCEPTABLE PRODUCTS

A. Stationary Type Weather Louvers

1. Subject to the requirements specified herein, stationary type weather louvers shall be equivalent to the following:

Ruskin "ELF-375XH"

Arrow United Industries "EA-410"

B. Acoustical Louvers

1. Subject to the requirements specified herein, 6 inch deep acoustical louvers shall be equivalent to the following:

Ruskin "EAL6811"

American Warming and Ventilating "LAA-66"

C. Accessories

1. Stationary type louvers and acoustical louvers shall have aluminum removable bird screens.

2.3 Materials

Aluminum Extrusions	ASTM B221, Alloy 6063-T5, minimum 0.125 inch thick.
Bird Screen	0.051 inch expanded, 0.50-inch flattened bird screen.

PART 3 - EXECUTION

3.1 GENERAL

A. Products shall be installed in accordance with this section, the manufacturer's instructions, and as indicated on the Drawings.

B. Complete specifications and detailed drawings covering arrangement, dimensions, hardware, accessories, and details of construction and installation of the louvers and vents will be made available to the louver and vent installer.

3.2 INSTALLATION

A. The louvers shall be installed with anchors suitable for the adjacent material and shall be caulked as specified in the caulking section. When required, bird screens or insect screens shall be installed on the louvers.

B. Where aluminum work is to be attached to steel supporting members or other dissimilar metal, the aluminum shall be kept from direct contact with such metals by a heavy coat of epoxy enamel in accordance with the Architectural Painting section. Aluminum surfaces which will be in contact with concrete or masonry when installed shall be given a heavy coat of epoxy enamel. All paint shall be dry and hard when the coated parts are installed.

End of Section

SECTION 10800 - TOILET ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers toilet accessories and associated items.

1.2 GENERAL

A. Toilet accessories shall be furnished and installed as specified herein and in accordance with the details and arrangements indicated on the drawings. Whether or not specifically indicated or specified, all fasteners, gaskets, sealants, and other accessories shall be provided as required and as recommended by the manufacturer of the specific item.

1.3 SUBMITTALS

A. Specifications, installation drawings, and other data covering items specified herein shall be submitted in accordance with Section 01300, Submittals Procedures.

PART 2 - PRODUCTS

2.1 TOILET ACCESSORIES

Item Designation	Item	Description	Mounting Height
A / A.5	Towel Dispenser and Waste Receptacle	Surface-mounted; stainless steel; American Specialties "20210", Bobrick "B-4262", or equal.	5'-4"
B	Soap Dispenser	Wall-mounted liquid dispenser; stainless steel or chrome plated; American Specialties "9343", Bobrick "B-2111", Bradley "6563", or equal.	4'-0"

Item Designation	Item	Description	Mounting Height
C	Grab Bar	Stainless steel, wall-mounted, concealed fastenings, 1-1/2 inch diameter, toilet compartment bar with safety grip surface; Bobrick "B-62061x48", Bradley "8122-00148", or equal.	3'-0"
D	Grab Bar	Stainless steel, wall-mounted, concealed fastenings, 1-1/2 inch diameter, toilet compartment bar with safety grip surface; Bobrick "B-6206x36", Bradley "8122-00136", or equal.	3'-0"
E	Toilet Paper Holder	Surface-mounted, double roll; satin aluminum; American Specialties "0264-1", Bobrick "B-2740", McKinney "1031D", or equal.	2'-4"
F	Framed Wall Mirror	24 inches by 36 inches, stainless steel framed with shelf; Bobrick "B-166 2436", McKinney "190", or approved equal.	6'-0"
G	Shelf	Surface mounted stainless steel, 24 inches by 8 inches; American Specialties "0692-824", Bobrick "B-298", or approved equal.	5'-0"
H	Mop Hanger	American Specialties "0796A", Bobrick "B-223-24", or McKinney"232-24".	6'-0"

PART 3 - EXECUTION

3.1 INSTALLATION

3.2 Toilet accessories shall be installed straight, plumb, level, and rigid, in accordance with the manufacturer's instructions, the IBC Building Code, and ADA.

End of Section

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SECTION 10990 MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the miscellaneous items of work not covered in other sections.

1.2 GENERAL.

A. Miscellaneous specialties shall be furnished and installed as specified herein and in accordance with the details, arrangements, and dimensions indicated on the drawings. Where not specifically indicated or specified, fasteners, gaskets, and other accessories shall be provided as required and as recommended by the manufacturer of the specific item.

1.3 DRAWINGS AND DATA.

A. Complete specifications, detailed drawings, and setting or erection drawings covering miscellaneous specialties shall be submitted in accordance with the submittals section.

PART 2 - PRODUCTS

2.1 PORTABLE FIRE EXTINGUISHERS.

A. Carbon Dioxide Fire Extinguisher (CO2).

1. Portable fire extinguishers of the carbon dioxide type shall be provided where indicated on the Drawings. The fire extinguishers shall be UL-approved for Class B and C fires and shall have a 20 lb capacity, such as Potter-Roemer Model 3420, or acceptable equal with UL rating of 10B:C. Finish of shell shall be red.

B. Multipurpose Dry Chemical Fire Extinguishers (DCP).

1. Portable fire extinguishers of the all-purpose, nitrogen-pressured, dry chemical type shall be provided as scheduled herein. The fire extinguishers shall be UL approved for Class A, B, and C fires and shall have a 10 pound capacity, such as Badger "10MB-8H", Buckeye "10 LB - ABC", or Kidde "Pro 460". Finish of shell shall be red with all metal handle and valve.

C. Wall-mounted fire extinguishers shall be mounted on suitable wall brackets at the specific locations as indicated on the Drawings.

2.2 HAZARDOUS CHEMICAL WARNING SIGNS.

A. Hazardous Chemical Warning Signs with Hazard Indicators.

1. Door-mounted hazardous chemical warning signs with hazard indicators shall be provided as required by local Fire Marshall and as indicated below. These signs shall be diamond-shaped with four color quadrants conforming to NFPA 704. The exact location, number and text of these signs shall be determined by the local Fire Marshall with jurisdiction. These signs shall be 10-inch square overall size and shall be equivalent to Seton Name Plate Co. “Metal-backed butyrate (BMB)”. Style shall be suitable for screw fastening to metal doors and attachment to storage tanks.

2. Hazardous chemical warning signs shall be furnished and installed for the chemicals as indicated below. A sign shall be provided on each room entrance.

Location	Type of Hazard	Health	Flammability	Reactivity	Specialty
Pump Station: Laboratory	Sulfuric Acid	3	0	2	~~W~~
	Nitric Acid	4	0	1	OX

2.3 NO SMOKING SIGNS.

A. A “No Smoking” sign, combination of words and symbol, shall be mounted on each exterior door to the Pump Station and Electrical Building, for a total of 11 signs. Signs shall be 17 inches by 7 inches and shall be semi-rigid plastic.

2.4 SITE ENTRANCE SIGN.

A. A Site Entrance sign, stating:

1. “BEAVER WATER DISTRICT CONTACT (XXX) XXX-XXXX FOR ACCESS”

B. Sign shall be mounted on the site entrance gate to the Western Corridor Pump Station facility. Sign shall be 18 inches by 24 inches and shall be painted aluminum.

PART 3 - EXECUTION

A. PROTECTION.

1. All parts and assemblies shall be protected during fabrication, shipment, storage, and erection to prevent damage. Damaged units will be rejected and shall be replaced at no additional cost to the Owner.

End of Section

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SECTION 11060 - EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers general installation requirements of new equipment units that have been purchased by Contractor as part of this Work. Equipment specific installation requirements are covered in the equipment sections.

1.2 GENERAL.

A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

1. Coordination. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services furnished by others.

2. Flanged connections to equipment including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section.

PART 2 - PRODUCTS

2.1 MATERIALS.

A. Materials shall be as follows:

Grout	As specified in the Grouting section.
Anti-Seize thread lubricant for SS bolts	As specified in the Anchorage in Concrete and Masonry section.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results as specified in the Startup Requirements section.

1. Each equipment unit shall be leveled, aligned, and shimmed into position. Installation procedures shall be as recommended by the equipment manufacturer and as required herein. Shimming between machined surfaces will not be permitted.

2. Anti-seize thread lubricant shall be liberally applied to the threaded portion of all stainless steel bolts during assembly. For equipment installed in drinking water facilities, the anti-seize lubricant shall meet requirements of NSF-61.

3. When specified in the equipment sections, the equipment manufacturer will provide installation supervision and installation checks. For installation supervision, the manufacturer's field representative will observe, instruct, guide, and direct Contractor's erection or installation procedures as specified in the equipment specifications. For installation checks, the manufacturer's field representative will inspect the equipment installation immediately following installation by Contractor, and observe the tests indicated in the Startup Requirements section. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

4. All equipment shall be protected after installation, prior to final acceptance by Owner. Protection provisions shall be as recommended by the manufacturer, and shall include provisions to prevent rust, mechanical damage, and foreign objects entering the equipment.

3.2 STARTUP AND TESTING.

A. Startup requirements, and tests associated with startup shall be as indicated in the Startup Requirements section. Other field tests shall be as indicated in the specific equipment sections. Startup and tests required shall occur in the order listed in the following paragraphs. Tests shall not begin until any installation supervision and installation checks by the equipment manufacturer have been completed, except where noted below.

B. Preliminary Field Tests.

1. Preliminary field tests shall be conducted on all equipment by Contractor as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's representative will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

C. Field System Operation Tests.

1. Field system operation tests shall be conducted on all equipment by Contractor as indicated in the Startup Requirements section. When an installation check is specified in the equipment sections, the equipment manufacturer's service personnel will participate in these tests to the extent described in the Startup Requirements section and in the equipment sections.

End of Section

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SECTION 11110 - HORIZONTAL SPLIT CASE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of single-stage, horizontal, split case, double suction centrifugal pumping units.

Pump designation.	Springdale Pump No. 1, No. 2, and No. 3	Fayetteville Pump No. 1, No. 2, and No. 3
Number of pumps.	3	3
Pump tag numbers.	42-PSC-301, 42-PSC-302, 42-PSC-303	42-PSC-401, 42-PSC-402, 42-PSC-403
Pump location.	Western Corridor Pump Station Interior	

B. Each pumping unit shall be complete with a pump, electric motor, coupling, coupling guard, anchor bolts, and other appurtenances specified or otherwise required for proper operation, all mounted on a common baseplate.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer. Hydraulic considerations and definition of terms shall be as set forth in the Hydraulic Institute Standards. All pump wetted components exposed to the process fluid shall be NSF-61 certified.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

E. Power Supply

1. Unless otherwise indicated, power supply to the equipment shall be 4160 volts, 60 Hz, 3 phase.

F. Identification

1. Pumps shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Pumps

1) Name of manufacturer.

2) Type and model.

3) Tag number.

4) Pump location.

5) Rotative speed.

6) Size of suction nozzle.

7) Size of discharge nozzle.

8) Net weight of pump only.

9) Net weight with baseplate and couplings.

10) Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire-to-water efficiency, and pump input power.

11) Data on coupling.

12) Data on shop painting.

b. Complete Pumping Unit

1) Max overall dimensions.

2) Total weight.

3) Detailed fabrication drawings are required if the base plate is 8 feet long or longer.

4) Base and anchor bolt details.

c. Motors

1) As specified in the Medium-Voltage Induction Motors section.

d. Adjustable Frequency Drives

1) As specified in the Medium-Voltage Adjustable Frequency Drives section.

e. Seismic Design Requirements

1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE

A. Balance

1. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration velocity, as measured at any point on the machine including the motor, shall not exceed the maximum vibration limits of the governing standard unless otherwise required.

2. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

B. Efficiency Evaluation

1. If the efficiency, as determined by the shop test, is below the specified minimum efficiency, Owner may, at his option, reject the unit.

1.5 SPARE PARTS AND ACCESSORIES

A. The following spare parts and accessories shall be furnished in substantial wooden boxes with identifying labels and delivered to the vicinity of the project site or the Owner as directed:

Spare Parts	Quantity
Mechanical seals.	1 set per pump
Complete sets of pump bearings.	1 set per pump
Complete sets of wearing rings.	1 set per pump
Complete sets of shaft sleeves	1 set per pump
Complete sets of gaskets and seals.	1 set per pump
Flexible coupling.	1 set per pump
Bearings and seals of drive motor.	1 set per pump

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. The pumping units shall be suitable for the following service conditions:

Seismic design requirements.	See Meteorological and Seismic Design Criteria section
Type of environmental exposure.	Indoor
Pumps start and stop against a closed valve.	Yes
Site elevation.	See Meteorological and Seismic Design Criteria section

B. Parts shall be interchangeable between units of similar size and capacity to extent practical.

C. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at this elevation.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Pumping units shall be designed for the operating conditions as follows:

Pump tag numbers.	42-PSC-301, 42-PSC-302, 42-PSC-303	42-PSC-401, 42-PSC-402, 42-PSC-403	
Rated head.	247	321	ft

Pump tag numbers.	42-PSC-301, 42-PSC-302, 42-PSC-303	42-PSC-401, 42-PSC-402, 42-PSC-403	
Capacity at rated head.	6,910	7,222	gpm
Secondary head.	200	246	ft
Minimum capacity at secondary head.	8,333	9,030	gpm
Operating head range for full speed continuous operation.	175 to 280	230 to 340	ft
Minimum shutoff head.	310	347	ft
Maximum shutoff head.	350	420	ft
Maximum nominal pump speed.	1,800	1,800	rpm
Minimum head at reduced speed.	157	212	ft
Capacity at minimum head at reduced speed.	5,625	4,375	gpm
Approximate minimum pump speed.	1,200	1,200	rpm
Maximum nameplate motor horsepower required at any point from minimum operating head to shutoff head.	650	900	bhp
Minimum Efficiency.	82	82	%
Type of efficiency indicated.	Pump	Pump	
Efficiency calculated at.	Rated head	Rated head	
Pump designed for reverse rotation.	Yes	Yes	

Pump tag numbers.	42-PSC-301, 42-PSC-302, 42-PSC-303	42-PSC-401, 42-PSC-402, 42-PSC-403	
Maximum head for reverse rotation.	247	321	ft
Minimum NSPHA at rated head.	60	60	ft
Minimum NSPHA at minimum operating head.	68	68	ft
Maximum suction pressure.	58	58	psi
Maximum "A" rated weighted noise at 3 ft.	89	89	dBa
Maximum unfiltered vibration velocity.	HIS	HIS	in/s
Pump rotation as viewed from driven end.	See Drawings	See Drawings	
Minimum pump suction nozzle size.	18	18	in
Minimum pump discharge nozzle size.	10	10	in

B. All specified conditions shall be at rated speed, unless otherwise indicated.

C. Overall (wire-to-water) efficiency for variable speed pumps shall include losses in the pump, motor, adjustable frequency drive, and any transformers supplied as part of the adjustable frequency drive equipment.

D. The minimum hydrostatic test pressure shall be 1.5 times shutoff head plus max suction pressure.

E. Pump performance shall be stable and free from cavitation and noise throughout the specified operating head range at design suction submergences. The design performance shall be based on a wearing ring diametral clearance of not less than 1 mil per inch of wearing ring diameter, or 12 mils total, whichever is greater.

F. Pumping units shall be designed so that maximum reverse rotation due to reverse flow at the head specified above, will not cause damage to any component. Pump supplier shall coordinate this provision with the motor supplier.

2.3 MATERIALS

A. Each pump shall be cast iron, bronze fitted, NSF-61 certified, using the following materials:

Casing	Cast iron, ASTM A48.
125 lb flange rating	ANSI/ASME B16.1, Class 125 flat-faced dimensions and drilling.
Casing Wearing Ring	Bronze, ASTM B505-952.
Impeller	Bronze, ASTM B148.
Impeller Wearing Ring	Bronze, ASTM B505-954.
Shaft	Carbon steel, AISI 1045.
Shaft Sleeve	Bronze, ASTM B505-954.
Stuffing Box Hardware	Corrosion-resistant metal.
Mechanical Seal	Durametallic "Type RO" or John Crane "Type 1."
Bearings	Antifriction.
Drive Shaft Coupling	Gear Type; All metal, oil or grease filled.
Baseplate	Cast iron or fabricated steel.
Rust-preventive compound	As recommended by manufacturer.

2.4 PUMP CONSTRUCTION

A. Casing

1. The upper and lower casing halves shall be flange-bolted and doweled together with tapered dowels. The upper half casing flange shall have tapped holes for jacking screws and lifting lugs or eyebolts. Supporting feet, bearing arms, and nozzles shall be either cast integrally with or bolted and doweled to the lower half casing. Pipe tapped openings shall be provided for draining, priming, and venting the casing and for draining stuffing box leakage.

2. For pumping units driven by 100 hp or larger motors, pump feet shall be provided for bolting and doweling to a baseplate.

3. The discharge volute shall be of the double or dual type to minimize hydraulic radial thrust.

B. Impeller

1. The impeller shall be a one-piece casting completely machined on all exterior surfaces and dynamically balanced. The interior water passages shall have uniform sections and smooth surfaces and shall be free from cracks and porosity.

2. The impeller shall be keyed to the shaft and positively held in the center of the discharge volute.

C. Shaft and Shaft Sleeves

1. The shaft shall be completely machined. If the shaft is more than 2-1/2 inches in diameter, it shall be tapered at the coupling end. Deflection at the stuffing box shall not exceed 0.002 inch at any operating head.

2. The shaft shall be provided with sleeves extending from the impeller through each stuffing box. Each sleeve shall be positively secured to the shaft and shall be sealed to prevent leakage between the shaft and the sleeve. After assembly on the shaft, total runout shall not exceed 0.002 inch.

D. Wearing Rings

1. Renewable wearing rings shall be provided in the casing and on the impeller. The casing ring shall be positively locked against rotation in the lower half casing. The impeller ring shall be locked against rotation.

2. For pumping units rated for 7,000 gpm and larger, the impeller ring shall be doweled to the impeller. When the rated head is greater than or equal to 230 feet, the casing ring shall be shouldered for the full circumference of the ring.

E. Stuffing Box

1. The stuffing boxes shall each contain a single mechanical seal. A lubrication water connection shall be provided at each stuffing box.

F. Bearings

1. Bearings may be either grease or oil lubricated antifriction type. The outboard bearing shall carry both radial and axial loads imposed by the pump. The inboard bearing shall carry the radial loads imposed by the pump and drive unit.

2. Antifriction bearings shall have an ABMA L_{10} Life Rating of 40,000 hours at specified operating conditions. The pump shaft speed shall not exceed the limits specified by the bearing manufacturer.

3. Bearing housings shall be designed to maintain shaft alignment and ensure long bearing and lubricant life. Housings shall have labyrinth type running clearance designed to effectively retain the lubricant and keep out contaminants. Ample clearance for stuffing box maintenance shall be provided between the bearing housings and the stuffing box glands.

G. Flexible Coupling

1. The pump coupling shall be sized for continuous operation at full load and at maximum rpm when the misalignment is within the manufacturer's tolerance limit. Coupling design shall permit removal of the pump rotating element without disconnecting the piping, moving the drive unit, or causing axial movement of the coupling halves on the shafts.

2. Couplings for motors with sleeve type bearings shall have a limited end float feature. A suitable service factor shall be used when the pump is driven by an internal combustion engine.

3. Flexible couplings shall be gear type.

H. Equipment Bases

1. Each unit and its drive assembly shall be supported on a single baseplate of neat design.

2. When the motor weight exceeds 1,000 lbs baseplates shall be provided with adequate openings to facilitate grouting. Other equipment base requirements are specified in the General Equipment Stipulations.

2.5 ACCESSORIES

1. Each pump shall be provided with lifting eyebolts or lugs, plugged gauge cock connections at the suction and discharge flanges, tapped and plugged openings for casing and bearing housing vents and drains, and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

B. Bearing Temperature Gauge

1. Each pump bearing shall be provided with a direct reading dial thermometer with a bulb or probe in a well, situated in the bearing metal to detect the highest temperature in the bearing. The thermometer shall have a 6 inch dial face and a stainless steel probe or capillary and bulb, and a range of 50° to 300° F.

2.6 DRIVE UNITS

A. Electric Motors

1. The electric motors shall be designed as specified in Medium-Voltage Induction Motors section.

B. Adjustable Frequency Drives

1. Adjustable frequency drives shall be coordinated with the requirements of the pumping unit. The pump manufacturer shall be responsible for furnishing information to the adjustable frequency drive supplier to match the motor and the drive and for coordinating the collection of data and the design to limit harmonics to the levels specified.

2. Adjustable frequency drives shall be designed as specified in the Medium-Voltage Adjustable Frequency Drives section.

2.7 SHOP TESTS

A. Each pump shall be tested at the factory for capacity, power requirements, and efficiency at specified rated head, evaluated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. All tests and test reports shall be made in conformity with the requirements and recommendations of the Hydraulic Institute Standards. Acceptance testing shall be per Table 14.6.3.4 Grade 1U, with no minus tolerance or margin allowed.

B. The pumping unit shall be shop tested with the motor to be installed in the work.

C. For pumping units with adjustable frequency drives, the wire-to-water efficiency data submitted for information shall include the adjustable frequency drive certified shop efficiency data (and transformers if supplied with the adjustable frequency drive) to be installed in the work. Shop pump performance testing with the job AFD is not required.

D. Engineer and Owner will witness shop tests, inspect and check the testing equipment used, and observe the calibration of pressure gauges and transducers. Contractor shall furnish Engineer a plan and elevation sketch of the test setup showing the piping and instrumentation and shall notify Engineer at least 10 days in advance of the time of each shop test. For witnessed tests, all readings are to be read manually from the certified and/or calibrated instruments. The use of computer data acquisition systems will not be acceptable.

E. If the pump fails to operate properly or fails to meet the specified conditions or requirements during witnessed shop testing, the pump manufacturer shall modify the pumping unit and perform additional tests. Labor, travel, and expenses associated with the witnessing or observation of additional tests, whether due to incomplete tests or re-testing, shall be paid by the pumping unit supplier.

F. For pumping units 100 horsepower and larger, a certified test report shall be prepared. Five certified copies of a report covering each test shall be prepared by the pump manufacturer and delivered to Engineer not less than 10 days prior to the shipment of the equipment from the factory. The report shall include data and test information as stipulated in the Hydraulic Institute Standards, copies of the test log originals, test reading to curve conversion equations, and certified performance curves. The curves shall include head, pump input power, pump efficiency, and wire-to-water efficiency (when specified), rpm, and shop test NPSH available, plotted against capacity. The curves shall be easily read and plotted to scales consistent with performance requirements, with all test points clearly shown.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each pumping unit shall be installed in accordance with the Hydraulic Institute Standards, the Equipment Installation section, and as specified herein.

B. The equipment base shall be grouted after initial fitting and alignment, but before final bolting of connecting piping. Special care shall be taken to maintain alignment of pumping unit components. No stresses shall be transmitted to the pump flanges. After final alignment and bolting, connections to pumping equipment shall be tested for applied piping stresses by loosening the flange bolts. If any movement or opening of the joints is observed, piping shall be adjusted to proper fit.

C. Couplings shall be realigned after grouting. Final coupling misalignment shall be within one-half of the coupling manufacturer's allowable tolerance.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

End of Section

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SECTION 11630 - COMPRESSED AIR EQUIPMENT - BASE MOUNTED COMPRESSORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of compressed air equipment to be installed as indicated on the drawings and as required herein.

Compressor type.	
Number of compressors.	3
Compressor tag numbers.	42-CMB-300
	42-CMB-301
	42-CMB-400
Compressor location.	PUMP STATION

B. The compressed air equipment shall include three base-mounted compressed air units with remotely mounted accessories. Each base-mounted compressed air unit shall include an air-cooled, two-stage reciprocating compressor with inlet filter and intercooler mounted on a common baseplate with its electric drive motor, V-belt drive, belt guard, and control panel.

C. Remotely mounted accessories shall include aftercoolers, receivers, and filters, and traps, valves, controls, instruments, and all other appurtenances specified, indicated on the drawings, or otherwise required for a complete, properly operating installation.

D. Receiver-mounted compressor packages are not acceptable.

E. All required interconnecting air piping and valves between base-mounted components shall be provided under this section. Air piping and valves, not a part of the compressed air equipment package, are covered in the piping and valve sections, respectively.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Components of the compressed air equipment shall be the latest standard products of manufacturers regularly engaged in the production of equipment of this type.

C. Coordination

1. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

2. When required, each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 72 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

F. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

2. All work shall comply with Underwriters' Laboratories (UL) safety requirements.

G. Power Supply

1. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase. Power supply to controls shall be 120 volts.

H. Dimensional Restrictions

1. Layout dimensions will vary between equipment manufacturers and the layout area indicated on the drawings is based on typical values. The supplier shall review the contract drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on both ends and one long side of each base-mounted compressed air unit. At least 3.5 feet clearance shall be provided in front of the control panel. Aftercooler access space shall be as recommended by the manufacturer.

I. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

J. Identification

1. Equipment specified herein shall be tagged in accordance with the Equipment and Valve Identifications section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. General

1) A statement from the equipment supplier certifying that the specified shop test has been performed (prior to shipment).

2) Drawings indicating base-mounted package pipe routing and trap and valve locations.

3) Electrical schematics.

4) Wiring diagrams.

5) Control panel layout.

b. Baseplates

1) Overall dimensions.

2) Number, size, and location of structural members.

3) Thickness of top plate.

4) Number, size, and location of grout openings.

c. Compressors

1) Manufacturer.

2) Type and model.

3) Operating speed, rated and maximum.

4) Dimensions.

5) Weight, including motor.

6) Performance data at various speeds and discharge pressures, including capacity and brake horsepower.

7) Bearing data and ABMA L_{10} life.

8) Discharge air temperature at design conditions.

d. Motors

1) As specified in the Common Motor Requirements for Process Equipment section.

e. Receiver

1) Capacity.

2) Pressure rating.

3) Dimensions.

4) Connection sizes and locations.

5) Verification of ASME Code stamp.

f. Aftercoolers

1) Type.

2) Manufacturer.

3) Materials of construction.

4) Model number.

5) Dimensions.

6) Connection sizes and locations.

7) Capacity.

8) Pressure drop at rated capacity.

9) Verification of ASME Code stamp.

10) Cooling fan motor size for air cooled units.

11) Approach temperature.

g. Coalescing Oil Removal Filters

1) Manufacturer.

2) Materials of construction.

3) Model.

4) Capacity.

5) Pressure drop at rated capacity.

6) Pressure rating.

7) Efficiency.

h. Oil-Mist Eliminator

1) Manufacturer.

2) Materials of construction.

3) Model.

4) Capacity.

5) Pressure drop at rated capacity.

6) Pressure rating.

7) Temperature rating.

i. Accessories

1) Manufacturer.

2) Materials of construction.

3) Model.

4) Accuracy, if applicable.

5) Size and dimensions.

6) Connection size.

j. Seismic Design Requirements

1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SPARE PARTS

A. The following spare parts and accessories shall be furnished in substantial wooden boxes with identifying labels and delivered to the vicinity of the project site or the Owner as directed:

PART 2 - PRODUCTS

Spare Parts	Quantity
Intake air filter elements.	1 Per Compressor
V-belts.	1 Matched Set Per Compressor
Inlet valve assembly.	1 Per Compressor
Inlet valve springs.	1 Set Per Compressor
Discharge valve assembly.	1 Per Compressor
Discharge valve springs.	1 Set Per Compressor
Piston rings.	1 Set Per Compressor
Coalescing filter elements.	1 Per High Efficiency coalescing filter

2.1 SERVICE CONDITIONS

1. The compressed air package and accessories shall be suitable for the following service conditions:

Seismic design requirements and site elevation.	See Meteorological and Seismic Design Criteria section	
Barometric pressure.	14.0	Psia
Indoor ambient air temperature range.	50 to 107	° F
Design relative humidity at maximum ambient air temperature.	60	%

2. Parts shall be interchangeable between units of similar size and capacity to extent practical.

3. All equipment furnished shall be designed to meet all specified conditions and to operate satisfactorily at the specified elevation.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The compressed air equipment shall be designed for the operating conditions and requirements as follows:

Air Compressors

Tag numbers.	42-CMB-300 42-CMB-301 42-CMB-400	
Number of compressor units.	3	
Compressor discharge pressure.	250	psig
Minimum inlet capacity per unit when operating at specified discharge pressure.	33	cfm
Maximum average piston speed.	720	fpm
Maximum power required at input shaft.	14.25	bhp
Drive motor rating.	15	hp
Drive motor speed.	1800	rpm

Aftercoolers

Tag numbers.	42-AFC-301 42-AFC-401	
Type	Air cooled	
Quantity required.	2	
Design air inlet temperature.	480	° F
Maximum discharge air temperature.	137	° F
Maximum capacity at design conditions.	33	Scfm
Minimum airside design pressure.	250	psig
Maximum cooling fan motor size.	1/20	hp

Air Receivers

Tag numbers.	42-AR-301 42-AR-401	
Number of receivers required.	2	
Minimum design pressure.	275	psig
Minimum nominal volume.	400	gal

Coalescing Oil Removal Filter.

Tag numbers.	42-FLCO-301 42-FLCO-302 42-FLCO-401 42-FLCO-402	
Quantity required.	4	
Design minimum air inlet pressure.	215	psig
Maximum air inlet pressure.	250	psig
Minimum capacity at design conditions.	33	scfm
Maximum air pressure loss.	5	psig

Mist Eliminator

Tag numbers.	42-MELM-301 42-MELM-401	
Quantity required.	2	
Minimum inlet pressure.	220	psig
Minimum design pressure.	250	psig
Minimum design capacity.	33	scfm

2.3 BASE-MOUNTED COMPRESSED AIR UNIT CONSTRUCTION

A. The base-mounted compressor units shall be supplied by a packager regularly engaged in packaging equipment of this type. The arrangement shall permit access from the front and ends of the package for maintenance of components.

B. Compressors

1. The compressors shall be air-cooled, reciprocating type with cylinders and crankcase manufactured entirely from cast iron.

2. Crankshaft bearings shall be antifriction roller or ball type with a minimum ABMA L_{10} life of 40,000 hours. Connecting rod bearings shall be steel backed, babbitt-lined, insert type plain bearings. Connecting rod, crankshaft, and piston pin bearings shall be oil lubricated by a force feed positive pressure lubrication system. A lubrication system pressure gauge, of the compressor manufacturer's standard size and range, shall be furnished. As an alternative, a pressure transducer with pressure indication on the HMI screen is acceptable.

3. Compressor cylinder valves shall be fabricated from corrosion-resistant materials. Cylinders and cylinder heads shall be designed so that the compressor sheave provides all required external forced air circulation.

4. Each compressor shall be driven by an electric motor connected to the compressor through a V-belt drive.

5. Compressors shall be manufactured by Quincy, FS Curtis, and Gardner Denver.

C. Intercooler

1. An air-cooled intercooler shall be provided with each two-stage compressor. The intercooler shall be an integral part of the compressor and shall be mounted so that the compressor sheaves provide all required external forced air circulation.

D. Baseplate

1. The baseplate shall be constructed of heavy steel plate and structural members and shall be designed for no measurable deflection with the equipment mounted thereon and the baseplate supported around its perimeter. The base shall be designed so that all equipment bolted to it can be removed without access to the underside of the plate, and with a flat top surface for ease of cleaning. Openings shall be provided to permit grout filling of the entire underside of the baseplate. Structural stiffeners shall be located under the compressors at the compressor anchor points. A drip lip will not be required.

E. Equipment Bases

1. Unless otherwise indicated or specified, all equipment will be installed on concrete bases at least 6 inches high. Cast iron or welded steel baseplates shall be provided for compressors and other equipment. Baseplates will be anchored to the concrete base with suitable anchor bolts and the space beneath filled with grout as specified in the Grouting section.

F. Drive Units

1. Each compressor shall be driven by an electric motor through a belt drive. Drive units shall be designed for 24 hour continuous service.

2. Belt Drive

a. Belt drives shall be V-belt. V-belt and sheave groove dimensional tolerances shall be in accordance with the "Engineering Standards - Multiple V-Belt Drives" published by the Multiple V-Belt Drive and Mechanical Power Transmission Association. Belt drives shall have a service factor of at least 1.4 at maximum speed based on the nameplate power rating of the drive motor. The speed reduction ratio of belt drives shall not exceed 4 to 1. Each belt drive shall include a sliding base or other suitable means of tension adjustment. Belts for each compressor shall be matched sets.

3. Electric Motors

a. The electric motors and motor controls shall be designed as specified in the Common Motor Requirements for Process Equipment section. All motors for air compressors and other compressed air system components shall be rated for 50 °C ambient temperature.
b. Prewired electric motors installed in packaged equipment are not required to have clamp type grounding terminals in the conduit box or oversized conduit boxes.

G. Control Equipment

1. All control equipment for each compressor shall be furnished as needed for a complete installation, requiring only field connection of the remote alarm and a single electrical power supply. Equipment shall include all control switches, pressure switches, timing relays, auxiliary relays, unloaders, circuit breaker combination magnetic motor starters, and other accessories required for control of each compressor. Each starter shall include a motor circuit protector type circuit breaker with external operating handle and a control power transformer with a 120 volt secondary, with both primary leads shall be fused, one secondary lead fused and the other grounded. Starter overloads (one per phase) shall be bimetallic ambient compensated type, matched to motor current and shall be provided with a manual "Reset" push button.

2. All control equipment for each compressor package shall be housed in a common control panel mounted near the compressor packages.

3. All system wiring shall be shop installed to terminal blocks in the control panel. Wiring from the panel to system components shall be completely enclosed in liquid-tight flexible conduit.

4. All pneumatic tubing shall be shop installed to bulkhead fittings at the control panel.

5. Control Panel

a. The control panel shall be NEMA 12, fabricated from 14 USS gage or heavier steel, and shall be equipped with an approximately full-size gasketed door with chromium plated or stainless steel three-point latch and hinges. All control devices shall be rigidly mounted within the enclosure except for breaker handles, selector switches, push buttons, and indicating lights, which shall be mounted on the panel door. As an alternative, the manufacturer's standard PLC Microprocessor based control system with human machine interface (HMI) equivalent functionality may be provided. The temperature rating for the microprocessor and HMI shall not exceed 131 ° F. The control panel size and location shall locate all operational

switches, indicating lights, and gauge dials between 2'-6" and 5 feet above the bottom of the baseplate.

b. Internal panel tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipping without damage. Compression type bulkhead fittings shall be provided through the panel for all connections.

c. Internal panel wiring shall be neatly bundled and tied and shall be identified with suitable wire markers. Terminal blocks for external connections shall be furnished complete with marking strips, covers, and pressure connectors. A terminal shall be provided for each conductor or external circuit. All wiring shall be grouped or cabled and securely attached to the panel. Clearance for field wiring shall be provided between the terminal strips and base.

6. Compressor Control

a. Each compressed air unit shall be furnished with a control system which shall start and stop and load and unload the compressor at the following receiver pressures.

Duty Compressor

Start/load pressure.	225	psig
Stop/unload pressure.	250	psig

b. The control system shall unload the compressor on shutdown and while coming up to speed during startup. Unloading shall be accomplished by inlet valve control.

c. Each compressor shall be provided with a control switch with Duty and Standby positions. One pressure switch with separately adjustable settings shall be furnished for each compressor, for "Duty" control.

d. In addition to the "Duty/Standby" control switch, each compressor shall be furnished with a "Jog" control switch. The "Jog" control switch shall run the compressor only when the "Duty/Standby" control switch is in the "Standby" position. The "Jog" switch shall be spring operated to return the compressor to “Standby” when the operator's hand is removed.

7. Protection Controls

a. A protection control system shall be provided for each compressor. The control system shall stop the compressor on low oil pressure and high discharge air temperature.

8. Automatic Exercising Control

a. To prevent moisture from settling in the compression chambers during extended periods of inactivity and to exercise the compressed air system, a solenoid valve shall be provided as shown in the Drawings. The solenoid valve shall be controlled by the pump station DCU.

b. The pump station DCU shall provide a timer program which shall open the solenoid valve after 168 hours (one week) of inactivity on either compressor. The timer

program shall open the solenoid vent valve to automatically lower the pressure in the receivers and trigger the lead compressor to run loaded. The solenoid valve shall be set to stay open for an adjustable period of time from 0 to 60 minutes. After 30 minutes of run time is achieved on the lead compressor, the compressor pressure switch shall be automatically alternated to switch the lead and lag compressors and thus exercising both the compressor for at least 30 minutes.

c. The frequency of the automatic exercise shall also be adjustable from 0 to 7 days at the SCADA system. The frequency of exercising the compressors shall be recommended by the compressor manufacturer in the Operation and Maintenance Manual of the air compressors.

d. The solenoid vent valve shall be provided on the vent line as shown in the Drawings and shall be provided with a manual globe style vent valve and an annular vent silencer suitable for a velocity approaching sonic velocity to dampen noise. The silencer shall provide at least 20 dB attenuation at the 1000 Hz octave band. The automatic exercising control valves (42-SV-304 AND 42-SV-404) and silencer shall be provided by the compressed air system supplier.

e. Solenoid Valves shall be as specified herein.

f. Globe valves for automatic compressor exercise shall be provided by the compressed air equipment supplier but shall be as specified in section 15096.

g. Contractor shall supply dielectric fittings to prevent dissimilar metal contact between piping and solenoid valves and piping and globe valves. Dielectric fitting shall be as specified in section 15020.

9. Miscellaneous Controls

a. A dial type thermometer and discharge pressure gauge shall be furnished for each compressor air discharge. As an alternative, pressure and temperature readouts on the HMI may be provided.

b. White indicating lights shall be provided on the control panel for the following alarm conditions (equivalent functionality in an HMI is also acceptable):

1) Motor overload.

2) High discharge air temperature.

3) Low oil pressure.

c. Indicating lights shall be heavy-duty, oiltight, semiflush type, with escutcheon plates to identify the malfunction. A mechanical latching relay circuit with a common "Reset" push button shall be provided so that the alarm lights remain on until manually reset. The latching relays shall have a contact rated 10 amperes at 120 volts, which closes on alarm. An alarm light "Test" push button shall also be provided on the front of the control panel to test the lights simultaneously without actuating the remote alarm.

d. Two normally open contacts, which close under alarm conditions, shall be provided for remote alarm. Both contacts shall close when any alarm occurs for either compressor. Contacts shall be rated at 10 amps at 120 volts.

e. Each compressor shall be provided with an elapsed time meter mounted on the front of the control panel or equivalent on alternative HMI.

f. Non-Critical Air Usage System.

1) The non-critical air usage system shall consist of solenoid valve with strainer, pressure switches, and a junction box. Pressure switches shall be provided to control the noncritical air usage solenoid valve. When the receiver pressure falls to 220 psig, the non-critical air usage solenoid valve shall close. When the receiver pressure rises to 235 psig, the non-critical air usage solenoid valve shall open. The associated pressure switches shall be as specified herein and shall have independently adjustable set points.
2) The solenoid valve shall be a 1-1/2 inch ASCO valve, normally closed type. The solenoid valve shall have a bronze body and bonnet, and shall be packless construction without packing box or sliding seal. Solenoid coils shall be 115 volts ac, 60 Hz, single phase, encapsulated, Class F for continuous duty at rated voltage +/-10 percent and 40 C ambient, in a NEMA Type 4 enclosure with a conduit hub.
3) A strainer shall be provided in the piping immediately upstream of each solenoid valve. Strainers shall be bronze-bodied, Y-pattern units with monel or stainless steel screens and shall be Cash-Acme "SY" or Hoffman "420" suitable for operation in compressed air systems at the full compressor discharge pressure. The blowoff from each strainer shall be equipped with a shutoff valve.
4) A NEMA 12 panel shall be provided for mounting pressure switches and for a junction box.

H. Piping

1. All interconnecting piping and tubing between components of the equipment package shall be shop installed.

2. Pneumatic control and instrument tubing shall be ASTM A269, Type 316 stainless steel tubing with Type 316 stainless steel compression fittings. Tubing shall be not less than 1/4 inch OD with a wall thickness of 0.028 inch.

3. All piping and tubing shall be run in vertical and horizontal planes and shall not contact the baseplate. Piping shall be arranged to ensure that undue stresses from thermal expansion are not transmitted to equipment components. All control and instrument tubing shall be continuously supported.

4. Compressor discharge piping shall be sloped to drain to the receiver to prevent condensate in the discharge piping from draining back to the compressor.

5. Drain lines from each compressor crankcase and receiver shall be piped to the edge of the baseplate.

2.4 AFTERCOOLERS

A. Air-cooled aftercoolers shall be provided and shall be constructed of copper tubes and headers with aluminum fins, aluminum fan with direct drive motor, corrosion-resistant housing, legs suitable for floor mounting, and fan guard. Aftercoolers shall be rated for the compressor maximum discharge air temperature. The motors shall have permanently lubricated bearings. The aftercooler fan motors shall be interlocked to operate when the associated compressor motor runs.

B. Aftercoolers shall be furnished complete with moisture separator, electric "No-Loss" type condensate drain trap, and drain valves. The condensate drain trap shall be powered by the compressor control panel and no additional wiring shall be required. Aftercoolers shall be manufactured by Hankison, Pioneer, Thermal Transfer, Pneumatech, or equal.

2.5 AIR RECEIVERS

A. Air receivers shall be of all-welded construction with semi-ellipsoidal heads, shall be hot-dipped galvanized or internally epoxy coated with a coating that is suitable for hot/moist compressed air service. Each air receiver shall be supported with a base ring or leg supports for vertical mounting on a concrete base or on the floor with grout. Receivers shall be designed and constructed in accordance with the ASME Code for Unfired Pressure Vessels and shall bear the code stamp.

B. Receivers shall be furnished with openings for inlet, outlet, drain, compressor control, instrumentation, and vent piping connections. Additional openings shall be provided as needed. All receiver connections 2-1/2 inches or larger shall be flanged.

C. Receivers shall be furnished with a safety relief valve, vent valve, electric "No-Loss" type condensate drain trap, and pressure gauge.

1. Air receivers shall be manufactured by Brunner, Hanson, Manchester Tank, or equal.

2.6 OIL REMOVAL FILTERS

A. Each oil removal filter shall be the coalescing type with replaceable filter elements. Each filter shall remove 100 percent of the solids and liquids 0.025 micron or larger. Each filter shall be furnished with a differential pressure indicator to indicate the need for service or replacement of the elements. Each filter shall be furnished with an electric, no-loss condensate trap and all necessary prefilters. Each filter and prefilter shall be oversized to fit the piping sizes as indicated on the drawings. Oil removal filters shall be manufactured by Gardner-Denver, Hankison, Kaeser, Pioneer, Pneumatech, Sullair, or equal.

2.7 OIL MIST ELIMINATORS

A. One mist eliminator shall be provided, and shall be rated to meet the capacity of at least one air compressor.

B. Mist eliminators shall be capable of removing 100 percent of particles three (3) microns and larger, and 99.98 percent of particles 0.1 microns and larger. Each mist eliminator element shall have a minimum life of five (5) years before needing replacement.

C. Each mist eliminator shall each be provided with an electric, no-loss condensate trap.

2.8 ACCESSORIES

A. The compressed air equipment shall be furnished with the following accessories.

B. Safety Valves

1. Safety valves with manual lifting levers shall be installed in the compressor discharge piping and on the receiver. Valves in the compressor discharge piping shall be capable of protecting the compressors from damage when operating against a closed discharge valve and shall be suitable for the maximum compressor discharge air temperature. The safety valve on the receiver shall be capable of protecting the receiver from excessive pressure.

C. Intake Filter Silencers

1. Each compressor shall be provided with a bottom outlet, dry type intake filter silencer supported by the suction pipe and close-coupled to the compressor intake connection. Intake filter silencers shall have an outer cover and replaceable filter element. Silencers shall be constructed of steel and shall be sized in accordance with the recommendations of the manufacturer. Sound attenuation shall be not less than 20 dB at 1,000 Hz; particle arrestance shall be not less than 99 percent at 25 micron size and 70 percent at 5 micron size. Filter silencers shall be as manufactured by Endustra or Stoddard.

D. Discharge Check Valves

1. A line-mounted check valve shall be provided in the discharge piping leading from each compressor. Check valves shall be sized in accordance with the valve manufacturer's recommendations and shall be suitable for service with reciprocating compressors at the maximum compressor discharge air temperature.

2. Check valves shall be disc and spring type designed for installation in the discharge piping from reciprocating compressors. Combination unloading devices/check valves will not be acceptable. Check valves shall be Hoerbiger or equal.

E. Shutoff Valves

1. All shutoff valves shall be ball valves. Valves in steel piping shall have carbon steel bodies, chrome plated or stainless steel balls, and reinforced teflon seals and seats. Shutoff valves in stainless steel tubing shall have AISI Type 316 stainless steel bodies and balls and reinforced teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperature.

F. Receiver Vent Valve

1. A globe type vent valve with bronze body and brass stem shall be provided on the receiver.

G. Pressure Gauges

1. Each pressure gauge shall have a phenol case, adjustable pointer, and stainless steel rotary geared movement. Each gauge shall be accurate to within 1 percent of full scale. Gauges shall have a dial size of at least 4-1/2 inches and the units of measurement shall be indicated on the dial face.

2. Panel-mounted gauges shall have a 1/4 inch NPT connection. All other gauges shall have a 1/2 inch NPT connection. All gauges shall be provided with a shutoff valve.

H. Pressure Switches

1. Pressure switches shall have an accuracy of 0.5 percent, a repeatability of 0.1 percent, and shall require a 120 volt, 60 Hz, single phase power supply. Pressure switches shall be United Electric Controls "One Series Classic" or equal. Pressure switches shall be capable of the settings specified herein.

2. Oil pressure switches shall have normally closed contacts which shall open on low pressure and an integral time delay to allow the compressor to start and come up to speed.

3. For pressure transmitters refer to section 13563.

I. Thermometers

1. Thermometers shall be of the remote reading, gas actuated dial type. Thermometers shall have a dial size of at least 5 inches and an adjustable pointer and shall be accurate within 1 percent of full scale. Thermometers shall be furnished complete with a uniformly graduated dial indicator, armored capillary tube, bulb or temperature sensor, and thermowell. Thermometer ranges shall be such that the normal operating reading will be near the midpoint of the range. The units of measurement shall be indicated on the dial face. Spare capillary tubing shall be neatly coiled and tied.

2. The diameter of air piping shall increase at the thermowell location, so that the area between the well and the pipe is not smaller than the cross-sectional area of the original piping. The entire sensitive portion of the temperature sensor shall be installed within the airflow stream.

J. Temperature Switches

1. Temperature switches shall be remote bulb type with spdt contacts rated 10 amperes at 120 volts ac. Temperature switches shall have NEMA Type 1 housings, stainless steel thermowell assemblies, and armored capillaries. Capillary tubing shall be sufficient length for mounting the switch inside the control panel. Spare length of capillary tubing shall be neatly coiled and tied.

2. The diameter of air piping shall be increased at the thermowell location, so that the area between the well and pipe is not smaller than the cross-sectional area of the original piping. The entire sensitive portion of the temperature sensor shall be installed within the airflow stream.

K. Flexible Connections

1. Braided stainless steel flexible connections shall be furnished and installed on the compressor discharge piping connection to limit the transmission of vibration to the connecting piping.

2.9 SHOP COATINGS

A. Components of each compressed air equipment package shall be shop coated as specified herein prior to shipment to the site.

B. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

C. All ferrous metal surfaces, except stainless steel, motors, and gear reducers, shall be shop coated with epoxy enamel. The coating shall be applied in a minimum of three coats, at 5 mils per coat, and shall have a total DFT of at least 15 mils. Surfaces exposed to UV shall also have an aliphatic polyurethane topcoat applied after complete drying and curing of the epoxy enamel. The aliphatic polyurethane shall be applied in a single coat and shall have a minimum DFT of 2 mils.

D. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Speed reducers, starters, and other self-contained or enclosed components shall be shop primed with a universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

E. Galvanized, stainless steel, nonferrous, and nonmetallic surfaces shall not be coated.

F. One quart of epoxy enamel shall be provided with the equipment package for field touch-up.

2.10 SHOP TEST

A. Prior to shipment, each base-mounted compressed air unit shall be operated to check alignment; faulty equipment and controls; proper wiring; leaks in piping, seals, or wells; and proper operation of the safety and operating controls. Compressor pressure controls shall be adjusted to the specified pressures. Defective equipment and controls disclosed by such tests shall be replaced and the package placed in satisfactory operating condition before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless otherwise indicated or specified, the compressed air equipment shall be installed on concrete bases at least 6 inches high. The equipment shall be installed level and plumb using removable metal shims to provide approximately a 1-1/2 inch grout space below the baseplate. The equipment shall be anchored in accordance with the seismic design requirements and the space between the baseplate and concrete base filled with grout. The entire baseplate of the compressed air package shall be filled with grout. After the grout has set, the leveling shims shall be removed, the resulting grout cavity shall be filled with grout and finished to match the adjacent grout surface, and the anchor bolts shall be tightened per the compressor package manufacturer's recommendations.

B. The equipment shall be installed in accordance with the manufacturer's recommendations, and all work shall be completed in a neat manner using good workmanship.

C. Installation shall provide the required accessibility for adjusting, cleaning, lubricating working parts, and replacing controls, safety devices, and other control components.

D. Care shall be exercised to ensure that piping stresses are not transmitted to the equipment. The unit shall be operated, adjusted, and tested after installation as required to ensure proper adjustment and operation of all controls.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.3 TRAINING

A. The manufacturer's representative shall provide training for Owner in proper operation and maintenance of the equipment.

End of Section

SECTION 11910 - ENGINE-GENERATORS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers the furnishing of two (2) natural gas fueled engine-driven electric generator units designated 43-EG-101 and 43-EG-102 and Engine-generator system controls. Each engine-generator shall be located outdoors each in its own weatherproof sound attenuated enclosure as indicated on the Drawings.

B. The Engine-Generator System Supplier (EGSS) shall be fully responsible to furnish a complete and coordinated package system. Each engine-generator shall be a skid-mounted package unit consisting of engine-generator, generator controls, exhaust silencer/exhaust after treatment, cooling system, auxiliary systems, emergency shutdown control station, and accessories as required for a complete operating system.

C. The Master Control Panel furnished under this section shall be mounted remotely within the Electrical building.

1.2 GENERAL.

A. Equipment furnished under this section shall be assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

1. General Equipment Stipulations. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

2. Meteorological and Seismic Design Requirements. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

B. Coordination.

1. All equipment specified in this section shall be furnished through a single engine-generator manufacturer who shall be responsible for the design, manufacture, coordination, and proper installation and operation of the entire system.

2. Each engine-generator unit shall be a standard product of the manufacturer and shall be a packaged type unit, fully shop assembled, wired and tested, requiring no field assembly of critical moving parts.

3. Contractor shall verify and coordinate that each component of the system is compatible with all other parts of the system; that all piping, materials, transfer switch, and motor sizes

are appropriate; and that all devices necessary for properly functioning system have been provided.

4. Contractor shall, at his own expense, arrange for and obtain all necessary permits, inspections, and approval by the proper authorities in local jurisdiction of such work.

5. Contractor shall properly coordinate the work between the Suppliers of the equipment to be used with or connected to the engine-generator, including the switchgear furnished by the Switchgear manufacturer, to ensure that all provisions for mounting the accessories are included.

6. Contractor shall properly coordinate the requirements of the Switchgear and Engine Generator Master Control Panel based on the equipment being provided to provide the functionality specified here in and as required for a complete system. The appearance and control capabilities available at the Switchgear and Engine Generator Master Control Panel shall be duplicated at the Owner's existing Plant Control System. The modifications to the existing Plant Control System HMI will be completed by the Owner. Contractor shall provide support to the Owner to incorporate the monitoring and control of the Engine Generator Facilities into the existing Plant Control System.

7. Contractor shall provide field services specified to assist in commissioning, testing and placing each unit in operation in full conformity with equipment manufacturer's specifications.

C. Governing Standards.

1. Except where modified or supplemented by these specifications, all equipment and materials shall be designed and constructed in accordance with the latest applicable requirements of the standard specifications and codes of ANSI, ASTM, NEMA, IEEE, EEI, HEI, ISO, NFPA, SAE, UL and other such regularly published and accepted standards as well as state and local codes.

D. Equipment Identification.

1. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification Section.

2. All equipment, valves, devices, panels, and control equipment denoted by a symbol and an identifying number shall be provided with equipment identification tag or nameplate.

E. Manufacturer's Nameplates.

1. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a nameplate securely affixed in a conspicuous place. The nameplate of a distributing agent only will not be acceptable.

F. Power Supply.

1. Site power supply provided will be 480 volts, 60 Hz, three phase, 60 amp feeder circuit for operation of the equipment and accessories. Each engine-generator shall be provided with a transformer and panelboard sized to power the required loads inside the enclosures specified herein.

2. The engine (starting and controls) will operate from batteries specified herein. When needed, a control transformer shall be provided within the panelboard for control supply.

1.3 SUBMITTALS.

A. Drawings and Data.

1. Complete assembly and installation drawings, together with detailed specifications and data covering materials, drive unit, parts, devices and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

Manufacturer, model, and type:

Engine

Alternator

Enclosure

Battery charger and batteries

Unit Mounted or Remote Mounted Radiator

Silencer / emission control/silencer

Surge control

Neutral Grounding Resistor

Engine output horsepower and efficiency curves at rated capacity.

Fuel consumption at rated capacity.

Ratings at specified conditions:

Engine (net horsepower).

Generator kW at specified power factor.

Volts.

Amperes.

Overall dimensions and weight:

Length.

Width.

Height.

Net weight.

Radiator performance data at full capacity:

Heat rejection rate.

Sound pressure level (dBA at 25 ft).

Fluid pressure drop through core, per circuit, in psi.

Ambient Capability, deg F.

Air flow, scfm, per fan.

Motor nameplate data (hp, service factor, FLA, Insul. class, etc.).

Radiator overall dimensions and weight:

Length.

Width.

Height.

Net weight.

Radiator dimensional drawing to include location and size of all piping connections.

Wiring diagrams and schematics, including the engine control panel, master control panel and generator line circuit breaker.

Sequence of Operations

Alternator insulation class and temperature ratings.

Alternator winding pitch.

Calculations or test results showing compliance with specified motor starting and voltage dip requirements.

Generator line circuit breaker rating.

Control panel layout, identifying location of all instrumentation being supplied.

Engine drawing to include location of all piping connections.

Operation instructions.

Letter from the engine-generator manufacturer confirming that the unit will provide the specified minimum kW rating at the specified design conditions and time duration, including ambient air temperature rise from all equipment located inside the enclosure.

Confirmation that the starting batteries provide the specified number of start attempts for the specified time period.

Confirmation that the batter charger is sized to recharge the batteries for the specified time period.

Maximum output short circuit kvA available.

Exhaust gas emission data, maximum values at loads of 1/2, 3/4, and full:

Carbon Monoxide (CO), lb/hr

Nitrogen Oxides (NO_x), lb/hr

Temperature, F

Flow, acfm

Particulate Matter, lb/hr

Volatile Organic Compounds, lb/hr

Equipment skid drawing including material list.

Confirmation that the exhaust through the exhaust silencer and emission control equipment does not exceed the specified maximum pressure loss at the specified power outage capacity of the unit and that the exhaust silencer provides sound attenuation equal to or greater at the specified frequencies.

Name, address, and phone number of manufacturer's repair facility.

Drawings showing engine-generator that shows location of all engine-generator mounted equipment. Drawings to indicate maintenance access clearances for electrical and mechanical equipment.

Drawing showing locations of all electrical connections, including the grounding system.

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

Letter from the engine-generator manufacturer confirming that the Units are in full compliance with Federal EPA, State, and local air emission requirements and will not exceed emission limits when all units operate continuous (24/7).

Drawings showing engine-generator inside the enclosure that shows location of all enclosure mounted and engine-generator mounted equipment. Drawings to indicate maintenance access clearances for electrical and mechanical equipment. Drawing to show location of all enclosures bracing, location of doors, and removable panels.

Color chart showing available options for the enclosure color. The color of the enclosure shall be as directed by Owner during shop drawing review.

Provide recommendation for mounting the engine-generator for the specified seismic parameters.

Recommendations for Anchor Bolts required to meet Seismic Design Criteria Section.

Letter from the engine-generator manufacturer confirming that the enclosure is suitable for the specified wind velocity and is designed as specified for rain penetration when the unit is operating.

Electric governor control.

Anchor bolts.

B. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING.

A. Shipping shall be in accordance with the Product Delivery Requirements Section. Handling and storage shall be in accordance with the Product Storage and Handing Requirements Section.

1.5 SPARE PARTS.

A. The following spare parts and accessories shall be furnished in substantial wooden boxes with identifying labels and delivered to the project site or the Owner as directed:

Spare Parts	Total Quantity
Air filters.	2 sets
Oil filters.	4 sets
V-belts.	1 set*
Spark plugs	2 sets

*For both unit and remote mounted radiator options.

B. All spare parts shall be provided in waterproof packages suitable for export service, labeled with its description and part numbers. Each item or set of parts expected to be installed at one time shall be in an individual package. The spare parts shall be stored as directed by the Owner.

C. If any of the above spare parts are used during the installation process, they shall be replaced by the Supplier at no cost to the Owner.

1.6 Keys.

A. Three (3) sets of identical keys for locks on the enclosure and all cabinets shall be provided for each engine-generator. Each set of keys shall be identified.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS.

A. Each engine-generator unit shall be designed to operate under the following service conditions:

Seismic zone.	See Meteorological and Seismic Design Criteria Section	
Ambient air temperature range.	-20 to 110	°F
Site elevation.	1,260	ft

B. Each engine-generator shall be suitable for “black start” and will be used as a power unit for selected electrical loads when the utility supplied power fails and as shedding during control periods for a maximum of 400 hours operation per year.

C. Each engine-generator shall automatically start and connect to the plant’s electrical system from a signal from the utility or when initiated from the automatic transfer switchgear controls. Each unit shall be furnished with automatic synchronizing controls.

D. Each unit shall be furnished with all equipment required to allow it to operate alone or in parallel. When operating in parallel, the units shall divide the load (kW and kvar) equally.

E. The engine-generator supplier shall provide the correct amount and grade of crankcase oil, coolant, and other fluids (except fuel) necessary for initial testing and operation.

F. Engine Mounting.

1. Each engine-generator shall be attached to an associated skid suitable for mounting on top of a reinforced concrete base. The skid shall be constructed of heavy-duty steel. Designed and built to resist deflection and to maintain alignment during lifting and operation during any range of operation. Mounting holes in the structural skid shall be suitably sized to accommodate thermal expansion of the unit and shall be drilled prior to setting the unit in place.

2. Unless otherwise recommended by the manufacturer, the engine-generator package shall be attached to the reinforced concrete base using a suitable number of hold down lugs and anchor bolts. Anchor bolts may be pre-cast in the reinforced concrete base or holes drilled into the concrete base at the required location and the anchor bolts secured with epoxy resin. Unless otherwise recommended by the manufacturer, the nuts for the anchor bolts shall be hand tightened to the specific torque value.

G. Anchor Bolts.

1. All field assembly bolts, anchor bolts, nuts, and washers shall be stainless steel as specified in the Anchorage in Concrete and Masonry Section. All anchor bolts, nuts, and washers required for installation shall be provided by the Concrete and Masonry Supplier.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Each engine-generator unit shall be designed for the operating conditions and requirements as follows:

Tag number	43-EG-101, 43-EG-102	
Generator		
Minimum continuous power rating capacity with accessories, for each generator voltage output and service conditions specified herein.	1,325	kW
Output frequency.	60	Hz
Output voltage.	4,160	VAC
Output power factor.	0.8	

Output phase and configuration.	Three phase, 4 wire, wye configuration	

Engine

Fuel supply.		
Type.	Natural gas	
Btu/cu ft.	905	
Supply pressure.	2-5	psi
Maximum speed.	1,800	rpm
Minimum piston displacement.	4,765	In^3
Black start required.	Yes	
Maximum engine generator package length including inlet and discharge plenums, if used.	48.33	ft
Maximum engine generator package width.	12	ft
Maximum remote radiator package length.	20	ft
Maximum remote radiator package width.	8	ft

1. Each engine-generator shall be designed to operate at a continuous (24/7) basis. Each engine-generator shall be certified for Non-Emergency use in accordance with the Environmental Protection Agency (EPA) regulations, including, but not limited to chapter 40, subpart JJJJ.

2. Engine-generators submitted with ratings in excess of current published data will not be acceptable.

3. Each engine-generator unit furnished shall be of a design that can be accommodated in the space as specified herein and as indicated on the drawings.

4. Any special fittings or piping required for connection to fuel piping shall be furnished and installed.

5. Each entire engine-generator package shall be electrically grounded

B. Performance Requirements.

1. Engine performance, cooling, and all accessories to account for the outside ambient air temperature increase from heat rejected from all the equipment located inside the enclosure.

2. The engine-generator shall meet the required Environmental Protection Agency New Source Performance Standard emission regulations, and any other local requirement. The unit shall be certified at the factory prior to shipping.

3. The engine-generator supplier shall coordinate with the local air quality management authority to ensure the equipment meets all local air emission requirements. The engine-generator Supplier shall guarantee the equipment supplied meets all local air emission requirements at the time of startup.

C. Loading Performance.

1. Both engine-generators operating in parallel shall satisfactorily start the following loads in the listed order, while meeting the specified voltage dip.

Step	Load Description	Rating (hp)	Maximum Voltage Dip (%)	Comments
1	Building Loads	520 kVA	20	
	Remote Radiator Fans*	24	20	
2	Pump 1	900	10	VFD
3	Pump 2	650	10	VFD
4	Pump 3	450	10	VFD
5	Pump 4	300	10	VFD

*Coordinate with equipment supplied

D. Unloading Requirements.

1. Each engine-generator shall satisfactorily unload the loads indicated above in any order one at a time while not exceeding overspeed, and voltage deviation for either alternative.

2.3 ACCEPTABLE MANUFACTURERS.

A. Each engine-generator shall be a current production model and shall be identical. The engine-generator shall be manufactured by the supplier Caterpillar or Cummins, without exception.

B. The complete engine-generator package shall be assembled by the engine-generator manufacturer or their representative.

C. The manufacturer of the engine-generator unit shall have a full-time, fully factory trained technical staff and an equipped 24-hour service facility having all personnel and all equipment required to maintain, repair, or overhaul the engine-generator unit and associated equipment. The repair facility shall be within 100 miles from the installation location.

2.4 ENGINE-GENERATOR UNIT.

A. Engine.

1. Each engine shall be reciprocating 4-stroke cycle spark ignition type and shall be equipped with the following:

Dry type air cleaner with replaceable elements.

B. Ignition System.

1. Each engine shall be equipped with a coil on plug ignition system of proven design. The system shall be comprised of three principal elements: ignition control module, coil on plugs, and spark plugs.

2. All high-tension leads shall be enclosed within the coil on plug. The low-tension leads connecting the ignition control module to the coil on plugs shall be shielded and protected by rigid conduit that is compatible with the system's operating characteristic and design.

3. All components shall be of a type and design suitable for the intended service and shall be suitable for dismantling and reinstallation by plant personnel without cutting of wires.

C. Alternator.

1. Each engine-generator alternator shall be a 4 pole, revolving field design with temperature compensated solid state voltage regulator, brushless rotating rectifier exciter system, and drip-proof construction with amortisseur windings. The alternator shall be directly connected to the engine flywheel housing, and the rotor shall be driven through a semi-flexible driving flange to ensure permanent alignment.

2. Frequency regulation shall be isochronous ±0.15 Hz from no load to rated load. Voltage regulation shall be within ±2 percent of rated voltage, steady state, from no load to full load. The momentary voltage drop shall not exceed the specified percent without starter coils dropping out or stalling the engine at any time when applying or starting the specified loads. Recovery to stable operation shall occur within 2 seconds.

3. The alternator shall have Class F insulation as defined by NEMA MG1-1.65 and temperature rise shall be within NEMA MG1-22.40 definition at rated condition.

4. Three current transformers shall be furnished and installed in a box on the generator for generator differential current protection. This requires all the winding leads to be brought outside the generator before forming the neutral. After the neutral is formed, a current transformer shall be provided in the box for generator ground fault relaying. The ground fault current transformer may be installed in the neutral grounding resistor as an alternative.

The characteristics of the current transformers used for differential protection shall be coordinated with those supplied in the generator switchgear. Current transformer ratings are indicated on the drawings and shall be confirmed by the coordination study.

5. The alternator conduit box shall be sized to accommodate the separate phase leads, neutral leads, current transformers, voltage surge arrestors and capacitors, and connections as indicated on the electrical one-lines.

6. The winding pitch shall be 2/3 pitch for use in paralleling with the utility or other units if desired.

7. Harmonic filters shall be provided where determined by the supplier for proper operation when powering solid-state motor starters.

D. Surge Protection.

1. Each engine-generator shall be provided with voltage surge protection system installed in the generator terminal box or in a separate enclosure near the generator terminal box.

E. Neutral Grounding Resistor.

1. Each engine-generator shall be provided with a neutral grounding resistor as shown on the Drawings for installation by Others. The neutral grounding resistor shall be located in a free standing NEMA 4 enclosure. The resistor shall be sized by the Supplier but shall be minimum 200 amperes, 5kV, and rated 760 degrees C for 10 seconds. Resistor shall be furnished with entry bushings, current transformer, and stand. Resistor shall be suitable for outdoor mounting on the top of the generator enclosure. Generator enclosure manufacturer shall be responsible for furnishing all structural items needed to support the neutral grounding resistor based on weight, size and seismic requirements. Resistor shall be manufactured by Post Glover or approved equal.

F. Fuel System.

1. Each engine shall be furnished with a complete fuel gas train system suitable for attaching to piping from the natural gas distribution piping. The fuel gas train shall include but not be limited to pressure regulators, pressure relief valves, electrically operated valves, manual shutoff valves, strainer, all stainless steel flexible connections, flame arrestor, and with any equipment required by the engine to accept the specified fuel and pressure listed under Design Conditions paragraph and as required to meet NFPA 37 requirements. Fuel valves shall have stainless steel or aluminum trim.

2. The fuel gas train shall include two electrically operated valves for shutoff of the fuel and shall be spring-closed when de-energized to shut off the fuel supply on engine shutdown. The valves shall be 24 volt dc powered and located upstream from the stainless steel flexible connectors in the fuel line, and shall open when engine start is initiated. A manual shutoff valve shall be located upstream from the electrically operated valves.

3. The fuel system shall operate with the specified gas pressure and shall be furnished with any pressure reducing valves or other equipment required by the engine to accept the gas pressure as required. In the event that two stages of pressure reducing valves are required, both shall be provided by the Supplier. All piping shall be provided by the installing

contractor. The pressure reducing valve or valves shall be constructed of suitable material for natural gas service and shall contain an internal pressure relieve valve. The pressure reducing valve vent line shall be provided with vent cap assembly to prevent the entrance of rain, snow, and insects, and shall be routed up inside the enclosure and terminate above the enclosure. Any system requiring equipment to raise the gas pressure for proper engine-generator operation will not be acceptable. Safety pressure relief valve shall be provided downstream of the pressure reducing valves. The outlet of the pressure relief shall be piped outdoors and provided with suitable rain caps. Pressure regulators shall be shipped loose and installed on the outside of the enclosure such that the pressure entering the enclosure does not exceed 5 psi.

4. Stainless steel flexible connections shall be provided for the fuel lines.

5. Pressure taps with stainless steel shutoff valves shall be provided at the inlet and outlet of the regulators and electrically operated valves, and at the inlet of the carburetor. Fuel pressure gauges shall be provided at the inlet of the regulator and carburetor.

6. The fuel system controls shall be as indicated in the control panel paragraph.

G. Exhaust Silencer and Emissions Control System.

1. Each engine-generator unit shall be furnished with a complete exhaust system including an exhaust silencer, emission control equipment, differential pressure switch, all exhaust piping shall be steel, steel bellows expansion joints, and accessories required for a complete operating system. The differential pressure switch set points shall be set by the manufacturer. The entire exhaust and emission control system shall be designed and sized by the engine manufacturer to comply with all emission requirements. Emissions control equipment shall be provided by the engine-generator manufacturer.

2. Either an exhaust silencer or combination emission control /exhaust silencer unit shall be provided as required to meet all Federal, State, and Local emission requirements.

3. All exhaust piping shall be schedule 40S steel.

4. If equipment requires maintenance and is located on the top of the enclosure, the enclosure shall be provided a service access platform that includes a ladder, safety railing on top of enclosure, nonslip top and fall protection to provide adequate maintenance around the equipment and all shall meet OSHA requirements.

5. The silencer and emission control equipment, if located inside the enclosure, and all exhaust piping inside the enclosure shall be acoustically insulated with removable insulation.

6. Each exhaust system shall discharge vertically. A rain cap shall be provided to prevent rain from entering the exhaust system. The rain cap shall open from exhaust pressure from the engine and shall close when exhaust flow stops. The cap shall be steel counter-balancing with vertical discharge.

7. Exhaust system to meet overall noise emission requirements as specified herein.

8. Minimum attenuation for the silencer or the emission control/silencer for the following mid band frequencies shall be as follows:

63 Hz	35	dB
125 Hz	40	dB
250 Hz	40	dB
500 Hz	40	dB
1,000 Hz	35	dB
2,000 Hz	35	dB
4,000 Hz	35	dB
8,000 Hz	35	dB

   a. If a separate exhaust silencer is used in lieu of a combined emissions control/exhaust silencer unit, the exhaust silencer shall be the chamber type, shall meet the specified sound attenuations, and shall be all welded steel construction. The silencer shall be furnished with suitable steel bracket supports for horizontal mounting. Silencers shall be GT Exhaust Systems, maxim, or equal.

9. Emission Control/Exhaust Silencer.

   a. If a combined emission control/exhaust silencer unit is used in lieu of a separate exhaust silencer, the equipment shall be sized to fit within the footprint of the enclosure specified herein to allow adequate clearance for maintenance of the unit. Any modification required by the emission control/exhaust silencer shall be provided at no additional cost to the Owner.
   b. The emissions control system shall reduce all emissions as required to meet all regulations and shall be supplied with all accessories required for a complete and operating system. All housings shall be constructed of all steel materials, insulated, and meet the specified sound attenuation as specified herein.
   c. All emission control/exhaust silencer units shall be provided with access doors if required to access the filters. The doors shall be easily removed without the assistance of lifting equipment and be located for easy access without removing the exhaust emissions control equipment/silencer. The doors shall be provided with gaskets to prevent exhaust gas from leaking to the atmosphere.
   d. Removable insulation covers shall be provided for the emission control/exhaust silencer. The covers shall be of sewn construction with end closures and securing ties. The covers shall be constructed of fiberglass-base fabric fill with asbestos free material and of suitable thickness to provide a cold face temperature of 140 °F. Covers shall be easily removed and replaced. Covers shall allow removing the access cover.

H. Starting System.

1. Each engine-generator unit shall be furnished with a complete electric motor start system including starting motors, battery pack with rack, cables, and battery charger.

2. The batteries shall be of the high rate, nickel-cadmium type and have a 24 volt output. The batteries shall be electrically sized for the engine furnished for the specified design conditions or electrically sized for the engine furnished using electric strip heaters to maintain minimum cell voltages of 0.65 volt per cell during initial starting, and 0.85 volt per cell throughout the cranking time for five consecutive starting attempts of 10 seconds each. Battery voltages shall be maintained under the conditions specified herein.

3. The battery charger shall be suitable for the nickel-cadmium battery pack. The charger shall have a DC output suitable to supply power for all continuous loads and to recharge the batteries from a fully discharged state to normal operating voltage within 8 hours. The battery charger shall be provided with a NEMA 2 corrosion resistant enclosure. The battery charger shall be provided with the following: on/off switch, DC ammeter, DC voltmeter, AC input and DC output circuit breakers or fuses, floating voltage equalization, equalizing timer, and relays with form c contacts for remote annunciation of loss of AC power, low battery voltage, and high battery voltage.

4. The batteries, battery rack, and battery charger shall be located inside the engine-generator enclosure. The battery rack frame shall be constructed of corrosion resistant material.

5. Engine-generator shall automatically supply power to the remote bus that powers the battery charger when it is operating and when utility power is not available.

6. Electric strip heaters, used due to the design conditions, shall be thermostatically controlled and shall be sized to maintain the batteries at 50ºF with a winter ambient temperature as specified herein. The strip heaters shall be powered from the panelboard specified herein and shall be wired by the engine-generator Supplier.

I. Cooling System.

1. Each engine-generator shall be supplied with either a skid mounted radiator cooling system or a remote-mounted radiator cooling system complete with radiator, expansion tanks, cooling water pumps, electric motor-driven fan(s), fan guard(s), thermostatic temperature control, booster pumps (if required by equipment supplied), stainless steel expansion joints at the remote radiators, high-water temperature cut out, electric jacket water heater, structural supports, and all accessories as required for proper operation. The cooling system for each engine-generator shall consist of two cooling loops, one for the jacket water and one for after cooler all to be piped to a single forced-draft radiator containing two separate (dual) cooling cores. Each loop shall include an engine driven cooling water pump, temperature and pressure indicators, flexible connections, and all other accessories as shown on the Drawings or as required for a fully operational system.

    a. Each engine and each associated radiator shall be furnished with flexible intake and discharge water connections. Connections shall be all stainless steel corrugated hose with braid, and shall be Flexonics “Series 401M” or equal.
    b. The radiator shall be protected against thermal shock or damage from the engine-generator cooling system while operating in cold weather.

c. The cooling system shall be filled with a permanent antifreeze mixture of the ethylene glycol type with rust inhibitor suitable for the minimum outdoor temperature conditions specified herein. Suitable for six (6) years before coolant charge, Caterpillar, ELC, or equal.

2. Jacket Water Heater.

a. An electric jacket water heater shall be furnished with each engine to maintain jacket water at 90°F with a winter ambient temperature specified herein. The jacket water heater shall be thermostatically controlled. The jacket water heater shall be powered from the panelboard supplied in this section and shall be wired by the engine-generator supplier.

3. Remote Radiator Alternative.

a. Each radiator shall be a dual-core horizontal-core unit with vertical air discharge with motorized fan(s) and structural steel support frame, and shall be suitable for operating in all types of weather conditions which may be encountered throughout the life of the equipment. Each radiator shall be sized with sufficient capacity for cooling its associated engine-generator running at full load and all other accessories required for proper operation during outdoor ambient temperature as specified in the service conditions section. Each radiator shall produce a maximum of 75 dBA at 25 feet from the equipment. Each radiator shall be no more than 16'-0" long by 8'-0" wide, as indicated on the Drawings.
b. Each radiator shall be provided with four (4) support legs suitable for bolting to the concrete pad and wind and seismic conditions. The length of the radiator support legs shall not be less than the required height for the expansion tank to be located at the highest point in the piping system.
c. Contractor to coordinate number and location of support legs supplied.
d. Each core tube bank manifold shall be removable for tube cleaning and access. The cores shall be pitched to a drain connection with a shutoff valve. The cores shall be capable of withstanding the pressure and flow required by the engine-generator during full load operation. Water flow through either core shall have a maximum pressure drop of 6 psi at full load operation.
e. Each cooling loop shall be furnished with an expansion tank, to be located at the highest elevation in each piping system. Each expansion tank shall include a pressure relief valve, low level switch, inspection port with cap, piping to the radiator cores, mounting brackets, all stainless steel flexible connections, and all other accessories required for safe operation with the radiator. Contractor to provide all piping between the highest point and the expansion tank. Each expansion tank shall be capable of being separated from the radiator and mounted at a higher elevation on a vertical surface, and shall include mounting brackets for such. Level switches shall alarm for low water level in the expansion tanks to the plant control system.
f. The radiator fan shall be belt-driven, forced-draft, fixed-center, air foil section with aluminum blades. Each motor shall be 460 V, 60 Hz, 3-phase motor with TEFC enclosure and operate at a maximum speed of 1,800 rpm. Motor shall be provided

in accordance with Section 16220. The fan shall not operate above 11,200 fpm tip speed and shall avoid vibration sensitive speed ranges.

g. A junction box shall be provided on each radiator package for a single power connection from the remote radiator control panel.

h. Each radiator shall include a hot-dip galvanized steel frame, fan ring, lifting lugs, core guard, fan, fan drive guards and including radiator support legs. Each support leg shall include bolt holes for fastening to a concrete equipment pad.

i. All valves supplied with each remote radiator shall be individually labeled and numbered by the manufacturer as specified in the Identifying Devices section and shall be provided with a corresponding valve schedule.

j. The cooling water supply and return lines shall be housed in a trench underneath grating as shown on the drawings.

k. Radiator manufacturer shall be IEA, or equal.

1) Remote Radiator Local Control Panel.

a) A motor starter with overload protection and field terminals shall be mounted within the control panel as indicated on Drawings for operation and control of its associated remote radiator electric motor-driven fan(s), and all accessories as required for proper operation. The radiator motor starter shall be housed in a NEMA 12 enclosure and shall include an external disconnect switch, motor starter with overload protection, circuit protection, control relays, if necessary, and field connection terminals. Control panels shall be equipped with control power transformers. Each control panel shall automatically start and stop the radiator equipment in coordination with the engine-generator and shall include the accessories necessary to accept a remote run contact from its associated engine generator.

b) The control panel shall, at a minimum, include the following instruments and control devices:

c) Control Power ON Indication.

d) Dry contact that closes for remote common alarm.

e) Three-position selector switch with “RUN-OFF-AUTO” positions.

f) Dry contact that closes and indicating light when the Jacket Water expansion tank water level is low.

g) Dry contact that closes and indicating light when the Aftercooler water level is low.

h) Dry contacts for Radiator selector switch in Running and In-Auto position.

i) The control panel shall be provided with a three-position selector switch with the following positions: “RUN-OFF-AUTO”. In the “RUN” position, individual water pumps and radiator fan to provide local control for maintenance. In the “AUTO” position, the radiator control panel will be remotely started and stopped with the operation of its associated engine-generator. Isolated contacts for when the unit is in the “AUTO” position shall be provided for remote indication.

j) The control panel furnished shall conform to the requirements of the Panels, Consoles, and Appurtenances Section 13570 including color designations for indicating lights and graphic displays.

2) Cooling Water Pumps.

a) The jacket water and aftercooler cooling water pumps, shall be sized to provide sufficient cooling flow to the radiator, as shown on the Drawings. The pumps shall be either integral to the engine-generator or mounted on the engine-generator skid. The capacity of the water pumps shall be coordinated with the cooling water requirements of the engine-generator being supplied, the radiator being supplied, and with the piping indicated on the Drawings. The jacket water pump shall be engine-driven through a belt drive.

b) The cooling water pumps shall be sized to allow 2.0 psig pressure drop to account for piping loss from contractor provided piping for the water jacket supply and return lines. The cooling water pumps shall be sized to allow 1.5 psig pressure drop to account for piping loss from contractor provided piping for the aftercooler and return lines. If engine driven pumps are not suitable for this increased pressure, manufacturer to provide auxiliary pumps powered from the panelboard inside the engine generator enclosure to account for the pressure drop accordingly.

3) In Line Gauges.

a) Pressure and temperature gauges and snubbers shall be provided on both cooling water circuits at the inlet and outlet of the engine. The gauges shall be the analog dial-type with stainless steel case, bezel, fittings, and stem. The gauges shall be hermetically sealed with acrylic plastic or shatter-proof glass window and shall have a 4-1/2 inch minimum dial size. Gauge shall have contrasting markings against background and shall be sized such that the normal operating point will be at the midpoint of its range. Temperature gauges shall be provided with thermowells and pressure gauges with ball type shutoff valves. Pressure gauges shall include snubbers.

4. Unit-Mounted Option.

1) Unit-Mounted Radiator

a) The engine-generator unit(s) shall be cooled with unit-mounted radiator cooling system complete with radiator, expansion tank, water pump, belt-driven fan, fan guard, thermostatic temperature control, high-water temperature cutout, electric jacket water heater and all accessories required for proper operation. The radiator shall be sized with sufficient capacity for cooling of the engine and all other accessories required for proper operation including the ambient air temperature rise inside the enclosure. The fan shall draw air over the engine and discharge through the radiator.

b) The electric jacket water heater shall be furnished to maintain jacket water at 90°F with a winter ambient temperature as specified herein. The jacket water heater shall be thermostatically controlled.

J. Crankcase Vent Blow-By Absorber.

a. Engine-generator manufacturer shall provide a suitable crankcase breather system to remove oil mist form the crankcase emission prior to induction in to the air intake system. The system provided shall meet the applicable level emission requirements.

K. Enclosure.

1. Each engine-generator unit, including its control panel, battery rack, battery charger, panelboard, auxillary cooling water pumps (if required), and other ancillary equipment, shall be housed in a steel or aluminum weatherproof enclosure. The enclosure shall be shop mounted on the engine-generator skid or field erected by the supplier.

2. Each engine-generator enclosure shall be designed to withstand the specified wind as specified in the Meteorological and Seismic Design Criteria.

3. Enclosure shall be as manufactured by Pritchard-Brown or equal.

4. Enclosure Fabrication.

a. The enclosure shall be designed to withstand the specified wind velocity without damage.
b. Steel enclosures shall be constructed with a support frame of not less than 14 gage steel and roof panels of 16 gage. Aluminum enclosure shall be formed sheet aluminum construction, made of modular panels and louvers. Posts, rails, channels, and roof bows shall be 6061-T6 extruded aluminum. The panels shall be 0.040 inch thick minimum.
c. The enclosure shall consist of two side walls, two end walls, and roof. The roof shall be braced as necessary to support the exhaust system. All bracing and reinforcing members shall be integral to the enclosure. Roof penetrations for the installation of the silencer shall be gasketed to prevent the entrance of rain.
d. The enclosure shall be rain proof type as defined by UL2200 and shall prevent the wetting of live parts when the unit is operating. Is required to meet the rain penetration requirements, “rain resistant” louvers, vertical air turning plenums or a combination of the two shall be provided.
e. The enclosure walls shall be reinforced to support the plenums. Plenums shall utilize bracing as required to prevent vibration and damage from the specified wind velocity and shall bolt to the enclosure walls to permit removal and reinstallation.
f. A minimum of four separate doors, two per side, shall be provided and located for easy maintenance access to the engine-generator, controls, and accessories. Doors shall be lockable with stainless steel hardware. Width of each individual door shall not exceed three (3) feet.
g. Engine oil and coolant drains shall be piped to outside of enclosure, with lockable shutoff valves and caps.
h. All enclosure penetrations shall be gasketed or sealed to prevent the entry of rodents, oil, coolant, cooling water supply and return, natural gas supply and vent piping.

i. Enclosure noise.
j. Access door for power panel.
k. Clean and painted paragraphs.

5. Enclosure Ventilation.

a. The enclosure shall be provided with intake and exhaust louvers with dampers to open on engine start. Louvers and dampers shall be sized for 120 percent of the cooling air requirements. Louvers shall be AC powered closed and spring open on unit start. The louvers shall be screened from the inside to prevent the entry of birds.
b. The enclosure shall be rain proof type and all cooling air openings shall be designed to prevent the entrance of rain when the unit is operating.
c. If required, engine-generator manufacturer shall provide air intake plenums.
d. If required, electric fan shall be provided for cooling suitable for the ambient temperatures.

6. Electrical.

a. An AC/DC operated maintenance lights, controlled with a 1 hour, wind-up timer switch shall also be provided. A duplex receptacle rated 20 amp, 125 volts with a weatherproof enclosure shall be mounted inside and near the middle of the enclosure.
b. The enclosure shall be prewired, requiring only external connection to the panelboard and the control panel outputs.

L. Engine-Generator Local Control Panel.

1. Each engine-generator unit shall have a control panel mounted inside the enclosure with panel mounted controls accessible when the enclosure doors are open. The panel shall be provided with vibration isolators to prevent damage to the instruments from engine-generator vibration.

2. Adequate clearance shall be provided between the panel and engine to allow engine maintenance without removing the control panel.

3. The control panel shall be automatic and safety type and shall, at a minimum, include all items required by NFPA 110, Level 1. In addition, the control panel shall be provided with the following instrumentation and controls:

Non-resettable hour meter.

AC voltmeter, AC ammeter, voltmeter/ammeter selector switch with “off” position.

Two normally open dry contacts which close when the engine is running and open when it is stopped.

Dry contact that closes for remote common alarm.

Dry contact that closes when the control selector switch is in “Remote” mode”.

Three-position selector switch with "RUN-OFF-REMOTE"

4. The control panel shall provide Ethernet (Modbus TCP/IP) communications to the Switchgear and Engine Generator Master Control Panel (MCP) in addition to any hardwired controls required by the Engine Generator and Switchgear manufacturer. At a minimum the following information and control shall be provided over the Ethernet communications link:

    a. AC voltage (V)
    b. Power (kW)
    c. Volt-Amps (kVA)
    d. Power Factor
    e. Frequency (Hz)
    f. Coolant temperature (F)
    g. Oil pressure (PSI)
    h. Speed (RPM)
    i. Warning/Alarm Indication
    j. Low oil pressure
    k. High coolant temperature
    l. Overspeed
    m. Overcrank
    n. Emergency stop
    o. Fault shutdown
    p. In-Remote Mode
    q. Start Command
    r. Stop Command
    s. Droop Mode Command
    t. Isochronous Mode Command

5. The control panel furnished shall conform to the requirements of the Panels, Consoles, and Appurtenances Section 13570 including color designations for indicating lights and graphic displays.

M. Engine-Generator Master Control Panel.

1. The Engine-Generator Master Control Panel (MCP) shall be provided by the Engine-Generator System Supplier to be remote mounted within the Electrical building as indicated on the Drawings. The master control panel shall control the individual engine generators through their respective control panels to achieve the desired functionality specified and as recommended by the Engine Generator manufacturer.

2. The Master Control Panel (MCP) shall include a programmable logic controller and shall be programmed by the Engine-Generator System Supplier as specified herein to control and monitor the Engine Generators and Switchgear. The Master Control Panel shall communicate with the Plant Control System using Ethernet/IP. Programming shall at a minimum meet the Owner's requirements. Contractor shall be responsible for coordinating between the Switchgear and Engine-Generator System Suppliers to provide a complete and functional control system for full automatic operation of the Beaver Western Corridor Pump Station.

3. Panel Fabrication Requirements.

   a. The control panel furnished shall be rated NEMA 12 and shall conform to the requirements of the Panels, Consoles, and Appurtenances Section 13570 including color designations for indicating lights and graphic displays.

4. Programmable Logic Controllers.

   a. Programmable logic controllers (PLCs) complete with power supply, chassis, input and output cards for overall system control shall be furnished in the Master Generator Control Panel to control and monitor all necessary logic functions of the system. A PLC register access panel shall be provided on the Master Generator Control Panel door. The panel shall allow access to the PLC so that adjustable parameters can be changed without having to implement software changes.
   b. If required, each Generator Local Control Panel shall be furnished with a PLC with power supply, chassis, input and output cards for control and monitoring of its respective generator. Each Generator Local Control Panel PLC shall communicate to the master PLC as required by the engine-generator manufacturer.
   c. All PLC programming shall be performed by the engine-generator manufacturer. Engine-generator manufacturer shall be responsible for coordinating information concerning programs, addressing, communications, etc. with the Owner and Engineer.

5. Industrial Panel Mounted Ethernet Switches.

   a. The Engine Generator System Supplier shall provide industrial Ethernet switch that meets the requirements of Network Systems Section 13590.

6. Human Machine Interface (HMI).

   a. The Master Generator Control Panel and each individual Local Control Panel, as required, shall be furnished with an HMI panel with a series of screens to show system operation, specific alarms and operating status. All alarm status windows shall be furnished with color LCD industrial displays capable of displaying both text and graphics. Each panel shall include the points listed below and any additional points as required by the System Supplier. A minimum of 5 spare windows shall be included in each panel.
   b. All alarm and status points shall be terminated at the Master or Local Control panel PLCs. The respective PLC shall distribute signals to the HMI panels. All primary alarm and status points indicated below shall be available for viewing by the plant control system over hard-wired connections.
   c. In addition to switchgear and generator inputs, the battery chargers shall provide dry contact inputs to the master PLC for annunciation on the Master Generator Control Panel HMI panel.
   d. The Master Generator Control Panel HMI panel shall include but not be limited to the following alarms and status points.
      1) Utility Power Available
         a) Start Signal Present
         b) Generator Start Failure
         c) Control Panel Control Power Fail
         d) Generator Bus Common Alarm

2) Under Voltage
   a) Under Frequency

e. If additional alarm and status points are required as a result of the design by the engine-generator supplier, they shall be furnished for the respective control panel.

f. From the Overview Screen on the OIT or HMI, the operator shall be able to select from the following modes of operation:
   1) Manual Transfer Mode – Plant is powered by Utility with the engine-generators on Standby until Plant control system or HMI calls for the generators to begin startup sequence.
   2) Auto Transfer Mode – Plant is powered by Utility with the engine-generators on standby until detected loss of Utility calls for the generators to begin startup sequence.
   3) No Load Test Mode – Plant is powered by the Utility. The generators are started and brought up to voltage and frequency but are not closed to the bus.

7. Master Control panel Control Descriptions.

a. The engine-generator switchgear controls shall provide complete automatic and manual operation of the switchgear circuit breakers and generators to restore electric power to 42-SWGR-1 and 42-SWGR-2 via 43-SWGR-1, upon loss of electric utility power or load transitioning. Switchgear breaker control shall be monitored and operated by the Engine Generator Master Control Panel located in Electrical Building. Communication and control cable shall be installed from the Engine-Generator Master Control Panel to the Plant Control System, feeder protection relays, solid state meters, PTs, CTs, and circuit breakers including: UM-1, G-1, G-2 and GM-1 in 43-SWGR-1, M-1 and T-1 in 42-SWGR-1 AND M-2 in 42-SWGR-2 as indicated on the Drawings. Equipment shall provide momentary closed transition transfer between electric utility and generator power, and the ability to operate in momentary closed transition with the utility for load transitioning purposes. At a minimum, all relays, meters, controllers, logic and circuit breakers shall be provided to perform the functions stated below.

b. Normal Operation.
   1) Under normal operating conditions, breakers UM-1, M-1 and M-2 are closed, and tie breaker T-1 is open. Generator breakers G-1, G-2 and generator main breaker GM-1 shall remain open when utility power is available. The generators are shut down and in standby mode waiting for the call to run.

c. Generator Startup Sequence.
   1) Circuit breakers GM-1, G-1 and G-2 are open. Engine Generators 43-EG-101 and/or 43-EG-102 are called to run as determined by the Engine-Generator Master Control Panel. The first generator to reach the rated voltage and frequency shall be closed to the bus via circuit breaker G-1 or G-2. The next generator shall be selected and closed to the bus after paralleling with the first generator. Once all required generators are connected to the 43-SWGR-1 generator bus, circuit breaker GM-1 shall remain open until called to close.

d. Manual Transfer Mode.

1) When the Manual Transfer Mode is selected at the HMI or from the Plant control system, the Engine-Generator Master Control Panel shall not automatically initiate a generator startup or shutdown sequence upon loss or availability of utility source until a signal from the Plant Control System or HMI is sent to initiate the sequence. Controls shall also be furnished that will allow for complete manual operation of the generators and switchgear such that properly trained personnel can start and synchronize the generators to the generator bus, and open and close all circuit breakers from the Master Control Panel or the Plant Control System HMI. All necessary interlocking shall be in place that will prevent an unsafe condition and all required sync check relays shall be furnished that will prevent a circuit breaker from being closed during an out of phase condition.
2) In manual control mode circuit breaker interlocking shall be in place that will prevent the main breakers UM-1 or M-2 from being closed at the same time as circuit breaker GM-1, without exception.

e. Automatic Transfer Mode

When the Automatic Transfer Mode is selected at the HMI or from the Plant control system, the following sequence of operations shall occur.

1) Loss of Electric Utility on UM-1 Only.
   a) The Engine-Generator Master Control Panel shall sense an electric utility source outage on UM-1 line side. Circuit breaker M-1 shall open and tie breaker T-1 shall close to allow utility power from M-2 to feed both 42-SWGR-3 and 42-SWGR-2.

2) Loss of Electric Utility on M-2 Only.
   a) The Engine-Generator Master Control Panel shall sense an electric utility source outage on M-2 line side. Circuit breaker M-2 shall open and tie breaker T-1 shall close to allow utility power from UM-1 to feed both 42-SWGR-2 and 42-SWGR-3.

3) Loss of Electric Utility on Both UM-1 and M-2.
   a) The Engine-Generator Master Control Panel shall sense an electric utility source outage on both UM-1 and M-2 line side. Circuit breakers UM-1 and M-2 shall open, and tie breaker T-1 shall close. The generators shall perform the generator startup sequence. Circuit breaker GM-1 shall close.

4) Electric Utility Restoration.
   a) The Engine-Generator Master Control Panel shall sense an electric utility source voltage on either UM-1 or M-2 line side, and shall verify synchronization of the 43-SWGR-1 generator bus and the circuit breaker UM-1 and M-2 line side before closing circuit breaker UM-1. Engine-generators shall soft transfer the plant loads back to the utility and open circuit breaker GM-1. Circuit breaker M-2 shall close in a momentary closed transition (less than 100ms) before opening Tie breaker T-1. Engine-generators shall perform a shutdown sequence as determined by the engine-generator supplier and both circuit breakers G-1 and G-2 shall open.

f. No Load Test Mode.
   1) When the No Load Test Mode is selected at the HMI or from the Plant control system, the following sequence of operations shall occur.
      a) The generators shall perform the generator startup sequence but do not close to the bus.
      b) The system is now performing a No Load Test.
   2) The following sequence of operation shall occur when the operator ends the No Load Test from the HMI or Plant control system.
      a) The generators are allowed to run for their programmed cool-down period and then shutdown.
      b) The system is now back in Manual Transfer Mode.

8. Future Master Control panel Control Descriptions.
   1) Engine-Generator Master Control Panel shall be provided with the capability to monitor and control (5) future circuit breakers and (2) future engine-generators with a similar configuration and sequencing as 43-SWGR-1.

9. Panelboard.

   a. Each engine-generator unit shall have a 480 to 120/208 volt transformer and a 120/208 volt panelboard with main and branch circuit breakers rated as required to power the required loads inside the enclosure as specified herein. A minimum of 4 spaces for future breakers shall be provided. The panel board shall be pre-wired to all engine-generator accessories. The panelboard enclosure shall have a Door-In-Door hinged trim cover. The panel board shall be mounted inside each enclosure and isolated from generator vibration.
   b. The panel board shall supply power to the services including but not limited to the following:
      1) Engine-generator starting system battery charger.
      2) Enclosure lights and receptacles.
      3) Fuel System
      4) Enclosure intake and exhaust louvers/dampers.
      5) Engine jacket water heater.
      6) Alternator winding heater.
      7) Battery pad heater strip heater for starting batteries.
      8) Unit heater.
      9) Local Control Panel.
      10) Auxiliary Cooling Pumps (If required).
      11) Remote Radiator Control Panel.

   c. Each panelboard shall have an integral surge protection device as specified in the Electrical section. All electrical equipment and materials shall meet the applicable requirements of the Electrical section.

10. Emergency Shutdown Control Station.

   a. A remotely located emergency shutdown control station shall be furnished under this section and connected into the engine-generator control panel. The control

station when activated shall shutdown the engine-generator regardless of the position of the RUN-OFF- REMOTE selector switch. The control station shall be located as indicated on the power plan. Control wiring between the control station and the engine-generator control panel shall be furnished by the Contractor as indicated on the Drawings.

11. Electric Governor Control.

    a. The governor control for each engine-generator shall be electronic and shall have the capability for speed control and load sharing (kW & kVAR). The equipment shall consist of, but not be limited to, the following:

    Governor actuator.

    Magnetic pickup for speed sensing.

    Monitoring of voltage and current for the generator 3 phase output.

    Load sensor.

    Speed sensor.

    Ramp generator for control of ramp time and idle speed.

    Speed control rheostat.

    Control power voltage regulation.

    Switch for selecting either isochronous or droop control mode.

    Controls for the following:

        Rated speed.

        Stability.

        Gain.

        Ramp time.

        Low idle speed.

        Load gain.

        Droop.

        De-droop.

    Rheostat for control of speed for synchronizing.

b. The electronic governor control shall be furnished as a complete governor and control package, Device 65. All items except the governor actuator and magnetic pickup for speed sensing shall be furnished to the switchgear manufacturer for mounting in the generator switchgear as specified in Medium-Voltage, Metal-Clad Switchgear section. The electronic package for speed control shall be Woodward 2301A load sharing and speed controls or equal.

12. Generator Line and Generator Component Overcurrent Protection.

a. Overcurrent protection devices shall be provided as needed by the system design to protect generator rotor and excitation system components.
b. Ground fault indication shall be provided per NEC 700.6(D). The indication shall be connected to the Control Panel common alarm.

13. Limiting Dimensions.

a. Each engine-generator unit and associated remote radiator if used furnished shall be of a design that can be accommodated in the space available as specified herein.

14. Noise Emissions.

a. The engine-generator unit(s), including the enclosure, louvered openings, remote radiator if used, and exhaust system, shall be designed to limit the noise emissions to not exceed the A-weighted sound pressure level of 75 dB(A) at 23 feet from any point the engine-generator unit(s) when operating all the loads as specified during the performance test, and when measured in accordance with industry standards such as but not limited to ANSI S12.18, ASME PTC 36, ISO 8528-10.

2.5 SHOP PAINTING.

A. Engine-Generator

1. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, engine, alternator, piping, and valves shall be shop primed and finish painted prior to shipment to the site.

2. Stainless steel, nonferrous, and nonmetallic surfaces shall not be painted.

3. Enclosure.

a. Each enclosure shall be thoroughly cleaned after assembly, etched, and shop painted, both interior and exterior surfaces. The enclosure shall be painted according to the manufacturer's standard practices with the interior receiving at least one coat of ANSI Gray. Exterior paint colors shall be as selected by the Owner.

2.6 SHOP TESTS.

A. Engine-Generator

1. The manufacturer shall shop test each engine-generator set with its control panel and radiator to demonstrate that the equipment conforms to specified requirements for load capacity.

2. All items included on the control panel shall be assembled, wired, and tested in the manufacturer's shop.

3. The tests shall consist of repeated starts and stops, operation under a load bank at specified capacity frequency, voltage, phase, and power factor for a minimum of 1 continuous hour, and tests to demonstrate that each safety shutdown device is working properly. Contractor shall submit certified copies of the shop test results prior to shipping the unit which shall include date of manufacturer of each unit and serial numbers of engine and alternator.

2.7 OPERATION INSTRUCTION.

A. Step-by-step instructions shall be furnished by each engine manufacturer for each unit. The instructions shall include, but not be limited to, the following procedures or information:

Startup of the unit.

Normal shutdown of the unit.

Emergency shutdown of the unit.

Normal operation of the unit, typical temperatures, pressures, speed, etc., for gauges and instruments which are displayed on the panel.

B. The operation instructions shall be submitted for review in accordance with the Submittals Procedures section. When the review is complete, the instruction sheets shall be printed on heavy paper or cardboard stock and laminated with clear plastic. Two copies of the laminated instructions shall be furnished with the unit. One copy shall be located or displayed at the control panel for the unit. Each reserve copy shall be delivered to Owner. The instructions specified here are in addition to the operation and maintenance manuals required by the Submittals Procedures section.

2.8 PERMITS.

A. Engine-Generator.

1. Contractor shall be responsible for preparing and submitting air emissions permit application on behalf of the Owner to the local air quality authority for the engine-generator being supplied based on the maximum number of operating hours and the guaranteed emissions.

2. The permit shall include provisions for the Owner to contact the local air quality authority to operate the unit in the event the permit hours may be exceeded due to unforeseen emergency conditions.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Each engine-generator shall be installed in accordance with the Equipment Installation section and as specified herein.

B. The exposed finish shall be inspected after completing system installation, including pipe connections, fittings, valves, and specialties. Burrs, dirt, and construction debris shall be removed and any damaged finishes, including chips, scratches, and abrasions shall be repaired.

3.2 FIELD QUALITY CONTROL.

A. Installation Check.

1. When required, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

3.3 FIELD TESTING.

A. Manufacturer's field services shall be provided for field testing. All costs for these services shall be included in the contract price.

B. Performance Test.

1. Each unit shall be mechanically checked for proper operation. Each alarm and safety shutdown shall be checked by artificially simulating an alarm condition. Defective equipment and controls disclosed by the tests shall be replaced or corrected, and the packages placed in satisfactory operating condition.

2. Each engine-generator set shall be tested to demonstrate that the equipment conforms to specified requirements for load capacity, and starting duty. Demonstration shall include paralleling, automatic synchronizing, and load sharing.

3. The complete system (engine, generator, fuel system, unit mounted or remote radiator, and control panel) shall be field tested together by the manufacturer as a complete system to assure compatibility.

4. Each unit shall be individually tested. The tests shall consist of repeated starts and stops, operation under a load bank at the specified power rating for the duration indicated below. Contractor shall furnish the lubricants, load bank, and the owner shall supply the fuel for the tests.

5. Before each of the following tests, the engine shall be brought to steady state conditions as determined by the instrument reading.

    a. Individually test each unit to successfully demonstrate four (4) consecutive start, run and stop sequences of the unit without any alarm conditions.
    b. Individually test each unit to demonstrate that each safety shutdown device is working properly per manufacturer's recommendations and accessibility.
    c. Individually test each unit for four (4) continuous hours at specified power rating and power factor within normal operating conditions of the unit without any alarm conditions.
    d. After each unit has been individually tested, the units shall start and automatically synchronously operate in parallel operation. This shall consit of four (4) starts followed by 30 minutes of continuous operation at specified power rating and power factor within normal operating conditions of the units without any alarm conditions.
    e. Four (4) starts of the specified electrical loads for both units in the order listed without exceeding the maximum voltage drop allowance followed by 30 minutes of continuous operation per start within normal operating conditions of the unit without any alarm conditions.
    f. With both units operating in parallel, four (4) consecutive, successful transfers to and from utility power per the specified transition times as defined in Section 16385.
    g. Demonstration that each safety shutdown device is working properly for both units.
    h. Any retesting or modifications to the equipment to meet the above requirements shall be approved by the Engineer. All costs of modifications and retesting shall be at no cost to the owner.

6. In addition to the required emissions levels being monitored, the following items shall be measured, recorded at 15 minute intervals, and submitted in a field test report:

    Outdoor ambient temperature.

    Indoor ambient temperature.

    Barometric pressure.

    kW output.

    Engine speed, rpm.

Engine jacket water temperature.

Engine oil pressure.

Start time.

Completion time.

7. Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

C. Field Sound Level Test.

1. The installed equipment shall be tested for noise. The maximum measured sound levels outside the enclosure, shall not exceed the specified noise level at any octave band frequencies, at the specified distance\ when operating alone or at the same time as the second unit. Background noise shall be included in the specified sound level. The Contractor shall take background noise measurements as necessary to determine the level of sound attenuation required for the enclosures.

2. Any retesting or modifications to the equipment to meet the above requirements shall be approved by the Engineer. All costs of modifications and retesting shall be at no cost to the Owner.

3. Test reports shall verify that the specified tests have been performed and shall state results. Test results shall be submitted as required in the Submittals Procedures section.

3.4 TRAINING.

A. The manufacturer shall conduct on-site training to instruct the Owner on operation and maintenance of the units. The training shall be arranged and coordinated with the Owner though the Contractor. All costs for these services shall be included in the contract price.

B. The training program shall consist of two sessions for each of the following categories for the minimum specified duration for a class size up to ten persons selected by the Owner.

Training Subject	Minimum Hours/Session
General System Overview	2
Engine/Generator Operations	2
Emissions Equipment	2
Paralleling Switchgear	4
Control System	4

Follow up subject as determined by Owner 6 months following startup	4

C. For each training session, approximately half of the time should be spent in a classroom environment and the other half in a hands-on environment.

D. A detailed outline of the material to be covered during each training session and training materials are to be submitted to the Engineer at least one month before the start of training for review, comment, and approval. The equipment representative shall provide an adequate number of printed trainee materials for all persons being trained.

3.5 WARRANTY.

A. The System Supplier shall guarantee that all the components of the system including the engine-generator, emissions control system, control system, all equipment specified herein an all ancillary equipment, shall perform to the conditions specified herein or in the respective equipment section.

B. The guarantee period shall be 60 months after the date of Substantial Completion. If within the guarantee period, any system component is found to be defective, the System Supplier shall promptly, without cost to the Owner, satisfactorily correct or repair such defective work.

End of Section

SECTION 12625 - LABORATORY FURNITURE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers wood laboratory furniture to be furnished and installed in the Pump Station laboratory areas including base cabinets, worktops, wall cabinets, , and other furnishings as indicated on the Drawings. All water service fixtures, sinks, traps, strainers, overflows, plugs, and tailpieces; and all electrical service fixtures installed in the laboratory furniture or countertops shall be furnished with the laboratory furniture.

1.2 GENERAL

A. Except as otherwise noted, all laboratory furniture items are designated on the Drawings by catalog numbers of the Kewaunee Manufacturing Company. The catalog numbers identify type and quality desired. Products shall be furnished by the Kewaunee Manufacturing Company or approved equal.

B. The general arrangement and dimensions shall be as indicated on the Drawings.

1.3 SUBMITTALS

A. Detailed drawings, specifications, descriptive data, and complete information concerning all laboratory furniture, fixtures, materials, and appurtenances shall be submitted in accordance with the Submittals Procedure section. Submittals shall include manufacturer's name, catalog numbers, materials, construction details, and other pertinent data.

B. The drawings shall show dimensions, installation details, and relation to adjoining and related work where close fitting is required, and shall show reinforcement, anchorage, and other details required for proper installation. The drawings shall also include plumbing roughing-in data where necessary.

1.4 COLOR SELECTION

A. Colors for wood and steel components shall be selected by the Engineer from manufacturer’s standard color line.

1.5 FINISHES

A. All exposed exterior and interior coatings shall be a smooth, satin luster finish highly resistant to acids, alkalis, salts, solvents, water, and abrasion. The finish shall be as selected by the Engineer from the manufacturer's standard line of colored finishes. Sample cards shall be submitted by the Contractor.

1. Finish of Metal Surfaces.

    a. All steel used in laboratory furniture shall be given a corrosion-resistant finish after fabrication of component parts. Adhesion of finish to the metal shall be implemented by multistage cleaning and bonding treatment. Exposed surfaces shall be given as many filler coats as required to provide a smooth and uniform surface for painting. A prime coat shall then be applied and baked on. The highest quality baked enamel shall be applied over the prime coat.

2. Finish of Wood Surfaces.

    a. All exposed exterior and interior wood surfaces shall receive the manufacturer's standard satin stain, sealer, and filler coatings, followed by at least three coats of chemical resistant synthetic varnish. The surfaces shall be thoroughly dried, sanded, and wiped clean between coats.
    b. Unexposed exterior and interior surfaces shall receive two coats of resinous wood sealer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials used in construction of the laboratory furniture shall comply with the following requirements:

Wood	Kewaunee's Signature Series Wood Furniture Cabinets or approved equal. Cabinets shall have ¾" hardwood plywood panels with front exposed edges faced with solid hardwood.
Stainless Steel	AISI Type 316 or 304 as indicated.
Glass	¼" laminated safety glass.
Top Material	Molded modified epoxy resin, matte finish, black color.
Pegboard	Model numbers and options as scheduled on the Drawings.

2.2 FURNITURE CONSTRUCTION

A. All laboratory furniture shall be the product of a manufacturer regularly producing high quality laboratory furniture. Unless otherwise required, laboratory furniture shall be wood. Laboratory furniture shall be standing and sitting fixed height wood casework with applied tops and

backsplash as indicated on the Drawings. ADA height base cabinets shall be provided where indicated on the Drawings.

1. Construction.

    a. Contemporary full overlay construction shall be provided on all doors and drawers with vertical matching grain. All joints shall be mortise and tenon construction for maximum strength. All cabinet work shall be glued and screwed together, using precision jibs and clamps to ensure square corners and plumb vertical surfaces. All exposed surfaces shall be sanded smooth before finishing.
    b. When assembled, each cabinet shall be an integral unit which will fit with congruity into the assembly of laboratory furniture, but which may be readily relocated. Adjoining units shall be connected with concealed fasteners. All units extending to the floor shall be equipped with leveling threaded adjusters. All drawers and doors of similar sizes shall be interchangeable.
    c. Metal gauges used herein are minimum thicknesses and refer to US Standard gage.

2. Base Cabinets.

    a. Unexposed ends shall be of 3/4-inch thick fir plywood and exposed ends shall be of 3/4-inch hardwood plywood and hardwood facing on exposed edges of all panels. Front and back top rails, bottom front rail, and toe spaces rails shall be of solid hardwood extending full width of cabinet and fastened into cabinet ends. Bottoms shall be of 3/4-inch hardwood plywood set into front rails and ends. Backs shall be of 1/4-inch fir plywood and shall be removable from inside to provide access to chase space beyond. Removable shelves shall be provided as specified.

3. Wall Cabinets.

    a. Wall cabinets shall be constructed similar to base cabinets except the top and bottom front rails shall be designed to accommodate glazed swinging doors as indicated on the Drawings. Wall cabinets shall be of double bottom construction with the exposed soffit of 1/4-inch hardwood plywood of the same material and finish as other exposed parts set flush with the end panels and bottom front rail.

4. Drawers.

    a. Drawer fronts shall be of 13/16-inch solid hardwood with overlap at sides, top, and bottom. Sides shall be 1/2-inch thick and shall extend beyond the drawer back. Backs shall be 1/2-inch thick. Drawers shall be complete with stops to allow convenient removal without the use of tools. Bottoms shall be1/4-inch tempered hardboard set and glued into fronts, sides, and back.

5. Doors.

    a. Swinging doors shall be solid panel type or glazed as indicated by the model numbers on the Drawings. Single type swinging doors shall overlap cabinet openings on all sides. Glazed doors shall have 1-1/16-inch thick solid hardwood framing, mortised, tenoned, glued, and doweled; 1/4-inch safety glass shall be set in from the rear and secured in place with molding. Solid panel doors shall be of

hardwood plywood with solid hardwood edging, approximately 1-1/16-inch thick and may be of solid core construction.

b. Swing doors shall be fitted into casework openings with 1/16 inch clearance between doors and frames. Swing door openings shall be provided with rubber bumpers at top and bottom. All doors shall operate easily and quietly and shall be easily removable.

6. Cabinet Shelves.

a. Shelves shall be removable and shall be supported at four points. Shelves shall be full width and support brackets shall be adjustable in not to exceed 2-inch vertical increments.

7. Filler Panels.

a. Manufacturer's standard filler panels, prefinished to match adjacent furniture, shall be provided where required to complete the installation.

8. Miscellaneous Items.

a. All necessary connectors, spacers, pipe supports, and closures shall be provided as necessary for a complete installation.

9. Hardware.

a. Hardware and trim shall be best quality for the intended use. All hardware, including screws and bolts, shall be protected against corrosion by plating or painting. Drawer and door pulls shall have adequate cross section to ensure against breakage under rough use and shall all be the same style.
b. Hinges shall be stainless steel, heavy-duty type.
c. Door catches shall be nylon roller catches.

2.3 TOP MATERIALS

A. Table tops and splashbacks shall be modified epoxy resin. Configuration of the tops and splashbacks shall be as indicated on the Drawings.

1. Modified Epoxy Tabletops.

a. Table tops and splashbacks to be of modified epoxy resin shall be at least 1 inch thick and shall be furnished in as large sections as practicable. Tops of wall tables shall extend 1 inch beyond face of the base unit. All tabletops shall be field jointed into continuous tops. Field joints shall be made with an acid, alkali, and solvent resistant cement. Field joints shall be at least as strong as the top material. Where noted on the Drawings, working surfaces shall be provided with a 1/4 inch raised edge along all exposed top edges and on all exposed corners. Color of the modified epoxy shall be black.
b. Integral drainage slots shall be provided adjacent to sinks where indicated on the Drawings.

2. Accessories.

a. Tabletops shall have a suitable opening for each sink. Holes shall be drilled as necessary for service fixtures.

2.4 SINKS

A. Sinks for installation in epoxy resin tops shall be single-piece solid castings of epoxy resin and shall be Duriron Company "Durcon" or Kewaunee "Kemresin". Sink drainboards shall be made of material identical and continuous with adjoining table tops and shall be made of identical material with a watertight joint between each sink and the drainboard (table top).

2.5 SERVICE FIXTURES

A. The general arrangement and locations of the service fixtures shall be as indicated on the Drawings.

B. Potable water and DI water fixtures shall be designed for laboratory use and shall be brass finished in polished heavy chrome.

C. Water fixtures shall have renewable seats and washers. Gooseneck spouts shall be heavy seamless brass tubing finished in polished chrome. Aerators shall be provided on all water faucets which are not required to be equipped with hose connectors. Each cock shall be leak proof at 125 psi air pressure. Each cock shall be lubricated with suitable sealing lubricant.

D. Laboratory sinks and faucets shall be provided as scheduled on the Drawings. The fixtures listed on the Drawings are by the Kewaunee Manufacturing Company. Equivalent items by other manufacturers may be furnished subject to acceptance by the Engineer.

2.6 ELECTRICAL FIXTURES

A. Receptacles and switches shall be installed in flush-mounted boxes or pedestal boxes as indicated on the drawings or specified. All boxes shall be provided with satin finished 18-8 stainless steel plates and shall conform to the National Electrical Code.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Laboratory furniture, fixtures, and equipment shall be installed by skilled workers. All items shall be shipped, handled, and installed by methods which will prevent damage of any kind. Each unit of furniture shall be erected in proper position, and fixtures shall be properly installed on the furniture.

B. Each unit of laboratory furniture shall be installed level and plumb. Leveling adjusters shall be adjusted and locked in position. Cove base shall not be installed until after laboratory furniture has been completely checked.

End of Section

SECTION 13110 - CATHODIC PROTECTION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the material and construction specifications to furnish, install, and test the corrosion protection system for the following:

1. Steel Pipe -Cathodic protection with galvanic anodes.

B. The items specified in this section include materials and installation procedures for miscellaneous cathodic protection materials and equipment for stray current interference testing

1.2 GOVERNING STANDARDS

A. ANSI/AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems, NACE International SP0169 and RP0286.

1.3 GENERAL REQUIREMENTS

A. The Contractor shall be responsible for all specified testing and the furnishing and proper installation of all materials and equipment, as specified herein and as indicated on the Drawings.

B. The Contractor shall obtain the services of a NACE certified corrosion or cathodic protection specialist to review installation procedures and supervise the testing. The corrosion or cathodic protection specialist shall be acceptable to the Owner and the Engineer.

1.4 SUBMITTALS

A. Drawings and Data – General

1. Complete specifications, data, and catalog information or drawings covering the items furnished under this section shall be submitted in accordance with the Submittals Procedures section. Submittals shall include, but not be limited to, the items listed in this Section.

B. Specialist Experience Record.

1. Experience record for the proposed NACE certified corrosion or cathodic protection specialist.

C. Drawings and Data – Protection Systems.

1. Drawings and data shall include the following items:

a. Drawings which indicate the location of each anode, underground reference electrode, buried insulated flange, and field test station complete with a description of piping connected are indicated.
b. Drawings with sufficient information that each underground galvanic anode and underground reference electrode can be exactly excavated or replaced.

D. Operations and Maintenance Manual

1. Operations and maintenance manual for the cathodic protection system.

E. Reports.

1. Tabulated reports of the following, where the reports are relevant to the specified cathodic protection systems:

a. Underground reference electrode tests.
b. Insulated flange tests.
c. Anode current measurements of each test station connected galvanic anode.
d. Pipe system potential measurements.

F. Test Reports

1. All test reports shall be submitted 15 days after completion of the cathodic protection tests.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 MAGNESIUM GALVANIC ANODES

A. Magnesium galvanic anodes shall be high potential magnesium anodes furnished as a packaged assembly with insulated lead wire. The packaged assembly shall consist of a permeable cloth bag containing the anode and special compacted backfill. The anode shall be centered in the bag and completely surrounded by the backfill.

B. High potential magnesium anode alloy shall be Grade M1C, UNS alloy M15102, complying with ASTM B843 and shall have the following composition in percent by weight:

Element	Percent
Aluminum	0.010 maximum
Manganese	0.50 to 1.30
Silicon	0.05 maximum
Copper	0.02 maximum
Nickel	0.001 maximum
Iron	0.03 maximum
Other	0.05 each and 0.30 maximum total
Magnesium	Remainder

C. Backfill surrounding the anode shall have the following composition in percent by weight:

Material	Percent
Ground hydrated gypsum	75
Powdered bentonite	20
Anhydrous sodium sulfate	5

D. Packaged anode component specifics shall be as follows:

Bare anode dimensions	4 inches by 6.5 inches by 60 inches
Bare anode weight	60 pounds
Lead wire type and size	Type TW insulated, 12 AWG solid copper
Lead wire length	50 feet
Approximate packaged weight	130 pounds

E. High potential Magcorp magnesium anodes shall be as manufactured by Mesa Products, Inc.; Stuart Steel Protection Company; Farwest Corrosion Control Company; or acceptable equal. High potential Winca (formerly Dow) magnesium anodes shall be as manufactured Norton Corrosion, Allied Corrosion, or equal.

2.2 WIRE AND CABLE ACCESSORIES

A. Cathodic Protection Cable

1. All cable, sizes 12 AWG and larger, where specified herein or on the Drawings to be cable Type CP, shall be stranded copper cathodic protection cable with low density high molecular weight polyethylene (HMWPE) insulation as supplied by the Kris-Tech Wire Company, Inc.; Energy Economics, Inc.; or Mesa Products, Inc. Provide color coding as indicated on the Drawings.

B. Wire and Cable Markers

1. Markers for wire and cable circuits shall be of an opaque nylon material consisting of a marker board, non-releasing holding device, and cable fastening tail. The holding device shall be designed to allow the fastening tail to pass around the cable and through the holding device, so the cable marker can not be removed except by cutting it loose from the cable. The marker board shall not be less than 3/8 inch wide, 3/4 inch long, and 25 mils thick with one side roughened to hold ink from a marking pen.

2. Cable markers shall be "TY-RAP" identification cable ties, "Part Number TY551M" as manufactured by Thomas & Betts; or "PAN-TY" marker ties, "Type PLF" as manufactured by Panduit Corporation, or equal.

3. As an alternative one inch diameter brass tags with 3/16 inch minimum stamped identification for anode, referenced electrode, or identified pipe test lead connected to cable with nylon wire ties is acceptable.

C. Marking Pens

1. Marking pen ink shall be suitable for marking on nylon and shall be black, permanent, and waterproof. Marking pens shall be Part Number "H-873" as manufactured by ULINE Industrial Markers, or "Part Number PX-0" as manufactured by Panduit Corporation, or equal.

D. Compressed Ring-Tongue Terminals

1. Compression ring tongue terminals shall be single hole, uninsulated, compression type terminal lugs made of corrosion-resistant copper, bronze, or nickel-plated brass. Compression ring tongue terminal part numbers shall be as indicated in the table below:

Wire Size	Stud Size	Ring-Tongue Terminal Part No.	Manufacturer
14 AWG Stranded	1/4 inch	YAV12-G3	Burndy Corporation
12 AWG or 10 AWG Stranded or Solid	1/4 inch	YAV10-T3	Burndy Corporation

E. Exothermal Connections

1. Welding charge formulation, equipment selection, and welding procedures shall be as recommended by the manufacturer of the exothermal weld materials for the size, shape, and composition of the materials being welded. Where the manufacturer offers a choice of exothermal weld materials, the recommended materials for cast iron pipe shall be used for ductile iron pipe. Materials shall be Cadweld as manufactured by Erico Products, Inc., or Thermoweld, a Division of Continental Industries, or equal.

F. Oxidation Inhibiting Compound

1. Oxidation inhibiting compound shall be an electrically conductive paste material, compatible with both steel and copper, and shall be Contax Type CT as manufactured by Thomas & Betts; Kopr-Shield as manufactured by Jet-Lube, Inc.; Dostex Type AP as manufactured by Dossert Corporation, Ox-Gard, as manufactured by Gardner Bender, Inc.; DEOX Oxide Inhibitor as manufactured by Ilsco; or equal.

G. Solder Connections

1. All soldering shall be with 50/50 tin/lead hollow core solder with non-acid flux.

2.3 ABOVEGROUND FIELD TEST STATIONS

A. Aboveground field test stations shall consist of a cast aluminum enclosure with a terminal block accessible from both sides and from when the cover is removed. Each terminal block shall be special-ordered with five nickel-plated marine brass terminals and one nickel-plated marine brass jumper strap. The cover fastener shall be stainless steel. The enclosure shall have a threaded hub suitable for connection of 2 inch rigid conduit. Aboveground field test stations shall be Testox 715 as manufactured by Gerome Manufacturing Company, Cathodic Protection Services Company, or equal.

2.4 UNDERGROUND REFERENCE ELECTRODES

A. Underground reference electrodes shall be of the saturated, gelled, copper-copper sulfate type, packaged in a special backfill and complete with 75 feet of 14 AWG stranded copper lead wire with high molecular weight polyethylene insulation. Underground reference electrodes shall have a 30 year minimum design life. Underground reference electrodes shall be “Stealth SRE-007-CUY” as manufactured by Borin Manufacturing, Inc., “Model UL-CUG” as manufactured by Electrochemical Devices, Inc., or equal.

2.5 FLANGE INSULATING KITS

A. The flange insulating materials and special gasket diameters specified in this article may not be stock items and shall be ordered early to allow time for manufacture. Ordering information should include:

1. Type E retainer.

2. Double washers.

3. Retainer material.

4. Sealing element material.

5. Insulating washer material.

6. Insulating sleeve material.

7. Nominal flange size.

8. ANSI pressure class.

B. Each insulated flange kit shall include the following:

1. One Type "E," full-faced insulating and sealing flange gasket, consisting of a 1/8 inch thick retainer with special ring seal. The inside diameter shall be 1/8 inch less than the inside diameter of the flange in which it is to be installed and shall be PSI Linebacker, Advance Products Trojan, or acceptable equal.

2. One full length bolt insulating sleeve, 1/32 inch thick, for each flange bolt.

3. Two flat insulating washers, 1/8 inch thick, for each flange bolt.

4. Two flat steel backing washers, 1/8 inch thick, for each flange bolt. The backing washer outside diameter shall not be larger than the outside diameter of the insulating washer.

5. Insulating material selection shall be based on the application as indicated in the following table and notes:

Fluid	Sleeves	Insulating Washers	Gasket / Retainer	Seal Element
Water	G-10	G-10	G-10	Nitrile or EPDM

2.6 SHRINK SLEEVES FOR BURIED INSULATED FLANGES

A. Shrink sleeves shall be used where indicated on the Drawings to coat buried insulated flanges and shall conform to the requirements of ANSI/AWWA C217. Shrink sleeves shall be of the wraparound type for all pipe sizes for which they are available. Widths shall be as

recommended by the manufacturer for the flange size being coated. Flange shrink sleeves shall be Type Raychem FCWS-F/FLANGESEAL as manufactured by Berry Plastics, Corrosion Protection Group, or Aqua-Shield Flange Protection Kit, Type AQW-FPK, as manufactured by Canusa-CPS.

2.7 PIPE COATING REPAIR MATERIALS AT CABLE CONNECTIONS

A. Materials used to repair pipe coating at lead wire or joint bond connections shall be Thermit Weld Caps and Thermit Weld Mastic as manufactured by Mesa Products Incorporated; Royston Handy Caps as manufactured by Royston Laboratories, Inc., or equal.

2.8 NONDETECTABLE UNDERGROUND MARKING TAPE

A. Underground, nondetectable marking tape shall be a minimum 3 inches in width, red in color, with "Caution Electric Line Buried Below," "Caution Cathodic Protection Cable Buried Below," or similar words printed in black. Nondetectable underground marking tape shall be "Shieldtec" as manufactured by Empire Level Manufacturing Company and as supplied by Hoff Company, Inc., or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. An insulated type joint shall be provided at each connection through a structure wall, and where indicated on the Drawings.

B. Field test stations shall be provided at each buried insulated joint.

C. Underground reference electrodes shall be provided where indicated on the Drawings.

D. Galvanic anodes shall be installed where indicated on the Drawings.

E. Galvanic Anodes

1. The burial depth of galvanic anodes and distance from the pipe shall be as indicated on the Drawings.

2. When installing anodes, penetration of layers of brick, concrete, or other debris may be required to properly place the anodes. It is not intended that anodes be installed at locations where penetration of solid reinforced concrete or rock is necessary.

3. If solid rock or reinforced concrete is encountered at the location and burial depth indicated on the Drawings for an anode, and prevents vertical installation of the anode, an investigation of the immediate area shall be made to determine a suitable location for vertical installation of the anode at the specified burial depth. If the Contractor is unable to find a suitable location in the immediate area of the specified anode location, the anode shall be installed vertically closer to the surface with a minimum earth cover of 5 feet. If

a minimum earth cover of 5 feet cannot be maintained, the Engineer will direct the Contractor how to proceed.

4. After placement of packaged galvanic anodes, at least 5 gallons of water shall be poured over and around packaged anodes before backfilling.

5. Packaged galvanic anodes shall be backfilled with clean earth, free from rocks and debris. Anodes shall not be backfilled with sand.

F. Wire, Cable, and Cable Accessories

1. Routing

a. Unless otherwise indicated on the Drawings, lead wire and cable shall be installed at a minimum of 3 feet below grade. Where lead wire is connected to pipe or to field test stations, a minimum of 18 inches of slack shall be left in the lead wire to permit settling of the backfill without stressing the electrical connection.

2. Pipe Lead Wires

a. Pipe lead wires shall be connected to the pipe at each field test station location as indicated on the Drawings. Pipe lead wires shall be two Type CP cables, size 12 AWG.
b. Connection of the lead wires to the pipe shall be as specified in the Cable Connections to Pipe article. To the extent practical, pipe lead wires shall be attached to the pipe on the top center line and separated a minimum distance of 12 inches.
c. Pipe lead wires shall not be spliced.
d. Pipe lead wires shall be clearly identified by and indication of the pipe they are connected to. Identification shall be made at installation using the specified permanent cable markers. The Contractor shall maintain the identification markings throughout construction to ensure that each pipe lead wire is clearly and correctly marked when terminated in the field test stations.

3. Field Test Station Terminations

a. Terminations shall be arranged on the field test station terminal boards as indicated on the Drawings.
b. Terminations at field test stations shall be made with single hole compression type terminal lugs of corrosion-resistant copper, bronze, or nickel-plated brass. A calibrated crimping tool designed to crimp the connector shall be used for all compression connections. The connector shall not release from the conductor when pulled or twisted.
c. All terminals, terminal lugs, jumpers, link bars, and any other terminal board metal parts or hardware installed in flush mounted field test stations shall be coated with a conductive oxidation inhibiting compound as specified in the article titled Oxidation Inhibiting Compound.
d. Solid conductors shall additionally be soldered in the terminal lug before terminating the lug in the field test station.
e. Permanent, legible identification markers shall be attached to each lead wire in each field test station. Each pipe lead wire shall be identified with pipe diameter

and service, as a minimum. Underground reference electrode lead wires for pipe installation shall be identified as "Cu-$CuSO_4$."

4. Cable Connections to Pipe

   a. Except for stainless steel pipe, cables shall be exothermally welded to pipe. Cable connections to stainless steel pipe shall be made with silver brazing.
   b. No connection to pipe shall be coated or covered until it has been inspected by the Engineer. The Engineer may reject any connection if it fails when the cable is pulled, breaks loose from the pipe when struck at an angle with a hammer, or does not appear to be a complete, properly shaped and made connection. Inspection by the Engineer in no way relieves the Contractor of responsibility for the performance of the connection.
   c. After the connection has been inspected by the Engineer, the exposed part of the wire and the connection shall be coated as specified in the article titled Coating Electrical Connections to Pipe.

5. Splices

   a. Splices in solid wires shall be made by twisting the conductors together and soldering with 50-50 solid solder and non-acid flux. Splices in stranded wires shall be performed using a properly sized uninsulated butt splice compression connector and a calibrated crimping tool designed to crimp the connector. The connector shall not release from the conductor when pulled or twisted. Acceptable butt splice connectors for the various cable sizes shall be as follows.

Stranded Cable Size	Connector Type	Manufacturer
14-10 AWG	Hylink, Type YSV Box	Burndy
8 AWG	Pan-Term Splice-Type SCS	Panduit
6 AWG and larger	Copper Hylink, Type YS	Burndy

   b. A compression connection installed underground shall additionally be soldered before insulation and burial. After inspection by the Engineer, splices shall be insulated with one half-lapped layer of varnished cambric tape covered by two half-lapped layers of rubber tape elongated not more than 20 percent. Two half-lapped layers of vinyl electrical tape shall be applied over the rubber tape. At each end of each splice the vinyl tape shall overlap the rubber tape onto the undamaged cable insulation a minimum of two cable diameters.

6. Exothermal Welds

   a. This article covers requirements for exothermal welding, including but not restricted to, cable-to-cable, cable-to-rod, cable-to-pipe, and cable-to-steel structure connections.
   b. Exothermal welds shall be made using molds, sleeves, and cartridges sized in accordance with the welding equipment manufacturer's recommendations for the particular application.

c. Completed welds shall be capable of withstanding moderate hammer blows. Porous or deformed welds will not be acceptable. Damaged or worn molds shall not be used and shall be removed from site.
d. The inspection of, and responsibility of the Contractor for, exothermal welds shall be as described in the article titled Cable Connections to Pipe.

7. Joint Bonds

a. All underground non-insulated steel pipe and ductile iron pipe gasketed joints shall be made electrically continuous by joint bonding.
b. Non-insulated mechanical pipe couplings shall be joint bonded as detailed on the Drawings.
c. The method of attaching joint bond cables to pipe or to pipe fittings shall be as described in the article titled Cable Connection to Pipe.
d. Joint bonding cable connections on either side of a joint shall be separated a minimum distance of 12 inches. Except where indicated otherwise, joint bonding cables shall be made with two #8 AWG Type CP cables. Joint bond cables shall contain at least 6 inches of slack wire to compensate for pipe movement and backfill settlement.

G. Underground Reference Electrodes

1. Underground reference electrodes shall be installed at the locations indicated on the Drawings.

2. Underground reference electrodes shall be stored and maintained in a dry environment, above freezing temperatures, until activation and installation. Underground reference electrodes shall be activated by complete immersion in clean, fresh water for approximately 8-12 hours prior to installation.

3. Except as indicated otherwise on the Drawings, the packaged underground reference electrode shall be installed horizontally below the frost line, in permanently moist soil, with a minimum of 6 inches of clean earthfill between the electrode package and any surrounding rock.

4. Activated reference electrodes shall be tested for proper operation in accordance with applicable articles of the subsection titled TESTING, after placement and before backfilling.

H. Insulated Joints

1. Flange insulating kits shall be installed in pipe flanges where indicated on the Drawings and as specified herein. After installation, protective coatings shall be provided around the joint as specified herein.

2. Bolting at insulated flanges shall consist of studs and nuts with sufficient stud length to allow at least one full stud thread protruding through each nut. Sleeves shall extend into the insulating washers.

3. Flange gasket seating surfaces shall be free from tool marks, scratches, pits, deposits, and other defects. Stud tensioning shall be performed using a torque wrench or other

tensioning device such as a hydraulic wrench. Torque settings shall not exceed the maximum value specified by the insulated flange kit manufacturer.

4. Insulated flange kits shall be installed as follows:

    a. Inspect the gasket kits. Verify that the material is as specified and provided in a new and undamaged condition.
    b. Clean the bolting materials. Apply lubricant or antiseizing compound to all threads required for engagement with nuts and nut facings.
    c. Align flange faces so that they are parallel and concentric with each other within 0.010 inch without extemal loading or springing.
    d. Line up bolt holes by driving two tapered drift pins in opposite directions to each other into two diametrically opposite bolt holes.
    e. Insert insulating sleeves into the bolt holes. If they do not slide in easily, the flanges are not lined up properly. Do not force sleeves into bolt holes as sleeve damage may result.
    f. Assemble the studs (or bolts) as follows:

        1) Run one nut on each stud so that two full threads are showing beyond the nut.

        2) Slide a steel washer onto stud and insert into bolt hole. (If the flange requires two sided insulation, add an insulating washer after the steel washer.)

        3) From the opposite end of the stud, place an insulating washer, a steel washer, and then a nut. Hand tighten.

    g. Torque studs to a maximum of 30 percent of the final torque value specified. Replace the two drift pins with stud assemblies. Torque the remaining studs to 30 percent of the final torque value in a star pattern sequence.
    h. Repeat steps in g., increasing the torque to approximately 60 percent to 80 percent of the final torque value.
    i. Continue torquing all studs in the sequence using the specified torque setting (100 percent) until there is no further rotation of nuts.

5. After installation, all insulated fittings shall be tested as specified in the paragraph entitled Insulated Fitting Tests.

6. Buried Insulated Flange Coating

    a. Coat buried insulated pipe flanges with an external wax-tape coating in accordance with ANSI/AWWA C217. Do not apply the wax-tape coating until the insulated pipe flanges have been tested and approved by the Owner. The wax-tape coating shall consist of a surface primer, wax-tape and an outer covering. The wax tape coating system shall extend over the adjacent pipe coating by a minimum 12 inches or18 inches away from the flange surface, whichever is greater.
    b. The surfaces to receive the wax tape coating shall be clean and free of all dirt, grease, and other foreign material. Apply the primer by gloved hand or brush onto all exposed metal surfaces. Apply the wax tape immediately after the primer application. Cut strips of wax tape and apply them by gloved hand around all bolts,

nuts, and other irregular shapes so that there are no voids or spaces under the tape. Apply a sufficient amount of tape to completely encapsulate all exposed metal surfaces with a minimum wax tape thickness of 140-mils. Apply by hand two layers of polyvinylidene chloride, high cling membrane sheet over the wax tape coating by tightly wrapping it around the pipe such that it adheres and conforms to the wax tape. Secure the plastic wrap to the pipe with adhesive tape.

I. Field Test Stations

1. Field test stations shall be at locations indicated on the Drawings. **]**Where it is not practical to locate field test stations directly over the pipe it is connected to because of interference with the normal use of the area, field test stations shall be located nearby. Test station locations shall be in protected locations, such as in fence rows or adjacent to manholes, or similar structures where they will experience minimum chance of damage and provide minimum interference with normal use of the area in which they are installed.

J. Coating Electrical Connections to Pipe

1. Electrical connections to pipe having a dielectric coating system shall be coated immediately following inspection of the connection. Coating shall be with the materials specified in the article titled Pipe Coating Repair Materials at Cable Connections, and shall be as recommended by the coating repair material manufacturer and as specified in this article.

2. All slag, splatter, and scale shall be removed from welded connections. Sharp edges or burrs shall be removed by grinding or filing. Connections shall be allowed to cool to handling temperature. All moisture shall be removed from surfaces prior to application of the coating materials. The coating material shall be firmly pressed into place, forcing the mastic material to completely cover the exposed connection area and to conform around the wire, and the undamaged pipe coating.

3.2 TESTING

A. Testing to verify acceptable installation and performance of the cathodic protection system and associated equipment and materials shall be performed by the Contractor as specified in this section.

B. The Contractor shall ensure that all necessary safety precautions are taken, and shall provide all necessary equipment, materials, and labor for the performance of tests. If defects are discovered, the Contractor shall perform additional tests as are required to establish the nature of the defects.

C. If tests indicate that defects exist in materials, equipment, or installations which are the sole responsibility of the Contractor, these defects shall be immediately corrected. Tests and repairs shall continue until the materials, equipment, and installations are in accordance with the specification requirements. Corrective action shall include the restoration of all other construction and facilities disturbed by the repair work.

D. Test Equipment

1. Required test equipment to be used for the specified testing shall include the following:

    a. Eight inch saturated copper-copper sulfate solution portable reference electrode, M.C. Miller Model RE7, available from the M.C. Miller Co., Inc.; or Tinker and Rasor Model 8A, available from Agra Equipment Company; or equal. The reference electrode copper rod shall be clean and filled with a fresh copper-sulfate and distilled water saturated solution within 30 days of testing time.
    b. Flexible test leads as required.
    c. High input impedance dc voltmeter with millivolt scale and built-in ohmmeter, Wavetek Model HD110, available from Mesa Products; Fluke Model 87 hand-held multimeter available from John Fluke Mfg. Co.; or equal.
    d. Insulation checker, Gas Electronics Model 601. Available from M.C. Miller Company.
    e. Six volt lantern battery or 12 volt automotive battery.
    f. Low resistance dc ohm-meter, AVO International "Catalog No. 247001 (Biddle DLRO)," complete with helical spring point test leads; AVO International "Catalog No. 242011-7," available from E.I.L. Instruments; Transcat.

E. Test Procedures

1. The Contractor shall record and submit test data for each test performed.

2. Joint Bond Continuity Tests

    a. The Contractor shall not permanently cover any joint bonded pipe with soil, concrete, or other backfill until the pipe continuity is tested. The pipe joint or joints shall be tested for continuity using low-resistance dc ohm-meter as follows:

        1) A helical spring point test lead shall be placed in contact with the pipe adjacent to continuity bond wire exothermal weld on each side of the pipe joint being tested.

        2) The electrical resistance across the mechanical joint under test shall be measured directly using the low-resistance ohm-meter. The electrical resistance of the pipe joint shall be less than 250 micro-ohms.

        3) Discontinuities shall be repaired and testing repeated to verify successful repair.

3. Underground Reference Electrodes

    a. After each underground reference electrode is installed, a minimum of 10 gallons of water shall be poured over and around the electrode. After the surrounding soil and underground reference electrode is saturated with water, place a mild steel stake or rod in firm contact with the soil, several feet from the reference electrode package. Connect the negative test lead of the specified dc voltmeter to the reference electrode lead wire. Firmly connect the voltmeter positive test lead to the mild steel stake or rod. Measure and record the dc voltage on the voltmeter.
    b. For copper-copper sulfate type underground reference electrodes, the reading shall be stable between -0.4 and -0.8 volts. For zinc type underground reference electrodes, the reading shall be stable between +0.3 and +0.7 volts.

4. Insulated Fitting Tests

   a. Tests to verify acceptable insulated pipe fitting installations shall be performed after pipe installation is completed. Insulated flanges shall not be disassembled or reworked after the insulated fitting tests are complete. Underground insulated fittings shall not be backfilled until the insulation integrity is verified by the Engineer. If the tests indicate that an insulating flange is not providing satisfactory isolation of connecting piping, the Contractor shall perform additional tests and work as required to locate and correct deficiencies.
   b. Insulated flange testing shall be performed using the insulation checker. Prior to testing, the insulation checker shall be calibrated and zeroed as recommended by the manufacturer.
   c. Firm metal-to-metal contact shall be established between each instrument probe and flange face across the insulator being tested. An effective insulator is indicated by a full scale reading on the instrument. Any deflection less than full scale indicates a shorted insulator.
   d. Electrical insulation tests shall be performed at 6 inch (150 mm) intervals around the circumference of the insulated flange. Failure of the insulation test at any location around the circumference shall qualify as a failed insulator.
   e. Defective components shall be identified and replaced. Testing shall be repeated to verify insulator effectiveness.

5. Cathodic Protection Tests

   a. Electrical and mechanical connections to the underground piping systems shall be complete before testing. Underground piping shall be electrically isolated from above-ground piping during testing. Underground piping shall have been completely backfilled for at least one month before final testing, although prior tests may be made at the Contractor's option for his own information.

      1) Pipe Lead Wire Continuity Testing. Prior to performing anode current measurement tests or pipe potential tests, electrical continuity of pipe lead wires terminated in field test stations shall be verified.

      2) The measurements shall be made as follows:

         a) At the field test station, pipe lead wire or wires shall be disconnected from any anodes or shunts. The voltmeter shall be connected between the two pipe lead wires, and potential measurements recorded.

         b) If no potential exists between the pipe lead wires, the resistance between the two pipe lead wires shall be measured. This resistance reading should be a relative reading to nullify the resistance of the meter lead wires or the lead wire resistance shall be subtracted from the reading to calculate the resistance of the pipe lead wires. The resistance reading shall be stable and less than 0.1 ohm.

         c) If a potential exists, if the reading is unstable, or if there is a high resistance between the pipe lead wires, one or both of the pipe lead wires may be damaged. To determine if either of the pipe lead wires is satisfactorily connected to the pipe, the following tests shall be

performed after satisfactory results have been obtained for the anode open circuit potential test:

d) The current flowing from a pipe lead wire to an anode shall be measured and recorded. The above procedure shall be repeated using the spare pipe lead wire. Low current flow through pipe lead wires indicates a discontinuity. Pipe lead wires with discontinuities shall be repaired or appropriately marked in the test station as determined by the Engineer.

e) Pipe lead wires shall be reconnected to the test station terminal board in their original positions.

b. Pipe Connected Anode Current Measurements. After the piping and galvanic anodes have been backfilled for a minimum of 30 days, and connecting above-grade piping has been isolated, galvanic anode current shall be measured as follows:

1) At each field test station with connected anodes, the voltage across and resistance through the shunt associated with each anode shall be recorded. The current through each shunt shall be calculated and recorded.

2) For test stations not furnished with shunts, the positive terminal multimeter test lead wire shall be connected to the Pipe Lead Wire 1 lug in the test station terminal block and the negative terminal multimeter test lead wire to the anode lead wire lug in the test station terminal block. The current shall be measure using the multimeter mA scale and recorded. The current polarity shall be confirmed to be positive.

c. Pipe System Potential Measurements. After satisfactory current measurements have been obtained for all test station connected anodes, pipe potentials shall be measured.

1) The measurements shall be made as follows:

a) At each field test station, the negative terminal of the voltmeter shall be connected to the portable reference electrode and the positive terminal connected directly to a pipe lead wire. The portable reference electrode shall be placed in moist soil, free of vegetation, on the surface directly over the pipe. The potential measurement and the location where the reference electrode was placed shall be recorded. The potential polarity shall be confirmed to be negative.

b) At locations where underground reference electrodes are installed, measurements shall be made as follows.

c) The negative terminal of the voltmeter shall be connected to the underground reference electrode lead wire and the positive terminal connected directly to a pipe lead wire. The potential shall be recorded and polarity of the measurement confirmed to be negative.

F. Test Reports and Acceptance

1. Within 15 calendar days after completion of the cathodic protection tests, a complete report of the test results shall be submitted to the Engineer. The Engineer will interpret the results and advise the Contractor whether or not the system is acceptable.

2. For the system to be acceptable, tests results shall indicate that a protective anode current output of 0.03 milliamperes per square foot of coated pipe surface will produce potentials which are more negative than -0.90 volts at any location.

3. If the indicated protective current outputs are in excess of 0.03 milliamperes per square foot of coated pipe surface, the system will not be acceptable and the Contractor shall locate and repair defective coating and/or locate and remove grounds on the system.

4. If the galvanic system anode current output is less than 0.03 milliampere per square foot of coated pipe surface and potentials do not indicate protection has been achieved, the Engineer will advise the Contractor how to proceed.

5. The test reports shall include the following items:

    a. Drawings upon which the location of each test station, underground reference electrode, galvanic anode, and insulated fitting is indicated.
    b. Drawings with sufficient information that each underground galvanic anode can be exactly excavated or replaced.
    c. Drawings showing the location of each field test station complete with a description of pipe lead wire connections.
    d. Records of all anode installation details.

6. Tabulated reports of:

    a. Final anode current measurements of each test station connected galvanic anode.
    b. Final insulated fitting test measurements, with the test method indicated.
    c. Final pipe system potential measurements.
    d. Underground reference electrode tests.

End of Section

SECTION 13122 - METAL BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design, fabrication and erection of the following framed pre-engineered metal building(s) and miscellaneous components.

Building Identification	Beaver Water District Western Corridor Pump Station
Location	Springdale, Arkansas

B. Earthwork, concrete, masonry, overhead doors, interior partitions and ceilings, floor finishes, plumbing, heating, ventilating, air conditioning, louvers, hoisting equipment, and electrical work are covered in other sections.

1.2 GENERAL

A. Building components and accessories shall be designed and erected in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the building manufacturer unless exceptions are noted by Engineer.

B. The building dimensions shall be as indicated on the Drawings. Fascias, parapets, canopies, screens, and other architectural features shall be as indicated on the Drawings.

C. The building shall be furnished complete with all primary and secondary structural framing, bracing, connections, and other miscellaneous components or accessory items when required, as specified or indicated on the Drawings. Other appurtenant items such as crane runway beams, supports, and bracing; secondary framing for piping, conduit, and equipment hangers, etc.; shall be provided as indicated on the Drawings and as specified herein. Framing and connections shall be provided to transfer lateral and vertical loadings from any appurtenant items and secondary framing into the primary structural framing systems.

D. Doors, hardware, windows, glazing, and louvers shall be as specified in other sections.

E. Coordination

1. The metal building erector shall coordinate with Engineer and Contractor for the erection and field quality control of the metal building and appurtenances, the erection of any hoisting equipment, installation of equipment, and the installation of any interior systems and finishes.

F. Governing Standards

1. The building design and erection shall comply with the codes indicated in the Meteorological and Seismic Design Criteria section.

2. The building design shall also comply wholly or in part, as specified herein, with the Metal Building Manufacturers Association (MBMA) "Metal Building Systems Manual." In case of conflicting requirements, the applicable building code shall govern.

3. Steel construction with hot-rolled structural shapes and plates shall be in accordance with AISC "Specifications for Structural Steel Buildings." Light gauge structural steel members shall be designed and detailed in accordance with AISI "Specifications for the Design of Cold-Formed Steel Structural Members." Welding shall be in accordance with AWS D1.1, Structural Welding Code - Steel.

4. Building erection shall comply with the applicable provisions of OSHA Standard 29 CFR 1926, Subpart R.

G. Manufacturer Certification

1. The building manufacturer shall be certified in accordance with the International Accreditation Service (IAS) metal building inspection program, IAS AC472.

1.3 DELIVERY, STORAGE, AND HANDLING

A. All factory finished materials shall be protected for shipment in accordance with accepted packaging standards. Minor damage to finishes shall be touched up before installation using color-matched, air-drying paint furnished by the manufacturer. No other finish will be acceptable. Any significantly damaged components shall be replaced at no cost to Owner. Anchor bolts and their accessories shall be delivered in time to avoid delays in placing concrete.

1.4 SUBMITTALS

A. Drawings and Data General.

1. The following items shall be submitted to Engineer for review prior to fabrication of the building elements. All drawings and data shall be submitted in accordance with the Submittals Procedures section.

B. Building Drawings and Data.

1. Complete drawings and data showing anchor bolts, construction details, lateral thrust details, and cross-sections., Drawings shall be sealed by a professional engineer registered in the state where the building is to be erected.

C. Design Certification Letter.

1. A letter of design certification listing the design criteria, including design codes, standards, loads, and other design information indicated in this section; and the structural calculations. The letter of design certification and the structural calculations shall be sealed by a professional engineer registered in the state where the building is to be erected.

D. Foundation Load List

1. All loads imposed by the metal building to the foundation.

2. The building manufacturer shall provide a loading table that matches the column grouping and load combination parameters shown on the foundation drawings.

E. Documentation of IAS AC472 Certification.

F. Installation Drawings and Data.

1. Manufacturer's erection information indicating standard recommendations, erection details, and piece markings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pre-engineered metal buildings shall be as manufactured by American Buildings Company, Butler Manufacturing, or Varco-Pruden Buildings, .

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Minimum design loadings and requirements shall be in accordance with the applicable building code and as specified. Design data for determining seismic, wind, snow and ice loads shall be as indicated in the Meteorological and Seismic Design Criteria section. Load combinations shall be in accordance with the applicable building code.

B. The building shall be designed in accordance with the following requirements.

Building identification.	Western Corridor Pump Station
Minimum roof live load.	20 psf

Minimum roof uplift load.	Per building code.
Minimum platform live load.	100 psf
Collateral roof dead load.	5 psf
Interior walls lateral load.	5 psf
Hoisting loads.	See Drawings for hoist/trolley locations and lifting capacities.

Maximum permissible deflections

Roof Purlins	Maintain positive drainage under dead plus the greater of (0.5) snow or 5 psf.
Roof Purlins (supporting roof mounted equipment, or process piping)	L/240 under dead plus live, L/360 under the greater of roof live, snow, or wind.
Main Roof Members (supporting cranes, equipment, or process piping)	L/240 under dead plus live, L/360 under the greater of roof live, snow, or wind.
Roof Purlins or Main Roof Members (with a partition wall below)	3/8 inch under the greater of 0.5 (roof live) or snow.
Runway Beams for Top-Running (Bridge) Cranes	L/800 under crane vertical static load.
Runway Beam Supports	1/2 inch inward under live or snow, 1 inch outward under snow.
Girts and Wind Columns (providing horizontal support to CMU walls)	Lesser of L/240 or 1.5 inches under wind.
Bare Frame (providing horizontal support to reinforced CMU walls)	H/200 under wind.
Bare Frame (next to a partition wall)	H/500 under wind.

Notes

1. Wind load (for purposes of deflection calculations only) shall be 0.7 times the service level components and cladding pressure.

2. The roof live load or snow load shall not be reduced in consideration of the tributary area.

C. The building design shall account for all dead, live, and impact loads in accordance with the Metal Building Systems Manual, including conservative estimates for the hoisting equipment weights.

D. In addition, the building shall be designed to carry loads, including crane rails and runway beams, pipe and equipment, lateral loads of wall systems furnished by others, and other loads as indicated on the Drawings. Secondary framing to carry these loads to the main building frames shall be provided with the building system unless otherwise specifically noted on the Drawings.

E. Unless specifically authorized by Engineer in writing, for steel building design, columns and posts shall be considered "hinged" at their base. The building foundation shall not be required to accept either full or partial moment fixity from steel building columns or posts.

F. The wall cladding dead load shall be considered as supported by the foundation and not the wall girts of the building.

G. Anchor rods shall be as specified in the Materials paragraph. Anchor rods and related anchorages shall be designed to resist column and brace reactions from loading combinations. The metal building manufacturer shall determine anchor rod diameter, quantity, projection, and arrangement. Each column base plate shall have a minimum of four anchor rods, and the minimum spacing between anchor rods shall be six rod diameters. Anchor rod diameter shall be determined in accordance with ACI 318, Appendix D, assuming that a maximum of two anchor rods transfer shear forces from the columns to the foundation.

H. If additional shear capacity beyond the shear capacity of the anchor rods is required, a design utilizing shear lugs field welded to an embedded foundation weld plate shall be utilized. No shear lugs or bars on the underside of the base plate will be permitted unless approved by Engineer.

I. Bracing shall clear all openings indicated on the Drawings.

J. Girts shall be as indicated on the Drawings.

K. Columns shall be straight-sided up to the elevation indicated on the Drawings.

L.

2.3 MATERIALS

A. Materials for the building shall be new and free from defects and shall meet the following requirements unless otherwise indicated on the Drawings.

Frames and Structural Components	Steel, ASTM A36 or A572.
Structural Bolts	ASTM A325, black, for main framing. ASTM A307, black, for girts and purlins.
Anchor Rods and Nuts	Headed ASTM F1554, Grade 36 with compatible nuts and washers; hot-dip galvanized, ASTM A153 and A385. Heads may be provided by using a nut on a threaded shaft with mechanically deformed threads to prevent nut rotation.

Flat Washers	ANSI B18.22.1; of a material and with coating compatible with anchor bolts and nuts.
Secondary Framing	ASTM A1011 or A1008, cold-formed, with a minimum yield strength of 50 ksi.
Flashing and Trim	Steel with factory applied painted finish or galvalume finish for non-painted areas.
Miscellaneous Accessories	Manufacturers' standard.

2.4 FABRICATION

A. All primary framing shall be shop fabricated for bolted field assembly. Secondary framing shall have bolted or welded connections. All members shall be accurately shop punched. All framing members shall have an easily visible identifying mark.

B. Trim and Flashings

1. Trim and flashing members shall be fabricated from the same materials and with the same finishes as the materials to which they are attached. Trim members shall be manufacturer's standard profiles for the use intended.

C. Anchor Rods

1. Contractor shall furnish anchor rods. Rod embedment shall be in accordance with the Drawings.

2. The diameter, quantity, projection, and arrangement of the anchor rods shall be based on information provided by the metal building manufacturer.

D. Hoist and Crane Runways

1. Hoist monorails and crane runway framing, including crane rails with necessary stops and appurtenances, shall be furnished as indicated on the Drawings and as specified in the Metal Building Systems Manual. Crane and hoist capacities, location and number, span, and travel shall be as indicated on the Drawings.

2.5 COATINGS

A. Unless otherwise required, finish on exposed surfaces of wall panels, roof panels, flashings, appurtenances, and trim shall be a baked-on 70% PVDF, "Kynar 500" or "Hylar 500," minimum 0.8 mil thick, over a minimum 0.2 mil primer. Finish on sides concealed by insulation or interior finishes may be manufacturer's standard.

B. All steel parts which are not specified to be factory finished and which are not hot dipped galvanized coated shall be cleaned and shop primed.

C. Any surfaces abraded or damaged during fabrication shall be touched up or repainted. All welds shall be thoroughly cleaned and touched up with a suitable primer.

D. A suitable quantity of touchup paint shall be provided with the metal building.

PART 3 - EXECUTION

3.1 ERECTION

A. Building parts shall be plumb and level with a tolerance as recommended by the metal building supplier. Fasteners shall be installed and tightened for all connections. High strength structural bolts shall be tensioned by any method set forth in the AISC Steel Construction Manual, except calibrated wrench. Necessary field welding shall be by certified welders in accordance with AWS D1.1, Structural Welding Code - Steel. Welders' qualifications shall be submitted in accordance with the Submittals Procedures section.

B. A copy of the building manufacturer's erection information shall be kept at the erection site at all times and shall be available for all building trades.

C. The metal building erector shall be responsible for verifying prior to starting building erection that the anchor rods are correctly set in the field and the corresponding holes in the baseplates are properly located. If adjustments or corrections are necessary, they shall be submitted to Engineer for review prior to execution and shall be made at no expense to Owner.

D. Any factory finished surfaces abraded or damaged during erection shall be repaired and the coating system touched up or repainted with manufacturer's touchup paint. All welds shall be thoroughly cleaned and prime painted.

E. Field painting of metal surfaces not finish painted at the factory is covered in the painting section.

3.2 PROTECTION

A. All portions of the building shall be protected from damage during site storage and erection. Damaged parts shall be replaced with undamaged units unless field repairs are authorized by Engineer.

3.3 CLEANING

A. After completion of construction all soiled surfaces shall be cleaned in accordance with the manufacturer's instructions.

End of Section

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SECTION 13500 - INSTRUMENTATION AND CONTROL SYSTEM

1.1 SCOPE

A. This section covers the furnishing and installation of an instrumentation and control system designated as the Distributed Control System at the Western Corridor Pump Station.

B. Th System Supplier shall furnish, install and test the pump station instrumentation (flow, pressure, analytical), analyzer wall-mounted subpanel, a DCU enclosure with terminal blocks, network enclosure, fiber optic cable, CAT6 cable, bring 2 48 strand single mode fiber optic cables into the pump station (which was installed under another contract), cellular backup modem and antenna, Ethernet switches, fiber patch panels, security PTZ cameras, access gate intercom/access card reader, motion detection and door access card readers and electronic locks.

C. The Owner will provide, program and test the DCU on an enclosure subpanel and DSC workstations.

D. The system shall be furnished as specified, complete with all software, human machine interface (HMI) hardware, input/output hardware, instrumentation, and all devices, accessories, appurtenances, testing, and training necessary for proper operation.

E. Associated Sections

1. This section also includes the equipment and services specified in the following sections.

Section 13561	PANEL MOUNTED INSTRUMENTS
Section 13562	FLOW INSTRUMENTS
Section 13563	PRESSURE AND LEVEL INSTRUMENTS
Section 13564	PROCESS ANALYTICAL INSTRUMENTS
Section 13565	TEMPERATURE INSTRUMENTS
Section 13566	MISCELLANEOUS INSTRUMENTS
Section 13570	PANELS, CONSOLES, AND APPURTENANCES
Section 13590	NETWORK SYSTEMS
Section 13591	METALLIC AND FIBER OPTIC COMMUNICATION CABLE

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications,

engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. The Drawings indicate locations and arrangements of equipment and may include installation details and block and one-line diagrams showing connections and interfaces with other equipment. The input/output (I/O) lists are attached as an appendix to this section.

2. Principal components of the instrumentation systems shall be as indicated on the P&ID drawings and instrument device schedule attached to this section.

D. Codes, Permits and Agency Approvals

1. All work performed and all materials used shall be in accordance with the National Electrical Code, and with applicable local regulations and ordinances. Where mandated by codes, panels, assemblies, materials, and equipment shall be listed by Underwriters' Laboratories or other NRTL. Contractor shall, as part of their work, arrange for and obtain all necessary permits, inspections, and approvals by the authorities having local jurisdiction of such work. This shall include any third-party inspections and testing of panels and equipment.

E. Supplier’s Qualifications

1. Equipment furnished under this section and under other related sections listed in the Scope paragraph above shall be designed, coordinated, and supplied by a single manufacturer or supplier, hereinafter referred to as the System Supplier. The System stems. The Contractor shall utilize the services of the System Supplier to coordinate all control system related items, to check-out and calibrate instruments, and to perform all testing, training, and startup activities specified to be provided.

2. The System Supplier shall have the following minimum qualifications:

   a. The supplier shall maintain a design office staffed with qualified technical design personnel.
   b. The supplier shall maintain competent and experienced service personnel to service the hardware and software furnished for this project.
   c. The supplier shall have as a minimum 5 years of experience in the design, coordination and supply of computer-based monitoring, control, and data acquisition systems.

F. Coordination

1. Systems supplied under this section shall be designed and coordinated by System Supplier for proper operation with related equipment and materials furnished by other suppliers under other sections of these specifications, under other contracts, and, where applicable, with related existing equipment. All equipment shall be designed and installed in full conformity with the Drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, and the manufacturer of the related equipment.

G. Related Equipment and Materials

1. Related equipment and materials may include, but will not be limited to, instrumentation, motor controllers, valve actuators, chemical feeders, analytical measuring devices, conduit, cable, and piping as described in other sections or furnished under other contracts.

H. Device Tag Numbering System

1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with System Supplier's equipment drawings and shall be as close as practical to the tag numbers used on the Drawings and device schedules. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered or tape labels will not be acceptable.

1.3 GENERAL REQUIREMENTS

A. The Drawings and Specifications indicate the extent and general arrangement of the systems. If any departures from the Drawings or Specifications are deemed necessary by System Supplier, details of such departures and the reasons shall be submitted to Engineer for review with or before the first stage submittal. No departures shall be made without prior written acceptance.

B. The specifications describe the minimum requirements for hardware and software. Where System Supplier's standard configuration includes additional items of equipment or software features not specifically described herein, such equipment or features shall be furnished as a part of the system and shall be warranted as specified herein.

C. Governing Standards

1. Equipment furnished under this section shall be designed, constructed, and tested in accordance with IEEE 519, ANSI C37.90, FCC Part 15 - Class A, and NEMA ICS-1-109.60.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The System Supplier shall review the Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications requisite for proper installation subject to acceptance by Engineer. At least

three feet of clear access space shall be provided in front of all instrumentation and control system components.

E. Workmanship and Materials

1. System Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except for testing.

F. Corrosive Fluids

1. All parts which are exposed to corrosive conditions shall be made from corrosion resistant materials. System Supplier shall submit certification that the instrument manufacturer approves the selection of materials of primary elements that are in contact with the specified process fluid to be inert to the effects of the process fluid.

G. Appurtenances

1. Signal converters, signal boosters, amplifiers, special power supplies, special cable, special grounding, and isolation devices shall be furnished as needed for proper performance of the equipment.

H. Programming Devices

1. A programming or system-configuring device shall be provided for systems that contain any equipment that requires such a device for routine calibration, maintenance, and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup.

1.4 SUBMITTALS

A. General

1. Complete dimensional, assembly, and installation drawings, wiring and schematic diagrams; and details, specifications, and data covering the materials used and the parts, devices and accessories forming a part of the system furnished, shall be submitted in accordance with the submittals section. Submittal data shall be grouped and submitted in three separate stages. The submittal for each stage shall be substantially complete. Individual drawings and data sheets submitted at random intervals will not be accepted for review. Equipment tag numbers or identifications used on the Drawings shall be referenced where applicable.

B. First Stage Submittal

1. The first stage submittal shall include the following items.

a. A detailed list of any exceptions, functional differences, or discrepancies between the system proposed by System Supplier and this specification.

b. Product catalog cut sheets on all hardware and software items, clearly marked to show the model number, optional features, and intended service of each device.

c. A brief, concise description of the proposed system, including major hardware and software components and personnel training.

d. A block diagram or schematic drawing showing the principal items of equipment furnished, including model numbers, and their interrelationships.

e. Drawings showing floor and wall space or desktop area requirements for all equipment items, including allowances for door swings and maintenance access.

f. Environmental and power requirements, including heat release information for each equipment item.

g. Standard field termination drawings for all process input/output equipment, showing typical terminations for each type of point available in the system.

h. A copy of the proposed software licenses for all software associated with the system.

i, Outline for training classes.

j. Additional requirements identified in other Division 13 sections.

C. Second Stage Submittal

1. Before any equipment is released for shipment to the site and before factory testing is scheduled, the following data shall be submitted.

2. At System Supplier's option, the first and second stage submittals may be combined.

a. Detailed functional descriptions of all software modules specified and furnished as part of System Supplier's standard system. The descriptions shall be identified with the applicable specification paragraph.

b. Complete panel fabrication drawings and details of panel wiring, piping, and painting. Panel and subpanel drawings shall be to scale and shall include overall dimensions, metal thickness, door swing, mounting details, weight, and front of panel arrangement to show general appearance, with spacing and mounting height of instruments and control devices.

c. Wiring and installation drawings for all interconnecting wiring between components of the system and between related equipment and the equipment furnished under this section. Wiring diagrams shall show complete circuits and indicate all connections. If

panel terminal designations, inter-device connections, device features and options, or other features are modified during the fabrication or factory testing, revised drawings shall be submitted before shipment of the equipment to the site.

d. Fiber termination diagrams to show all fiber terminations at fiber patch panels and final termination at equipment. Fiber termination diagrams shall show individual fiber type (single or multimode), fiber core/cladding dimensions, fiber colors, circuit identifications, and type of terminator.

e. Review of drawings submitted prior to the final determination of related equipment shall not relieve System Supplier from supplying systems in full compliance with the specific requirements of the related equipment.

f. Input/output listings showing point names, numbers, and addresses. Input/output identification numbers from the contract documents shall be cross-referenced in this submittal.

g. Proposed lesson plans or outlines for all training courses specified herein, including schedule, instructors' qualifications and experience, and recommended prerequisites.

h. Additional Requirements identified in other Division 13 sections.

D. Third Stage Submittal

1. Complete system documentation, in the form of Operation and Maintenance Manuals, shall be submitted before the commencement of field acceptance testing. Operation and Maintenance Manuals shall include complete instruction books for each item of equipment and software furnished. Where instruction booklets cover more than one specific model or range of device, product data sheets shall be included which indicate the device model number and other special features. A complete set of "as-built" wiring, fabrication, and interconnection drawings shall be included with the manuals. If field-wiring modifications are made after these drawings are submitted, the affected drawings shall be revised and resubmitted. Additional requirements are identified in other Division 13 specification sections.

1.5 PREPARATION FOR SHIPMENT

A. All electronic equipment and instruments shall be suitably packaged to facilitate handling and to protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements, shall be kept dry at all times, and shall not be exposed to adverse ambient conditions.

B. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces that are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.

C. Each shipment shall include an appropriate shipping list that indicates the contents of the package, including the specific instrument tags. The shipping list shall be accessible without exposing the instruments to the atmosphere. The shipping list shall also contain any cautionary

notes regarding storage of the instruments, including requirements to protect the instrument from static discharge, desensitizing chemicals (solvents, paints, etc.), or ambient atmospheric conditions.

D. Individual instruments shall be appropriately tagged or labeled to positively identify the device. All identification shall be visible without the need to unpack the instrument from its protective packaging.

E. Instrument shipment and storage requirements shall be coordinated with Engineer or Owner prior to shipment. System Supplier shall provide adequate storage and be ready to accept the shipment before shipping any equipment to the site. Additional shipping and storage requirements shall be as detailed in the individual instrument specifications.

F. Components which are shipped loose due to transportation limitations shall be assembled and disassembled by the manufacturer prior to shipment to assure that all components fit together and are adequately supported.

1.6 DELIVERY, STORAGE, AND SHIPPING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.7 SPARE PARTS

A. Spare parts and consumable items are specified in other sections. In addition to spare parts and consumable items specified in other sections, the following spares and consumable items shall be provided:

Spare Parts	Quantity
Lamps for indicating lights	1 full set

B. Packaging

1. All spare parts shall be delivered to Owner before final acceptance of the system. Packaging of spare parts shall provide protection against dust and moisture and shall be suitable for storage. Circuit boards and other electronic parts shall be enclosed in anti-static material. All packages shall be clearly marked with the manufacturer's name, part number or other identification, date of manufacture, and approximate shelf life.

C. Replacement

1. System Supplier may utilize spare parts and supplies during system installation, de-bugging, startup, or training, but shall restore all such materials and supplies to the specified quantities before final acceptance of the systems.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. All equipment furnished under each section referenced in SCOPE is a part of this section and shall be selected by System Supplier for its superior quality and intended performance. Equipment and materials used shall be subject to review.

B. Standard Products

1. The systems furnished shall be standard products. Where two or more units of the same type of equipment are supplied, they shall be the products of the same manufacturer; however, all components of the systems furnished hereunder need not be the products of one manufacturer unless specified herein.

2. To the extent possible, instruments used for similar types of functions and services shall be of the same brand and model line. Similar components of different instruments shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. The design of the systems furnished hereunder shall utilize concepts, techniques and features that provide maximum reliability and ease of maintenance and repair. The systems shall include board-level devices such as light emitting diodes or other indicators to facilitate quick diagnosis and repair. Diagnostic software shall be furnished to facilitate system-level troubleshooting.

B. Where redundant hardware is provided, the system shall be capable of performing all specified functions, without reconfiguring hardware or software, with only one device of each category in service.

C. Factory Assembly

1. Equipment shall be shipped completely factory assembled, except where its physical size, arrangement, configuration, or shipping and handling limitations make the shipment of completely assembled units impracticable.

2.3 POWER SUPPLY AND INSTRUMENT SIGNAL

A. Power supply to all control system equipment will be 120 volts ac. System Supplier shall be responsible for distribution of power among enclosures, consoles, peripherals, and other components of the system from the power supply receptacles and junction boxes indicated on the Drawings. Power distribution hardware shall include cables and branch circuit overcurrent protection installed in accordance with the electrical section.

B. Unless otherwise indicated, power supply to the instrumentation will be unregulated 120 volts ac. Unless otherwise indicated, all transmitted electronic analog instrument signals shall be 4-20 mA dc and shall be linear with the measured variable.

C. Facility Distribution System

1. Equipment not indicated to be powered from an uninterruptible power source shall be suitable for being supplied from the facility distribution system and shall be capable of withstanding voltage variations of ±10 percent and harmonics up to the limits of IEEE 519 without affecting operation. System Supplier shall provide voltage conditioning or filtering equipment if necessary to meet the requirements specified.

D. Power Supplies

1. Power supplies for voltages other than those listed above shall be an integral part of the equipment furnished. Internal power supplies shall be regulated, current limiting, and self-protected.

E. Surge Withstand

1. All equipment shall meet all surge withstand capability tests as defined in ANSI C37.90 without damage to the equipment.

F. Uninterruptible Power Supply

1. An uninterruptible power supply (UPS) shall be furnished hereunder to power the equipment indicated on the Drawings or will be furnished under another section. System Supplier shall be responsible for coordinating the size of the UPS unit with the equipment furnished hereunder, and shall advise Engineer if a unit of higher capacity is necessary.

2.4 SERVICE CONDITIONS AND ENVIRONMENTAL REQUIREMENTS

A. The equipment provided for the instrumentation and control system shall be suitable for the service conditions specified in the attached equipment sections.

B. All equipment shall be designed and selected to operate without degradation in performance throughout the environmental extremes specified. Equipment shall be designed to prevent the generation of electromagnetic and radio frequency interference and shall be in compliance with FCC Rules and Regulations, Part 15, for Class A computing devices.

C. Ambient Temperature and Elevation

1. All system equipment located in air conditioned rooms shall be suitable for operation in ambient temperatures from 10° C to 35° C and a relative humidity of 10 to 80 percent, noncondensing. All equipment located in non-air conditioned indoor areas shall be suitable for an ambient temperature range of 0° C to 50° C and a relative humidity of 10 to 95 percent, noncondensing. All equipment located outdoors shall be suitable for operation in an ambient temperature range -20° C to 60° C and a relative humidity of 5 to 100 percent. Heaters and air conditioning/cooling equipment shall be provided where essential to maintain equipment within its manufacturer-recommended operating ranges.

2. All equipment and instruments shall be designed to operate at the site elevation of 1,200 ft.

D. Deleterious Effects

1. All system equipment will be installed in areas without anti-static floor construction and without any provisions for control of particulates or corrosive gases other than ordinary office-type HVAC filtering. System Supplier shall furnish any additional air cleaning equipment, anti-static chair pads, or other protective measures necessary for proper operation of the system.

2. All input/output hardware shall meet or exceed, without false operation, all requirements of NEMA ICS-1-109.60, Electrical Noise Tests.

E. Noise Level

1. The equivalent "A" weighted sound level for any system equipment located in the control room, except printers, shall not exceed 35 dBA. The sound level for printers shall not exceed 65 dBA. Sound reduction enclosures shall be provided where necessary to comply with these limits.

F. Lightning Protection

1. In addition to other environmental protection specified herein, the entire system shall be provided with lightning protection. Lightning protection measures shall include the following.

2. Grounding

a. All major components of the system shall have a low resistance ground connection. Grounding system provisions indicated on the Drawings shall be modified as recommended by System Supplier.

3. Surge Suppressors

a. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied for the following:

1) All 120 volts ac power connections to RTUs, PLCs, DCUs, instruments and control room equipment. Surge arresters shall be Transtector "ACP-100-HW Series", Power Integrity Corporation “ZTA Series”, Phoenix Contact “Mains PlugTrab”, or MCG Surge Protection “400 Series”

2) All connections to coaxial-based networked equipment (including CCTV, CATV, Ethernet and cellular) where any part of the circuit is outside of the building envelope. Surge arresters shall be Telematic “VP08”, Transtector CCTV-PTZ Series”, Phoenix Contact “CoaxTrab Series”, or Northern Technologies “TCS-CP3 Series”.

3) All analog signal circuits where any part of the circuit is outside of the building envelope. Circuits shall be protected at both the transmitter and the control system end of the circuit. Surge protection devices shall not impede

or interfere with the use of smart transmitter calibration/communication. Protection devices located near the transmitter shall be Telematic "TP48." Protection devices in control panels shall be Transtector "PDS Series or FSP Series", Telematic "SD Series", Phoenix Contact "PipeTrab Series", or Citel "BP1-24."

4) All metallic pair (twisted and untwisted) conductor local area network and data highway termination points, where any part of the data highway cable is routed outside of the building envelope. Single-port protective devices shall be Phoenix Contact "PlugTrab Series", Transtector "FSP" Series", or Telematic "NP Series."

2.5 SOFTWARE DOCUMENTATION

A. System Supplier shall furnish complete documentation on all software supplied with the systems specified herein. Operating systems, compilers, assemblers, and utility and diagnostic programs that are standard commercial products of third parties need not be included in the optical media backup. Software documentation shall consist of the following principal items.

1. One backup set of any integrated circuit or solid-state memory-based plug-in firmware used.

2. Two complete back-up copies of system and application software in executable format on optical media compatible with the system furnished.

3. Three sets of user reference manuals for all standard system and application software.

4. One set of user reference manuals for all operating system software.

5. Three sets of printed as-built reference documentation for any special software provided specifically for this contract.

6. For each licensed software product, all documentation provided by the product manufacturer shall be provided. This includes all reference manuals and any other documents that were provided by the manufacturer. One set of this documentation shall be supplied for each and every piece of equipment provided. Multiple pieces of similar equipment or software require multiple copies of this documentation.

2.6 SOFTWARE LICENSE

A. All software programs supplied as a standard part of System Supplier's products for this project shall be licensed to Owner for use on the system specified herein. Such license shall not restrict Owner from using the software on the system provided hereunder or its replacement. Owner shall have the right to make copies of the software for use on the system provided. Specific requirements of System Supplier's software license are subject to review and approval by Owner and Engineer.

2.7 INSTALLATION TEST EQUIPMENT

A. All necessary testing equipment for calibration and checking of system components shall be provided by System Supplier. System Supplier shall also furnish calibration and maintenance records for all testing and calibration equipment used on the site if requested by Engineer.

2.8 PROGRAMMING DEVICES

A. An instrument programming device shall be provided for the instruments specified in other sections. Quantity of programming devices shall be as specified in other sections.

2.9 PROGRAMMING SOFTWARE

A. Instrument programming software shall be provided for the instruments specified in other sections. One software license shall be provided.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. The installation of equipment furnished hereunder shall be by the Contractor or their assigned subcontractors.

B. Field Wiring

1. Field wiring materials and installation shall be in accordance with the electrical section.

C. Instrument Installation

1. Instruments shall be mounted so that they can be easily read and serviced and so that all appurtenant devices can be easily operated. Installation details for some instruments are indicated on the Drawings.

2. All outdoor instrumentation shall be protected from direct sun exposure. Instruments shall be placed in locations to limit south and west sun exposure. Sunshades shall be provided on instruments that are subject to the direct sun exposure. Sunshades shall be located so the opening faces north or east where possible. Sunshades shall be provided as shown on the Drawings.

D. Salvage of Existing Equipment

1. Existing equipment and materials removed or replaced under this contract shall be delivered to Owner at a location designated by Owner, or shall be properly disposed of at Owner's discretion. Care shall be taken to avoid damage to equipment delivered to Owner.

2. Any mounting brackets, enclosures, stilling wells, piping, conduits, wiring, or openings that remain after removal of equipment and support hardware shall be removed or repaired in a manner acceptable to Owner and Engineer. Transmitters or switches containing mercury shall be removed and disposed of by personnel trained in the handling of hazardous materials and using approved procedures.

3.2 SYSTEM SOFTWARE CONFIGURATION

A. The system software will be configured by Owner. System Supplier shall be responsible for the following configuration support tasks:

1. Furnish and apply all standard communications software and develop any custom communications software needed for the components of the system to communicate information as indicated on the functional block diagram on the Drawings.

2. Provide the services of an experienced applications engineer for 8-hour day visits, at Owner's facilities, to assist with the configuration. One of these visits shall be scheduled to coincide with the delivery of equipment for configuration. The remaining visits shall be scheduled with Engineer and Owner.

3. Provide the services of the applications engineer for telephone consultation and trouble shooting from System Supplier's facility for eight hours.

4. Provide configuration information to Engineer at least two weeks before the shipment of equipment for configuration. Include specific I/O address numbering schemes for all field I/O points, database tag numbering format, address numbers of points for internal use, and other information necessary to begin database, HMI, and DCU programming.

5. Provide complete startup, checkout, and calibration of all system hardware and I/O specified herein.

6. Provide any programming requisite to implementing the features and functions described herein that are not a standard part of the system software.

3.3 SYSTEMS CHECK

A. System Supplier shall provide the services of a trained and experienced field supervisor to assist the installation contractor during installation, and to calibrate, test, and advise others of the procedures for installation, adjustment, and operation.

B. Field Manager

1. System Supplier shall appoint a field services manager who shall be responsible for the coordination of all system check-out and startup activities, and who shall be immediately available to Engineer and Owner by phone or on site for the duration of this project.

C. Field Inspection at Delivery

1. The field supervisor shall inspect major equipment items within five working days of delivery, to assure that the equipment was not damaged during shipment and shall supervise or assist with unpacking, initial placement, and initial wiring of the system.

D. Field Calibration of Instruments

1. After each instrument has been installed, a technical representative of System Supplier shall calibrate each instrument and shall provide a written calibration report for each instrument, indicating the results and final settings. The adjustments of calibrated instruments shall be sealed or marked, insofar as possible, to discourage tampering. Instrument calibration shall be done before checkout of the system operation. A typical instrument calibration report is attached to the end of this section.

E. Training for Installation Personnel

1. The field supervisor shall train the installation personnel in reading and understanding submittal drawings, and in the correct installation and wiring procedures for the equipment. four days shall be included for this training.

F. Field Inspection Prior to Start Up

1. After installation and wiring connections are complete, the field supervisor, with additional System Supplier's personnel shall verify that each external connection to the system is correctly wired and field process components and devices are functioning as intended. A minimum of thirty working days shall be included for this task, but System Supplier shall be responsible for completing the following scope of work.

2. Analog Signals

a. Analog input signals shall be simulated at the transmitting source, and verified to be received at the proper register address in the control system. Analog outputs shall be generated at the control system, and verified to be received with the correct polarity, at the respective receiving device.

3. Discrete Signals

a. Discrete input and output signals shall be simulated and verified that they are received at the respective receiving device, and at the proper voltage.

4. Devices by Other Suppliers

a. If interrelated devices furnished by other suppliers, under other contracts, or by Owner, such as valve actuators, motor controls, chemical feeders, and instruments, do not perform properly at the time of system checkout, the field supervisor shall use suitable test equipment to introduce simulated signals to and/or measure signals from these devices to locate the sources of trouble or malfunction.

5. System Check Out Report

a. The System Supplier shall submit a written report on the results of such tests to Engineer. Additional documentation shall be furnished as requested by Engineer to establish responsibility for corrective measures. System Supplier shall verify, in writing, to Engineer or Owner that System Supplier has successfully completed the external connection check before beginning system startup or field acceptance testing.

G. Start Up Assistance

1. After the field supervisor has completed the system check and submitted his report, System Supplier shall supply a factory-trained engineer and programmer to provide on-site start up assistance. During the startup period, these personnel shall thoroughly check all equipment, correct any deficiencies, and verify the proper operation of all components. Seven working days shall be included for this task.

3.4 TESTING

A. The system shall be acceptance tested at the factory and on site.

B. System Supplier shall prepare a testing procedure to be approved by Owner and Engineer that shall demonstrate that the system conforms to the specifications. The testing procedure shall be submitted at least 30 days in advance of testing. The testing shall be conducted by System Supplier and witnessed by Owner and/or Engineer.

C. Site Acceptance Testing

1. After installation and checkout by System Supplier's personnel, the system shall be subjected to an acceptance test.

2. Site acceptance testing shall be scheduled after receipt of the System Check Out Report and System Supplier shall verify that all field signal changes are reflected in the proper address locations in the system database.

3. The site acceptance testing shall follow the same procedure as the factory testing and shall operate without loss of basic functions. The number of working days of continuous operation for the test shall be thirty (30). The operational demonstration shall confirm that the status, alarm, and process variable signals are valid and are being updated appropriately, and that the discrete and analog output signals from the control system are being correctly transmitted and implemented. Any errors or abnormal occurrences shall be recorded by System Supplier's field representative. System Supplier's field representative need not be continuously present during the site acceptance testing, but shall be available to respond to the site within one hour of notification. The representative shall inspect the system for faults at least once every 24 hours and shall log or record any noted problems. The log shall include a description of the problem, its apparent cause, and any corrective action taken.

4. Failure of Redundant Equipment

    a. Failure of redundant equipment shall not be considered downtime provided that automatic failover occurs as specified and, in the opinion of Engineer, the failure was not caused by deficiency in design or installation. In the event of repeated failure of any hardware component or software module, the acceptance test shall be terminated and re-started.

5. Completion of Test

    a. Successful completion of the site acceptance test, including the operational demonstration, is prerequisite to Substantial Completion as specified in the General Conditions.

3.5 TRAINING

A. System Supplier shall conduct training courses for personnel selected by Owner. Training shall be provided in the categories below. Training shall be conducted by experienced instructors who are familiar with the specific system supplied.

B. General Training Requirements

1. In general, System Supplier's standard training courses may be used to meet the training objectives specified. Where standard courses do not meet these objectives, additional coursework shall be developed. Clock hour requirements for each level of training are shall be as listed. A "clock hour" is defined as one hour of instruction or supervised training exercise. Training hour requirements are the number of hours of training to be provided for each student. Additional training time shall be provided if considered necessary to meet the training objectives.

2. Training Costs

    a. All costs associated with the training program; excluding travel, lodging, and per diem expenses for Owner's and Engineer's personnel to attend off-site training programs; shall be the responsibility of System Supplier and shall be included in the contract price.

3. Lessons

    a. Training lesson plans and other information for the second stage submittal as defined herein shall be submitted at least 30 days prior to the start of training.

4. Video Recording

    a. All training sessions shall be video recorded by the System Supplier for Owner's future use in training other personnel. Video recorded sessions shall be saved to DVD/R media for delivery to Owner. Pre-recorded videos of System Supplier's standard training programs may be substituted if they cover the same topics and are developed for the same versions of hardware and software. Furnishing videos

of standard training programs shall not relieve System Supplier from any of the training requirements specified herein.

5. Instrument Training

   a. Training on the calibration, maintenance, troubleshooting, and repair for the instrument devices provided under this project shall be provided. Training shall also be provided for any hand-held or computer-based calibration devices and their associated software. Four (4) hours of training for 8 students shall be provided at the Owner's facility.

6. Network Training

   a. System Supplier shall provide training on network equipment provided. Network training shall be conducted in one session at Owner's facilities using the hardware and software installed for this project.
      1) Course shall provide an overall description of the network and how it operates.
      2) A two hour course (for each make/model of Ethernet switch, router, modem, camera and firewall) on configuration shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding, and shall be provided by the individual that configured the devices. The course shall review the configuration settings. Course training material shall be vendor provided equipment manuals.
      3) A one hour course on the use of the management software shall be provided for up to five people. This instruction shall be aimed at a network administrator's level of understanding, and shall be provided by the individual that configured the software. Course training material shall be vendor provided software manuals.
      4) Training shall be provided on the use of any Network Test Equipment provided. Course training material shall be vendor provided equipment manuals.

   b. The training shall provide instruction for up to 5 Owner-selected students.

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Item No. This is an arbitrary sequential number which is for reference only.
Area. Contains the Process area number assigned to each instrument/device. Area codes are found on legend sheet I-003
System. Contains the system code assigned to each instrument/device. System code abbreviatons are found on legend sheet I-002
Type. This is the ISA (or similar) alpha tag representing the function of the instrument.
Loop Number. This is the numeric (or alphanmeric) loop designation for the instrument.
Service Description. This is the description of the instrument service (i.e. Filter No. 1 Loss-of-Head).
Device Type and Size. This is the instrument device type and should match the description as listed in the specification. A size is given if applicable (e.g., flow meters)
Output Type. This generally will be '4-20 mA' or "Dry Contact'. It could also be a serial output for smart devices (such as HART or FIELD-BUS) but only if the serial output is the primary I/O interface.
Output Range. This is the calibrated range for analog devices or the trip point(s) for discrete devices.
Power Type. This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.
DWG Name. This is the drawing number of the P&ID where the device is shown.
Spec. The provider for the specification section listed is responsible for supplying the device.
Remarks. This column may include a cross reference to another specification section where applicable or to a note which provides additional information.

Item no.	Area	System	Type	Loop Number	Tag	Service Description	Device Type	Size	Output_Type	Output_Range	Power_Type	DWG Number	Specification	Remarks
1	42	PW	PIT	301	42-PW-PIT-301	DISCHARGE HEADER TO SPRINGDALE PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-160 PSI	2-WIRE	I-42-601	13563	
2	42	PW	FE	301	42-PW-FE-301	DISCHARGE HEADER TO SPRINGDALE FLOW	ELECTRO-MAG FLOW ELEMENT	36"	mV to FIT	N/A	N/A	I-42-601	13562	
3	42	PW	FIT	301	42-PW-FIT-301	DISCHARGE HEADER TO SPRINGDALE FLOW	ELECTRO-MAG FLOW TRANSMITTER	N/A	4-20 mA	0-30 MGD	4-WIRE	I-42-601	13562	
4	42	PW	FG	001	42-PW-FG-001	SUCTION HEADER WATER QUALITY PANEL FLOW 1	ROTAMETER		N/A	0-5 GPH	N/A	I-42-601	13562	
5	42	PW	FG	002	42-PW-FG-002	SUCTION HEADER WATER QUALITY PANEL FLOW 2	ROTAMETER		N/A	0-5 GPH	N/A	I-42-601	13562	
6	42	PW	FG	003	42-PW-FG-003	SUCTION HEADER WATER QUALITY PANEL FLOW 3	ROTAMETER		N/A	0-5 GPH	N/A	I-42-601	13562	
7	42	PW	FG	004	42-PW-FG-004	SUCTION HEADER WATER QUALITY PANEL FLOW 4	ROTAMETER		N/A	0-5 GPH	N/A	I-42-601	13562	
8	42	PW	FG	005	42-PW-FG-005	SUCTION HEADER WATER QUALITY PANEL FLOW 5	ROTAMETER		N/A	0-5 GPH	N/A	I-42-601	13562	
9	42	PW	PG	001	42-PW-PG-001	SUCTION HEADER WATER QUALITY PANEL PRESSURE	PRESSURE GAUGE	N/A	N/A	0-10 PSI	N/A	I-42-601	13563	
10	42	PW	AE	001	42-PW-AE-001	SUCTION HEADER WATER TOTAL CHLORINE	TOTAL CHLORINE SENSOR	N/A	N/A	N/A	N/A	I-42-601	13564	
11	42	PW	AIT	001	42-PW-AIT-001	SUCTION HEADER WATER TOTAL CHLORINE	TOTAL CHLORINE ANALYZER	N/A	4-20 mA	0-10 mg/L	4-WIRE	I-42-601	13564	
12	42	PW	AE	002	42-PW-AE-002	SUCTION HEADER WATER FLUORIDE	FLUORIDE SENSOR	N/A	N/A	N/A	N/A	I-42-601	13564	
13	42	PW	AIT	002	42-PW-AIT-002	SUCTION HEADER WATER FLUORIDE	FLUORIDE ANALYZER	N/A	4-20 mA	0.1 -10 mg/L	4-WIRE	I-42-601	13564	
14	42	PW	AE	003	42-PW-AE-003	SUCTION HEADER WATER TURBIDITY	TURBIDITY SENSOR	N/A	N/A	N/A	N/A	I-42-601	13564	
15	42	PW	AIT	003	42-PW-AIT-003	SUCTION HEADER WATER TURBIDITY	TURBIDITY ANALYZER	N/A	4-20 mA	0-700 NTU	4-WIRE	I-42-601	13564	
16	42	PW	AE	004	42-PW-AE-004	SUCTION HEADER WATER pH	pH SENSOR	N/A	N/A	N/A	N/A	I-42-601	13564	
17	42	PW	AIT	004	42-PW-AIT-004	SUCTION HEADER WATER pH	pH ANALYZER	N/A	4-20 mA	0-14 pH	4-WIRE	I-42-601	13564	
18	42	PW	AE	005	42-PW-AE-005	SUCTION HEADER WATER CHLORINE DIOXIDE (CLO2)	CHLORINE DIOXIDE (CLO2) SENSOR	N/A	N/A	N/A	N/A	I-42-601	13564	
19	42	PW	AIT	005	42-PW-AIT-005	SUCTION HEADER WATER CHLORINE DIOXIDE (CLO2)	CHLORINE DIOXIDE (CLO2) ANALYZER	N/A	4-20 mA	0-2 mg/L	4-WIRE	I-42-601	13564	
20	42	PW	PG	301	42-PW-PG-301	SPRINGDALE PUMP NO. 1 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-601	13563	
21	42	PW	PG	301A	42-PW-PG-301A	SPRINGDALE PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-601	13563	
22	42	PW	TE	301A	42-PW-TE-301A	SPRINGDALE PUMP NO. 1 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
23	42	PW	TE	301B	42-PW-TE-301B	SPRINGDALE PUMP NO. 1 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
24	42	PW	TE	301C	42-PW-TE-301C	SPRINGDALE PUMP NO. 1 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
25	42	PW	TE	301D	42-PW-TE-301D	SPRINGDALE PUMP NO. 1 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
26	42	PW	TE	301E	42-PW-TE-301E	SPRINGDALE PUMP NO. 1 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
27	42	PW	TE	301F	42-PW-TE-301F	SPRINGDALE PUMP NO. 1 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
28	42	PW	TE	301G	42-PW-TE-301G	SPRINGDALE PUMP NO. 1 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
29	42	PW	TE	301H	42-PW-TE-301H	SPRINGDALE PUMP NO. 1 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
30	42	PW	ZSO	301	42-PW-ZSO-301	SPRINGDALE PUMP NO. 1 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-601	15093	CHECK VALVE SUPPLIER
31	42	PW	PG	302	42-PW-PG-302	SPRINGDALE PUMP NO. 2 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-601	13563	
32	42	PW	PG	302A	42-PW-PG-302A	SPRINGDALE PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-601	13563	
33	42	PW	TE	302A	42-PW-TE-302A	SPRINGDALE PUMP NO. 2 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
34	42	PW	TE	302B	42-PW-TE-302B	SPRINGDALE PUMP NO. 2 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
35	42	PW	TE	302C	42-PW-TE-302C	SPRINGDALE PUMP NO. 2 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
36	42	PW	TE	302D	42-PW-TE-302D	SPRINGDALE PUMP NO. 2 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
37	42	PW	TE	302E	42-PW-TE-302E	SPRINGDALE PUMP NO. 2 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
38	42	PW	TE	302F	42-PW-TE-302F	SPRINGDALE PUMP NO. 2 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
39	42	PW	TE	302G	42-PW-TE-302G	SPRINGDALE PUMP NO. 2 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
40	42	PW	TE	302H	42-PW-TE-302H	SPRINGDALE PUMP NO. 2 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
41	42	PW	ZSO	302	42-PW-ZSO-302	SPRINGDALE PUMP NO. 2 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-601	15093	CHECK VALVE SUPPLIER
42	42	PW	PG	303	42-PW-PG-303	SPRINGDALE PUMP NO. 3 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-601	13563	
43	42	PW	PG	303A	42-PW-PG-303A	SPRINGDALE PUMP NO. 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-601	13563	
44	42	PW	TE	303A	42-PW-TE-303A	SPRINGDALE PUMP NO. 3 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
45	42	PW	TE	303B	42-PW-TE-303B	SPRINGDALE PUMP NO. 3 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
46	42	PW	TE	303C	42-PW-TE-303C	SPRINGDALE PUMP NO. 3 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
47	42	PW	TE	303D	42-PW-TE-303D	SPRINGDALE PUMP NO. 3 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
48	42	PW	TE	303E	42-PW-TE-303E	SPRINGDALE PUMP NO. 3 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
49	42	PW	TE	303F	42-PW-TE-303F	SPRINGDALE PUMP NO. 3 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
50	42	PW	TE	303G	42-PW-TE-303G	SPRINGDALE PUMP NO. 3 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
51	42	PW	TE	303H	42-PW-TE-303H	SPRINGDALE PUMP NO. 3 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-601	11110	PUMP SUPPLIER
52	42	PW	ZSO	303	42-PW-ZSO-303	SPRINGDALE PUMP NO. 3 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-601	15093	CHECK VALVE SUPPLIER
53	42	PW	PG	300	42-PW-PG-300	SPRINGDALE PUMP STATION SURGE TANK PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-601	13563	
54	42	PW	PIT	300	42-PW-PIT-300	SPRINGDALE PUMP STATION SURGE TANK PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-170 PSI	2-WIRE	I-42-601	13563	
55	42	PW	LG	300	42-PW-LG-300	SPRINGDALE PUMP STATION SURGE TANK LEVEL	LEVEL GAUGE	N/A	N/A	BY MFR	N/A	I-42-601	13800	SURGE TANK SUPPLIER
56	42	PW	LIT	300	42-PW-LIT-300	SPRINGDALE PUMP STATION SURGE TANK LEVEL	DIFFERENTIAL PRESSURE SENSING LEVEL TRANSMITTER	N/A	4-20 mA	BY MFR	2-WIRE	I-42-601	13800	SURGE TANK SUPPLIER
57	42	PW	PIT	001	42-PW-PIT-001	60 INCH SUCTION HEADER FROM EXISTING WTP FACILITY PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-60 PSI	2-WIRE	I-42-601	13563	

Item no.	Area	System	Type	Loop Number	Tag	Service Description	Device Type	Size	Output_Type	Output_Range	Power_Type	DWG Number	Specification	Remarks
58	42	PW	PIT	401	42-PW-PIT-401	DISCHARGE HEADER TO FAYETTEVILLE PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-160 PSI	2-WIRE	I-42-603	13563	
59	42	PW	FE	401	42-PW-FE-401	DISCHARGE HEADER TO FAYETTEVILLE FLOW	ELECTRO-MAG FLOW ELEMENT	36"	mV to FIT	N/A	N/A	I-42-603	13562	
60	42	PW	FIT	401	42-PW-FIT-401	DISCHARGE HEADER TO FAYETTEVILLE FLOW	ELECTRO-MAG FLOW TRANSMITTER	N/A	4-20 mA	0-30 MGD	4-WIRE	I-42-603	13562	
61	42	PW	PG	401	42-PW-PG-401	FAYETTEVILLE PUMP NO. 1 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-603	13563	
62	42	PW	PG	401A	42-PW-PG-401A	FAYETTEVILLE PUMP NO. 1 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-603	13563	
63	42	PW	TE	401A	42-PW-TE-401A	FAYETTEVILLE PUMP NO. 1 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
64	42	PW	TE	401B	42-PW-TE-401B	FAYETTEVILLE PUMP NO. 1 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
65	42	PW	TE	401C	42-PW-TE-401C	FAYETTEVILLE PUMP NO. 1 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
66	42	PW	TE	401D	42-PW-TE-401D	FAYETTEVILLE PUMP NO. 1 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
67	42	PW	TE	401E	42-PW-TE-401E	FAYETTEVILLE PUMP NO. 1 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
68	42	PW	TE	401F	42-PW-TE-401F	FAYETTEVILLE PUMP NO. 1 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
69	42	PW	TE	401G	42-PW-TE-401G	FAYETTEVILLE PUMP NO. 1 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
70	42	PW	TE	401H	42-PW-TE-401H	FAYETTEVILLE PUMP NO. 1 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
71	42	PW	ZSO	401	42-PW-ZSO-401	FAYETTEVILLE PUMP NO. 1 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-603	15093	CHECK VALVE SUPPLIER
72	42	PW	PG	402	42-PW-PG-402	FAYETTEVILLE PUMP NO. 2 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-603	13563	
73	42	PW	PG	402A	42-PW-PG-402A	FAYETTEVILLE PUMP NO. 2 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-603	13563	
74	42	PW	TE	402A	42-PW-TE-402A	FAYETTEVILLE PUMP NO. 2 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
75	42	PW	TE	402B	42-PW-TE-402B	FAYETTEVILLE PUMP NO. 2 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
76	42	PW	TE	402C	42-PW-TE-402C	FAYETTEVILLE PUMP NO. 2 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
77	42	PW	TE	402D	42-PW-TE-402D	FAYETTEVILLE PUMP NO. 2 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
78	42	PW	TE	402E	42-PW-TE-402E	FAYETTEVILLE PUMP NO. 2 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
79	42	PW	TE	402F	42-PW-TE-402F	FAYETTEVILLE PUMP NO. 2 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
80	42	PW	TE	402G	42-PW-TE-402G	FAYETTEVILLE PUMP NO. 2 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
81	42	PW	TE	402H	42-PW-TE-402H	FAYETTEVILLE PUMP NO. 2 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
82	42	PW	ZSO	402	42-PW-ZSO-402	FAYETTEVILLE PUMP NO. 2 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-603	15093	CHECK VALVE SUPPLIER
83	42	PW	PG	403	42-PW-PG-403	FAYETTEVILLE PUMP NO. 3 SUCTION PRESSURE	PRESSURE GAUGE	N/A	N/A	0-100 PSI	N/A	I-42-603	13563	
84	42	PW	PG	403A	42-PW-PG-403A	FAYETTEVILLE PUMP NO. 3 DISCHARGE PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-603	13563	
85	42	PW	TE	403A	42-PW-TE-403A	FAYETTEVILLE PUMP NO. 3 PHASE A TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
86	42	PW	TE	403B	42-PW-TE-403B	FAYETTEVILLE PUMP NO. 3 PHASE A TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
87	42	PW	TE	403C	42-PW-TE-403C	FAYETTEVILLE PUMP NO. 3 PHASE B TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
88	42	PW	TE	403D	42-PW-TE-403D	FAYETTEVILLE PUMP NO. 3 PHASE B TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
89	42	PW	TE	403E	42-PW-TE-403E	FAYETTEVILLE PUMP NO. 3 PHASE C TEMPERATURE 1	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
90	42	PW	TE	403F	42-PW-TE-403F	FAYETTEVILLE PUMP NO. 3 PHASE C TEMPERATURE 2	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
91	42	PW	TE	403G	42-PW-TE-403G	FAYETTEVILLE PUMP NO. 3 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
92	42	PW	TE	403H	42-PW-TE-403H	FAYETTEVILLE PUMP NO. 3 BEARING TEMPERATURE	RTD SENSOR	N/A	RTD	BY MFR	3 -WIRE	I-42-603	11110	PUMP SUPPLIER
93	42	PW	ZSO	403	42-PW-ZSO-403	FAYETTEVILLE PUMP NO. 3 DISCHARGE CHECK VALVE POSITION OPEN	POSITION SWITCH	N/A	DRY CONTACT	N/A	N/A	I-42-603	15093	CHECK VALVE SUPPLIER
94	42	PW	PG	400	42-PW-PG-400	FAYETTEVILLE PUMP STATION SURGE TANK PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-603	13563	
95	42	PW	PIT	400	42-PW-PIT-400	FAYETTEVILLE PUMP STATION SURGE TANK PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-170 PSI	2-WIRE	I-42-603	13563	
96	42	PW	LG	400	42-PW-LG-400	FAYETTEVILLE PUMP STATION SURGE TANK LEVEL	LEVEL GAUGE	N/A	N/A	BY MFR	N/A	I-42-603	13800	SURGE TANK SUPPLIER
97	42	PW	LIT	400	42-PW-LIT-400	FAYETTEVILLE PUMP STATION SURGE TANK LEVEL	DIFFERENTIAL PRESSURE SENSING LEVEL TRANSMITTER	N/A	4-20 mA	BY MFR	2-WIRE	I-42-603	13800	SURGE TANK SUPPLIER
98	42	PW	TG	300	42-PW-TG-300	SPRINGDALE PUMP STATION AIR COMPRESSOR DISCHARGE TEMPERATURE	TEMEPERATURE GAUGE	N/A	N/A	0-200 DEGF	N/A	I-42-605	13565	
99	42	PW	PIT	302	42-PW-PIT-302	SPRINGDALE PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-260 PSI	2-WIRE	I-42-605	13563	
100	42	PW	TSH	300	42-PW-TSH-300	SPRINGDALE PUMP STATION AIR COMPRESSOR DISCHARGE TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	TRIP @ 120 DEGF INC.	N/A	I-42-605	13565	
101	42	PW	PG	305	42-PW-PG-305	SPRINGDALE AIR RECEIVER TANK PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-605	13563	
102	42	PW	PSL	305	42-PW-PSL-305	SPRINGDALE AIR RECEIVER TANK PRESSURE LOW	PRESSURE SWITCH	N/A	DRY CONTACT		N/A	I-42-605	13563	
103	42	PW	PG	305A	42-PW-PG-305A	SPRINGDALE AIR RECEIVER TANK OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	0-300 PSI	N/A	I-42-605	13563	
104	42	PW	PSL	405	42-PW-PSL-405	FAYETTEVILLE AIR RECEIVER TANK PRESSURE LOW	PRESSURE SWITCH	N/A	DRY CONTACT		N/A	I-42-606	13563	
105	42	PW	TG	400	42-PW-TG-400	FAYETTEVILLE PUMP STATION AIR COMPRESSOR DISCHARGE TEMPERATURE	TEMEPERATURE GAUGE	N/A	N/A	0-200 DEGF	N/A	I-42-606	13565	
106	42	PW	PIT	402	42-PW-PIT-402	FAYETTEVILLE PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-260 PSI	2-WIRE	I-42-606	13563	
107	42	PW	TSH	400	42-PW-TSH-400	FAYETTEVILLE PUMP STATION AIR COMPRESSOR DISCHARGE TEMPERATURE	TEMPERATURE SWITCH	N/A	DRY CONTACT	TRIP @ 120 DEGF INC.	N/A	I-42-606	13565	
108	42	PW	PG	405	42-PW-PG-405	FAYETTEVILLE AIR RECEIVER TANK PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-606	13563	
109	42	PW	PG	405A	42-PW-PG-405A	FAYETTEVILLE AIR RECEIVER TANK OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	0-400 PSI	N/A	I-42-606	13563	
110	43	GEN	PIT	101	43-GEN-PIT-101	NATURAL GAS SUPPLY TO GENERATOR NO. 1 PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-100 PSI	2-WIRE	I-43-601	13563	
111	43	GEN	PG	101	43-GEN-PG-101	NATURAL GAS SUPPLY TO GENERATOR NO. 1 PRESSURE	PRESSURE GAUGE	N/A	N/A	0-200 PSI	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
112	43	GEN	PG	102	43-GEN-PG-102	NATURAL GAS SUPPLY TO GENERATOR NO. 1 PRESSURE	PRESSURE GAUGE	N/A	N/A	0-60 PSI	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
113	43	GEN	HS	101	43-GEN-HS-101	ENGINE GENERATOR 1 E-STOP	PUSH BUTTON	N/A	N/A	N/A	N/A	I-43-601	13561	
114	43	GEN	TG	101	43-GEN-TG-101	ENGINE GENERATOR 1 RADIATOR JACKET WATER LOOP INLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
115	43	GEN	TG	102	43-GEN-TG-102	ENGINE GENERATOR 1 RADIATOR JACKET WATER LOOP OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
116	43	GEN	TG	103	43-GEN-TG-103	ENGINE GENERATOR 1 RADIATOR AFTERCOOLER WATER LOOP INLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
117	43	GEN	TG	104	43-GEN-TG-104	ENGINE GENERATOR 1 RADIATOR AFTERCOOLER WATER LOOP OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
118	43	GEN	PG	103	43-GEN-PG-103	ENGINE GENERATOR 1 RADIATOR JACKET WATER LOOP INLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
119	43	GEN	PG	104	43-GEN-PG-104	ENGINE GENERATOR 1 RADIATOR JACKET WATER LOOP OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
120	43	GEN	PG	105	43-GEN-PG-105	ENGINE GENERATOR 1 RADIATOR AFTERCOOLER WATER LOOP INLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
121	43	GEN	PG	106	43-GEN-PG-106	ENGINE GENERATOR 1 RADIATOR AFTERCOOLER WATER LOOP OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
122	43	GEN	LSL	101	43-GEN-LSL-101	ENGINE GENERATOR 1 JACKET WATER EXPANSION TANK LEVEL LOW	LEVEL SWITCH	N/A	DRY CONTACT	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
123	43	GEN	LSL	102	43-GEN-LSL-102	ENGINE GENERATOR 1 AFTERCOOLER EXPANSION TANK LEVEL LOW	LEVEL SWITCH	N/A	DRY CONTACT	BY MFR	N/A	I-43-601	11910	ENGINE GENERATOR SUPPLIER
124	43	GEN	PIT	102	43-GEN-PIT-102	NATURAL GAS SUPPLY TO GENERATOR NO. 2 PRESSURE	PRESSURE TRANSMITTER	N/A	4-20 mA	0-100 PSI	2-WIRE	I-43-602	13563	
125	43	GEN	PG	107	43-GEN-PG-107	NATURAL GAS SUPPLY TO GENERATOR NO. 2 PRESSURE	PRESSURE GAUGE	N/A	N/A	0-200 PSI	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
126	43	GEN	PG	108	43-GEN-PG-108	NATURAL GAS SUPPLY TO GENERATOR NO. 2 PRESSURE	PRESSURE GAUGE	N/A	N/A	0-60 PSI	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER

Item no.	Area	System	Type	Loop Number	Tag	Service Description	Device Type	Size	Output_Type	Output_Range	Power_Type	DWG Number	Specification	Remarks
127	43	GEN	HS	102	43-GEN-HS-102	ENGINE GENERATOR 2 E-STOP	PUSH BUTTON	N/A	N/A	N/A	N/A	I-43-602	13561	
128	43	GEN	TG	105	43-GEN-TG-105	ENGINE GENERATOR 2 RADIATOR JACKET WATER LOOP INLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
129	43	GEN	TG	106	43-GEN-TG-106	ENGINE GENERATOR 2 RADIATOR JACKET WATER LOOP OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
130	43	GEN	TG	107	43-GEN-TG-107	ENGINE GENERATOR 2 RADIATOR AFTERCOOLER WATER LOOP INLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
131	43	GEN	TG	108	43-GEN-TG-108	ENGINE GENERATOR 2 RADIATOR AFTERCOOLER WATER LOOP OUTLET TEMPERATURE	TEMPERATURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
132	43	GEN	PG	109	43-GEN-PG-109	ENGINE GENERATOR 2 RADIATOR JACKET WATER LOOP INLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
133	43	GEN	PG	110	43-GEN-PG-110	ENGINE GENERATOR 2 RADIATOR JACKET WATER LOOP OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
134	43	GEN	PG	111	43-GEN-PG-111	ENGINE GENERATOR 2 RADIATOR AFTERCOOLER WATER LOOP INLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
135	43	GEN	PG	112	43-GEN-PG-112	ENGINE GENERATOR 2 RADIATOR AFTERCOOLER WATER LOOP OUTLET PRESSURE	PRESSURE GAUGE	N/A	N/A	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
136	43	GEN	LSL	103	43-GEN-LSL-103	ENGINE GENERATOR 2 JACKET WATER EXPANSION TANK LEVEL LOW	LEVEL SWITCH	N/A	DRY CONTACT	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER
137	43	GEN	LSL	104	43-GEN-LSL-104	ENGINE GENERATOR 2 AFTERCOOLER EXPANSION TANK LEVEL LOW	LEVEL SWITCH	N/A	DRY CONTACT	BY MFR	N/A	I-43-602	11910	ENGINE GENERATOR SUPPLIER

Input/Output List - Legend/Description Sheet

Item. This is an arbitrary sequential number which is for reference only.

IO Type: This is the type of I/O signal, as follows:

AI = Analog Input

AO = Analog Output

DI = Discrete Input

DO = Discrete Output

PI = Pulse Input (totalizer or accumulator type input)

Description. This is the description or the function (i.e. Filter No. 1 Loss-of-Head).

Field Device. This is the tag number of equipment identifier associated with the I/O point.

Controller ID. This is a sequential number for a given type within a specific controller (PLC or DCU).

Analog Data (Signal Type). This will typically be 4-20mA, but could also be 1-5Vdc, serial, HART, FLD-BUS, or similar to indicate the signal type of the associated input or output.

Analog Data (Calibrated Range). This will be the scaled value of the input in engineering units.

Analog Data (Power). This will typically be '2-wire' for devices which are loop powered from the PLC enclosure, or '4-wire' for devices which are powered form external power supplies, unless noted otherwise.

Discrete Data (Signal Type). This will be 120VAC, 24VDC, or similar to indicate the signal type of the associated input or output.

Discrete Data (Closed State). This will indicate the state of the input or output when it is considered to be closed or energized (normal, alarm, running, failed, etc.).

Discrete Data (Power Source). This will indicate the location of the power source for the wetting voltage on the contacts, as follows:

Field = External field power source. (May require interposing relays or isolated I/O module type.)

Local = Power originates from within the PLC or I/O enclosure.

Discrete Data (Interp Relay). This will be either 'Yes' or 'No' to indicate whether the input or output requires an interposing relay. Relays are typically required to isolate external voltage sources. See specifications for additional details.

P&ID. This column indicates associated Process & Instrumentation Diagram.

Remarks. This column may include a cross reference to another specification section where applicable, or to a note which provides additional information. Notes are appended to the end of the I/O listing.

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
1	AI	FI	301	FLOW	DISCHARGE HEADER TO SPRINGDALE FLOW	42-FIT-301	42-DCU-100	4 -20 mA	0-30 mgd	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
2	AI	PI	301	PRESSURE	DISCHARGE HEADER TO SPRINGDALE PRESSURE	42-PIT-301	42-DCU-100	4 -20 mA	0-160 psi	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
3	AI	AI	001	CL2	SUCTION HEADER WATER TOTAL CHLORINE	42-AIT-001	42-DCU-100	4 -20 mA	0-10 mg/l	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
4	AI	AI	002	FL	SUCTION HEADER WATER FLUORIDE	42-AIT-002	42-DCU-100	4 -20 mA	0-10 mg/l	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
5	AI	AI	003	TURB	SUCTION HEADER WATER TURBIDITY	42-AIT-003	42-DCU-100	4 -20 mA	0-700 NTU	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
6	AI	AI	004	pH	SUCTION HEADER WATER pH	42-AIT-004	42-DCU-100	4 -20 mA	0-14 pH	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
7	AI	AI	005	CLO2	SUCTION HEADER WATER CHLORINE DIOXIDE (CLO2)	42-AIT-005	42-DCU-100	4 -20 mA	0-2 mg/l	4-WIRE	N/A	N/A	N/A	N/A	I-42-601	
8	AI	PI	001	PRESSURE	60 INCH SUCTION HEADER FROM EXISTING WTP FACILITY PRESSURE	42-PIT-001	42-DCU-100	4 -20 mA	0-60 psi	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
9	AI	SI	301	SPEED	SPRINGDALE PUMP NO. 1 SPEED INDICATION	42-PSC-301	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
10	AO	SC	301	SPEED CMD	SPRINGDALE PUMP NO. 1 SPEED CMD	42-PSC-301	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
11	DI	YIR	301	RUNNING	SPRINGDALE PUMP NO. 1 RUNNING	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-601	
12	DI	YI	301	IN-REMOTE	SPRINGDALE PUMP NO. 1 IN-REMOTE	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	
13	DI	TAH	301	HIGH TEMP	SPRINGDALE PUMP NO. 1 TEMPERATURE HIGH	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-601	
14	DI	UA	301	COMMON FAIL	SPRINGDALE PUMP NO. 1 COMMON FAIL	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-601	
15	DI	YA	301	FAIL TO START	SPRINGDALE PUMP NO. 1 FAIL TO START	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-601	
16	DI	YA	301	E-STOP	SPRINGDALE PUMP NO. 1 E-STOP	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-601	
17	DO	UCR	301	RUN CMD	SPRINGDALE PUMP NO. 1 RUN CMD	42-PSC-301	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-601	
18	AI	SI	302	SPEED	SPRINGDALE PUMP NO. 2 SPEED INDICATION	42-PSC-302	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
19	AO	SC	302	SPEED CMD	SPRINGDALE PUMP NO. 2 SPEED CMD	42-PSC-302	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
20	DI	UA	302	COMMON FAIL	SPRINGDALE PUMP NO. 2 COMMON FAIL	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-601	
21	DI	YA	302	E-STOP	SPRINGDALE PUMP NO. 2 E-STOP	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-601	
22	DI	YI	302	IN-REMOTE	SPRINGDALE PUMP NO. 2 IN-REMOTE	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	
23	DI	TAH	302	HIGH TEMP	SPRINGDALE PUMP NO. 2 TEMPERATURE HIGH	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-601	
24	DI	YIR	302	RUNNING	SPRINGDALE PUMP NO. 2 RUNNING	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-601	
25	DI	YA	302	FAIL TO START	SPRINGDALE PUMP NO. 2 FAIL TO START	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-601	
26	DO	UCR	302	RUN CMD	SPRINGDALE PUMP NO. 2 RUN CMD	42-PSC-302	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-601	
27	AI	SI	303	SPEED	SPRINGDALE PUMP NO. 3 SPEED INDICATION	42-PSC-303	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
28	AO	SC	303	SPEED CMD	SPRINGDALE PUMP NO. 3 SPEED CMD	42-PSC-303	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	
29	DI	YI	303	IN-REMOTE	SPRINGDALE PUMP NO. 3 IN-REMOTE	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	
30	DI	TAH	303	HIGH TEMP	SPRINGDALE PUMP NO. 3 TEMPERATURE HIGH	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-601	
31	DI	UA	303	COMMON FAIL	SPRINGDALE PUMP NO. 3 COMMON FAIL	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-601	
32	DI	YIR	303	RUNNING	SPRINGDALE PUMP NO. 3 RUNNING	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-601	
33	DI	YA	303	FAIL TO START	SPRINGDALE PUMP NO. 3 FAIL TO START	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-601	
34	DI	YA	303	E-STOP	SPRINGDALE PUMP NO. 3 E-STOP	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-601	
35	DO	UCR	303	RUN CMD	SPRINGDALE PUMP NO. 3 RUN CMD	42-PSC-303	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-601	
36	AI	SI	304	SPEED	SPRINGDALE FUTURE PUMP NO. 4 SPEED INDICATION	42-PSC-304	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	FUTURE I/O
37	AO	SC	304	SPEED CMD	SPRINGDALE FUTURE PUMP NO. 4 SPEED CMD	42-PSC-304	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-601	FUTURE I/O
38	DI	YI	304	IN-REMOTE	SPRINGDALE FUTURE PUMP NO. 4 IN-REMOTE	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	FUTURE I/O
39	DI	TAH	304	HIGH TEMP	SPRINGDALE FUTURE PUMP NO. 4 TEMPERATURE HIGH	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-601	FUTURE I/O
40	DI	YIR	304	RUNNING	SPRINGDALE FUTURE PUMP NO. 4 RUNNING	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-601	FUTURE I/O
41	DI	UA	304	COMMON FAIL	SPRINGDALE FUTURE PUMP NO. 4 COMMON FAIL	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-601	FUTURE I/O
42	DI	YA	304	FAIL TO START	SPRINGDALE FUTURE PUMP NO. 4 FAIL TO START	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-601	FUTURE I/O
43	DI	YA	304	E-STOP	SPRINGDALE FUTURE PUMP NO. 4 E-STOP	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-601	FUTURE I/O
44	DO	UCR	304	RUN CMD	SPRINGDALE FUTURE PUMP NO. 4 RUN CMD	42-PSC-304	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-601	FUTURE I/O
45	DI	YA	302	FAULT	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE FAULT	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-601	FUTURE I/O
46	DI	YI	302	IN-REMOTE	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE IN-REMOTE	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	FUTURE I/O
47	DI	ZIO	302	OPEN	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE OPEN	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	FUTURE I/O
48	DI	ZIC	302	CLOSED	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE CLOSED	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-601	FUTURE I/O
49	DO	ZCO	302	OPEN CMD	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE OPEN CMD	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-601	FUTURE I/O
50	DO	ZCC	302	CLOSE CMD	SPRINGDALE PUMP NO. 1 DISCHARGE VALVE CLOSE CMD	42-VBF-302	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-601	FUTURE I/O
51	DI	ZIC	305	CLOSED	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE CLOSED	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-601	FUTURE I/O
52	DI	YI	305	IN-REMOTE	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE IN-REMOTE	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	FUTURE I/O
53	DI	YA	305	FAULT	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE FAULT	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-601	FUTURE I/O
54	DI	ZIO	305	OPEN	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE OPEN	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	FUTURE I/O
55	DO	ZCO	305	OPEN CMD	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE OPEN CMD	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-601	FUTURE I/O

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
56	DO	ZCC	305	CLOSE CMD	SPRINGDALE PUMP NO. 2 DISCHARGE VALVE CLOSE CMD	42-VBF-305	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-601	FUTURE I/O
57	DI	YI	308	IN-REMOTE	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE IN-REMOTE	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	FUTURE I/O
58	DI	ZIC	308	CLOSED	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE CLOSED	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-601	FUTURE I/O
59	DI	YA	308	FAULT	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE FAULT	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-601	FUTURE I/O
60	DI	ZIO	308	OPEN	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE OPEN	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	FUTURE I/O
61	DO	ZCO	308	OPEN CMD	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE OPEN CMD	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-601	FUTURE I/O
62	DO	ZCC	308	CLOSE CMD	SPRINGDALE PUMP NO. 3 DISCHARGE VALVE CLOSE CMD	42-VBF-308	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-601	FUTURE I/O
63	DI	YI	311	IN-REMOTE	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE IN-REMOTE	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-601	FUTURE I/O
64	DI	ZIC	311	CLOSED	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE CLOSED	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-601	FUTURE I/O
65	DI	YA	311	FAULT	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE FAULT	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-601	FUTURE I/O
66	DI	ZIO	311	OPEN	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE OPEN	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	FUTURE I/O
67	DO	ZCO	311	OPEN CMD	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE OPEN CMD	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-601	FUTURE I/O
68	DO	ZCC	311	CLOSE CMD	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE VALVE CLOSE CMD	42-VBF-311	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-601	FUTURE I/O
69	DI	ZIO	301	OPEN	SPRINGDALE PUMP NO. 1 DISCHARGE CHECK VALVE OPEN	42-VCK-301	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	
70	DI	ZIO	302	OPEN	SPRINGDALE PUMP NO. 2 DISCHARGE CHECK VALVE OPEN	42-VCK-302	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	
71	DI	ZIO	303	OPEN	SPRINGDALE PUMP NO. 3 DISCHARGE CHECK VALVE OPEN	42-VCK-303	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	
72	DI	ZIO	304	OPEN	SPRINGDALE FUTURE PUMP NO. 4 DISCHARGE CHECK VALVE OPEN	42-VCK-304	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-601	FUTURE I/O
73	AI	EI	101A	OUTPUT VOLTAGE	PUMP STATION AREA UPS 1 OUTPUT VOLTAGE	42-UPS-101	42-DCU-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-42-602	
74	AI	II	101	OUTPUT CURRENT	PUMP STATION AREA UPS 1 OUTPUT CURRENT	42-UPS-101	42-DCU-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-42-602	
75	AI	EI	101B	BATTERY VOLTAGE	PUMP STATION AREA UPS 1 BATTERY VOLTAGE	42-UPS-101	42-DCU-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-42-602	
76	DI	YA	101	FAULT	PUMP STATION AREA UPS 1 FAULT	42-UPS-101	42-DCU-100	N/A	N/A	N/A	ETHERNET	FAULT	PLC	N/A	I-42-602	
77	AI	FI	201	FLOW	DISCHARGE HEADER TO ROGERS FLOW	42-FIT-201	42-DCU-100	4 -20 mA		4-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
78	AI	PI	201	PRESSURE	DISCHARGE HEADER TO ROGERS PRESSURE	42-PIT-201	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
79	AI	SI	201	SPEED	FUTURE ROGERS PUMP NO. 1 SPEED INDICATION	42-PSC-201	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
80	AO	SC	201	SPEED CMD	FUTURE ROGERS PUMP NO. 1 SPEED CMD	42-PSC-201	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
81	DI	YIR	201	RUNNING	FUTURE ROGERS PUMP NO. 1 RUNNING	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-602	FUTURE I/O
82	DI	YI	201	IN-REMOTE	FUTURE ROGERS PUMP NO. 1 IN-REMOTE	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
83	DI	TAH	201	HIGH TEMP	FUTURE ROGERS PUMP NO. 1 TEMPERATURE HIGH	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-602	FUTURE I/O
84	DI	UA	201	COMMON FAIL	FUTURE ROGERS PUMP NO. 1 COMMON FAIL	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-602	FUTURE I/O
85	DI	YA	201	FAIL TO START	FUTURE ROGERS PUMP NO. 1 FAIL TO START	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-602	FUTURE I/O
86	DI	YA	201	E-STOP	FUTURE ROGERS PUMP NO. 1 E-STOP	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-602	FUTURE I/O
87	DO	UCR	201	RUN CMD	FUTURE ROGERS PUMP NO. 1 RUN CMD	42-PSC-201	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-602	FUTURE I/O
88	AI	SI	202	SPEED	FUTURE ROGERS PUMP NO. 2 SPEED INDICATION	42-PSC-202	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
89	AO	SC	202	SPEED CMD	FUTURE ROGERS PUMP NO. 2 SPEED CMD	42-PSC-202	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
90	DI	UA	202	COMMON FAIL	FUTURE ROGERS PUMP NO. 2 COMMON FAIL	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-602	FUTURE I/O
91	DI	YA	202	E-STOP	FUTURE ROGERS PUMP NO. 2 E-STOP	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-602	FUTURE I/O
92	DI	YI	202	IN-REMOTE	FUTURE ROGERS PUMP NO. 2 IN-REMOTE	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
93	DI	TAH	202	HIGH TEMP	FUTURE ROGERS PUMP NO. 2 TEMPERATURE HIGH	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-602	FUTURE I/O
94	DI	YIR	202	RUNNING	FUTURE ROGERS PUMP NO. 2 RUNNING	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-602	FUTURE I/O
95	DI	YA	202	FAIL TO START	FUTURE ROGERS PUMP NO. 2 FAIL TO START	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-602	FUTURE I/O
96	DO	UCR	202	RUN CMD	FUTURE ROGERS PUMP NO. 2 RUN CMD	42-PSC-202	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-602	FUTURE I/O
97	AI	SI	203	SPEED	FUTURE ROGERS PUMP NO. 3 SPEED INDICATION	42-PSC-203	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
98	AO	SC	203	SPEED CMD	FUTURE ROGERS PUMP NO. 3 SPEED CMD	42-PSC-203	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
99	DI	YI	203	IN-REMOTE	FUTURE ROGERS PUMP NO. 3 IN-REMOTE	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
100	DI	TAH	203	HIGH TEMP	FUTURE ROGERS PUMP NO. 3 TEMPERATURE HIGH	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-602	FUTURE I/O
101	DI	UA	203	COMMON FAIL	FUTURE ROGERS PUMP NO. 3 COMMON FAIL	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-602	FUTURE I/O
102	DI	YIR	203	RUNNING	FUTURE ROGERS PUMP NO. 3 RUNNING	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-602	FUTURE I/O
103	DI	YA	203	FAIL TO START	FUTURE ROGERS PUMP NO. 3 FAIL TO START	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-602	FUTURE I/O
104	DI	YA	203	E-STOP	FUTURE ROGERS PUMP NO. 3 E-STOP	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-602	FUTURE I/O
105	DO	UCR	203	RUN CMD	FUTURE ROGERS PUMP NO. 3 RUN CMD	42-PSC-203	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-602	FUTURE I/O
106	AI	SI	204	SPEED	FUTURE ROGERS PUMP NO. 4 SPEED INDICATION	42-PSC-204	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
107	AO	SC	204	SPEED CMD	FUTURE ROGERS PUMP NO. 4 SPEED CMD	42-PSC-204	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-602	FUTURE I/O
108	DI	YI	204	IN-REMOTE	FUTURE ROGERS PUMP NO. 4 IN-REMOTE	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
109	DI	TAH	204	HIGH TEMP	FUTURE ROGERS PUMP NO. 4 TEMPERATURE HIGH	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-602	FUTURE I/O
110	DI	YIR	204	RUNNING	FUTURE ROGERS PUMP NO. 4 RUNNING	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-602	FUTURE I/O
111	DI	UA	204	COMMON FAIL	FUTURE ROGERS PUMP NO. 4 COMMON FAIL	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-602	FUTURE I/O
112	DI	YA	204	FAIL TO START	FUTURE ROGERS PUMP NO. 4 FAIL TO START	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-602	FUTURE I/O
113	DI	YA	204	E-STOP	FUTURE ROGERS PUMP NO. 4 E-STOP	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-602	FUTURE I/O
114	DO	UCR	204	RUN CMD	FUTURE ROGERS PUMP NO. 4 RUN CMD	42-PSC-204	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-602	FUTURE I/O
115	DI	YA	202	FAULT	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE FAULT	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-602	FUTURE I/O
116	DI	YI	202	IN-REMOTE	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE IN-REMOTE	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
117	DI	ZIO	202	OPEN	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE OPEN	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
118	DI	ZIC	202	CLOSED	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE CLOSED	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-602	FUTURE I/O
119	DO	ZCO	202	OPEN CMD	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE OPEN CMD	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-602	FUTURE I/O
120	DO	ZCC	202	CLOSE CMD	FUTURE ROGERS PUMP NO. 1 DISCHARGE VALVE CLOSE CMD	42-VBF-202	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-602	FUTURE I/O
121	DI	ZIC	205	CLOSED	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE CLOSED	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-602	FUTURE I/O
122	DI	YI	205	IN-REMOTE	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE IN-REMOTE	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
123	DI	YA	205	FAULT	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE FAULT	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-602	FUTURE I/O
124	DI	ZIO	205	OPEN	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE OPEN	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
125	DO	ZCO	205	OPEN CMD	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE OPEN CMD	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-602	FUTURE I/O
126	DO	ZCC	205	CLOSE CMD	FUTURE ROGERS PUMP NO. 2 DISCHARGE VALVE CLOSE CMD	42-VBF-205	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-602	FUTURE I/O
127	DI	YI	208	IN-REMOTE	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE IN-REMOTE	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
128	DI	ZIC	208	CLOSED	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE CLOSED	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-602	FUTURE I/O
129	DI	YA	208	FAULT	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE FAULT	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-602	FUTURE I/O
130	DI	ZIO	208	OPEN	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE OPEN	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
131	DO	ZCO	208	OPEN CMD	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE OPEN CMD	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-602	FUTURE I/O
132	DO	ZCC	208	CLOSE CMD	FUTURE ROGERS PUMP NO. 3 DISCHARGE VALVE CLOSE CMD	42-VBF-208	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-602	FUTURE I/O

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
133	DI	YI	211	IN-REMOTE	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE IN-REMOTE	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-602	FUTURE I/O
134	DI	ZIC	211	CLOSED	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE CLOSED	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-602	FUTURE I/O
135	DI	YA	211	FAULT	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE FAULT	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-602	FUTURE I/O
136	DI	ZIO	211	OPEN	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE OPEN	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
137	DO	ZCO	211	OPEN CMD	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE OPEN CMD	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-602	FUTURE I/O
138	DO	ZCC	211	CLOSE CMD	FUTURE ROGERS PUMP NO. 4 DISCHARGE VALVE CLOSE CMD	42-VBF-211	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-602	FUTURE I/O
139	DI	ZIO	201	OPEN	FUTURE ROGERS PUMP NO. 1 DISCHARGE CHECK VALVE OPEN	42-VCK-201	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
140	DI	ZIO	202	OPEN	FUTURE ROGERS PUMP NO. 2 DISCHARGE CHECK VALVE OPEN	42-VCK-202	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
141	DI	ZIO	203	OPEN	FUTURE ROGERS PUMP NO. 3 DISCHARGE CHECK VALVE OPEN	42-VCK-203	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
142	DI	ZIO	204	OPEN	FUTURE ROGERS PUMP NO. 4 DISCHARGE CHECK VALVE OPEN	42-VCK-204	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-602	FUTURE I/O
143	AI	FI	401	FLOW	DISCHARGE HEADER TO FAYETTEVILLE FLOW	42-FIT-401	42-DCU-100	4 -20 mA		4-WIRE	N/A	N/A	N/A	N/A	I-42-603	
144	AI	PI	401	PRESSURE	DISCHARGE HEADER TO FAYETTEVILLE PRESSURE	42-PIT-401	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
145	AI	SI	401	SPEED	FAYETTEVILLE PUMP NO. 1 SPEED INDICATION	42-PSC-401	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
146	AO	SC	401	SPEED CMD	FAYETTEVILLE PUMP NO. 1 SPEED CMD	42-PSC-401	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
147	DI	YIR	401	RUNNING	FAYETTEVILLE PUMP NO. 1 RUNNING	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-603	
148	DI	YI	401	IN-REMOTE	FAYETTEVILLE PUMP NO. 1 IN-REMOTE	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	
149	DI	TAH	401	HIGH TEMP	FAYETTEVILLE PUMP NO. 1 TEMPERATURE HIGH	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-603	
150	DI	UA	401	COMMON FAIL	FAYETTEVILLE PUMP NO. 1 COMMON FAIL	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-603	
151	DI	YA	401	FAIL TO START	FAYETTEVILLE PUMP NO. 1 FAIL TO START	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-603	
152	DI	YA	401	E-STOP	FAYETTEVILLE PUMP NO. 1 E-STOP	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-603	
153	DO	UCR	401	RUN CMD	FAYETTEVILLE PUMP NO. 1 RUN CMD	42-PSC-401	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-603	
154	AI	SI	402	SPEED	FAYETTEVILLE PUMP NO. 2 SPEED INDICATION	42-PSC-402	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
155	AO	SC	402	SPEED CMD	FAYETTEVILLE PUMP NO. 2 SPEED CMD	42-PSC-402	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
156	DI	UA	402	COMMON FAIL	FAYETTEVILLE PUMP NO. 2 COMMON FAIL	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-603	
157	DI	YA	402	E-STOP	FAYETTEVILLE PUMP NO. 2 E-STOP	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-603	
158	DI	YI	402	IN-REMOTE	FAYETTEVILLE PUMP NO. 2 IN-REMOTE	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	
159	DI	TAH	402	HIGH TEMP	FAYETTEVILLE PUMP NO. 2 TEMPERATURE HIGH	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-603	
160	DI	YIR	402	RUNNING	FAYETTEVILLE PUMP NO. 2 RUNNING	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-603	
161	DI	YA	402	FAIL TO START	FAYETTEVILLE PUMP NO. 2 FAIL TO START	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-603	
162	DO	UCR	402	RUN CMD	FAYETTEVILLE PUMP NO. 2 RUN CMD	42-PSC-402	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-603	
163	AI	SI	403	SPEED	FAYETTEVILLE PUMP NO. 3 SPEED INDICATION	42-PSC-403	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
164	AO	SC	403	SPEED CMD	FAYETTEVILLE PUMP NO. 3 SPEED CMD	42-PSC-403	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	
165	DI	YI	403	IN-REMOTE	FAYETTEVILLE PUMP NO. 3 IN-REMOTE	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	
166	DI	TAH	403	HIGH TEMP	FAYETTEVILLE PUMP NO. 3 TEMPERATURE HIGH	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-603	
167	DI	UA	403	COMMON FAIL	FAYETTEVILLE PUMP NO. 3 COMMON FAIL	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-603	
168	DI	YIR	403	RUNNING	FAYETTEVILLE PUMP NO. 3 RUNNING	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-603	
169	DI	YA	403	FAIL TO START	FAYETTEVILLE PUMP NO. 3 FAIL TO START	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-603	
170	DI	YA	403	E-STOP	FAYETTEVILLE PUMP NO. 3 E-STOP	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-603	
171	DO	UCR	403	RUN CMD	FAYETTEVILLE PUMP NO. 3 RUN CMD	42-PSC-403	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-603	
172	AI	SI	404	SPEED	FUTURE FAYETTEVILLE PUMP NO. 4 SPEED INDICATION	42-PSC-404	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	FUTURE I/O
173	AO	SC	404	SPEED CMD	FUTURE FAYETTEVILLE PUMP NO. 4 SPEED CMD	42-PSC-404	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-603	FUTURE I/O
174	DI	YI	404	IN-REMOTE	FUTURE FAYETTEVILLE PUMP NO. 4 IN-REMOTE	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	FUTURE I/O
175	DI	TAH	404	HIGH TEMP	FUTURE FAYETTEVILLE PUMP NO. 4 TEMPERATURE HIGH	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-603	FUTURE I/O
176	DI	YIR	404	RUNNING	FUTURE FAYETTEVILLE PUMP NO. 4 RUNNING	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-603	FUTURE I/O
177	DI	UA	404	COMMON FAIL	FUTURE FAYETTEVILLE PUMP NO. 4 COMMON FAIL	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-603	FUTURE I/O
178	DI	YA	404	FAIL TO START	FUTURE FAYETTEVILLE PUMP NO. 4 FAIL TO START	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-603	FUTURE I/O
179	DI	YA	404	E-STOP	FUTURE FAYETTEVILLE PUMP NO. 4 E-STOP	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-603	FUTURE I/O
180	DO	UCR	404	RUN CMD	FUTURE FAYETTEVILLE PUMP NO. 4 RUN CMD	42-PSC-404	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-603	FUTURE I/O
181	DI	YA	402	FAULT	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE FAULT	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-603	FUTURE I/O
182	DI	YI	402	IN-REMOTE	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE IN-REMOTE	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	FUTURE I/O
183	DI	ZIO	402	OPEN	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE OPEN	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	FUTURE I/O
184	DI	ZIC	402	CLOSED	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE CLOSED	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-603	FUTURE I/O
185	DO	ZCO	402	OPEN CMD	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE OPEN CMD	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-603	FUTURE I/O
186	DO	ZCC	402	CLOSE CMD	FAYETTEVILLE PUMP NO. 1 DISCHARGE VALVE CLOSE CMD	42-VBF-402	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-603	FUTURE I/O
187	DI	ZIC	405	CLOSED	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE CLOSED	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-603	FUTURE I/O
188	DI	YI	405	IN-REMOTE	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE IN-REMOTE	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	FUTURE I/O
189	DI	YA	405	FAULT	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE FAULT	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-603	FUTURE I/O
190	DI	ZIO	405	OPEN	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE OPEN	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	FUTURE I/O
191	DO	ZCO	405	OPEN CMD	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE OPEN CMD	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-603	FUTURE I/O
192	DO	ZCC	405	CLOSE CMD	FAYETTEVILLE PUMP NO. 2 DISCHARGE VALVE CLOSE CMD	42-VBF-405	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-603	FUTURE I/O
193	DI	YI	408	IN-REMOTE	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE IN-REMOTE	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	FUTURE I/O
194	DI	ZIC	408	CLOSED	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE CLOSED	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-603	FUTURE I/O
195	DI	YA	408	FAULT	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE FAULT	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-603	FUTURE I/O
196	DI	ZIO	408	OPEN	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE OPEN	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	FUTURE I/O
197	DO	ZCO	408	OPEN CMD	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE OPEN CMD	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-603	FUTURE I/O
198	DO	ZCC	408	CLOSE CMD	FAYETTEVILLE PUMP NO. 3 DISCHARGE VALVE CLOSE CMD	42-VBF-408	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-603	FUTURE I/O
199	DI	YI	411	IN-REMOTE	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE IN-REMOTE	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-603	FUTURE I/O
200	DI	ZIC	411	CLOSED	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE CLOSED	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-603	FUTURE I/O
201	DI	YA	411	FAULT	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE FAULT	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-603	FUTURE I/O
202	DI	ZIO	411	OPEN	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE OPEN	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	FUTURE I/O
203	DO	ZCO	411	OPEN CMD	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE OPEN CMD	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-603	FUTURE I/O
204	DO	ZCC	411	CLOSE CMD	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE VALVE CLOSE CMD	42-VBF-411	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-603	FUTURE I/O
205	DI	ZIO	401	OPEN	FAYETTEVILLE PUMP NO. 1 DISCHARGE CHECK VALVE OPEN	42-VCK-401	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	
206	DI	ZIO	402	OPEN	FAYETTEVILLE PUMP NO. 2 DISCHARGE CHECK VALVE OPEN	42-VCK-402	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	
207	DI	ZIO	403	OPEN	FAYETTEVILLE PUMP NO. 3 DISCHARGE CHECK VALVE OPEN	42-VCK-403	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	
208	DI	ZIO	404	OPEN	FUTURE FAYETTEVILLE PUMP NO. 4 DISCHARGE CHECK VALVE OPEN	42-VCK-404	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-603	FUTURE I/O
209	AI	FI	101	FLOW	DISCHARGE HEADER TO BENTONVILLE FLOW	42-FIT-101	42-DCU-100	4 -20 mA		4-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
210	AI	PI	101	PRESSURE	DISCHARGE HEADER TO BENTONVILLE PRESSURE	42-PIT-101	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
211	AI	SI	101	SPEED	FUTURE BENTONVILLE PUMP NO. 1 SPEED INDICATION	42-PSC-101	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
212	AO	SC	101	SPEED CMD	FUTURE BENTONVILLE PUMP NO. 1 SPEED CMD	42-PSC-101	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
213	DI	YIR	101	RUNNING	FUTURE BENTONVILLE PUMP NO. 1 RUNNING	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-604	FUTURE I/O
214	DI	YI	101	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 1 IN-REMOTE	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
215	DI	TAH	101	HIGH TEMP	FUTURE BENTONVILLE PUMP NO. 1 TEMPERATURE HIGH	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-604	FUTURE I/O
216	DI	UA	101	COMMON FAIL	FUTURE BENTONVILLE PUMP NO. 1 COMMON FAIL	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-604	FUTURE I/O
217	DI	YA	101	FAIL TO START	FUTURE BENTONVILLE PUMP NO. 1 FAIL TO START	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-604	FUTURE I/O
218	DI	YA	101	E-STOP	FUTURE BENTONVILLE PUMP NO. 1 E-STOP	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-604	FUTURE I/O
219	DO	UCR	101	RUN CMD	FUTURE BENTONVILLE PUMP NO. 1 RUN CMD	42-PSC-101	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-604	FUTURE I/O
220	AI	SI	102	SPEED	FUTURE BENTONVILLE PUMP NO. 2 SPEED INDICATION	42-PSC-102	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
221	AO	SC	102	SPEED CMD	FUTURE BENTONVILLE PUMP NO. 2 SPEED CMD	42-PSC-102	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
222	DI	UA	102	COMMON FAIL	FUTURE BENTONVILLE PUMP NO. 2 COMMON FAIL	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-604	FUTURE I/O
223	DI	YA	102	E-STOP	FUTURE BENTONVILLE PUMP NO. 2 E-STOP	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-604	FUTURE I/O
224	DI	YI	102	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 2 IN-REMOTE	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
225	DI	TAH	102	HIGH TEMP	FUTURE BENTONVILLE PUMP NO. 2 TEMPERATURE HIGH	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-604	FUTURE I/O
226	DI	YIR	102	RUNNING	FUTURE BENTONVILLE PUMP NO. 2 RUNNING	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-604	FUTURE I/O
227	DI	YA	102	FAIL TO START	FUTURE BENTONVILLE PUMP NO. 2 FAIL TO START	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-604	FUTURE I/O
228	DO	UCR	102	RUN CMD	FUTURE BENTONVILLE PUMP NO. 2 RUN CMD	42-PSC-102	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-604	FUTURE I/O
229	AI	SI	103	SPEED	FUTURE BENTONVILLE PUMP NO. 3 SPEED INDICATION	42-PSC-103	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
230	AO	SC	103	SPEED CMD	FUTURE BENTONVILLE PUMP NO. 3 SPEED CMD	42-PSC-103	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
231	DI	YI	103	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 3 IN-REMOTE	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
232	DI	TAH	103	HIGH TEMP	FUTURE BENTONVILLE PUMP NO. 3 TEMPERATURE HIGH	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-604	FUTURE I/O
233	DI	UA	103	COMMON FAIL	FUTURE BENTONVILLE PUMP NO. 3 COMMON FAIL	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-604	FUTURE I/O
234	DI	YIR	103	RUNNING	FUTURE BENTONVILLE PUMP NO. 3 RUNNING	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-604	FUTURE I/O
235	DI	YA	103	FAIL TO START	FUTURE BENTONVILLE PUMP NO. 3 FAIL TO START	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-604	FUTURE I/O
236	DI	YA	103	E-STOP	FUTURE BENTONVILLE PUMP NO. 3 E-STOP	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-604	FUTURE I/O
237	DO	UCR	103	RUN CMD	FUTURE BENTONVILLE PUMP NO. 3 RUN CMD	42-PSC-103	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-604	FUTURE I/O
238	AI	SI	104	SPEED	FUTURE BENTONVILLE PUMP NO. 4 SPEED INDICATION	42-PSC-104	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
239	AO	SC	104	SPEED CMD	FUTURE BENTONVILLE PUMP NO. 4 SPEED CMD	42-PSC-104	42-DCU-100	4 -20 mA	0-100%	2-WIRE	N/A	N/A	N/A	N/A	I-42-604	FUTURE I/O
240	DI	YI	104	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 4 IN-REMOTE	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
241	DI	TAH	104	HIGH TEMP	FUTURE BENTONVILLE PUMP NO. 4 TEMPERATURE HIGH	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH TEMP	PLC	N/A	I-42-604	FUTURE I/O
242	DI	YIR	104	RUNNING	FUTURE BENTONVILLE PUMP NO. 4 RUNNING	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-604	FUTURE I/O
243	DI	UA	104	COMMON FAIL	FUTURE BENTONVILLE PUMP NO. 4 COMMON FAIL	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-604	FUTURE I/O
244	DI	YA	104	FAIL TO START	FUTURE BENTONVILLE PUMP NO. 4 FAIL TO START	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	FAIL TO START	PLC	N/A	I-42-604	FUTURE I/O
245	DI	YA	104	E-STOP	FUTURE BENTONVILLE PUMP NO. 4 E-STOP	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	E-STOP	PLC	N/A	I-42-604	FUTURE I/O
246	DO	UCR	104	RUN CMD	FUTURE BENTONVILLE PUMP NO. 4 RUN CMD	42-PSC-104	42-DCU-100	N/A	N/A	N/A	120VAC	RUN CMD	FIELD	YES	I-42-604	FUTURE I/O
247	DI	YA	102	FAULT	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE FAULT	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-604	FUTURE I/O
248	DI	YI	102	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE IN-REMOTE	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
249	DI	ZIO	102	OPEN	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE OPEN	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
250	DI	ZIC	102	CLOSED	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE CLOSED	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-604	FUTURE I/O
251	DO	ZCO	102	OPEN CMD	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE OPEN CMD	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-604	FUTURE I/O
252	DO	ZCC	102	CLOSE CMD	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE VALVE CLOSE CMD	42-VBF-102	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-604	FUTURE I/O
253	DI	ZIC	105	CLOSED	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE CLOSED	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-604	FUTURE I/O
254	DI	YI	105	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE IN-REMOTE	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
255	DI	YA	105	FAULT	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE FAULT	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-604	FUTURE I/O
256	DI	ZIO	105	OPEN	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE OPEN	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
257	DO	ZCO	105	OPEN CMD	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE OPEN CMD	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-604	FUTURE I/O
258	DO	ZCC	105	CLOSE CMD	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE VALVE CLOSE CMD	42-VBF-105	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-604	FUTURE I/O
259	DI	YI	108	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE IN-REMOTE	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
260	DI	ZIC	108	CLOSED	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE CLOSED	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-604	FUTURE I/O
261	DI	YA	108	FAULT	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE FAULT	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-604	FUTURE I/O
262	DI	ZIO	108	OPEN	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE OPEN	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
263	DO	ZCO	108	OPEN CMD	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE OPEN CMD	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-604	FUTURE I/O
264	DO	ZCC	108	CLOSE CMD	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE VALVE CLOSE CMD	42-VBF-108	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-604	FUTURE I/O
265	DI	YI	111	IN-REMOTE	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE IN-REMOTE	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	IN-REMOTE	PLC	N/A	I-42-604	FUTURE I/O
266	DI	ZIC	111	CLOSED	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE CLOSED	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSED	PLC	N/A	I-42-604	FUTURE I/O
267	DI	YA	111	FAULT	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE FAULT	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	FAULT	PLC	N/A	I-42-604	FUTURE I/O
268	DI	ZIO	111	OPEN	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE OPEN	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
269	DO	ZCO	111	OPEN CMD	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE OPEN CMD	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-604	FUTURE I/O
270	DO	ZCC	111	CLOSE CMD	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE VALVE CLOSE CMD	42-VBF-111	42-DCU-100	N/A	N/A	N/A	120VAC	CLOSE CMD	FIELD	YES	I-42-604	FUTURE I/O
271	DI	ZIO	101	OPEN	FUTURE BENTONVILLE PUMP NO. 1 DISCHARGE CHECK VALVE OPEN	42-VCK-101	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
272	DI	ZIO	102	OPEN	FUTURE BENTONVILLE PUMP NO. 2 DISCHARGE CHECK VALVE OPEN	42-VCK-102	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
273	DI	ZIO	103	OPEN	FUTURE BENTONVILLE PUMP NO. 3 DISCHARGE CHECK VALVE OPEN	42-VCK-103	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
274	DI	ZIO	104	OPEN	FUTURE BENTONVILLE PUMP NO. 4 DISCHARGE CHECK VALVE OPEN	42-VCK-104	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN	PLC	N/A	I-42-604	FUTURE I/O
275	AI	PI	300	PRESSURE	SPRINGDALE PUMP STATION SURGE TANK PRESSURE	42-PIT-300	42-DCU-100	4 -20 mA	0-170 psi	2-WIRE	N/A	N/A	N/A	N/A	I-42-605	
276	AI	LI	300	LEVEL	SPRINGDALE PUMP STATION SURGE TANK LEVEL	42-LIT-300	42-DCU-100	4 -20 mA	BY MFR	2-WIRE	N/A	N/A	N/A	N/A	I-42-605	
277	DO	ZCO	301	OPEN CMD	SPRINGDALE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 1 OPEN CMD	42-SV-301	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	
278	DO	ZCO	302	OPEN CMD	SPRINGDALE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 2 OPEN CMD	42-SV-302	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	
279	DO	ZCO	304	OPEN CMD	SPRINGDALE SURGE TANK COMPRESSED AIR HEADER SOLENOID VALVE OPEN CMD	42-SV-304	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	
280	AI	PI	200	PRESSURE	FUTURE ROGERS PUMP STATION SURGE TANK PRESSURE	42-PIT-200	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-605	FUTURE I/O
281	AI	LI	200	LEVEL	FUTURE ROGERS PUMP STATION SURGE TANK LEVEL	42-LIT-200	42-DCU-100	4 -20 mA	BY MFR	2-WIRE	N/A	N/A	N/A	N/A	I-42-605	FUTURE I/O
282	DO	ZCO	201	OPEN CMD	FUTURE ROGERS SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 1 OPEN CMD	42-SV-201	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	FUTURE I/O
283	DO	ZCO	202	CLOSE CMD	FUTURE ROGERS SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 2 OPEN CMD	42-SV-202	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	FUTURE I/O
284	DO	ZCO	204	CLOSE CMD	FUTURE ROGERS SURGE TANK COMPRESSED AIR HEADER SOLENOID VALVE OPEN CMD	42-SV-204	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-605	FUTURE I/O
285	AI	PI	302	PRESSURE	SPRINGDALE PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	42-PIT-302	42-DCU-100	4 -20 mA	0-260 psi	2-WIRE	N/A	N/A	N/A	N/A	I-42-605	
286	AI	PI	202	PRESSURE	FUTURE ROGERS PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	42-PIT-202	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-605	FUTURE I/O

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
287	DI	AAH	102	HIGH H2	PUMP STATION 48VDC BATTERY CABINET NO. 2 HIGH H2 ALARM	42-LCP-102	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH H2	PLC	N/A	I-42-605	
288	DI	YIR	300	RUNNING	SPRINGDALE PUMP STATION AIR COMPRESSOR 1 RUNNING	42-CMB-300	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-605	
289	DI	UA	300	COMMON FAIL	SPRINGDALE PUMP STATION AIR COMPRESSOR 1 COMMON FAIL	42-CMB-300	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-605	
290	DO	UCS	300	STOP CMD	SPRINGDALE PUMP STATION AIR COMPRESSOR 1 STOP CMD	42-CMB-300	42-DCU-100	N/A	N/A	N/A	120VAC	STOP CMD	FIELD	YES	I-42-605	
291	DO	UCS	301	STOP CMD	SPRINGDALE PUMP STATION AIR COMPRESSOR 2 STOP CMD	42-CMB-301	42-DCU-100	N/A	N/A	N/A	120VAC	STOP CMD	FIELD	YES	I-42-605	
292	DI	YIR	301	RUNNING	SPRINGDALE PUMP STATION AIR COMPRESSOR 2 RUNNING	42-CMB-301	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-605	
293	DI	UA	301	COMMON FAIL	SPRINGDALE PUMP STATION AIR COMPRESSOR 2 COMMON FAIL	42-CMB-301	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-605	
294	DI	YIR	200	RUNNING	FUTURE ROGERS PUMP STATION AIR COMPRESSOR RUNNING	42-CMB-200	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-605	FUTURE I/O
295	DI	UA	200	COMMON FAIL	FUTURE ROGERS PUMP STATION AIR COMPRESSOR COMMON FAIL	42-CMB-200	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-605	FUTURE I/O
296	DO	UCS	200	STOP CMD	FUTURE ROGERS PUMP STATION AIR COMPRESSOR STOP CMD	42-CMB-200	42-DCU-100	N/A	N/A	N/A	120VAC	STOP CMD	FIELD	YES	I-42-605	FUTURE I/O
297	DI	YIR	400	RUNNING	FAYETTEVILLE PUMP STATION AIR COMPRESSOR RUNNING	42-CMB-400	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-606	
298	DI	UA	400	COMMON FAIL	FAYETTEVILLE PUMP STATION AIR COMPRESSOR COMMON FAIL	42-CMB-400	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-606	
299	DO	UCS	400	STOP CMD	FAYETTEVILLE PUMP STATION AIR COMPRESSOR STOP CMD	42-CMB-400	42-DCU-100	N/A	N/A	N/A	120VAC	STOP CMD	FIELD	YES	I-42-606	
300	DI	AAH	103	HIGH H2	PUMP STATION 48VDC BATTERY CABINET NO. 3 HIGH H2 ALARM	42-LCP-103	42-DCU-100	N/A	N/A	N/A	120VAC	HIGH H2	PLC	N/A	I-42-606	
301	DI	YIR	100	RUNNING	FUTURE BENTONVILLE PUMP STATION AIR COMPRESSOR RUNNING	42-CMB-100	42-DCU-100	N/A	N/A	N/A	120VAC	RUNNING	PLC	N/A	I-42-606	FUTURE I/O
302	DI	UA	100	COMMON FAIL	FUTURE BENTONVILLE PUMP STATION AIR COMPRESSOR COMMON FAIL	42-CMB-100	42-DCU-100	N/A	N/A	N/A	120VAC	COMMON FAIL	PLC	N/A	I-42-606	FUTURE I/O
303	DO	UCS	100	STOP CMD	FUTURE BENTONVILLE PUMP STATION AIR COMPRESSOR STOP CMD	42-CMB-100	42-DCU-100	N/A	N/A	N/A	120VAC	STOP CMD	FIELD	YES	I-42-606	FUTURE I/O
304	AI	PI	402	PRESSURE	FAYETTEVILLE PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	42-PIT-402	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-606	
305	AI	PI	102	PRESSURE	FUTURE BENTONVILLE PUMP STATION AIR COMPRESSOR DISCHARGE PRESSURE	42-PIT-102	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-606	FUTURE I/O
306	AI	PI	400	PRESSURE	FAYETTEVILLE PUMP STATION SURGE TANK PRESSURE	42-PIT-400	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-606	
307	AI	LI	400	LEVEL	FAYETTEVILLE PUMP STATION SURGE TANK LEVEL	42-LIT-400	42-DCU-100	4 -20 mA	BY MFR	2-WIRE	N/A	N/A	N/A	N/A	I-42-606	
308	DO	ZCO	401	OPEN CMD	FAYETTEVILLE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 1 OPEN CMD	42-SV-401	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	
309	DO	ZCO	402	OPEN CMD	FAYETTEVILLE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 2 OPEN CMD	42-SV-402	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	
310	DO	ZCO	404	OPEN CMD	FAYETTEVILLE SURGE TANK COMPRESSED AIR HEADER SOLENOID VALVE OPEN CMD	42-SV-404	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	
311	AI	PI	100	PRESSURE	FUTURE BENTONVILLE PUMP STATION SURGE TANK PRESSURE	42-PIT-100	42-DCU-100	4 -20 mA		2-WIRE	N/A	N/A	N/A	N/A	I-42-606	FUTURE I/O
312	AI	LI	100	LEVEL	FUTURE BENTONVILLE PUMP STATION SURGE TANK LEVEL	42-LIT-100	42-DCU-100	4 -20 mA	BY MFR	2-WIRE	N/A	N/A	N/A	N/A	I-42-606	FUTURE I/O
313	DO	ZCO	101	OPEN CMD	FUTURE BENTONVILLE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 1 OPEN CMD	42-SV-101	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	FUTURE I/O
314	DO	ZCO	102	OPEN CMD	FUTURE BENTONVILLE SURGE TANK COMPRESSED AIR INLET SOLENOID VALVE 2 OPEN CMD	42-SV-102	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	FUTURE I/O
315	DO	ZCO	104	OPEN CMD	FUTURE BENTONVILLE SURGE TANK COMPRESSED AIR HEADER SOLENOID VALVE OPEN CMD	42-SV-104	42-DCU-100	N/A	N/A	N/A	120VAC	OPEN CMD	FIELD	YES	I-42-606	FUTURE I/O
316	DI	AAH	101	HIGH H2	PUMP STATION 48VDC BATTERY CABINET NO. 1 HIGH H2 ALARM	43-LCP-101	43-RIO-100	N/A	N/A	N/A	120VAC	HIGH H2	PLC	N/A	I-43-601	
317	DI	AAH	104	HIGH H2	PUMP STATION 48VDC BATTERY CABINET NO. 4 HIGH H2 ALARM	43-LCP-104	43-RIO-100	N/A	N/A	N/A	120VAC	HIGH H2	PLC	N/A	I-43-601	
318	AI	PI	101	PRESSURE	NATURAL GAS SUPPLY TO GENERATOR NO. 1 PRESSURE	43-PIT-101	43-RIO-100	4 -20 mA	0-100 psi	2-WIRE	N/A	N/A	N/A	N/A	I-43-601	
319	DI	YA	111	COMMON ALARM	EG1 RADIATOR LCP COMMON ALARM	43-LCP-111	43-RIO-100	N/A	N/A	N/A	120VAC	COMMON ALARM	PLC	N/A	I-43-601	
320	DI	LA	101	LOW LEVEL	EG1 RADIATOR JACKET WATER TANK LEVEL LOW	43-LSL-101	43-RIO-100	N/A	N/A	N/A	120VAC	LOW LEVEL	PLC	N/A	I-43-601	
321	DI	LA	102	LOW LEVEL	EG1 RADIATOR AFTERCOOLER TANK LEVEL LOW	43-LSL-102	43-RIO-100	N/A	N/A	N/A	120VAC	LOW LEVEL	PLC	N/A	I-43-601	
322	DI	YI	101	NORMAL	ELECTRICAL BUILDING AUTOMATIC TRANSFER SWITCH IN NORMAL MODE	43-ATS-1	43-RIO-100	N/A	N/A	N/A	120VAC	NORMAL	PLC	N/A	I-43-601	
323	DI	UA	101	STANDBY	ELECTRICAL BUILDING AUTOMATIC TRANSFER SWITCH IN STANDBY MODE	43-ATS-1	43-RIO-100	N/A	N/A	N/A	120VAC	STANDBY	PLC	N/A	I-43-601	
324	DI	YA	101	TROUBLE	ELECTRICAL BUILDING AUTOMATIC TRANSFER SWITCH IN TROUBLE	43-ATS-1	43-RIO-100	N/A	N/A	N/A	120VAC	TROUBLE	PLC	N/A	I-43-601	
325	AI	JI	113	POWER FACTOR	ENGINE GENERATOR NO. 1 POWER FACTOR	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
326	AI	TI	101	COOL TEMPERATURE	ENGINE GENERATOR NO. 1 COOLENT TEMPERATURE	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
327	AI	EI	101	VOLTAGE	ENGINE GENERATOR NO. 1 VOLTAGE	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
328	AI	JI	111	VOLT AMPS	ENGINE GENERATOR NO. 1 VOLT AMPS	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
329	AI	SI	111	FREQUENCY	ENGINE GENERATOR NO. 1 FREQUENCY	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
330	AI	JI	112	POWER	ENGINE GENERATOR NO. 1 POWER	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
331	AI	SI	112	SPEED	ENGINE GENERATOR NO. 1 SPEED	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
332	AI	PI	101	OIL PRESSURE	ENGINE GENERATOR NO. 1 OIL PRESSURE	43-GEN-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-601	
333	DI	YA	113	FAULT	ENGINE GENERATOR NO. 1 FAULT	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	FAULT	PLC	N/A	I-43-601	
334	DI	YA	111	GENERAL WARNING	ENGINE GENERATOR NO. 1 GENERAL WARNING	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	GENERAL WARNING	PLC	N/A	I-43-601	
335	DI	YI	101	IN REMOTE	ENGINE GENERATOR NO. 1 IN REMOTE	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	N/A	I-43-601	
336	DI	PAL	101	LOW OIL PRESSURE	ENGINE GENERATOR NO. 1 LOW OIL PRESSURE	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	LOW OIL PRESSURE	PLC	N/A	I-43-601	
337	DI	TAH	101	HIGH COOLENT TEMP	ENGINE GENERATOR NO. 1 HIGH COOLENT TEMP	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	HIGH COOLENT TEMP	PLC	N/A	I-43-601	
338	DI	SAH	101	OVER SPEED	ENGINE GENERATOR NO. 1 OVER SPEED	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	OVER SPEED	PLC	N/A	I-43-601	
339	DI	YA	112	OVER CRANK	ENGINE GENERATOR NO. 1 OVER CRANK	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	OVER CRANK	PLC	N/A	I-43-601	
340	DI	YA	114	E-STOP	ENGINE GENERATOR NO. 1 E-STOP	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	E-STOP	PLC	N/A	I-43-601	
341	DI	JAL	101	LOW BATTERY	ENGINE GENERATOR NO. 1 LOW BATTERY	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	LOW BATTERY	PLC	N/A	I-43-601	
342	DI	YIR	101	RUNNING	ENGINE GENERATOR NO. 1 RUNNING	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	N/A	I-43-601	
343	DI	JA	101	BATTERY ALARM	ENGINE GENERATOR NO. 1 BATTERY ALARM	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	BATTERY ALARM	PLC	N/A	I-43-601	
344	DO	UCR	101	RUN COMMAND	ENGINE GENERATOR NO. 1 RUN COMMAND	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	RUN COMMAND	FIELD	YES	I-43-601	
345	DO	UC	111A	ISO MODE	ENGINE GENERATOR NO. 1 ISOLATION MODE	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	ISO MODE	FIELD	YES	I-43-601	
346	DO	UC	111B	DROOP MODE	ENGINE GENERATOR NO. 1 DROOP MODE	43-GEN-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	DROOP MODE	FIELD	YES	I-43-601	
347	AI	PI	102	PRESSURE	NATURAL GAS SUPPLY TO GENERATOR NO. 2 PRESSURE	43-PIT-102	43-RIO-100	4 -20 mA	0-100 psi	2-WIRE	N/A	N/A	N/A	N/A	I-43-602	
348	DI	YA	121	COMMON ALARM	EG2 RADIATOR LCP COMMON ALARM	43-LCP-121	43-RIO-100	N/A	N/A	N/A	120VAC	COMMAN ALARM	PLC	N/A	I-43-602	
349	DI	LA	103	LOW LEVEL	EG2 RADIATOR JACKET WATER TANK LEVEL LOW	43-LSL-103	43-RIO-100	N/A	N/A	N/A	120VAC	LOW LEVEL	PLC	N/A	I-43-602	
350	DI	LA	104	LOW LEVEL	EG2 RADIATOR AFTERCOOLER TANK LEVEL LOW	43-LSL-104	43-RIO-100	N/A	N/A	N/A	120VAC	LOW LEVEL	PLC	N/A	I-43-602	
351	AI	EI	101A	OUTPUT VOLTAGE	ENGINE GENERATOR UPS OUTPUT VOLTAGE	43-UPS-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
352	AI	II	101	OUTPUT CURRENT	ENGINE GENERATOR UPS OUTPUT CURRENT	43-UPS-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
353	AI	EI	101B	BATTERY VOLTAGE	ENGINE GENERATOR UPS BATTERY VOLTAGE	43-UPS-101	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
354	DI	YA	101	FAULT	ENGINE GENERATOR UPS FAULT	43-UPS-101	43-RIO-100	N/A	N/A	N/A	ETHERNET	FAULT	PLC	N/A	I-43-602	
355	AI	JI	123	POWER FACTOR	ENGINE GENERATOR NO. 2 POWER FACTOR	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
356	AI	TI	102	COOL TEMPERATURE	ENGINE GENERATOR NO. 2 COOLENT TEMPERATURE	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
357	AI	EI	102	VOLTAGE	ENGINE GENERATOR NO. 2 VOLTAGE	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
358	AI	JI	121	VOLT AMPS	ENGINE GENERATOR NO. 2 VOLT AMPS	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
359	AI	SI	121	FREQUENCY	ENGINE GENERATOR NO. 2 FREQUENCY	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
360	AI	JI	122	POWER	ENGINE GENERATOR NO. 2 POWER	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
361	AI	SI	122	SPEED	ENGINE GENERATOR NO. 2 SPEED	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
362	AI	PI	102	OIL PRESSURE	ENGINE GENERATOR NO. 2 OIL PRESSURE	43-GEN-102	43-RIO-100	ETHERNET		N/A	N/A	N/A	N/A	N/A	I-43-602	
363	DI	YA	123	FAULT	ENGINE GENERATOR NO. 2 FAULT	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	FAULT	PLC	N/A	I-43-602	

Item	IO Type	Type	Loop Number	IO Description	Service Description	Field Device	Controller_ID	Analog Signal Type	Analog Signal Range	Analog Power Type	Digital Signal Type	Digital Close State	Digital_Power_ Source	Digital_Interp_ Relay	DWG Number	Remarks
364	DI	YA	121	GENERAL WARNING	ENGINE GENERATOR NO. 2 GENERAL WARNING	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	GENERAL WARNING	PLC	N/A	I-43-602	
365	DI	YI	102	IN REMOTE	ENGINE GENERATOR NO. 2 IN REMOTE	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	IN REMOTE	PLC	N/A	I-43-602	
366	DI	PAL	102	LOW OIL PRESSURE	ENGINE GENERATOR NO. 2 LOW OIL PRESSURE	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	LOW OIL PRESSURE	PLC	N/A	I-43-602	
367	DI	TAH	102	HIGH COOLENT TEMP	ENGINE GENERATOR NO. 2 HIGH COOLENT TEMP	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	HIGH COOLENT TEMP	PLC	N/A	I-43-602	
368	DI	SAH	102	OVER SPEED	ENGINE GENERATOR NO. 2 OVER SPEED	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	OVER SPEED	PLC	N/A	I-43-602	
369	DI	YA	122	OVER CRANK	ENGINE GENERATOR NO. 2 OVER CRANK	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	OVER CRANK	PLC	N/A	I-43-602	
370	DI	YA	124	E-STOP	ENGINE GENERATOR NO. 2 E-STOP	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	E-STOP	PLC	N/A	I-43-602	
371	DI	JAL	102	LOW BATTERY	ENGINE GENERATOR NO. 2 LOW BATTERY	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	LOW BATTERY	PLC	N/A	I-43-602	
372	DI	YIR	102	RUNNING	ENGINE GENERATOR NO. 2 RUNNING	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	RUNNING	PLC	N/A	I-43-602	
373	DI	JA	102	BATTERY ALARM	ENGINE GENERATOR NO. 2 BATTERY ALARM	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	BATTERY ALARM	PLC	N/A	I-43-602	
374	DO	UCR	102	RUN COMMAND	ENGINE GENERATOR NO. 2 RUN COMMAND	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	RUN COMMAND	FIELD	YES	I-43-602	
375	DO	UC	121A	ISO MODE	ENGINE GENERATOR NO. 2 ISOLATION MODE	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	ISO MODE	FIELD	YES	I-43-602	
376	DO	UC	121B	DROOP MODE	ENGINE GENERATOR NO. 2 DROOP MODE	43-GEN-102	43-RIO-100	N/A	N/A	N/A	ETHERNET	DROOP MODE	FIELD	YES	I-43-602	

SECTION 13561 - PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The Panel Mounted Instruments section covers the furnishing of all panel mounted instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

B. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. For "smart" devices, calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

C. Panel mounted instruments for each filter in a water plant, shall be supplied with power from a common source.

1.3 SUBMITTALS

A. See Section Instrumentation and Control System section.

1. Submittals shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs describe minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Programming Device

1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training stipulations. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

C. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a laptop computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device need not be furnished.

2.2 PANEL FRONT MOUNTED DEVICES.

A. Switches, Lights, and Push Buttons.

1. Selector Switches

a. Selector switches shall be 30.5-mm, heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 V ac. Contact configuration shall be as indicated on the Drawings or for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Switches shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2. Indicating Lights

a. Indicating lights shall be 30.5-mm, heavy-duty, oil-tight type, with full voltage LED lamps. Legends shall be engraved on the lens or on a legend faceplate. Lights shall be push-to-test type. Indicating lights shall be Eaton/Cutler Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

3. Push Buttons

a. Push buttons shall be 30.5-mm, heavy-duty, oil-tight type. Legends shall be engraved on the push-button faceplate. Contacts shall be rated 10 amperes continuous at 120 V ac. Push buttons shall be Eaton/Cutler-Hammer "10250T", General Electric "CR104P", or Allen Bradley “800T”.

2.3 PANEL INTERIOR MOUNTED DEVICES

A. Power Supplies

1. Regulated dc power supplies for instrument loops shall be designed and arranged so that loss of one supply does not affect more than one instrument loop or system. Power supplies shall be suitable for an input voltage variation of ±10 percent, and the supply output shall be fused or shortcircuit protected. Output voltage regulation shall be by the instrumentation equipment supplied. Multiloop or multisystem power supplies will be acceptable if backup power supply units are provided which will automatically supply the load upon failure of the primary supply. The backup supply systems shall be designed so either the primary or the backup supply can be removed, repaired, and returned to service without disrupting the instrument system operation. Multiloop power supply connections shall be individually fused so a fault in one instrument loop will be isolated from the other loops being fed from the same supply. Fuses shall be clearly labeled and shall be located for easy access. Multiloop supply systems shall be oversized for an additional 10 percent future load. Failure of a multiloop supply shall be indicated on the respective instrument panel or enclosure.

2. Power supplies shall be Allen Bradley, Phoenix Contact, PULS, or equal.

B. Relays

1. Relays indicated to be provided in panels, enclosures, or systems furnished under this section shall be of the plug-in socket base type with dustproof plastic enclosures unless noted otherwise. Relays shall be UL recognized and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver cadmium oxide contacts rated 10 amperes at 120 V ac. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low-level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated at least 3 amperes. Time delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of ±2 percent of setting. Latching and special purpose relays shall be for the specific application. Unless otherwise indicated, all relays shall have an integral pilot light that illuminates to indicate an energized condition. Relays shall be IDEC "Series RR"; Potter & Brumfield "Series KRP, CB"; or Struthers-Dunn "Series 219, 246".

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 13562 - FLOW INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. The Flow Instrument Section covers the furnishing of flow instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

D. Where possible, each instrument shall be factory wet flow calibrated to the full scale flow range of the sensors or calibration ranges indicated on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration and configuration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or Instrument Device Schedule.

1.3 SUBMITTALS

A. See Section Instrumentation and Control System section.

1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device requirements. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated on the Drawings or in the Instrument Device Schedule. The interconnecting cable shall be provided in the length necessary for installation. Splices shall not be allowed in the installed cable.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. As a minimum, an appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under the Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 FLOW INSTRUMENTATION.

A. Magnetic Flow Meters, Signal Converters, and Accessories.

1. Magnetic Flow Meter

a. The magnetic flow meter shall be a completely obstructionless, in-line flow meter with no constrictions in the flow of fluid through the meter. The meter shall consist of a metallic tube with flanged ends and with grounding rings or grounding electrodes as required by the application. Flange diameter and bolt drilling pattern shall comply with ANSI/ASME B16.5 for line sizes from 0.5 inches to 24 inches or AWWA C207 for line sizes larger than 24 inches. Flange class ratings and meter maximum pressure ratings shall be compatible with the adjoining piping. Flangeless wafer insert style meters may be used for pipe sizes up to 6 inches, where compatible with adjacent piping flanges. Self-cleaning electrodes shall be provided for all meters used for sludge metering. Electrode and liner materials shall be fully compatible with the process fluid as approved by the Engineer and shall comply with the requirements specified in the instrument device schedules. Each meter shall be factory wet flow calibrated to the sensors full flow capacity, at a facility, which is traceable to NIST or other standard acceptable to Engineer, and a copy of the calibration, report shall be submitted as part of the operation and maintenance manual submittal.

b. The meter shall be capable of standing empty for extended periods of time without damage to any components.

c. The meter housing shall be of a splash-proof and drip-proof design, unless indicated on the Drawings or in the Instrument Device Schedule to be submersible. Where required to be submersible, the meter housing shall withstand submergence in 30 feet of water for 48 hours without damage.

d. Meters shall be Endress+Hauser L400, without exception.

2. Magnetic Flow Meter Signal Converters

a. Separately mounted, microprocessor-based signal converters shall be provided for the magnetic flow meters. The signal converters shall include output damping, self-testing, built-in calibration capability, and an "empty pipe zero" contact input. The overall accuracy of the magnetic flow meter transmitter and signal converter shall be ±0.5 percent of actual flow rate for full-scale settings of 3 to 30 fps. The meter manufacturer shall furnish the signal cable between the converter and the magnetic flow meter. Signal cable shall be continuous and not spliced between the meter and the signal converter. The signal converter shall be housed in a corrosion-resistant, weatherproof NEMA Type 4X housing and shall be suitable for operation over an ambient temperature range of -30 to +140°F (, and relative humidity of 10 to 100 percent. The converter shall have an analog output of 4-20 mA dc. Transmitters tagged on the Drawings or specified to be of the indicating type shall contain a local indicator with a minimum four digit LCD type display, scaled to read in engineering units of flow.

b. Magnetic flow meter systems shall provide zero flow stability by means of automatic zero adjustment of a DC excited metering circuit. Converters shall be capable of bi-directional flow measurement. Signal converters shall be of the same brand as the magnetic flow meters.

c. Where indicated on the Drawings or in the Instrument Device Schedule, the signal converter shall have a non-reset seven-digit totalizer on the face of the enclosure.

d. The signal converter shall be diagnosed and recalibrated with the use of a hand-held communicator/calibrator device. One device shall be furnished for all converters provided by a single manufacturer.

B. Liquid Service Rotameters

1. Rotameters shall be all metal variable area type utilizing an integral orifice plate and conical float. Float position shall be directly visible through a sealed glass or plexiglass viewing window. Flow scale shall be engraved on the viewing window. Flow meter components shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, flow meter wetted components shall be AISI Type 316 stainless steel. Float viewing window materials shall be compatible with the measured process, as indicated in the Instrument Data Sheets. Flow meter connections shall be 150-lb ANSI flanges.

2. Where indicated in the Instrument Data Sheets or Instrument Device Schedule, flow meters shall be provided with an adjustable, magnetic actuated switch. The switch shall actuate at the flow value listed in the Instrument Data Sheet. Switches shall be rated 5A at 120 volts ac.

3. Each rotameter shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Instrument Data Sheet or Instrument Device Schedule.

4. Mounting and installation hardware shall be AISI Type 316L stainless steel. Liquid service rotameters shall be ABB or equal.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

SECTION 13563 - PRESSURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of pressure instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or in the Instrument Device Schedule.

D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings and/or Instrument Device Schedule.

1.3 SUBMITTALS

A. See Instrumentation and Control System section.

1. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Drawings or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings or Instrument Device Schedule.

C. Programming Device

1. For systems that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section.) The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PRESSURE INSTRUMENTATION.

A. Pressure Transmitters

1. Transmitters shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. Process fluid shall be isolated from the sensing elements by AISI Type 316 stainless steel, Hastelloy-C, ceramic, or cobalt-chromium-nickel alloy diaphragms, and the transducer may use a silicone oil fluid fill. Transmitters shall have self-diagnostics and electronically adjustable span, zero, and damping. Transmitters shall be enclosed in a NEMA Type 4X housing and shall be suitable for operation at temperatures from 0° to 180°F (, and relative humidity of 5 to 100 percent. All parts shall be cadmium-plated carbon steel, stainless steel, or other corrosion-resistant materials. Transmitters shall have over-range protection to maximum line pressure. Accuracy of the transmitter shall be 0.075 percent of span, and transmitter output shall be 4-20 mA dc without the need for external load adjustment. Transmitters shall not be damaged by reverse polarity. Transmitters shall have an elevated or suppressed zero . For calibrated spans of less than 8 psig a differential pressure type transmitter with side vents shall be utilized. Transmitters shall be provided with brackets for wall and pipe-stand mounting.

2. Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

3. Transmitters tagged on the Drawings or specified to be indicating type shall be furnished with LCD type digital indicators.

4. Transmitters will have a turndown ratio of 30:1, or more.

5. Transmitters shall be Vega “Vegabar 38” without exception.

B. Field-Mount Pressure Gauges

1. Pressure gauges shall be of the indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

2. Gauge dials shall be 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

3. Surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where indicated in the Drawings or on the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

4. All pressure gauges shall measure in psi and all vacuum gauges in inches water. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 0.5 percent of scale range.

5. Each gauge shall be provided with a threaded end, ball-type gauge valve. Gauge valve materials shall be compatible with the measured process. Where the process is not defined, gauge valves shall have AISI Type 316 stainless steel wetted parts and Teflon seals. Multi-port gauge valves shall have all unused ports plugged. Gauge valve construction shall be as detailed in the Miscellaneous Instruments section.

6. Where indicated on the Drawings or the Instrument Device Schedule, the pressure gauge shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the gauge served. Snubbers shall be Ashcroft "Pulsation Dampers", or approved equal.

7. Where indicated on the Drawings or in the Instrument Device Schedule, a diaphragm seal shall be provided for the respective gauge. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the gauge with the system under pressure. The lower housing shall be provided with a tapped and plugged 1/4 inch NPT flushing connection. Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.

8. Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation details. All gauges, snubbers, and diaphragm seals shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation of the gauge or diaphragm seal.

9. Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or the Instrument Device Schedule.

10. Unless otherwise indicated, mounting and installation hardware shall be Type 316L stainless steel.

11. Pressure gauges shall be Ashcroft "1279 Duragauge", or equal.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 13564 - PROCESS ANALYTICAL INSTRUMENTS

PART 1 - GENERAL.

1.1 SCOPE

A. This section covers the furnishing of all process liquid and gas analytical instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple instruments of a particular type are specified, and each requires different features, the required features are described on the Drawings or the Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by Contractor.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

D. Where possible, each instrument shall be factory calibrated to the calibration ranges on the Drawings or in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Drawings or in the Instrument Device Schedule.

1.3 SUBMITTALS

A. See Section Instrumentation and Control System section. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in as specified in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Drawings and/or Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For instruments where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Drawings.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 PROCESS LIQUID ANALYTICAL INSTRUMENTATION

A. Low Range Turbidity Analyzers

1. Analyzers shall operate with a continuous flow of sample through the sample cell to drain. A Class 1 650 nm laser light source shall be passed through the sample and the amount of light scattered by the turbidity particles shall be measured. The analyzer shall utilize an US EPA approved method of turbidity analysis.

2. Sample flow rate shall be approximately 0.2 gpm. The sample cell shall be constructed of all corrosion-resistant materials and shall have an integral bubble trap. Accessories shall be provided to allow for a field calibration check of the analyzer. The secondary calibration standard shall be an optical glass calibration cube that has a known NTU value. One secondary calibration device shall be provided for each four analyzers. A one-year supply of consumables, including a primary standard formazin calibration kit, shall be provided with each analyzer.

3. The analyzer shall have a master indicator mounted near the sample cell and connected to the sample cell with a special cable. The unit shall have an auto-ranging three or four-digit display that indicates turbidity within a range of 0.001 to 100 nephelometric turbidity units (NTU). The master indicator shall be housed in a NEMA Type 12 moisture-resistant enclosure and shall be of the ac-powered type.

4. The master indicator shall have a linear 4-20 mA dc output signal that corresponds to a pre-selected turbidity range (typically 0 to 1 NTU). Where indicated on the Drawings or in the Instrument Device Schedule, the unit shall have two alarm output relays for high-low turbidity or other pre-selected alarms. Each turbidity sensor shall be provided with an automatic cleaning module.

5. Turbidity analyzers shall be Lovibond “PTV 1000” without exception.

B. pH and ORP Analyzers

1. The pH or ORP sensor and analyzer/transmitter shall be products of the same manufacturer. The cable between the sensor and the transmitter shall be provided by the manufacturer. The sensor shall consist of a Kynar, PVC, polypropylene, or other chemical-resistant electrode housing containing a glass pH electrode and a fouling-resistant reference electrode, or gold/platinum ORP electrodes. The pH reference electrode shall be self-contained and shall not require an external electrolyte reservoir. The sensor shall have automatic temperature compensation, and shall be the flow-through type.

2. Flow-through type sensors, shall have 3/4 or 1 inch NPT process connections and shall be suitable for a working pressure of 1 to 100 psig at 140°F (, with a sample flow rate of 0.5 gpm (.

3. Each pH sensor assembly shall be provided with a maintenance kit that shall include a spare pH electrode, a spare reference electrode, and other spare parts as recommended by the manufacturer.

4. The transmitter shall be enclosed in a cast aluminum or fiberglass reinforced plastic NEMA Type 4 housing. The transmitter shall be microprocessor based, with integral diagnostics, and with non-volatile memory. The transmitter shall be suitable for ambient temperatures of -22 to 140°F and a relative humidity of 0 to 100 percent. The transmitter shall have an isolated 4-20 mA dc output linearly proportional to the measured range, with an accuracy of ± 0.2 percent of scale. The transmitter shall have a 32 character alphanumeric multiline LCD display that is menu driven. Transmitter range shall be as indicated. The transmitter shall have automatic temperature compensation over a range of 32 to 122°F (. The transmitter shall be of the ac-powered type. The transmitter shall be supplied with an appropriate length of signal cable for connecting the transmitter to the sensor.

5. The pH analyzer shall be Endress Hauser "Liquiline M CM42" without exception.

C. Chlorine Residual Analyzers

1. Chlorine residual analyzers shall be the colorimetric type and shall be provided with all required appurtenances shall be provided. For each type of analyzer supplied, a chlorine analyzer cleaning kit shall be provided. A one year supply of all consumables shall be provided along with the cleaning kit. Chlorine analyzers shall measure the free chlorine residual in a continuous flow sample as indicated on the Drawings or in the Instrument Device Schedule.

2. Colorimetric Chlorine Residual Analyzers

   a. Colorimetric chlorine residual analyzers shall be furnished to measure the free chlorine residual in a continuous flow sample.
   b. The analyzers shall be of the colorimeterc type for operation over a range of 0 to 5 mg/L of chlorine. The assembly shall consist of a sample chamber where the sample and reagents shall be thoroughly mixed with a self-cleaning stir bar. Each analyzer shall use reagents to color the sample. Light shall then be passed though the sample and a detector will measure its intensity to obtain a residual reading. Each analyzer shall be factory calibrated for accurate measurements.
   c. Each analyzer shall operate with the following conditions:

Chlorine range, mg/L of chlorine	0 to 5
Analyzer accuracy	±5% or 0.035 mg/L of chlorine, whichever is greater
Minimum required detection limit, mg/L chlorine	0.035
Sample water flow, gph	3.1 to 8.0
Sample water pressure, psig	1 to 5

   d. Each analyzer shall complete a sample analysis every 2 minutes and 30 seconds. The use of chemical indicator and buffer shall not exceed 475 milliliters each over 30 days.
   e. Each analyzer shall be furnished with the following accessories:

1) Sample conditioning kit.

2) Instrument factory calibrated 0 to 5 mg/L chlorine.

3) A 30 day supply of chemicals and expendable materials.

4) Drain and overflow hose to bell-up.

f. Each sample conditioning kit shall be installed upstream of the analyzer and shall be able to accommodate pressures up to 70 psi. Each kit shall include the required valves, filter, fittings, and tubing required for proper analyzer operating conditions.

g. Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

h. The analyzer shall be installed in an enclosure for wall mounting. The analyzer dimensions shall not exceed 17 inches tall by 13 inches wide by 7 inches deep.

i. One colorimetric verification kit for measuring total or free residual shall be furnished for calibration of the chlorine residual analyzers. The verification kit shall be complete with 3 – way valve, bottle cap, pressurization apparatus, calibration standards set, instruction book, chemicals, and other items required for proper operation.

j. The analyzer shall be Chemtrac "Hydro ACT" without exception.

D. Fluoride Analyzers

a. Fluoride analyzers shall be furnished to measure the fluoride in a continuous flow sample.

b. Each analyzer shall operate with the following conditions:

Fluoride range, mg/L of fluoride	0.1 to 10.0
Analyzer accuracy	±10% or 0.10 mg/L of fluoride, whichever is greater
Minimum required detection limit, mg/L fluoride	0.1
Sample water flow, mL/min	200
Sample water pressure, psig	1 to 10
Air purge	0.1 cfm at 20 psig

c. Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer

system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

d. Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

e. The analyzer shall be Prominent "D1C" with DLG IV and PT 1000SE without exception.

E. Chlorine Dioxide Analyzers

a. Chlorine dioxide amperometric analyzers shall be furnished to measure the chlorine dioxide in a continuous flow sample.

b. Each analyzer shall operate with the following conditions:

Chlorine Dioxide range, mg/L of chlorine dioxide	0.01 to 2
Analyzer accuracy	±5% or ±10 ppb of chlorine dioxide, whichever is greater
Minimum required detection limit, mg/L chlorine dioxide	0.035
Sample water flow, mL/min	200 - 250
Sample water pressure, psig	1.45 to 29

c. Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

d. Each analyzer instrument shall include a transmitter having a programmable 4-20 mA dc signal output. The analyzer shall be equipped with two selectable alarms. The choices of alarms shall include high/low sample concentration, analyzer system warning to indicate a not-critical instrument malfunction, and analyzer system alarm to sound during analyzer failure. The analyzer shall operate using a 115 VAC, 60 Hz power supply.

e. The analyzer shall be Hach "9187 sc Chlorine Dioxide Sensor" and Hach "sc1000 Controller".

PART 3 - EXECUTION

3.1 Field Services

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 13565 - TEMPERATURE INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of all temperature instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the drawings or the Instrument Device Schedule.

C. When multiple temperature instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1.3 SUBMITTALS

A. See Section 13500 – Instrumentation and Control System. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 TEMPERATURE INSTRUMENTS

A. Resistance Temperature Transmitters

1. Each transmitter shall be an all solid state electronic two-wire device that does not require a direct power connection to the transmitter. The transmitter shall be designed for a resistance temperature detector input and shall have a 4-20 mA dc output or shall have a Foundation Fieldbus output where indicated on the instrument device schedule.

2. The transmitter shall be of the sensor lead wire compensated type with linearized output to provide an accuracy of ± 0.2 percent of temperature span. The transmitter shall be housed in a weatherproof enclosure designed for mounting directly on or near the thermowell. Shielded lead wire shall be provided as needed between the transmitter and the temperature detector. Each transmitter shall be coordinated with the sensor and thermowell. Transmitters shall be manufactured by Foxboro "RTT20/25", ABB Model TTH300, or Rosemount "644/3144".

3. Transmitters shall be factory calibrated to the required range and provided with the manufacturer's standard hand-held communications/calibration device. One device shall be furnished for all transmitters provided by a single manufacturer.

4. Transmitters tagged on the Drawings or specified to be the indicating type shall be furnished with LCD type digital indicators.

B. Temperature Switches

1. Temperature switches shall be ambient compensated, filled type, with integral sensor and thermowell. Switches shall be field adjustable type, with trip point repeatability better than 1 percent of actual temperature. Switches shall be housed in EEMAC Type 4 enclosures. Switch wetted parts shall be compatible with the process fluid. Where the process fluid is not defined, the switch shall be provided with an AISI Type 316 stainless steel sensing element and an AISI Type 316 stainless steel thermowell.

2. All temperature switches shall be ranged in degrees Fahrenheit. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum, switches shall be SPDT, rated 10 amp at 120 V ac.

3. Each switch shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel. The approximate process insertion length of the thermowell shall be as indicated on the Drawings or in the Instrument Device Schedule.

4. Switches shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All switches shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at switch locations prior to installation.

5. Each switch shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Drawings or Instrument Device Schedule.

6. Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

7. Temperature switches shall be Ashcroft, or equal.

C. Temperature Gauges

1. Temperature gauges shall be of the indicating dial type, with a stainless steel bimetal thermometer and a stainless steel thermowell; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

2. Gauge dial shall be minimum 4-1/2 inch size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard. Pointer travel shall be not less than 200 degrees or more than 270 degrees of arc.

3. Panel-mounted and surface-mounted gauges shall be provided with 1/4 inch NPT connections. All stem-mounted gauges shall be provided with 1/2 inch NPT connections. Where indicated on the Drawings or the Instrument Device Schedule, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.

4. All temperature gauges shall measure in degrees Fahrenheit. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 1 percent of scale range.

5. Each gauge shall be provided with a thermowell. Unless otherwise indicated in the Drawings or Instrument Device Schedule, thermowells shall be weld mount style. Thermowell materials shall be compatible with the process fluid. Where the process fluid is not defined, thermowells shall be AISI Type 316 stainless steel.

6. Gauges shall be installed at the locations indicated on the Drawings, with installation conforming to the installation standards. All gauges shall be installed in the vertical, upright position. Thread sealer, suitable for use with the associated process, shall be used in the assembly of threaded connections. All connections shall be free from leaks. Lines shall be purged of trapped air at gauge locations prior to installation.

7. Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated on the Drawings or the Instrument Device Schedule.

8. Unless otherwise indicated, mounting and installation hardware shall be AISI Type 316L stainless steel.

9. Temperature gauges shall be Ashcroft “EL Series, Code 60”, or equal.

PART 3 - EXECUTION

A. FIELD SERVICES

1. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

2. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 13566 - MISCELLANEOUS INSTRUMENTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of all miscellaneous instruments and accessories required for the Instrumentation and Control System as specified herein or as indicated on the Drawings.

B. Equipment and services provided under this section shall be subject to the Instrumentation and Control System section. This section shall be used and referenced only in conjunction with the Instrumentation and Control System section. Supplementing the Instrumentation and Control System section, instrument data, special requirements, and options are indicated on the Drawings or the Instrument Device Schedule.

C. When multiple miscellaneous instruments of a particular type are indicated, and each requires different selectable features, the required features are described on the Drawings or in Instrument Device Schedule.

1.2 DESIGN CRITERIA

A. Each device shall be a pre-assembled, packaged unit. Upon delivery to the work site, each device or system shall be ready for installation with only minor piping and electrical connections required by System Supplier.

B. Primary elements shall derive any required power from the transmitter, unless otherwise indicated.

C. The instruments shall be installed to measure, monitor, or display the specified process at the ranges and service conditions indicated on the Drawings or as indicated in the Instrument Device Schedule. The instruments shall be installed at the locations indicated on the Drawings or the Instrument Device Schedule.

D. Where possible, each instrument shall be factory calibrated to the calibration ranges indicated in the Instrument Device Schedule. Transmitters or similar measurement instruments shall be calibrated using National Institute of Standards and Technology (NIST) approved bench calibration procedures, when such procedures exist for the instrument type. Calibration data shall be stored digitally in each device, including the instrument tag designation indicated on the Instrument Device Schedule.

1.3 SUBMITTALS

A. See Instrumentation and Control System section. Submittals shall be as specified in the Instrumentation and Control System section.

1.4 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum device stipulations. The Instrument Device Schedule shall be used to determine any additional instrument options, requirements, or service conditions.

B. Interconnecting Cable

1. For systems where the primary element and transmitter are physically separated, interconnecting cable from the element to the transmitter shall be provided. The cable shall be the type approved by the instrument manufacturer for the intended purpose of interfacing the element to the transmitter. Length of cable shall be a minimum of three meters or as indicated in the Instrument Device Schedule.

C. Programming Device

1. For instruments that require a dedicated programming device for calibration, maintenance, or troubleshooting, one such programming device shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). The programming device shall include appropriate operation manuals and shall be included in the training requirements. For systems that allow the programming device functions to be implemented in software, running on a laptop computer, the software shall be provided instead of the programming device.

D. Configuration Software/Serial Interface

1. Devices indicated as requiring a serial interface shall be provided with all accessories required to properly communicate over the serial link. An appropriate cable shall be provided to allow the transmitter serial interface to be connected to a personal computer. One licensed copy of the diagnostic/interface software shall be provided for each Owner facility (quantity required shall be as indicated in the Instrumentation and Control System section). Software shall be capable of running under Microsoft's Windows 10 operating system. If the software furnished performs the same functions as the programming device, specified elsewhere, then the programming device shall not be furnished.

2.2 MISCELLANEOUS INSTRUMENTS

A. Instrument Shutoff Valves

1. Instrument shutoff valves shall be provided for instruments as indicated on the Drawings and as detailed in the specifications. The indicated shutoff valves shall be provided by System Supplier for all instruments furnished under the Panel Mounted Instruments section, Flow Instruments section, Pressure and Level Instruments section, Analytical Instruments section, and the Miscellaneous Instruments section. Shutoff valves shall be compatible with the measured process and shall be selected in accordance with the manufacturer's recommendations for the specified process. Unused ports of multi-port gauge valves shall be plugged. An instrument shutoff valve schedule shall be submitted indicating the quantity, material, size, and associated instrument. Permanent tagging of the instrument valves is not required. However, temporary hand-written tags or other means of identification shall be provided to ensure that the appropriate valve is installed for a given instrument.

2. Instrument shutoff valves shall be D/A Manufacturing, Anderson-Greenwood, or equal.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Manufacturer's field services shall be provided for installation, field calibration, startup, and training as specified in the Instrumentation and Control System section.

B. Instruments shall not be shipped to the Work Site until two weeks prior to the scheduled installation. The System Supplier shall be responsible for coordinating the installation schedule with the Installation Contractor. Each shipment shall contain a listing of protective measures required to maintain sensor operation, including a listing of any common construction or cleaning chemicals that may affect instrument operation.

End of Section

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SECTION 13570 - PANELS, CONSOLES, AND APPURTENANCES

PART 1 - GENERAL

1.1 SCOPE

A. The Panels, Consoles and Appurtenances section covers the furnishing of panels, consoles, and appurtenances as indicated on the Drawings and listed in the attached Equipment Schedules 13570-S01, 13570-S02, and 13570-S03.

B. This section also describes requirements for panels furnished under other sections whose respective specification refers to this section. Panels furnished under other sections are not listed in the attached Equipment Schedules.

C. Control System

1. The Instrumentation and Control System section shall apply to all equipment furnished under the Panels, Consoles and Appurtenances section.

1.2 GENERAL

1. Equipment furnished and installed under this section shall be fabricated and assembled in full conformity with the Drawings, specifications, equipment schedules, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Drawings

1. General dimensions and arrangements are indicated on the Drawings and on the attached equipment schedules. System Supplier shall be responsible for coordinating the console and enclosure sizes and arrangements to accommodate the equipment provided.

1.3 SUBMITTALS

A. See Section 13500 – Instrumentation and Control System

1. Submittals shall be as specified in the Instrumentation and Control System section.

B. Meterolical and Seismic Compliance

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 DELIVERY, STORAGE, AND SHIPPING

A. Delivery, storage and shipping shall be as per The Instrumentation and Control System section.

PART 2 - PRODUCTS.

2.1 PANEL DESIGN AND FABRICATION FEATURES

A. All panels furnished shall conform to the stipulations of NEMA ICS-6-1993 (R2001, R2006). Unless indicated otherwise on the Drawings, the following paragraphs describe general fabrication specifications for the PLC cabinets, instrument panels, consoles, enclosures, and subpanels.

B. Piping

1. Pneumatic tubing shall be 1/4-inch OD, soft annealed copper with compression fittings. Tubing and fittings shall be as specified in the Miscellaneous Piping section.

2. Fittings

a. Compression type bulkhead fittings shall be provided near the bottom or the top of the panel for all field connections. Compression nuts and sleeves shall be provided for the field connections. Indicators, recorders, controllers, and other pneumatic devices shall be provided with plugged test connections and shutoff valves for isolation.

3. Valves

a. All devices shall have separate air supply shutoff valves. Valves and compression fittings shall be as manufactured by Nupro, Parker Hannifin, Swagelock, Tylok, or Whitey.

C. Power Entrance

1. The power entrance to each panel shall be provided with a surge protection device. Refer to the Instrumentation and Controls section for surge suppression requirements.

D. Power Wiring

1. Power distribution wiring on the line side of panel fuses shall be minimum 12 AWG. Secondary power distribution wiring shall be minimum 14 AWG. Wiring for ac power

distribution, dc power distribution, intrinsically safe, and control circuits shall have different colors and shall agree with the color-coding legend on System Supplier's panel wiring diagrams. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded copper, insulated for not less than 600 volts, with a moisture resistant and flame retardant covering rated for not less than 90°C.

E. Instrument and Control Wiring

1. All internal panel wiring shall be type MTW stranded copper wiring rated not less than 600 volts. Electronic analog circuits shall be twisted and shielded pairs rated not less than 300 volts. Analog circuits shall be separated from ac power circuits. Intrinsically safe circuits shall be physically separated from other circuits in accordance with applicable codes. Wires within the panel shall conform to the minimum size as shown in the table below.

Type	Minimum Wire Size	Color
AC Control	16 AWG	Red
DC Control	16 AWG	Blue
Analog Circuits	18 AWG Twisted Pair	Yellow

2. All wiring shall be grouped or cabled and firmly supported inside the panel. Each individual wire in power, control, and instrumentation circuits shall be provided with identification markers at each point of termination. The wire markers shall be positioned to be readily visible for inspection and the identification numbers shall match the identification on the supplier's panel wiring drawings. Wiring shall be bundled in groups and bound with nylon cable ties or routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel, with removable covers, and with space equal to at least 40 percent of the depth of the duct remaining available for future use after completion of installation and field wiring. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

F. Terminal Blocks

1. Terminal blocks for external connections shall be suitable for 12 AWG wire and shall be rated 30 amperes at not less than 300 volts. Terminal blocks shall be fabricated complete with marking strip, covers, and pressure connectors. Terminals shall be labeled to agree with identification shown on the supplier's submittal drawings. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. Not less than 8 inches of clearance shall be provided between the terminal strips and the base of vertical panels for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Each control loop or system shall be individually fused, and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

G. Backup Power

1. Power supply to the panels shall be from electrical sources shown on the Drawings, which may be backed by redundant utility feeds, engine generators, or externally mounted uninterruptible power supplies (UPSs) specified in other sections.

2. Where indicated in the attached equipment schedules, on the Drawings or in the referring equipment specifications, free-standing vertical panels and wall cabinets shall each be provided with an interior-mounted UPS to provide backup power to critical loads upon loss of power supply to the panel. UPS-backed power shall be provided to the programmable logic controller CPU, instrument loops, I/O modules (operating and wetting voltages), all network communications devices, and any other load essential to preventing loss of control system function. Backup power for panel interior lights, heaters, and convenience receptacles is not required. UPSs for free-standing vertical panels and wall cabinets shall meet the requirements specified below. Where required within the respective enclosure specification or shown on the Drawings, Freestanding EIA 19-Inch Rack Enclosures and Data Server Enclosures shall each be furnished with an interior, rack-mounted UPS. UPSs for rack-type enclosures shall meet the requirements specified below.

H. Device Tag Numbering System

1. All devices shall be provided with permanent identification tags. The tag numbers shall agree with the Instrument Device Schedule and with the supplier's equipment drawings. All field-mounted transmitters and devices shall have stamped stainless steel identification tags. Panel, subpanel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device. Hand-lettered labels or tape labels will not be permitted.

a. Nameplates

1) Nameplates shall be provided on the face of the panel or on the individual device. Panel nameplates shall have legends and approximate dimensions as indicated on the Drawings and shall be made of laminated phenolic material having engraved letters approximately 3/16 inch high extending through the black face into the white layer. Nameplates shall be secured firmly to the panel. Panel face nameplates do not replace the requirement for device identification tags as specified under the Device Tag Numbering System paragraph.

b. Indicating Light Color Designations

1) Indicating lights are specified in the Panel Mounted Instruments section. Indicating lights shall be colored as shown in the following table unless indicated otherwise on the Drawings, in other specification sections, or in the instrument device schedule.

Color	Meaning
Red	Associated equipment or device is "running," "open," or is in an "unsafe" state or position
Green	Associated equipment or device is "stopped," "closed," or is in a "safe" state or position
Yellow or Amber	Associated equipment or device has "failed" or a process alarm condition is present or imminent.
White	All other conditions not defined above.

c. Painting

1) Interior and exterior surfaces of all carbon-steel panels shall be thoroughly cleaned and painted with rust inhibitive (universal) primer. The panel interior shall be painted white with the manufacturer's standard coating. All pits and blemishes in the exterior surface shall be filled. Exterior surfaces shall be painted with one or more finish coats of the manufacturer's standard coating. Finish coats shall have a dry film thickness of at least 4 mils. Color shall be ANSI 61 Gray. One quart of touch-up paint shall be furnished with the panels.

d. Panel-Mounted Instruments

1) Instruments, power supplies, pilot devices, and appurtenances mounted within or on the face of the panel shall meet the requirements specified in Section 13561, Panel Mounted Instruments, for those items unless noted otherwise herein, on the Drawings or, if applicable, within the referring equipment specification section.

e. Factory Test

1) Panels shall be factory tested electrically and pneumatically by the panel fabricator before shipment.

2.2 FREESTANDING VERTICAL PANELS

A. The following paragraphs specify the freestanding vertical panels:

1. Construction

a. Panel construction shall be an indoor, dusttight, completely enclosed cubicle formed from steel structural members and steel plates. The base shall be formed of steel channels, with flanges extending upwards. The base shall be provided with 1/2 inch diameter holes at 12 inch centers so that the base can be bolted to the concrete equipment base. Welds, seams, and edges on all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment.

2. Structure

a. Panel structure shall be suitably braced and of sufficient strength to support all equipment mounted on or within, to withstand handling and shipment, to remain in proper alignment, and to be rigid and freestanding. Top, sides, and back shall be fabricated from USS 10 gage or heavier carbon steel sheets, with stationary back suitable for back to wall installation, or designed for rear access with hinged back doors. Doors shall not be greater than 24 inches wide or spaced not greater than 36 inches center to center. Rear access doors shall be fabricated from USS 14 gage or heavier carbon steel.

3. Panel Front

a. The front shall be a hinged door, or doors, with mounted instruments and control devices, fabricated from USS 10 gage carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged fronts shall be of sufficient

width to permit door opening without interference with rear projection of flush mounted instruments.

4. Doors

   a. Doors shall be essentially full height, having turned back edges and additional bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a common door handle, shall hold doors securely compressed at top, side, and bottom against rubber gaskets.

5. Mounted Instruments

   a. The front shall be stationary, with mounted instruments and control devices, fabricated from 3/16 inch carbon steel plate. Panel fronts shall be suitably reinforced between mounting cutouts and drilling to support instruments and devices without deformation and shall be free from waves and other imperfections, Panel fronts shall be recessed at the base. Adjoining panel sections shall be accurately shop fitted to assure satisfactory assembly in the field.
   b. Instrument Arrangement
      1) Panel instruments and control devices shall be arranged in a logical configuration for the plant operators. The centerline of recorders shall be within 3 feet and 5'-9" above the base of the panel for convenient reading and chart replacement. Control switches shall be within 6 feet and 2'-6" above the base of the panel. Indicators may be located within 2'-6" and 6'-6" above the base of the panels. Annunciators and clocks may be mounted near the top of the panels.

6. Size and Arrangement

   a. Panel dimensions and general instrument arrangement shall be as indicated on the Drawings or in the attached equipment schedules.

7. Interior Lighting

   a. Illumination of panel interiors shall be provided by ceiling mounted lamp fixtures spaced at approximately 2'-6" and near the door. Fixtures shall be nominal 40-watt fluorescent tube type, with a common "On-Off" switch near each end door. Duplex-grounded receptacles shall be provided for service and maintenance tools at spacing not greater than 5 feet throughout the length of a panel. The lighting and receptacle circuit shall be fused separately from the instrumentation systems.

2.3 WALL-MOUNTED CABINETS

A. Cabinets, which contain the system components indicated on the Drawings, shall be suitable for wall mounting and shall meet the NEMA enclosure rating as indicated on the Drawings or, if applicable, in the attached equipment schedules or the referring equipment specification section. The enclosures shall be fabricated from USS 14 gage, or heavier, carbon steel, stainless steel, or fiberglass. Cabinets shall be equipped with full size gasketed doors with hinges and a chromium-plated or stainless steel three-point latch. The door shall be lockable with a key. A screened vent shall be provided in the bottom of enclosures that contain pneumatic devices.

B. Floor stands shall be provided to support cabinets not fastened to a wall or other support. Floor stands shall be full-depth and shall have a minimum height of 12 inches. Floor stand material and finish shall match the cabinet.

C. All wall-mounted cabinets shall meet the requirements of the panel fabrication paragraph of this section.

D. Outdoor cabinets shall be provided with sunshades as indicated on the Drawings or, if applicable, in the attached equipment schedules or the referring equipment specification section.

2.4 FIBER OPTIC PATCH PANELS

A. Fiber optic patch panels (also referred to as fiber termination cabinets) shall be furnished to terminate fibers at the fiber optic modules, and any other data highway attached equipment. The cabinets shall meet the following requirements:

1. The patch panels shall be the wall rack mounted type, having provisions for terminating multiple fiber optic cables. Splice trays, strain relief cable attachment points, fiber organizers and bend radius hardware shall be furnished with each termination cabinet.

2. Panel size shall be suited to the number of fibers to be terminated within the cabinet. Bayonet/flanged couplings shall be furnished and mounted for each fiber to be terminated.

3. Fiber terminations shall be spliced to pigtail cables (specified below) having ST connectors. The pigtails shall be terminated in an orderly method.

B. Fiber optic patch panels shall be OFS Technologies "LGX," Corning Cable Systems "WCH Series," or equal.

2.5 DATA SERVER ENCLOSURES

A. An enclosed equipment distribution rack shall be provided for mounting network equipment provided as rack-mounted, including switches, firewalls, routers, and patch panels. The rack shall be black painted steel or painted aluminum construction with fully tapped, standard 18.3 inch hole-to-hole centers and shall include all hardware and accessories including frame, shelves, and raceways as specified and as shown on Drawings. Rack enclosures shall be as manufactured by Amco Engineering, Hoffman, or equal.

B. Each data server enclosure shall be furnished with a rack-mounted uninterruptible power supply (UPS) to provide backup power to all enclosed loads. Rack-mounted UPSs are specified elsewhere in this section.

2.6 WALL MOUNTED INSTRUMENT SUBPANELS

A. Instrument subpanels shall be constructed from 1/8 inch thick carbon steel and shall be reinforced and braced to form a rigid assembly. Panels designed for wall mounting shall have 1 inch turned back edges and a minimum 2 inch air space between the panel and the wall

surface. All components on wall-mounted panels shall be mounted so as to be easily removable without requiring rear access to the subpanel.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Installation requirements are specified in the Instrumentation and Control System section. In addition, equipment furnished under this section shall conform to the following manufacturing stipulations.

1. Piping

    a. All tubing shall be run in horizontal and vertical planes and shall be rigidly supported to withstand handling and shipment. Flexible polyethylene tubing shall be used to connect devices mounted on hinged doors.

2. Wiring

    a. All wiring shall be grouped or cabled and firmly supported inside the panel. Wiring shall be bundled in groups and routed in Panduit or similar nonmetallic slotted ducts. Ducts shall be readily accessible within the panel with removable covers and shall have a space of at least 40 percent of the depth of the duct available for future use after installation is complete and all field wiring installed. Sufficient space shall be provided between cable groups or ducts and terminal blocks for easy installation or removal of cables.

3. More Than One Panel

    a. Where signal or loop wiring must be routed to more than one panel or device, the required circuit routing shall be as indicated on the one-line diagrams. The panel fabricator shall provide such additional circuits as may be indicated on the electrical schematic Drawings.

End of Section

Equipment Schedule 406711-S01

FREESTANDING VERTICAL PANELS

1.000	**General**					
1.010	Specification Section 406711					
2.000	**Freestanding Vertical Panels**					
2.010	Tag Number/Panel ID					
2.020	NEMA Enclosure Rating					
	12					
	4					
	4X					
2.030	Materials of construction					
	Carbon steel					
	316 Stainless steel					
	Fiberglass polyester					
2.040	Environmental provisions					
	Sunshade and drip shield					
	Cooling fan					
	Air conditioner					
2.050	Door Arrangements					
	Hinged rear doors					
	Hinged front door with instruments					
	Hinged front door without instruments					
	Fixed front					
	Recessed base					
2.060	Dimensions (min. L x W x H)					
2.070	Panel interior-mounted UPS					
2.080	Conduit entrance					
	Bottom open					
	Removable top plates					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	None					

Equipment Schedule 406711-S02

WALL-MOUNTED CABINETS

1.000	**General**					
1.010	Specification Section 406711					
2.000	**Wall Mounted Cabinets**					
2.010	Tag Number/Panel ID					
2.020	NEMA Enclosure Rating					
	12					
	3R					
	4					
	4X					
2.030	Materials of construction					
	Carbon steel					
	316 Stainless steel					
	Fiberglass polyester					
2.040	Environmental provisions					
	Sun shade					
	Cooling fan					
	Air conditioner					
2.050	Dimensions (min. L x W x H)					
3.000	**Exceptions, Clarifications, and Comments**					
3.010	**None**					

Equipment Schedule 406711-S03

NETWORK RACKS

1.000	**General**		
1.010	Specification Section 406711		
2.000	**Network Racks**		
2.010	Tag Number/Panel ID		
2.020	Rack Features		
	Open Frame		
	Enclosed		
	Wall Mounted		
	Floor Mounted		
	Doors with Windows		
2.030	Materials		
	Carbon steel		
	Stainless steel		
	Fiberglass polyester		
2.040	Optional Accessories		
	Internal UPS		
	Vertical Cable Management		
	Horizontal Cable Management		
	Light		
	Power Distribution Unit		
3.000	**Exceptions, Clarifications, and Comments**		
	Exterior dimensions (H x W x D), minimum		

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SECTION 13590 - NETWORK SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

A. The Network Systems section covers the furnishing of all hardware and software for network systems for the Instrumentation and Control System. Principal components of the network systems shall be as indicated on the block diagram Drawings and as described below.

B. System Supplier shall furnish all necessary equipment, interconnecting cables, accessories, and appurtenances for proper network operation and to meet the functional requirements indicated on the Drawings and specified herein. Configuration of all hardware shall be provided by the System Supplier.

C. Equipment and services provided under the Network section shall be subject to the general requirements specified in the Instrumentation and Control System section. Supplementing this section, network data, special requirements, and options may be indicated on the Drawings

D. Control System

1. The Instrumentation and Control System section shall apply to all systems described herein. All applicable requirements specified in the Instrumentation and Control System section shall apply to equipment and services provided herein.

E. Network Functional Description

1. The network system shall provide communications between the operator workstations, servers, and PLCs.

1.2 GENERAL

A. System Supplier shall select the equipment for its superior quality and the intended performance. The System Supplier shall install all equipment in accordance with the manufacturer's instructions. Equipment and materials used shall be subject to review and shall comply with the following requirements.

B. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

C. Drawings

1. Supplementing this section, the Drawings indicate locations and arrangement of hardware and enclosures, provide mounting details, and may show other information regarding the connection and interaction with other equipment.

D. Governing Standards

1. Governing Standards for network systems shall be as specified in the Instrumentation and Control System section.

E. Power and Instrument Signals

1. Unless otherwise specified, electric power supply to the network equipment will be unregulated 24 volts dc or 120 volts ac.

F. Appurtenances

1. Special power supplies, special cable, special grounding, and isolation devices shall be furnished for proper performance of the equipment.

G. Interchangeability and Appearance

1. To the extent possible, components used for similar types of functions and services shall be the same brand and model line. Similar components of different network hardware shall be the products of the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

H. Programming Devices

1. A programming or system-configuring device, or software required for programming, shall be provided for systems that contain any equipment that requires such a device or software for routine maintenance and troubleshooting. The programming device shall be complete, newly purchased for this project, and shall be in like-new condition when turned over to Owner at completion of startup. Programming software shall be licensed to the Owner.

1.3 SUBMITTALS

A. See Section 13500 – Instrumentation and Control System

1. Submittals shall be as specified in the Instrumentation and Control System section.

B. Network Design submittal (to be provided with the First Stage Submittals):

1. A complete network topology diagram, detailing all hardware, cabling and the interconnections between all connected equipment. Interconnections to existing installed equipment and Owner-furnished equipment shall be included in the diagram.

2. A complete listing of IP addresses to be assigned to all equipment furnished under this contract shall be provided. The assignment of IP addresses shall be coordinated with the Owner.

C. O&M Manuals.

1. All above documentation shall also be provided in the O&M manuals.

1.4 DELIVERY, SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored as specified in the Instrumentation and Control System section. Identification of packaging shall be as described in the Instrumentation and Control System section.

1.5 CONNECTION TO OWNER NETWORKS

A. Network hardware and software provided shall be compatible with the Owner's existing network systems wherever a system interconnection is provided. System Supplier shall verify existing systems to ensure compatibility.

B. All connections to the Owner's existing network shall be fully coordinated between the Owner and the System Supplier. Prior to connecting to the existing network, the System Supplier shall provide a written request to the Owner for an Owner's representative to be available when existing systems are disconnected and at the time of any new connections.

1.6 COORDINATION WITH OWNER

A. The System Supplier shall coordinate all demolitions, installations and rework on the existing networks with the Owner and the Engineer. No work shall be performed without the written consent of the Owner. The System Supplier shall submit a written request to perform work on the existing network, including date, time, scope of work, length of time, and any Owner's support that may be required.

PART 2 - PRODUCTS

2.1 GENERAL

A. The following paragraphs provide minimum Ethernet network device stipulations.

2.2 NETWORK CABLING SPECIFICATIONS

A. Individual network equipment and related devices shall be coordinated with items provided in the following sections:

1. 13591 Metallic and Fiber Optic Communication Cable

2.3 ETHERNET NETWORK HARDWARE

A. Ethernet network hardware shall be provided as specified and/or as shown on the Drawings. All specified functionality of provided Ethernet network equipment shall adhere to the IEEE 802 standards. Ethernet Hubs will not be accepted for network systems. Ethernet switches shall be provided to connect multiple network segments together, selectively forwarding traffic between the segments.

B. Ethernet Switches

1. Each switch shall include the following functionality:

   a. Switch shall support the quantity of 10/100/1000BaseTX ports and 10BaseFL/100BaseFX/1000BaseLX Fiber ports to meet the functionality indicated in this specification and as shown on the Drawings. Switches shall have a minimum of 10/100/1000Base-T, RJ-45 ports. A minimum of 20% spare ports shall be provided for the installed system.
   b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.
   c. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.
   d. Prioritization: IEEE 802.1p QoS Support.
   e. Support for Optional Redundant Power Supply as required on Drawings.
   f. Management: Fully Managed Switch with support for SNMP v.3., and port mirroring.
   g. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.
   h. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 40C.

2. Power over Ethernet (POE) switches shall have the following functionality:

   a. Power Enabling and standards: IEEE 812.3af
   b. Power: 48 VDC, 50 watt minimum power supply for power enabling switch.
   c. LED indication of the link activity for each port and power forwarding.

3. Switches shall be Cisco "Catalyst Series", Hewlett Packard "Procurve Switch" series, 3Com "SuperStack II" series, or equal.

C. Industrial (Panel-Mounted) Ethernet Switches

1. Each switch mounted in process areas shall include the following functionality:

   a. Ports: Switch shall support the quantity of 10/100BaseTX ports and 100BaseFX fiber ports to meet the functionality indicated on the Drawings, with a minimum of 20% spare auto-negotiating 10/100Base-T, RJ-45 ports, and two multimode fiber uplink ports. A minimum of four UTP ports shall be provided.
   b. Each switch connection shall automatically sense the network speed of the devices to which it is connected.
   c. Capable of ring-based media redundancy with 30 ms recovery time.
   d. Path Redundancy: IEEE 802.1w Rapid Spanning Tree Protocol.
   e. Prioritization: IEEE 802.1p QoS Support.

f. Network Segregation: Port VLAN.
g. Management: SNMPv3 and Browser-based management shall be supported.
h. IGMP snooping supported.
i. LED indication of the link activity for each port.
j. Environmental: Suitable for installation in industrial environments. Operating Temperature Range: 0 to 60C. Optional -40 to 60C rating availability.
k. Redundant 24 VDC power supply inputs
l. Conformal coating option for use in hazardous environments.
m. Mounting: DIN-rail mounted suitable for panel installation.
n. All necessary memory upgrades, software feature sets, and cables needed for proper operation of these switches shall be furnished with each switch.

2. Power over Ethernet (POE) switches for CCTV PTZ cameras shall have the following functionality:

a. Power Enabling and standards: IEEE 812.3af
b. Power: 48 VDC, 50 watt minimum power supply for power enabling switch.
c. LED indication of the link activity for each port and power forwarding.

3. Switches shall be GarretCom Magnum 6K Series, Hirschmann RS-20 series, Moxa 508A series, N-Tron 708FX series, SIXNET SL-8MG Series With POE Injector , or equal.

D. Ethernet Connectors

1. Ethernet wiring connectors shall be RJ-45 male modular plug connectors.

2. Standard RJ45 Connectors

a. Standard connectors shall be polycarbonate, clear connectors. Connectors shall conform to RJ-45 and ISO 8877 standards. Contacts shall be gold plated with a 0.5A current rating and a -25º to 60º C temperature rating. Connectors shall accept unshielded Cat-5e or Cat-6, AWG 24, solid conductor cable.

2.4 ETHERNET NETWORK SOFTWARE

A. All switches and routers shall be managed from a graphical user interface on a Microsoft Windows operating system computer. Network management software and all network equipment provided by the System Supplier shall be compatible with each other, allowing management of each device from the provided software. Network management software shall be the latest version of Cisco netmanager IP Infrastructure, or equal.

2.5 SPARE PARTS

A. Spare parts shall be provided as specified below.

Spare parts	Quantity
Switches	1 of each type

PART 3 - EXECUTION

3.1 NETWORK INSTALLATION REQUIREMENTS

A. Additional network installation requirements are specified in the Instrumentation and Control System section. Networks shall be installed and tested in accordance with the following requirements.

3.2 NETWORK CONFIGURATION

A. The System Supplier shall fully configure all network devices. All device selections shall be fully coordinated with the Owner to ensure compatibility with existing systems and standards.

B. Ethernet Switches

1. The System Supplier shall fully configure all Ethernet switches. The following shall be configured:

    a. Unused ports shall be disabled for security purposes.
    b. Spanning Tree or other appropriate redundancy scheme shall be configured for all redundant links. Trunking or other bandwidth sharing redundancy schemes shall be utilized where available to minimize switching times, and increase available bandwidth.
    c. Management Password Security
    d. Quality of Service, with any traffic to/from PLCs getting priority over all other traffic.

C. Network Configuration Report

1. The System Supplier shall provide a configuration report to the Owner detailing all connections, addresses, and port assignments

D. Management Software

1. Management software shall be fully configured for all network devices provided.

3.3 NETWORK TESTING

A. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test.

B. Field Testing

1. After each network has been installed, a technical representative of System Supplier shall test the network and shall provide a written report for each test. Specific testing requirements are described in the individual network specification sections.

C. Systems Check

1. A technical representative of System Supplier shall participate in the checkout of network systems. Systems check requirements shall be as specified in the Instrumentation and Control System section.

D. Test Equipment

1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

2. Ethernet Network Minimum Test Requirements

a. The following minimum tests are to be performed by the System Supplier:

1) Verify Link Integrity Status LED is lit on both sides of each link

2) Verify proper operation and failover of each redundant component and redundant link.

3) Verify alarming of each link failure.

4) Verify bandwidth Usage

3. Ethernet Network Test Reports

a. Upon completion and testing of the installed Ethernet network, the System Supplier shall submit test reports to the Engineer in printed form. Test reports are to show all test results performed by the System Supplier for each port and piece of equipment. Date of calibration of the test equipment is also to be provided.

3.4 NETWORK TROUBLESHOOTING

A. It is the System Supplier's responsibility to provide trouble-free and reliable networks. The System Supplier shall employ any means necessary to ensure operational networks. The System Supplier shall obtain any needed test equipment, including but not limited to time-domain reflectometers, protocol analyzers and network sniffers, to troubleshoot any problems. The System Supplier shall utilize the services of a trained and certified Network Engineer that is

regularly involved in troubleshooting network problems, in the event that operational or reliability problems exist. Acceptable certifications include Cisco CCNP, Cisco CCIE, or Network Professional Association Certified Network Professional (CNP).

3.5 CUSTOMER TRAINING

A. Training for networks is covered under Network Training in the Instrumentation and Control System section.

End of Section

SECTION 13591 - METALLIC AND FIBER OPTIC COMMUNICATION CABLE

PART 1 - GENERAL

1.1 SCOPE

A. The Metallic and Fiber Optic Communications Cable and Connectors section covers the furnishing and installation of cable systems to provide communications for the Instrumentation and Control System as indicated on the Drawings.

B. Accessories and appurtenances shall be provided as specified herein to provide a complete and properly operating system.

C. Equipment and services provided under this section shall be subject to the General Computer Control System Requirements specified in the Instrumentation and Control System Section and the Network Systems section. Supplementing the Metallic and Fiber Optic Communications Cable and Connectors section, network data, special requirements, and options are indicated on the Drawings.

1.2 SUBMITTALS

A. See Section Instrumentation and Control System section. Submittals shall be as specified in the Instrumentation and Control System section.

B. Qualifications

1. The name, address and telephone number of the proposed contractor or subcontractor, including specific personnel to perform the work shall be included with the submittals. Provide the experience record of the subcontractor and personnel in performing work similar to that specified. Include the agency, contact person, and telephone number of at least three (3) previous network installation projects completed by the proposed subcontractor. The Engineer shall review and approve the network installation subcontractor and personnel prior to any of the related work being performed. This review will be conducted during the project submittal phase, as described below.

C. Drawings and Data

1. All material and equipment documentation shall be submitted for review in accordance with the Submittals section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment.

2. Product data shall include the following in the Submittals section:

a. Cut sheets and catalog literature for proposed fiber optic cable, and fiber optic cable accessories (pigtails, connectors, etc.)
b. Manufacturer specifications and data that clearly shows that the fiber optic cable meets all requirement specified herein.

c. Sample of the proposed cable.
d. Physical dimension drawings of all fiber optic accessories.
e. Proposed fiber identification sequence and labeling.
f. Provide off-line maintenance aids and on-line diagnostics to check the performance of the communication links and interfaces of devices on the data highway.
g. Provide a Recommended Spare Parts List (RSPL).
h. Provide a list of recommended special tools for fiber installation testing or maintenance.

D. Operations and Maintenance Manuals

1. Operation and Maintenance Manuals shall have the following items included in addition to those items specified in other sections:

a. Description of all components.
b. Methods of connection.
c. Connection diagram.
d. OTDR trace plots for all fibers.

1.3 SHIPMENT, PROTECTION, AND STORAGE

A. Equipment provided under this section shall be shipped, protected, and stored in accordance with the requirements of the Instrumentation and Control System section.

1.4 QUALIFICATIONS

A. Due to the specialized nature of installing, splicing, terminating, and testing optical fiber cable, the Contractor shall utilize personnel who are experienced in such practices. The installing Contractor or Subcontractor shall have performed similar installation and testing work on at least three projects of similar size and complexity. The personnel assigned to the installation and testing shall also have experience on at least three projects of similar size and complexity.

PART 2 - PRODUCTS

2.1 GENERAL

A. All fiber optic cable, fiber optic hardware and accessories shall be designed, assembled and connected in accordance with the requirements of these Specifications and the Drawings.

2.2 ETHERNET UNSHIELDED TWISTED PAIR (UTP) CABLE

A. Ethernet cables and connectors shall be provided for a complete and working system, and/or as shown on the Drawings. Cable for Ethernet wiring shall be UTP Cat-6 cable. Jacket color coding for cables shall be as follows:

1. Standard Cat-6 - Yellow

2. Crossover cables - Red

B. Category 6 UTP Cable

1. Cat-6 cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid strand FEP Teflon insulation
c. 100 Ohm impedance
d. 1-250 MHz frequency range
e. Min attenuation 19.9 Db
f. 100 Ohm impedance
g. Min NEXT 44.3dB/100MHz
h. Min PS-NEXT 42.3dB/100MHz
i. Min ELFEXT 27.8dB/100MHz
j. Min PS-ELFEXT 24.8dB/100MHz
k. Min return loss 20.1 dB/100 MHz
l. Max delay skew 45 ns
m. Max propagation delay 540 ns

2. Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 1872 or equal.

C. Category 6 STP Cable

1. Cat-6 shielded cable shall meet the following requirements:

a. 24 AWG
b. 4 pair solid strand polyolefin insulation
c. Combination aluminum-polyester tape overall shield and 7-strand, 24 AWG minimum tinned copper drain wire
d. 100 Ohm impedance
e. 1-250 MHz frequency range
f. Min attenuation 19.9 Db
g. 100 Ohm impedance
h. Min NEXT 44.3dB/100MHz
i. Min PS-NEXT 42.3dB/100MHz
j. Min ELFEXT 27.8dB/100MHz
k. Min PS-ELFEXT 24.8dB/100MHz
l. Min return loss 20.1 dB/100 MHz
m. Max delay skew 45 ns
n. Max propagation delay 540 ns

2. Plenum rated cable shall have FEP insulation jacketing and FEP insulation for conductors. Non plenum rated cable shall have PVC insulation jacketing and polyethylene insulation for conductors. Cat-6 cable shall be Belden 7953A, Panduit IFRH6C04BL-UG, Southwire 336, or equal.

3. RJ-45 connectors for shielded Cat-6 cables shall be metallic nickel-plated with gold-plated prong pins. Connectors shall include strain relief boots.

D. Ethernet Patch Cables

1. Pre-wired and terminated patch cables with RJ-45 connectors and lever protecting boot shall be furnished for all connections to computers, network equipment, and controller equipment except where physical conditions (i.e. length over 12 ft. or conduit size) require unterminated wire to be installed. Patch cables shall be Cat-5e for networks speeds up to 100 MHz, and Cat-6 for networks speeds greater than 100 MHz and shall meet the requirements of Cat-5e and Cat-6 cable specified in this section. Straight through cables shall be wired using the T568-B standard for both connectors as shown in section 3 (Ethernet Cable Installation). Crossover cables shall be wired using the T568-A standard for one connector and the T568-B standard for the opposite end.

2.3 FIBER OPTIC CABLE

A. The fiber optic cable must meet all of the requirements of the following paragraphs.

1. The fiber optic cable must meet the following requirements of the National Electrical Code (NEC) Section 770.

2. Riser Applications – Applicable Flame Test UL 1666.

3. Finished cables shall conform to the applicable performance requirements of Table 8-6 and 8-7 in the Insulated Cable Engineers Association, Inc. (ICEA) Standard for Fiber Optic Premises Distribution Cable (ICEA S-83-596).

4. Every fiber in the cable must be usable and meet required specifications.

5. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.

6. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.

7. All optical fibers shall be proof tested by the fiber manufacturer at a minimum load of 100 kpsi.

8. All optical fibers shall be 100 percent attenuation tested. The attenuation shall be measured at 850 nm, and 1300 nm for multimode fibers. The attenuation shall be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer shall store these values for a minimum of 5 years. These values shall be available upon request.

9. The storage temperature range for the cable on the original shipping reel shall be –40°C to +70°C. The operating temperature range shall be –40°C to +70°C. Testing shall be in accordance with FOTP-3.

10. The attenuation specification shall be a maximum attenuation for each fiber at 23 $\pm$ 5°C.

11. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.

12. Required Fiber Grade: Maximum Fiber Attenuation at 850 nm shall be 3.5 dB/km.

13. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0 mm.

14. The cable shall contain 12 fibers. Each buffer tube shall contain up to 12 fibers.

15. The fibers shall not adhere to the inside of the buffer tube.

16. Each fiber shall be distinguishable from others by means of color coding in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."

17. The fibers shall be colored with ultraviolet (UV) curable inks.

18. Buffer tubes containing fibers shall also be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."

19. In buffer tubes containing multiple fibers, the colors shall be stable during temperature cycling and not subject to fading or smearing onto each other. Colors shall not cause fibers to stick together.

20. The buffer tubes shall be resistant to kinking.

21. The cable jacket color shall be black.

22. Fibers may be included in the cable core to lend symmetry to the cable cross-section where needed. Fibers shall be placed so that they do not interrupt the consecutive positions of the buffer tubes. In dual layer cables, any fillers shall be placed in the inner layer. Fillers shall be nominally 3.0 nm in outer diameter.

23. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.

24. The outer cable jacket shall be marked with the manufacturer's name or UL file number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet (e.g. "62.5/125 MICRON – TYPE OFNR – (UL) 00001 Feet"). The print color shall be white.

25. The cable shall be all-dielectric.

26. The cable shall be gel-free.

27. Flammability – All cables shall comply with the requirements of the 1996 NEC Article 770. All cables shall pass UL 1666.

B. Fiber optic cable shall be as manufactured by Corning Cable Systems, Belden, Commscope, TE Connectivity, or equal.

C. Singlemode Fiber

1. Singlemode fiber optic cable shall meet the following requirements:

a. The dispersion unshifted single-mode fiber utilized in the cable specified herein shall conform to the specifications herein.
b. Cladding Diameter: 125.0 + 1.0 μm.
c. Core-to-Cladding Offset: < 0.8 μm.
d. Cladding Non-Circuladty: < 1.0%.
e. Coating Diameter: 245 ± 10 μm.
f. Colored Fiber Diameter: nominal 900 μm.
g. Attenuation Uniformity: No point discontinuity greater than 0. 1 0 dB at either 1310 nm or 1550 nm.
h. Attenuation at the Water Peak: The attenuation at 1383 ± 3 nm shall not exceed 2.1 dB/km.
i. Cutoff Wavelength: The cabled fiber cutoff wavelength(λccf,) shall be < 1260 nm.
j. Mode-Field Diameter: 9.30±0.50 μm at 1310 nm 10.50 ± 1.00 micrometers at 1550 nm.
k. Zero Dispersion Wavelength (λo): 1301.5 nm < λo < 1321.5 nm.
l. Zero Dispersion Slope (So): < 0.092 ps/(nm^2 *km).
m. Fiber Polarization Mode Dispersion (PMD): < 0.5 ps/(sq. km)

D. Fiber optic cable connectors

1. All optical fibers shall be terminated with connectors that are type ST for multimode cable and type SC for singlemode cable.

2. Epoxy Connectors

a. Epoxy connectors shall be provided to terminate each fiber in the cable. Connector style, ST, SC, or other, shall be coordinated with the patch panels and field devices that will interface directly with the cable. Connectors shall be compatible with the supplied cable. Connector loss shall be no greater than 0.3 dB. Loss measurement shall be performed at the time of splicing and documentation shall be furnished for each termination. Connectors shall be Corning Cable Systems Connectors, or equal.

3. Fiber Optic Jumper Cables

a. Fiber optic jumper cables shall be furnished and installed for equipment interfacing and between termination cabinets. The jumpers shall meet the following requirements:

1) The jumpers shall be 50/125 microns, multimode for operation at 1300 nm. They shall be tight-buffered and be protected by Kevlar-type strength material.

2) The jumpers shall be supplied with connectors on each end. Connector types (ST, SC, LC, etc.) shall be matched to the equipment provided. Jumpers

shall be sized to provide a single connection between the fiber optic hardware being connected.

2.4 DCU COMMUNICATIONS MEDIA

A. System Supplier shall provide all necessary cabling for the DCU communications network and DCU remote I/O communications network. Communications cables shall meet the requirements of the manufacturers of the DCUs and communications modules.

2.5 ETHERNET CABLE TEST EQUIPMENT

A. One hand-held network cable tester that is compatible with the provided network cabling shall be provided. The cable tester shall check for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs for faults up to 100 m. Tester shall be Black Box "Model SOHO Plus Tester", Fluke MicroScanner2 Pro, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The System Supplier shall be responsible for the coordination of the installation of all cable furnished hereunder. The System Supplier shall be responsible for the termination of all cable furnished hereunder.

B. Cable Damage

1. If the cable becomes damaged during installation, the Contractor shall stop work and notify the Engineer immediately. The Owner and Engineer will decide whether to replace the entire reel of cable or to install a splice at the damaged section. If the Owner decides to replace the entire reel of cable, the Contractor shall begin the installation at the last designated splice point. The damaged cable between these points shall be removed, coiled, tagged, and given to the Owner. Installation of new cable to replace damaged cable shall not be a basis of extra payment or contract completion time. In addition to installation of the new cable, the Contractor shall reimburse the Owner for the entire cost of the replacement reel of cable. This cost will be withheld from the contract price. If the Owner decides to install a splice at the damaged point, and the cable is damaged a second time, the entire reel of damaged cable (and all subsequent damaged reels) shall be replaced with new reels at the Contractor’s expense.

C. Ethernet Cable Installation

1. Straight through cables shall be wired using the latest version of T568 standard for both connectors as shown in the table below (connector pin numbers are left to right with the clip down). Crossover cables shall be wired using the T568A standard for one connector and the T568B standard for the opposite end as shown in the table below.

Connector Pin	568A Wiring Conductor	568B Wiring Conductor
1	White/Green	White/Orange
2	Green	Orange
3	White/Orange	White/Green
6	Orange	Green
4	Blue	Blue
5	White/Blue	White/Blue
7	White/Brown	White/Brown
8	Brown	Brown

2. Shielded Cat-6 cabling shall be grounded on only one end of the cable.

D. Fiber Optic Cable Installation

1. The cable manufacturer shall provide installation procedures and technical support concerning the items contained in this specification. Fiber optic cable installation shall meet the following requirements:

   a. All fiber optic cable shall be installed, terminated, and tested by the System Supplier or his fiber subcontractor as specified above.
   b. In pulling the cable, strain-release, or other tension limiting devices shall be used to limit the pull tension to less than 600 lbs.
   c. Minimum bend radius restrictions shall be satisfied both during and after cable installation.
   d. Horizontal, unsupported cable runs shall be supported at continuous distances of 5 feet or less.
   e. All conduit and cabinet entrances shall be sealed with RTV or other re-enterable sealant material to prevent ingress of water, dust or other foreign materials.
   f. Cable routing within occupied office areas shall conform to Federal, State, and local electrical and fire codes.
   g. Any non-terminating (field) splices shall be documented as to the physical location and cable meter mark (prior to stripping). Field splices shall be OTDR-tested and documented prior to final cable acceptance testing.
   h. Fiber optic cables shall be installed in accordance with the latest version of NECA 301, Installing And Testing Fiber Optic Cables.

3.2 CABLE TESTING

A. After the network cabling has been installed, each network cable shall be tested.

B. Test Equipment

1. Unless specified otherwise, all test equipment for the calibration and checking of system components shall be provided by System Supplier for the duration of the testing work and this test equipment will remain the property of System Supplier.

C. Ethernet UTP Cable Testing

1. The System Supplier shall utilize the previously specified test equipment, and additional tools as needed to validate the Ethernet UTP cable installation. All test equipment shall bear current calibration certification from a certified calibration laboratory, as appropriate. Each cable shall be tested for open pairs, shorted pairs, crossed pairs, reversed pairs and split pairs. A check off sheet shall be utilized, shall be signed by the technician testing the cables, and shall be submitted for approval. Any identified faults shall be corrected at no additional cost.

D. Fiber Optic Cable Testing

1. Acceptance testing of the data highway (fiber and electronic equipment) shall be conducted as a part of integrated system field testing, as specified elsewhere. Prior to such tests, however, the fiber optic cable shall be tested as specified herein.

2. The System Supplier, or his fiber subcontractor, shall conduct fiber optic cable testing as specified below. All testing following field installation shall be witnessed by the Engineer. The Contractor shall bear the cost for field witnessed testing in accordance with the General Equipment Stipulations section. A test plan shall be submitted prior to the proposed test dates. The test plan and procedures shall be mutually agreed to prior to conducting the tests.

3. Each optical fiber of each fiber optic cable shall be OTDR (Optical Time Domain Reflectometer) tested on the reel at the factory, on the reel upon arrival at the jobsite, and after installation and termination. For each fiber, an OTDR (Optical Time Domain Reflectometer) trace soft/hardcopy is required to be provided to the Owner and Engineer. OTDR traces shall be provided for each test (at the factory, on the reel at the job-site, and after installation). A 100 foot launch cable shall be spliced to each fiber for each fiber OTDR test, to ensure accurate results. This end-to-end trace shall be performed from BOTH ends of the fiber. Also for each fiber, an end-to-end power attenuation (insertion loss) test shall be performed. The attenuation test shall use a stabilized optical source and an optical power meter calibrated to the appropriate operating wavelength (1300 nm).

4. For each installed fiber, the power attenuation shall not exceed the following, tested from connector to connector at the respective patch panels:

   a. $(0.0035)L + (0.25)N + 3.0$ dB

      1) Where L = The length of the fiber optic cable in meters and

      2) N = the number of splices in the fiber.

5. Any fiber optic cables containing one or more fibers not meeting this performance will not be accepted by the Owner, and shall be repaired or replaced at no additional cost.

6. Each fiber optic jumper cable shall be tested and must exhibit an end-to-end attenuation of less than 2.0 dB at 1300 nm. Any jumper exceeding this level shall be replaced at no additional cost to the owner. Any damaged cable still on the reel shall be returned to the manufacturer for replacement at no additional cost to the Owner.

7. All fiber cable testing shall be documented on pre-approved test forms. Three (3) copies of all documentation (including OTDR traces) shall be submitted to the Engineer upon successful completion of the testing.

End of Section

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SECTION 13800 - SURGE CONTROL SYSTEM

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers design, furnishing, and installation of steel pressure vessels, nozzles, supports, control panel, and accessories to be provided as indicated on the Drawings. The vessels shall be used for controlling surge pressures in the pump discharge transmission pipeline. Each pressure vessel shall normally be partially filled with potable water with a pad of compressed air above the water level and will be located indoors.

1.2 GENERAL.

A. Equipment furnished under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, specifications, engineering data, instructions, unless exceptions are noted by the Engineer.

B. Each item shall be furnished complete with all accessories required for proper operation, all components indicated on the Drawings or specified, and all additional materials or construction required by the design of each vessel.

C. Each vessel shall be provided complete with support saddles, access manholes, flanged nozzles, and any additional materials or construction essential for proper installation and operation of each vessel.

D. General Equipment Stipulations.

1. The General Equipment Stipulations shall apply to all equipment furnished under this section.

E. Governing Standard.

1. Except as modified or supplemented herein, design, materials, fabrication, erection, and testing of each vessel shall conform to all sections of ASME Boiler and Pressure Vessel Code for Unfired Pressure Vessels. Tank shall be ASME stamped and approved, and shall have a sufficient metal thickness to provide a minimum of 1/8-inch corrosion allowance and withstand the highest expected working pressure with a four to one factor of safety.

2. Each vessel shall bear the stamp of the National Board of Boiler and Pressure Vessel Inspectors and the manufacturer's number as registered with the National Board.

3. Welding procedures, welders, and welding operators shall be qualified in accordance with Section IX of the ASME Boiler and Pressure Vessel Code.

F. Permanent Identification.

1. Each vessel shall be stamped with the following information.

Manufacturer's name.

Maximum allowable working pressure of 165 psi (Springdale) and 195 psi (Fayetteville) at 100°F.

Manufacturer's serial number.

Date of manufacture.

Thickness and tensile strength of shell steel.

Thickness and tensile strength of head steel.

1.3 SUBMITTALS

A. Complete shop erection Drawings and specifications covering materials to be furnished, dimensions, sizes and thicknesses of plates and members, details of welded joints, fabrication and erection of steel work, fittings, and all accessories shall be submitted in accordance with the Submittal Procedures section.

Welded Steel Pressure Vessel

Submit a general arrangement drawing showing all connection sizes and locations for acceptance.

Name of manufacturer.

Dimensions.

Weight, empty and full of water.

Anchor bolt locations and details.

Reaction forces required for structural design of the vessel foundation.

Submit ASME calculations for heads, shell and penetrations, vessel support calculations per seismic requirements specified herein, and ASME Forms U-1A and U-3.

Full information and details concerning field assembly and installation.

Weld procedure specifications and procedure qualification records.

Chart indicating volume of water in each vessel for every 12 inches of side-water depth.

Prior to vessel fabrication, submit a roll-out layout of the vessel showing all weld seams, the types and thicknesses of each weld seam, total footage of each type of weld and approximate number of radiographs.

Manufacturer's Certificates

Functional Test Certification.

Performance Test Reports.

Welder's Qualifications - All welders shall be certified to the process, procedure and positions used in the assembly of the vessel.

Welder's Qualifications - Submit copies of each welder's qualifications prior to fabrication.

Submit welding procedures for all joints utilized in the fabrication of the vessel and accessories.

Mill test certifications of all load bearing plate, annular plates, structural components, and safety related components prior to the start of fabrication.

Control Panel

Control panel layout including interior and exterior views, identifying location of all instrumentation being supplied.

Complete electrical elementary diagrams and electrical interconnection diagrams for the level control system.

Accessory device data including catalog cut sheets on all control components.

Silencer

Name of manufacturer.

Equipment data indicating overall dimensions, connection sizes, weights and materials of construction, pressure losses, efficiencies, and noise attenuation as applicable.

Drawing showing internal silencer baffling and construction.

Sound attenuation at each octave band for each silencer.

Valves

Datasheets on each valve included as part of the surge control system identifying their tag numbers.

Materials of construction of all the components, end connection sizes and types, type of actuators, detailed dimensional drawings and pressure loss charts at various flow rates.

Datasheets and dimensional drawings of the air release valve indicating orifice size, air flow rate, materials of construction, and physical dimensions.

Accessories

Datasheets on all valves included as part of the control system. Datasheets and dimensional drawings of the air release valve indicating orifice size, air flow rate, materials of construction, and physical dimensions.

B. Test results of the standard hydrostatic test performed upon each vessel shall be submitted in accordance with the Submittal Procedures section.

C. If the design of the vessels utilizes radiographic examination of welds, copies of the results of the examination shall be submitted in accordance with the Submittal Procedures section.

D. Data shall include all horizontal and vertical loadings, anchor bolt sizes and locations, and maximum loads imparted to the foundation by each vessel.

PART 2 - PRODUCTS

2.1 DESCRIPTION AND DESIGN REQUIREMENTS

A. Each vessel shall be steel, electrically welded, cylindrical with ellipsoidal dished head of quality steel of 55,000 psi minimum tensile strength. Outlets shall be the sizes indicated and locations shown on the Drawings and as required for all instrumentation and control connection specified or otherwise required.

B. Each vessel shall be designed and rated as indicated below. The inlet/outlet connection shall be provided with an acceptable vortex suppressor sized for a minimum velocity of 16 feet per second.

Number of pressure vessels	2		
Pressure vessel location	Springdale	Fayetteville	
Tag Numbers	42-TNK-300	42-TNK-400	
Pressure vessel volume	1070	1030	ft^3
Pressure vessel orientation	Horizontal	Horizontal	
Inside diameter	8	8	ft

Approximate straight side length	19	18	ft
Design temperature	100	100	°F
Maximum working pressure due to surge	140	170	psig
Vessel design pressure	165	195	psig
Connection line to vessel	16	16	in
Seismic Design Criteria	See Specification Section 01611	See Specification Section 01611	

2.2 MATERIALS AND CONSTRUCTION

A. Fittings, manholes, and flanged pipe outlets shall be welded to each vessel on both inside and out. All horizontal and circumferential welding of shell and the dished head shall be of the double welded butt joint type.

B. Welding on the interior of each vessel shall be done in such a manner so as to not have any area that cannot be painted and tested. Couplings installed on the bottom side of each vessel shall be installed flush with the bottom. Backing strips used during the construction of each vessel shall be removed.

C. All slag, weld metal accumulation and splatters shall be removed by chipping and/or grinding. All sharp edges shall be peened or ground smooth. Basic materials shall be as follows:

Shell and Plate	ASTM A36 or ASTM A285, Grade C or SA-516-70.
Nozzle and Piping	ASTM A53, Grade B, seamless.
Flanges	ASTM A105.
Structural Shapes	ASTM A36.
Anchor Bolts, Nuts, Washers	ASTM F1554, Grade 36 with compatible nuts; hot-dip galvanized, ASTM A153. Washer ANSI B18.22.1.
Assembly Bolts and Nuts	ASTM A193-B7/A194-2H.
Gaskets	1/16-inch thick neoprene.
Welding Electrodes	Carbon steel of similar grade to the base metal (E70XX).

D. Certified mill test reports covering all plates and structural shapes to be used in work shall be furnished as evidence that such materials are new and in compliance with the governing specifications. Mill test reports shall be submitted.

E. Anchor Bolts

1. Anchor bolts with associated nuts and washers shall be furnished with each vessel. Manufacturer shall be responsible for design of anchor bolts (ex. number, diameter, embedment, etc.). Anchor bolts, together with templates or setting Drawings, shall be delivered sufficiently early to permit setting the anchor bolts when the structural concrete is placed. The bolts shall be at least 3/4 inch in diameter.

2.3 PRESSURE VESSEL CONSTRUCTION

A. The pressure vessel manufacturer shall determine each vessel wall, supports, and dished head wall thicknesses. Each vessel shall be designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, for Unfired Pressure Vessels. Each vessel and appurtenances shall be fabricated from a minimum number of pieces, and longitudinal shell seams shall be staggered.

B. General

1. Maximum Allowable Working Pressure (MAWP) shall be limited by the head, shell or transitions and it shall not be limited by other minor components such as nozzles or reinforcement pads.

2. Welding seams shall be located to clear all nozzle openings. All flange faces shall be true to the centerline of the nozzles and bolt holes shall straddle center lines unless noted otherwise. All welding shall be done by electric arc process. All welding shall be full and continuous, of uniform size and free from slag, porosity, undercuts, and other defects. All welds shall be fully penetrated. The maintenance access opening flange shall be machined smooth for a gasket surface after welding.

3. Flame cut edges, including edges of handholes in vessel skirts, shall be ground smooth.

4. Vessel components shall be carefully fitted to form joints which are free of voids. Voids at joints filled with weld metal will not be acceptable.

C. Lifting Lugs

1. Lifting lugs shall be provided for vessel lifting and placement.

D. Maintenance Access Manhole

1. One maintenance access manhole with an inside diameter of at least 24 inches, and an elliptical manway 14”x18” shall be provided on each vessel. The maintenance access manhole shall be flanged, fully gasketed, and fumished with a hinged steel blind flange suitable for each vessel design pressure specified herein.

E. Nozzles

1. Nozzles for connecting piping and vessel fittings shall be provided at the locations and in the sizes indicated on the Drawings. Blind flanges or plugs shall be provided for nozzles as indicated on the Drawings and shall be suitable for each vessel design pressure.

2. The number, locations, types, and sizes of the piping connections indicated are approximate and are subject to change. Submit a general arrangement drawing for acceptance by the Engineer.

F. Vessel Supports

1. Each vessel shall be provided with steel saddle supports. Suitable steel mounting plate shall be provided for attaching the legs to a concrete base, as indicated on the Drawings. The saddle supports shall be designed and coordinated with the foundation supports to provide the required clearance and to carry the vessel loads into the foundation, including seismic forces.

G. Connections

1. The ends of butt welding nozzles shall be prepared by machining. The ends of butt welding nozzles shall be internally trimmed by machining where required to match connecting pipe.

2. Unless otherwise indicated on the Drawings, vessel connections 2 inches and smaller shall be threaded connections. Vessel connections 2-1/2 inches and larger shall be flanged. All connections shall extend 6 inches from each vessel. Where differential pressure level indicating transmitters are specified, the connections on the vessel shall facilitate level measurement that spans the entire vessel height.

3. Unless otherwise indicated on the Drawings, internal and external vessel piping 2 inches and smaller shall be not less than Schedule 80.

H. Gaskets

1. Two sets of permanent gaskets for all manholes, handholes, and blind flanges shall be furnished and shipped separately. All manhole covers, handhole covers, and blind flanges shall be fitted with temporary gaskets for use during shipment and erection. The permanent gaskets shall be shipped in wooden boxes identified by vessel name. Gaskets containing asbestos are not acceptable.

I. Pressure Relief Valve

1. Safety-relief valve shall comply with the ASME Boiler and Pressure Vessel Code. Valve shall be bronze, and shall have a pressure rating of at least 150 psig WOG. Valve shall have a bottom NPT inlet, and shall incorporate a calibrated spring set to allow the valve to open at the vessel design pressure.

J. Shutoff Valves

1. All shutoff valves shall be ball valves. Valves in steel piping shall have carbon steel bodies, chrome plated or stainless steel balls, and reinforced teflon seals and seats. Shutoff valves in stainless steel tubing shall have AISI Type 316 stainless steel bodies and balls and reinforced Teflon seals and seats. Valves in the compressor discharge piping shall be suitable for the maximum compressor discharge air temperature.

K. Miscellaneous Components

1. Miscellaneous components shall be provided as required by the surge control system supplier for a complete and satisfactory working system. Miscellaneous components may include, but not be limited to, pushbuttons, selector switches, control relays, terminal strips, time delay relays, and indicating lights.

L. Surge Suppressors

1. Surge and lightning suppressors shall be non-faulting, non-interrupting, and shall protect against line-to-line and line-to-ground surges. Devices shall be solid-state metal oxide varistor (MOV) or silicon junction type, with a response time of less than 50 nanoseconds. Surge protective devices shall be applied to the incoming power to the control panel.

M. Sight Level Gauge

1. Each vessel shall be provided with a sight gauge for visual level indication. The gauges shall be clear type or magnetic flag type with a chemical-resistant valve and gauge tube assembly mounted on each vessel.

2. The gauge tube shall be fabricated of 1-inch diameter clear PVC, polycarbonate, or borosilicate glass each lined with clear PFA Teflon, as specified. An epoxy coated steel shield which does not obstruct the gauge shall be provided the full length of the gauge.

3. Alternatively, the gauge tube shall be fabricated of 1-inch diameter FEP (Fluorinated Ethylene Propylene) with flair through flange end connections. The FEP gauge tube shall have a wall thickness suitable for the rated MAWP of the vessel and the flanges shall be epoxy-coated ductile iron.

4. A graduation strip shall be mounted adjacent to or integral with the sight level gauge. The strip shall run the full length of the level gauge and shall be graduated in gallons with flags at each of the control levels indicated herein using 1-inch high black lettering over a range from zero gallons to the rated capacity of each vessel.

5. The gauge tube assembly shall be Jogler, Inc. "Model ULSS"; Pureflex, Inc. "Model Puresite"; or equal.

6. The vessel manufacturer shall provide a confirmation that the sight level gauge is included in the pressure testing of each vessel and that the gauge can withstand the test pressures of each vessel.

7. The top connection for the sight gauge shall be 6-inches below the top of the vessel. The bottom connection for the sight gauge shall be 6-inches above the bottom of the vessel.

N. Probe Well

1. Each vessel shall be provided with a probe well for level sensing instrumentation. Probe well shall be stainless steel pipe with flanged ends of at least 3-inch size at both top and bottom ends. Probe well shall be securely mounted to the side of each vessel with at least two intermediate supports and shall be provided with a drain valve at the bottom. Ball valves shall be provided on the connections for isolating the probe well from the vessel.

2. Probe well length from flange to flange shall equal to the diameter of the vessel. The distance between the connections on the vessel for the probe well shall be such that the top connection is 6-inches below the top of the vessel and the bottom connection is 6-inches above the bottom of the vessel. The length of the probe well should span the entire height of the vessel and the top and bottom flanges shall match the vessel top and bottom to enable measurement of the vessel level accurately.

3. The stainless steel probe well shall be galvanically separated from the steel vessel with dielectric fittings.

2.4 PROTECTIVE COATINGS.

A. Surface Preparation

1. All iron and steel surfaces that will receive a protective coating shall be cleaned and blasted in strict compliance with the paint manufacturer's recommendations. All mill scale, loose rust, and contaminants shall be removed before primer is applied. Surfaces shall be dry and free from grease, oil, dirt, dust, grit, rust, weld flux, slag, weld splatter, and other objectionable surfaces. Each vessel shall be cleaned by a high-speed power wire brushing or by blasting to the extent recommended by the coating manufacturer. Welds shall be scraped, chipped, and brushed to remove all weld splatter.

B. Interior Pressure Vessel Coating

1. Prepare the surface by sandblasting in accordance with Steel Structures Painting Council Specification No. 5. Immediately following the sandblasting, the interior surface shall be coated. The coating shall be approved for potable water with National Sanitation Foundation (NSF) Standard 61 certification. The coating shall be a surface primer with two additional coats of epoxy coating. All coatings shall be suitable for the interior vessel environment and shall be NSF certified. Apply no less than 3 coats in accordance with the manufacturer's printed instructions, with each coat having a dry film thickness of 5 to 10 mils. The first coat, primer, shall be blue. All additional coatings shall be gray. One quart of primer coating and one quart of each finish coat coating shall be furnished for surface touchup in the field.

C. Exterior Pressure Vessel Coating

1. All exterior iron and steel surfaces shall be shop primed with a universal primer, Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 888 Primer", or Tnemec "Series N27

S.T. Typoxy", and then given two shop coats of finish paint. The first finish coat shall be an epoxy enamel, Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series 69 Hi-Build Epoxoline II". The second finish coat shall be an aliphatic polyurethane, Ameron "Amercoat 450 HS", Carboline "Carbothane 134 HG", or Tnemec "Series 74 Endura-Shield". The shop coating, including primer, shall have a minimum dry film thickness of 10 mils. One quart of primer coating and one quart of each finish coat coating shall be furnished for surface touchup in the field.

2.5 CONTROLS.

A. General

1. Vessel water level shall be controlled by adding or venting compressed air to maintain the water level within the preset limits as specified herein.

B. Distributed Control Unit (DCU) will add compressed air to each vessel when each vessel air volume is reduced to the ADD-AIR volume specified herein. The compressed air addition will be shutoff once the total vessel air volume reaches CLOSE ADD-AIR volume.

C. DCU will release compressed air out of each vessel when the total vessel air volume reaches or exceeds the OPEN RELEASE-AIR volume specified herein. Releasing air out of each vessel will be discontinued once the total vessel air volume reaches CLOSE RELEASE-AIR volume.

D. The control volumes shall be used as follows:

Springdale:

1	Low Air Volume Alarm	627 cubic feet
2	Open Add-Air Valve	588 cubic feet
3	Close Add-Air Valve	509 cubic feet
4	Close Release-Air Valve	430 cubic feet
5	Open Release-Air Valve	390 cubic feet
6	High Air Volume Alarm	141 cubic feet

Fayetteville:

1	Low Air Volume Alarm	684 cubic feet
2	Open Add-Air Valve	647 cubic feet
3	Close Add-Air Valve	571 cubic feet
4	Close Release-Air Valve	490 cubic feet
5	Open Release-Air Valve	460 cubic feet

6	High Air Volume Alarm	136 cubic feet

E. The volumes indicated above are the volumes of air in each vessel. The vessel manufacturer shall provide water levels in inches from the bottom of the vessel for all corresponding control volumes specified herein based on the final vessel dimensions.

F. Level control system shall be by the surge tank local control panel.

G. Level Sensing Instruments.

1. The following level sensing instruments shall be provided for each vessel.

2. Level Sensing Electrode/Conductance Relays. Not used

3. Differential Pressure Level Indicating Transmitter

a. Each vessel shall be provided with a differential pressure level indicating transmitter as specified in the Pressure and Level Instruments section. Each differential pressure level indicating transmitter shall also provide a 4-20 mA signal to the DCU with the current level indication of each vessel on the SCADA/HMI. Each differential pressure level indicating transmitter shall be provided with diaphragm seals and capillary tubes on both air and water side. The capillary tube length shall be adequate to facilitate installation of the transmitter at the location shown in the Drawings. Diaphragm seal shall be flanged type, of at least 3-inch diameter.

H. Solenoid Valves.

1. Separate set of solenoid valves shall be provided for each vessel of the surge control system as indicated on the Drawings. One solenoid valve per vessel shall be provided to allow air into the appropriate vessel when each vessel air volume has reached the "Open Add-Air in Level" (42-SV-301 and 42-SV-401). One solenoid valve per vessel shall be provided to vent from each vessel when each vessel air volume has reached the "Open Release-Air Level"(42-SV-302 and 42-SV-402). All four previously mentioned shall be provided by the Surge Tank Supplier.

2. All solenoid valves shall be housed in a NEMA 4 panel, separate from the control panel, as indicated on the Drawings.

I. Local Control Panel

1. All control components shall be provided in a free-standing NEMA 4 steel local control panel, Hoffman or equal, mounted in the location indicated on the Drawings. The local control panel shall be provided with a lockable front access door with a continuous piano-type hinge, operated from a 3-point latch mechanism.

2. The local control panel shall include all required control logic to control operation of the vessel control valves as specified in the sequence of operations. The control panel shall contain power and control devices as specified herein.

3. The local control panel shall also be provided with an externally operable disconnect switch that can be locked into the "Off" position. Size shall be selected to suit the piping and hardware contained inside of the panel.

4. The power supply will be 120 volts, 60 Hz, 3-phase. Where control voltage lower than the power supply voltage is required, a suitable control power transformer shall be furnished by the surge control system supplier. A surge suppressor shall be provided to protect the panel from transient voltages.

5. Control components and indicating lights mounted through the panel front shall maintain the panel rating as specified. Interior control components shall be mounted on the back panel.

6. The panel shall be provided complete with labeled terminal strips for field wiring connections. All components shall be factory assembled and wired, requiring only the field connection of external circuitry and piping.

J. Control Switches

1. The following control switches shall be provided on the control panel.

   a. Control Power ON-OFF disconnect switch

2. Additionally, the control panel shall also be provided with the following components.

   a. Power indicating light
   b. One alarm indicating light for LOW AIR VOLUME per each vessel
   c. One alarm indicating light for HIGH AIR VOLUME per each vessel
   d. Audible alarm
   e. Alarm silence push button
   f. Push button reset for all alarms

3. Each alarm condition is transmitted to the DCU. One additional alarm shall be provided to the DCU if the Control Power is turned OFF at the control panel.

K. Level Alarms and Indicating Lights.

1. High and low level alarms shall be provided with separate, adjustable timer delays when the air volume remains too low (Low Air Volume Alarm Level) or too high (High Air Volume Alarm Level). The timer relay shall be adjustable in one-minute increments from 0 to 20 minutes, initially set to 10 minutes and adjusted as needed during commissioning. The 120V ac contacts from each timing relay shall be connected to the DCU for remote indication of each condition. Indicating lights shall also be provided on the panel front for "HIGH LEVEL" and "LOW LEVEL". Six additional normally closed dry contacts which open for "LOW LEVEL" shall be provided to relay status to the pumps. Contacts shall be rated minimum 5 amperes at 120V ac.

L. Programmable Logic Controller (PLC). Not used.

M. Control System Disabler.

1. Programming shall be provided in the DCU to disable the surge control system in case of a surge event. Surge event is described as the following:

   a. Uncontrolled shut down of one or more pumps due to loss of power to motor.
   b. Uncontrolled shut down of one of more pumps due to motor trip.
   c. Emergency stop of one or more pumps by the operator/DCU.
   d. Power loss to the entire pump station.

2. When any of the above listed events occurs, the DCU shall send a “SURGE EVENT IN PROGRESS” signal to the Surge Vessel Control Panel. The SURGE EVENT IN PROGRESS signal shall remain active for an operator adjustable time period, adjustable from the Human Machine Interface (HMI). After the time delay expires, the SURGE EVENT IN PROGRESS signal shall deactivate. When the SURGE EVENT IN PROGRESS signal is received at the surge vessel control panel, all controls on the surge control panel shall be disabled.

3. The disable time shall be adjustable in the DCU and shall be initially set to 15 minutes.

2.6 PRESSURE VESSEL ACCESSORIES

A. Accessories shall be provided on each vessel as indicated on the piping and instrumentation Drawings. The general arrangement of each vessel, including the locations of piping, manholes, accessories, and other appurtenances, shall be as indicated on the piping and instrumentation Drawings and specified herein.

B. Air Release Valves

1. For emergency operation, an automatic air release valve shall be installed on the side of each vessel. The connection on each vessel for the air release valve shall be located at the vessel volume of not more than 10 percent from the bottom of the vessel. The air release valve and its connection shall be sized such that the valve is capable of allowing at least 50 scfm of air out to the atmosphere at the design operating pressure of each vessel. Air release valve shall be designed for a minimum working pressure equal to or higher than the vessel MAWP.

2. Air release valves shall be Apco/Valve and Primer "No. 200A", GA Industries "Figure 920H", Multiplex "Crispin Type PL", or Val-Matic "No. 38".

C. Vent Silencer

1. A vent silencer shall be provided on the exhaust-air line outside the vessel level control valve panel as indicated on the Drawings. Adequate noise attenuation shall be provided at exhaust outlet such that exhaust air high frequency noise levels are attenuated at the exhaust outlet. The vent shall discharge vertically at the silencer outlet. The silencer shall be rated for outdoor installation. A rain cap shall be provided to prevent rain from entering the vent pipe and silencer. The rain cap shall open from the air pressure and shall close when air flow tops. The cap shall be of steel counter-balancing with vertical discharge. Silencer shall be as manufactured by Stoddard, Universal, or equal.

2. The noise level from the silencer at any frequency between 63 Hz and 8000 Hz shall not exceed 80 dBA at 3 feet under any operating condition. Calculations shall be provided by the silencer manufacturer indicating the attenuation and final expected noise based on air pressure in the vessel at the maximum allowable working pressure of the vessel.

3. The silencer shall be adequately supported using the required pipe supports to relieve excess loads on the connecting pipe.

D. Pressure Gauges

1. Each pressure gauge shall have a phenol case, adjustable pointer, and stainless steel rotary geared movement. Each gauge shall be accurate to within 1 percent of full scale. Gauges shall have a dial size of at least 4-1/2 inches and the units of measurement shall be indicated on the dial face.

2. Panel-mounted gauges shall have a 1/4 inch NPT connection. All other gauges shall have a 1/2 inch NPT connection. All gauges shall be provided with a shutoff valve.

3. For pressure transmitters refer to section 13563.

2.7 HYDROSTATIC PRESSURE TEST

A. Prior to painting, each vessel shall be hydrostatically pressure tested as required by the ASME Boiler and Pressure Vessel Code. At a minimum testing shall be to 1.3 times maximum allowable working pressure for a minimum of 2 hours and checked for leaks. During testing, connections shall be plugged outside each vessel. Any leaks shall be repaired, and each vessel shall be retested.

PART 3 - EXECUTION

3.1 FABRICATION

A. The surge control system shall be completely shop fabricated; no fabrication will be allowed in the field. Field work shall be limited to assembly of accessories, making piping and wiring interconnections, and testing and startup.

3.2 PROTECTION DURING SHIPMENT.

A. Pressure vessel shall be thoroughly cleaned before shipment. All weld connections, flanged connections, and other openings shall be covered with tight-fitting heavy sheet metal closures, securely attached, to prevent entry of dirt and moisture and to protect the interior of each vessel. Sheet metal closures vessel openings shall be carefully sealed with an adhesive backed waterproof cloth tape. All exposed threads shall be greased and protected with metallic or other substantial type protectors.

3.3 INSTALLATION.

A. Surge control system equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the surge control system supplier, unless exceptions are noted by the Engineer.

B. Contractor shall coordinate with the surge control system supplier regarding field services provided by the surge control system supplier. Contractor shall give the Engineer and the District written notice at least 30 days prior to the need for field services furnished by others.

C. Equipment shall not be installed or operated except by, or with the guidance of, qualified personnel having the knowledge and experience necessary to obtain proper results as specified in Equipment Installation section.

D. Each equipment unit shall be leveled, aligned, and shimmed into position. Installation procedures shall be as recommended by the equipment manufacturer and as required herein. Shimming between machined surfaces will not be permitted.

E. The surge control system supplier shall provide installation supervision and installation checks as specified herein. For installation supervision, the supplier's field representative will observe, instruct, guide, and direct the Contractor's erection or installation procedures. For installation checks, the supplier's field representative will inspect the equipment installation immediately following erection by the Contractor, and observe the tests indicated in Equipment Installation section.

3.4 FIELD HYDROSTATIC PRESSURE TEST

A. The surge control system shall undergo a field hydrostatic pressure test as a part of the pipeline hydrostatic pressure tests that are specified in Pipeline Pressure and Leakage Testing section.

3.5 FUNCTIONAL AND PERFORMANCE TESTING.

A. Startup and Testing shall be conducted in accordance with Equipment Installation section. All requirements herein are in addition to the requirements of Equipment Installation section and shall be performed and properly coordinated during the startup and testing period. Functional and performance testing shall be performed on site.

B. Functional Tests

1. Verify all electrical circuitry continuity and control settings. Operate controls manually to verify automatic operation is properly set.

C. Performance Test.

1. A dynamic test of the surge control system shall be performed in response to flow startup and stoppage. The number of pumps shall be increased, one at a time, with pump discharge pressure being recorded for each pump combination on a strip chart recorder or data logger. The pressure recorder shall be of the fast response type suitable for measuring transient pressures. The pressure recorder shall be located on the pump discharge header. This procedure shall be performed for both startup and shutdown of flow. The pump flow shutdown test shall simulate abrupt pump shutdown that would be caused by an electrical power outage. Take pressure readings for a sufficient period of time until the system pressures dampen.

2. Contractor shall provide to the Engineer a complete report of each test performed within 10 days after test completion. Reports shall include:

a. Date and time of all tests.

b. Description of method of testing, including pumping combinations, flows, pressures, method of collecting pressure records, and other pertinent data.
c. Summary of the results of pressure measurements and testing.

3.6 CLEANING AND DISINFECTION

A. After installation has been completed and all connections have been made, all vessel surfaces, interior and exterior, shall be thoroughly cleaned and disinfected in accordance with Cleaning and Disinfection of Water Pipelines section.

3.7 FIELD PROTECTIVE COATING INSPECTION AND TESTING.

A. Contractor shall perform a dry film thickness test for the interior and exterior surfaces of each vessel.

B. Contractor shall perform holiday testing for the interior and exterior surfaces of each vessel.

End of Section

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SECTION 14630 - BRIDGE CRANES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of bridge cranes, complete with trolleys and hoists, and accessories as indicated herein.

Equipment designation	Overhead Bridge Crane
Number of units	1
Equipment tag number	42-CRT-100
Equipment location	Pump Room

B. Each bridge crane assembly shall be furnished and installed in the location and arrangement indicated on the Drawing, complete with all structural members fabricated by the crane supplier and components (end trucks, wheels, bridge drive mechanism, trolley, and hoist), electric wiring (including collectors, conductor and conductor supports), controllers, pendant control station, and all other accessories necessary for a complete and properly operating installation.

C. Runway beams/crane rails are covered in the Structural and Miscellaneous Metals section.

1.2 GENERAL

A. Equipment and accessories furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that each component of the system is compatible with all other parts of the system and that all devices necessary for a properly functioning system have been provided.

2. Where two or more traveling bridge cranes are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer. Similar component parts of bridge cranes shall be from the same manufacturer to facilitate maintenance and stocking of repair parts. Whenever possible, identical units shall be furnished.

3. Each manufacturer of major equipment shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

5. Each bridge crane assembly shall be preassembled and run in the shop, then matchmarked and disassembled for shipment.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with Underwriters' Laboratories (UL) safety requirements.

3. Equipment furnished under this section shall comply with the applicable requirements of the following:

Occupational Safety and Health Standards of the U.S. Department of Labor; Subpart N, Materials Handling and Storage.

ANSI/ASME B30.10, "Hooks"

ANSI/ASME B30.11, "Monorails and Underhung Cranes"

ANSI/ASME B30.16, "Overhead Hoists (Underhung)"

For top running multiple girder electric overhead cranes:

Crane Manufacturers Association of America (CMAA) Specification No. 70, "Specifications for Electric Overhead Traveling Cranes."

For top running and under-running single girder overhead cranes:

Crane Manufacturers Association of America (CMAA) Specification No. 74, "Specification for Top Running & Under Running Single Girder Electric Overhead Traveling Cranes."

For underhung electric or manual cranes:

ANSI MH27.1, "Specifications for Underhung Cranes and Monorail Systems."

ANSI/ASME HST-2, "Performance Standard for Hand Chain Manually Operated Chain Hoists."

ANSI/ASME HST-4, "Performance Standard for Overhead Electric Wire Rope Hoists."

F. Power Supply

1. Unless otherwise indicated, power supply to the equipment shall be 480 volts, 60 Hz, 3 phase. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system. Control power voltage shall be derived from the main equipment power supply.

G. Labels

1. Each bridge, trolley, and hoist shall have a conspicuous, easy-to-read label showing manufacturer's name, crane serial number, and rated capacity. The rated capacity of the hoist shall also be shown on the load block.

H. Identification

1. Bridge cranes shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, accessories forming a part of the equipment furnished, and load test certificates shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable.

2. Drawings shall include electrical connection diagrams and schematics identifying all items requiring electrical control or power in the operation of the bridge crane assembly, and complete details and information of the power feed system.

3. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 QUALITY ASSURANCE.

A. Welding Qualifications

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

B. Manufacturer's Certification

1. The equipment manufacturer shall certify that each hoist provided has been load tested in accordance with ANSI/ASME B30.16 with a load of at least 125 percent of the rated load. A certificate shall be submitted for each hoist supplied and shall include the name of the project, the serial number on the hoist, and a description of the test performed. Testing of the equipment shall be the responsibility of the manufacturer and the certification shall be submitted before the equipment will be accepted for the project.

C. Contractor's Qualification

1. Contractor shall submit qualifications to do the work. Each bridge crane shall be designed, coordinated, and supplied by a qualified Supplier who is regularly engaged in the business of designing and assembling bridge cranes. The supplier shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years. Contractor shall submit proof of the following qualifications for the intended Supplier of each system:

a. The Supplier has the required financial capability.

b. The names of manufacturers whose products will be supplied.

c. The Supplier maintains a qualified technical staff.

d. The Supplier has the physical plant and fabricating personnel to complete the work specified.

e. The names of at least three references who are users of similar systems designed, assembled, and furnished by the Supplier.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed to operate under the following service conditions:

Seismic design requirements	See Meteorological and Seismic Design Criteria section

Type of environmental exposure	Indoor
Ambient air temperature range	60 to 104 ° F

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Each traveling bridge crane shall be designed for the specific hoist, trolley, and bridge performance and design requirements as follows:

Bridge Crane	42-CRT-100	
Use classification	CMAA, Class A	
Hoists		
Hoist and trolley arrangement	Hoist integral with trolley	
Hoisting capacity	7.5	tons
Elevation of hook at highest position	1271.85	ft
Elevation of hook at lowest position	1254.50	ft
Minimum vertical travel of lifting hook	16.5	ft
Motor type	Single	
Hook lifting speed	15	ft/min
True vertical lift required	Yes	
Trolleys		
Trolley and bridge arrangement	Underhung trolley	
Trolley type	Electric	
Motor type	Single	
Travel speed	40 to 60	ft/min

Bridges		
Bridge operation	Electric	
Motor type	Single	
Travel speed	50 to 100	ft/min
Drive chain location	See Drawings	
Crane Rails		
Size of ASCE crane rails	See Drawings	
Maximum available clearance beyond centerline of crane rail, each side	7	in
Maximum available clearance above top of crane rail	10.5	in
Elevation of top of crane rail	1272.65	ft
Operating floor elevation	1258.50	ft
Center-to-center distance	76.0	ft
Approximate length	187.5	ft
Controls		
Pendant mounting	Mounted to trolley	
Remote Control	Yes	

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable suppliers of bridge cranes shall be Accent Sales & Service Co., American Equipment Industries Inc., North American Industries, or equal.

B. Acceptable manufacturers of crane components shall be Yale, Acco, Chester, Coffing, R&M Material Handling Inc., or equal.

C. Equivalent products of manufacturers regularly producing traveling bridge crane systems, shall be subject to acceptance by Engineer.

D. All modifications necessary to accommodate the travelling bridge cranes shall be subject to acceptance by Engineer and shall be made at no additional cost to Owner.

2.4 HOISTS AND TROLLEYS

A. The hoist and trolley arrangement shall be low headroom type.

B. Hoists

1. Electric

a. Electric hoists shall consist of an electric motor, a grooved winding drum, and gearing arranged with the trolley. Antifriction bearings shall be used throughout. The winding drum shall have machined grooves designed to receive the full run of hoisting cable without overwrapping. The ratio between the diameter of the drum and the diameter of the hoisting cable shall be at least 20 to 1. At least two laps of cable shall remain on the drum when the lifting hook is in the lowest position.

b. Hoist gearing shall be spur or helical type and shall be fully enclosed in an oiltight housing. All bearings shall be antifriction type, with oil lubrication or lifetime grease packing.

c. The hoist shall be provided with mechanical and electrical load brakes arranged so that the load may be raised or lowered by electric power and automatically sustained at any position of the hook when the power is cut off. The mechanical load brake shall prevent acceleration of the load when lowering and shall completely sustain the load when brought to rest, independent of the electric brake. The electric brake shall be released whenever current is flowing to the hoist motor and shall be automatically activated when the current is shut off or interrupted. The mechanical load brake shall operate in oil in a sealed enclosure.

d. In lieu of a mechanical load brake, regenerative electric braking or dynamic electric braking may be provided along with a second electric holding brake. Regenerative or dynamic electric braking shall provide controlled braking to prevent uncontrolled acceleration of the load when the holding brake is released. The second holding brake shall be provided in addition to the electric brake for redundancy. The second holding brake shall be mounted on the gear case input shaft to engage with each stop providing redundancy on each brake engagement. Alternatively, the second holding brake may be mounted directly to the drum and provided with over-speed detection to only engage in the event of failure of the main brake and hold the load in the event of a failure anywhere in the drive train.

e. The hoist shall be provided with adjustable limit switches to stop the hoisting mechanism at the upper and lower limits of hook travel.

f. The lifting tackle shall consist of a lower block and hook, necessary sheaves, and wire rope, made especially for hoisting service. Wire rope shall be as recommended by the rope manufacturer for use on the specified drum. The lower block shall be of the safety type, with guarded sheaves. The sheaves shall have antifriction or sleeve type bearings.

C. Hooks

1. All hooks shall be a slow opening, non-fracturing, forged steel, and shall be provided with a safety latch. The hooks shall be mounted on anti-friction bearings to permit easy turning.

D. Trolleys

1. Each trolley shall have a rated capacity equal to or greater than the capacity of the corresponding hoist.

2. Each trolley frame shall be rigid. The trolley and bridge arrangement shall be as specified herein. For underhung type trolleys, the trolley frame shall be provided with lugs or wrap around side plates on both sides of the bridge. Wheels shall be double flange type for top-running trolleys, and single flange type for underhung trolleys. Wheels shall be made from rolled, forged, or cast steel, machined universal crowned or tapered treads of hardened steel. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

3. Electric

a. Electric trolley drives shall be a sealed worm or spur gear units, permanently lubricated with an oil bath. Each trolley shall be provided with a brake conforming to the governing standards. Drive wheels shall have integrally cut spur gear teeth or machine-cut gears pressed on hubs. Drive wheel treads shall be hardened.

2.5 BRIDGES

A. Each bridge shall be the single girder type, shall be rigidly supported by end trucks, and shall operate on a crane rail type of running surface. The bridge shall be constructed to accommodate the type of trolley specified. When underhung trolleys are specified, the wearing surface of the bridge's lower flanges shall be either specially fabricated flanges or standard flanges ground smooth.

B. Steel design and fabrication shall comply with applicable portions of the specifications of the American Institute of Steel Construction. Loadings, impact allowances, and allowable stresses shall be in accordance with the governing standards. Deflection of the bridge girder(s) shall not exceed 1/800 of the span, with the maximum hoist load at any point.

C. End Trucks

1. End trucks, each fabricated from structural steel members, shall be designed to distribute the loading equally to each wheel, shall be securely attached to the bridge girder by welding or with fitted bolts in reamed holes, and shall be provided with heavy gusset plates to ensure adequate rigidity and squareness. Each truck shall have heavy end plates to engage the stops located on the specified running surface. End trucks shall have a wheelbase of approximately 1/7 the bridge span. Underhung end trucks shall be provided with lugs or wrap around side plates on both sides of the track.

2. The end trucks and wheels shall be designed to operate on the specified running surface, and shall clear all fittings, anchors, and splices located on, or near, that surface.

D. Wheels

1. Bridge crane wheels shall be made of rolled, forged, or cast steel, with machined universal crowned or tapered hardened treads, designed to operate on the specified running surface. Drive wheels in each truck shall have integrally cut spur gear teeth, or machine-cut gears pressed on hubs. The other wheels in each truck shall be idlers. Axles may be either rotating or fixed type. Wheel bearings shall be permanently shielded, lifetime-lubricated, antifriction type, adequate for radial and end thrust loading.

2. For top running bridges, each end truck shall have double flange wheels and one drive wheel. For underhung bridges, each end truck shall have single flange wheels and one pair of drive wheels.

E. Bridge Drive Mechanism

1. The bridge drive shall be a CMAA A4 individual end truck type with rotating axle and shaft-mounted gearboxes. Gearing for the bridge drive mechanism shall be helical, spur, or herringbone type, made from rolled or cast steel, and shall have machine-cut teeth. All shafts shall be made from alloy steel and shall be heat treated.

2. Electric

a. The bridge drive shall consist of a single speed electric motor for single speed bridge drives, or a specially designed dual speed electric motor for two speed bridge drives, and enclosed reduction gearing.

b. The drive motor shall contain a built-in adjustable mechanical brake. The bridge brake shall be solenoid operated, adjustable shoe or disc type, acting directly on the bridge drive motor shaft.

2.6 BUMPERS AND STOPS

A. Bumpers and stops in compliance with the governing standards shall be installed on the bridge, trolley, and the specified running surface. The bumpers and stops shall be located so that no part of the bridge or trolley encroaches on the clearances specified or indicated on the Drawings.

2.7 ELECTRICAL

A. Motors

1. Motors shall be totally enclosed, high-starting torque, squirrel-cage type, designed especially for crane and hoist service and suitable for operation with the power supply specified. Motor size and speed shall be adequate to start the fully rated load capacity.

B. Controllers

1. Control of all electric hoist, trolley, and bridge motions shall all be from a single pendant push-button station or a remote control unit. Controllers shall be of the reversing, magnetic contactor type, with thermal overload protection, and shall be installed at the motor and operated from the pendant station or remote control as specified herein.

2. Bridge and trolley controllers shall be provided with adjustable frequency drives for cushioned starting and stopping.

3. Pendant Controls

    a. The pendant shall contain a separate push button for each of the following motions: off, on, hoist up and down (when electric hoists are specified), trolley forward and reverse (when electric trolleys are specified), and bridge forward and reverse (when electric bridges are specified). The pendant shall be mounted as specified herein.

    b. The pendant station shall be 4 feet above finished floor. The manufacturer shall determine the length of the pendant station cable.

    c. Push buttons shall be of the interlocking type to prevent possibility of damage to equipment should two or more buttons be pressed simultaneously. Push buttons shall be provided with a spring return to neutral and shall automatically return to the off position when pressure on the button is released.

    d. A control power transformer with one secondary lead fused and the other grounded shall be provided to reduce voltage at the push-button station to a maximum of 120 volts. The pendant control cable shall be heavy duty type with extra flexible stranding and neoprene jacket. Support for the pendant station shall be provided by a stainless steel wire rope or chain equipped with a suitable strain relief clamp for the conductor cable.

4. Remote Controls

    a. The remote control shall contain a separate push button for each of the following motions: off, on, hoist up and down (when electric hoists are specified), trolley forward and reverse (when electric trolleys are specified), and bridge forward and reverse (when electric bridges are specified).

    b. Push buttons shall be of the interlocking type to prevent possibility of damage to equipment should two or more buttons be pressed simultaneously. Push buttons shall be provided with a spring return to neutral and shall automatically return to the off position when pressure on the button is released.

    c. Remote controls shall have NEMA 4 transmitter protection, NEMA 12 receiver protection and shall be in accordance with relevant FCC regulations. The remote control shall be capable of operating in temperatures between 0° F and 130° F. Remote-operated cranes shall function such that if the control signal for any crane motion becomes ineffective, that crane motion will stop; conversely, signals received from any source other than the operating station (transmitter) shall not result in operation of any motion of the crane. The remote controller shall have a key switch, stop button, standby mode, hand strap, and a spare battery and a battery charger shall be furnished.

C. Power Feed System

1. When any part of the crane system is electrically operated, a complete electric power feed system shall be provided. The system shall consist of insulated conductors and insulated collector assemblies with copper-graphite collector shoes, and shall be U-S Safety Trolley's "Span-Guard," Conductix-Wampfler Insul-8 "8-Bar" or Duct-O-Wire "Duct-O-Bar" or equal 4 bar conductor system. The conductors shall be the completely enclosed type. The current and voltage rating of the conductors and collectors shall be not less than 90 amperes continuous duty, 135 amperes intermittent duty.

2. Stationary conductors shall be installed adjacent to the north runway, with supports and brackets as needed. Cross conductors shall be supported by angles across the top of the bridge. Collectors for hoist operation shall be installed on the hoist trolley and wired to the hoist. Conductors and collectors shall be installed in conformity with the recommendations and instructions of the system manufacturer.

3. The feeder circuit for the crane assembly will be furnished and installed under the Electrical section and at the location indicated on the Drawings. A suitable surface-mounted junction box, with all hanger brackets and other accessories required for a complete installation, shall be furnished and installed under this section at the location indicated, and the feeder circuit wired in.

D. Wiring

1. All insulated wire shall be heat resisting and shall be insulated for 600 volts.

PART 3 - EXECUTION

3.1 ERECTION

A. Each crane, hoist, and trolley shall be erected in accordance with the manufacturer's recommendations by workers who are regularly engaged in crane erecting and who are acceptable to the crane manufacturer. The orientation of installation of the hoist and trolley on each crane bridge shall be as directed by Engineer.

3.2 WIRING

A. All wiring on the bridge crane shall be installed in intermediate metal conduit in accordance with the National Electrical Code.

3.3 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the contract price.

B. FIELD TESTING

1. After complete assembly and installation, each crane shall be subject to an acceptance test. A manufacturer's representative shall be present during all testing. The inspection and testing shall verify that each crane has been assembled properly and that all required adjustments have been made.

2. Testing shall also confirm the remote control of the crane, hoist and trolley is functioning properly.

C. Acceptance Testing

1. Each crane shall be subject to operational and rated load testing.

2. Each crane shall raise, lower, hold in any position, and transport a test load equal to 125 percent of the rated capacity of the crane, with no detrimental effects on the crane. All motions shall be executed satisfactorily. Contractor shall provide the test weights.

3. The following functions shall be tested:

   a. Hoisting and lowering.

   b. Trolley travel.

   c. Bridge travel.

   d. Limit switches, locking and safety devices.

4. The trip setting of hoist limit switches shall be determined by tests with an empty hook traveling in increasing speeds up to the maximum speed. The actuating mechanism of the limit switch shall be located to trip the switch, under all conditions, in sufficient time to prevent contact of the hook or hook block with any part of the trolley.

5. Hoisting and lowering tests will be conducted with 0, 50, 100, and 125 percent of the nominal or rated load.

6. The rated load test shall consist of the following operations:

   a. The test load shall be lifted a sufficient distance to ensure that the load is supported by the crane and held by the hoist brakes.

   b. The test load shall be transported by means of the trolley for the full length of the bridge.

c. The test load shall be transported by means of the bridge for the full length of the runway in one direction with the trolley as close to the extreme right-hand end of the crane as practical and in the other direction with the trolley as close to the extreme left-hand end of the crane as practical.

d. The test load shall be lowered, stopped, and held with the brakes.

e. Wiring shall be given an insulation resistance test using a 500 volt megger.

7. Following completion of the tests, each crane shall be inspected by Contractor and the manufacturer's representative, in the presence of Engineer, for misalignment, breakage, and undue wear. All deficiencies shall be corrected by Contractor in a manner acceptable to Engineer.

D. Test Reports

1. Field inspection and testing of each crane shall be documented by the crane manufacturer's representative through the Contractor, noting the deficiencies and corrections and certifying that each crane is acceptable for operation. Certification of the inspection shall be submitted to Engineer.

End of Section

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SECTION 15010 - VALVE INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of new valves and actuators **[**purchased by Contractor as part of this Work**.**

B. Cleaning, disinfection, pressure and leakage testing, insulation, and pipe supports are covered in other sections.

C. The following specification sections are applicable to valves to be installed:

	Title
1.	Miscellaneous Ball Valves
2.	Check Valves
3.	Backflow Preventers
4.	Globe Valves
5.	Plug Valves
6.	Pressure Reducing Valves
7.	Miscellaneous Valves
8.	Hydrants and Curb Stops
9.	AWWA Butterfly Valves
10.	AWWA Ball Valves
11.	Air Valves

1.2 GENERAL

A. Equipment installed under this section shall be erected and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Any valves and actuators that are identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

C. Coordination

1. When manufacturer's field services or installation check services are provided by the valve manufacturer, Contractor shall coordinate the services with the valve manufacturer. Contractor shall give Engineer written notice at least 30 days prior to the need for manufacturer's field services.

2. Submittals for equipment that will be furnished by others under each procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

3. Flanged, push-on, and grooved connections to valves including the bolts, nuts, and gaskets are covered in the appropriate pipe specification section. Valve ends shall match piping.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 INSPECTION

A. All valves and accessories shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and re-cleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 INSTALLATION

A. General

1. Valves shall be installed with sufficient clearance for proper operation of any external mechanisms, and with sufficient clearance to dismantle the valve for in-place maintenance. Installation shall be in accordance with the valve manufacturer's recommendations.

2. Unless otherwise indicated on the Drawings or specified, all valves installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above the finish floor shall be installed with their operating stems vertical. Valves installed in horizontal runs of piping having centerline elevations between 4 feet 6 inches and 6 feet 9 inches above the finish floor shall be installed with their operating stems horizontal. If adjacent piping prohibits this, the stems and operating handwheel shall be installed above the valve horizontal centerline as close to horizontal as possible. Valves installed in vertical runs

of pipe shall have their operating stems oriented to facilitate the most practicable operation, as reviewed by Engineer.

B. Installation Checks

1. When specified in the valve sections, the valve manufacturer will provide installation checks. For installation checks, the manufacturer's field representative will inspect the valve installation immediately following installation by Contractor. The manufacturer's representatives will revisit the site as often as necessary to ensure installation satisfactory to Owner.

2. Contractor shall perform no work related to the installation or operation of materials or equipment furnished by others without direct observation and guidance of the field representative, unless Engineer and manufacturer furnishing such materials concur otherwise.

C. AWWA Butterfly Valves

1. Butterfly valves shall be installed with the shaft horizontal unless otherwise necessary for proper operation or as acceptable to Engineer.

2. Whenever an actuator must be removed to permit installation of a valve, the actuator shall be promptly reinstalled and shall be inspected and readjusted by a representative of the valve manufacturer.

D. Check Valves

1. Lift Check Valves

a. Horizontal lift checks shall be installed in a level horizontal position so that the internal parts rise and fall vertically, unless the valve is spring loaded. Angle pattern lift checks shall be installed in vertical pipe with flow upward from beneath the disc.

2. Swing Check Valves

a. Install valves oriented for the correct flow direction. Only valves designed for vertical installation shall be installed in vertical piping.

E. Plug Valves

1. Plug Valves

a. Installation of plug valves for gas service shall be according to the Plug Valve section.

F. Air Release and Combination Air Valves

1. The exhaust from each valve shall be piped to a suitable point acceptable to Engineer. Air release valve exhaust piping leading to a trapped floor drain shall terminate at least 6 inches above the floor.

G. Hydrants

1. Yard Hydrants

a. A concrete slab 18 inches square and 4 inches thick shall be provided around the top of each 3/4 inch and 1-1/2 inch yard hydrant. Hydrants shall be installed plumb. Hydrant drainage shall be provided by installing below each hydrant at least 1 cubic foot of gravel or crushed stone.
b. Each 4 inches yard hydrant shall be set on a reinforced concrete foundation at least 18 inches square and 6 inches thick. Each hydrant shall be anchored in place or adequately blocked to prevent the hydrant from blowing off the supply connection. Hydrant drainage shall be provided by installing at least 7 cubic feet of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.
c. An operating wrench shall be provided for each yard hydrant.

2. Fire Hydrants

a. Fire hydrants shall be set so that at least the minimum pipe cover is provided for the branch supply line and the nozzles are at least 12 inches above finished grade. Each hydrant shall be set on a concrete foundation at least 18 inches square and 6 inches thick. Each hydrant shall be blocked against the end of the trench with concrete or shall be suitably anchored.
b. Hydrant drainage shall be provided by installing at least 7 cubic feet of gravel or crushed stone around the hydrant and below the top of the hydrant supply pipe.
c. All hydrants shall stand plumb. Hydrants with pumper nozzles shall have hose nozzles parallel with, and the pumper nozzle perpendicular to, the curb line. Hydrants having hose nozzles 90 degrees apart shall be set so that the line bisecting the angle between the nozzles is perpendicular to the curb line. Hydrants located behind curbs, where sidewalks extend close to or abut the curb, shall be set so that no portion of the pumper or hose nozzle caps will be less than 6 inches or more than 12 inches from the gutter face of the curb. Where set between the curb and sidewalk, or between the sidewalk and property line, no portion of the hydrant or nozzle cap shall be within 6 inches of the sidewalk.
d. Immediately before installation of a fire hydrant, the following procedure shall be followed: (a) the hydrant shall be thoroughly inspected; (b) the hydrant interior shall be thoroughly cleaned; and (c) the hydrant shall be opened and closed as many times as may be necessary to determine if all parts are in proper working order, with valves seating properly and the drain valve operating freely.

H. Valve Boxes

1. Valve boxes shall be set plumb. Each valve box shall be placed directly over the valve it serves, with the top of the box brought flush with the finished grade. After each valve box is placed in proper position, earth fill shall be placed and thoroughly tamped around the box.

3.3 VALVE ACTUATORS

A. Valve actuators and accessories shall be factory mounted on the valve, calibrated, and tested by the valve or actuator manufacturer.

3.4 FIELD QUALITY CONTROL

A. Field Testing

1. After installation, all valves shall be tested in accordance with the Pipeline Pressure and Leakage Testing section.

2. Pressure Tests

   a. Pressure testing shall be in accordance with the Pipeline Pressure and Leakage Testing section.

3. Leakage Tests

   a. All valves shall be free from leaks. Each leak that is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor. This requirement applies whether pressure testing is required or not.

3.5 ADJUSTING

A. After installation, the opening and closing time shall be adjusted as needed for each pneumatic, hydraulic and electric actuated valve.

End of Section

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SECTION 15020 - MISCELLANEOUS PIPING AND ACCESSORIES INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of piping and accessories as indicated on the Drawings for the following piping sections:

1. Miscellaneous Piping and Accessories
2. Stainless Steel Pipe and Alloy Pipe, Tubing, and Accessories
3. Miscellaneous Steel Pipe, Tubing, and Accessories
4. Miscellaneous Plastic Pipe, Tubing, and Accessories
5. Cast Iron Soil Pipe and Accessories
6. Copper Tubing and Accessories

B. Contractor shall furnish all necessary jointing materials, coatings, and accessories that are specified herein.

C. Pipe supports and anchors shall be furnished by Contractor, and are covered in the Pipe Supports section. Pipe trenching and backfilling are covered in the Trenching and Backfilling section.

1.2 GENERAL

A. Coordination

1. Materials installed under this section shall be installed in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by Engineer.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but not be limited to, the following:

a. Watertight/dusttight pipe sleeves.
b. Materials as specified herein.

B. Welder Certification

1. Prior to the start of the work, Contractor shall submit a list of the welders he proposes using and the type of welding for which each has been qualified. Copy of certification and identification stamp shall be submitted for each welder. Qualification tests may be waived if evidence of prior qualification is deemed suitable by Engineer.

1.4 QUALITY ASSURANCE

A. Welding and Brazing Qualifications

1. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be submitted to the Engineer for review.

B. Tolerances

1. These tolerances apply to in-line items and connections for other lines.

2. The general dimension, such as face-to-face, face or end-to-end, face- or end-to center, and center-to-center shall be 1/8 inch .

3. The inclination of flange face from true in any direction shall not exceed 3/64 inch per foot .

4. Rotation of flange bolt holes shall not exceed 1/16 inch .

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Plastic pipe, tubing, and fittings shall be stored between 40°F and 90°F .

C. Coated Pipe

1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic-coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Pipe, tubing, and fittings covered herein shall be installed in the services indicated in the various pipe sections.

2.2 MATERIALS.

A. Threaded Fittings

1. Anti-Seize Thread Lubricant: Jet-Lube "Nikal," John Crane "Thread Gard Nickel," Never-Seez "Pure Nickel Special," or Permatex "Nickel Anti-Seize."

2. Teflon Thread Sealer: Paste type; Hercules "Real-tuff", John Crane "JC-30", or Permatex "Thread Sealant with Teflon."

3. Teflon Thread Tape: Hercules “Tape Dope” or John Crane “Thread Tape.”

B. Solvent Welded Fittings

1. Solvent Cement for PVC Systems: ASTM D2564.

2. Solvent Cement for CPVC Systems: ASTM F493.

a. Sodium Hypochlorite, Sodium Hydroxide, and Sodium Bisulfate Service: IPS Corporation “Weld-On 724.”

3. Primer for PVC Systems: ASTM F656.

C. Solder or Brazed Fittings

1. Solder: Solid wire, ASTM B32, ANSI/NSF 61 certified; Alloy Grade Sb5, (95-5).

2. Soldering Flux: Paste type, ASTM B813.

3. Brazing Filler Metal: AWS A5.8, BCuP-5; Engelhard “Silvaloy 15,” Goldsmith “GB-15,” or Handy & Harman “Sil-Fos.”

4. Brazing Flux: Paste type, Fed Spec O-F-499, Type B.

D. Insulating Fittings

1. Threaded: Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene-lined, zinc plated, Perfection Corp. “Clearflow Fittings.” Suitable for the service and temperature.

2. Flanged: Epco “Dielectric Flange Unions” or Central Plastics “Insulating Flange Unions.” Suitable for the service and temperature.

E. Pipe Insulation: See Mechanical Insulation section.

F. Watertight/Dusttight Pipe Sleeves: O-Z Electrical Manufacturing "Thruwall" and "Floor Seals," or Thunderline "Link Seals," with modular rubber sealing elements, nonmetallic pressure plates, and galvanized bolts.

1. Pipe Sleeve Sealant: Polysulfide or urethane, as specified in the Caulking section or as indicated in the Drawings.

2. Quick Disconnect for Compressed Air Service: ½ inch minimum one-way shutoff type stainless steel coupling as manufactured by Hansen, Foster, or Amflo. Socket end shall have shutoff and be attached to pipe.

G. Protective Coatings

1. Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils ; Protecto Wrap "200" or Tapecoat "CT."

2. Primer: As recommended by the tape manufacturer.

3. Coal Tar Epoxy: High build coal tar epoxy; PPG Amercoat "Amercoat 78HB Coal Tar Epoxy," Carboline "Bitumastic 300 M," Tnemec "46H-413 Hi-Build Tneme-Tar," or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy."

PART 3 - EXECUTION

3.1 INSPECTION

A. All piping components shall be inspected for damage and cleanliness before being installed. Any material damaged or contaminated in handling on the job shall not be used unless it is repaired and recleaned to the original requirements by Contractor. Such material shall be segregated from the clean material and shall be inspected and approved by Owner or his representative before its use.

3.2 PREPARATION

1. Field Measurement

a. Pipe shall be cut to measurements taken at the site, not from the Drawings. All necessary provisions shall be made in laying out piping to allow for expansion and contraction. Piping shall not obstruct openings or passageways. Pipes shall be held free of contact with building construction to avoid transmission of noise resulting from expansion.

3.3 INSTALLATION

A. General

1. All instruments and specialty items shall be installed according to the manufacturer's instructions and with sufficient clearance and access for ease of operation and maintenance.

2. Flat faced wrenches and vises shall be used for copper tubing systems. Pipe wrenches and vises with toothed jaws will damage copper materials and shall not be used. Bends in soft temper tubing shall be shaped with bending tools.

B. Pipe Sleeves

1. Piping passing through concrete or masonry shall be installed through sleeves that have been installed before the concrete is placed or when masonry is laid. Pipe sleeves installed through floors with a special finish, such as ceramic or vinyl composition tile, shall be flush with the finished floor surface and shall be provided with nickel or chromium plated floor plates. Unless otherwise indicated on the Drawings, in all other locations where pipes pass through floors, pipe sleeves shall project not less than 1 inch nor more than 2 inches above the floor surface, with the projections uniform within each area. In the case of insulated pipes, the insulation shall extend through pipe sleeves. Where the Drawings indicate future installation of pipe, sleeves fitted with suitable plastic caps or plugs shall be provided.

2. Holes drilled with a suitable rotary drill will be considered instead of sleeves for piping which passes through interior walls and through floors with a special finish.

3. Unless otherwise indicated on the Drawings, all pipes passing through walls or slabs which have one side in contact with earth or exposed to the weather shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies, or with sleeves and modular rubber sealing elements.

C. Pipe Joints

1. Pipe joints shall be carefully and neatly made in accordance with the indicated requirements.

2. Threaded

a. Pipe threads shall conform to ANSI/ASME B1.20.1, NPT, and shall be fully and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed after threading and before assembly to remove all burrs. Unless otherwise indicated, threaded joints shall be made up with teflon thread tape, thread sealer, or a suitable joint compound.

b. Threaded joints in plastic piping shall be made up with teflon thread tape applied to all male threads. Threaded joints in stainless steel piping shall be made up with teflon thread sealer and teflon thread tape applied to all male threads. Threaded joints in steel piping for chlorine service shall be made up with teflon thread tape or litharge and glycerine paste applied to all male threads.

3. Compression

a. Ends of tubing shall be cut square and all burrs shall be removed. The tubing end shall be fully inserted into the compression fitting and the nut shall be tightened not less than 1-1/4 turns and not more than 1-1/2 turns past fingertight, or as recommended by the fitting manufacturer, to produce a leaktight, torque-free connection.

4. Flared

a. Ends of annealed copper tubing shall be cut square, and all burrs shall be removed prior to flaring. Ends shall be uniformly flared without scratches or grooves. Fittings shall be tightened as needed to produce leaktight connections.

5. Soldered and Brazed

a. Where solder fittings are specified for lines smaller than 2 inches, joints may be soldered or brazed at the option of Contractor. Brazing alloy shall contain no tin.
b. Surfaces to be joined shall be thoroughly cleaned with flint paper and coated with a thin film of flux. At each joint, tubing shall enter to the full depth of the fitting socket.
c. Care shall be taken to avoid overheating the metal or flux. Each joint shall be uniformly heated to the extent that filler metal will melt on contact. While the joint is still hot, surplus filler metal and flux shall be removed with a rag or brush.**]**

6. Solvent Welded

a. Solvent welded connections shall only be used for PVC or CPVC pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations and ASTM D2855. Pipe ends shall be beveled or chamfered to the dimensions recommended by the manufacturer. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the setting time recommended by the manufacturer. Pressure testing of solvent welded piping systems shall not be performed until the applicable curing time, as set forth in Table X2.1 of ASTM D2855, has elapsed. Solvent welding shall be performed by bonding operators who have met the requirements of ASME B31.3 and A328.

7. Epoxy and Adhesive Bonded

a. Epoxy and adhesive bonded joints shall only be used for FRP pipe. All joint preparation, cutting, and jointing procedures shall comply with the pipe manufacturer's recommendations. Adhesive shall be mixed and applied in accordance with the manufacturer's recommendations. After joining, either the pipe or the fitting shall be rotated approximately one-half turn to uniformly distribute adhesive. A slight fillet of adhesive at the bond line is desirable, but all excess adhesive shall be wiped off immediately. Newly assembled joints shall be suitably blocked or restrained to prevent movement during the curing period recommended by the manufacturer.

8. Heat Fusion Bonded

a. Heat fusion bonded joints shall be used for polyethylene pipe with socket and butt fusion fittings. All joint preparation, cutting, jointing equipment, and jointing procedures shall comply with the pipe manufacturer's recommendations. The heating time, temperature, pressure applied to the joint during bonding, and cooling time shall consistently produce leaktight joints as strong as the pipe being joined.

9. Flanged

a. Flange bolts shall be tightened sufficiently to slightly compress the gasket and effect a seal, but shall not be torqued less than the minimum value required by the gasket manufacturer. Flange bolts shall not be so tight as to fracture or distort the flanges. A plain washer shall be installed under the head and nut of bolts connecting plastic pipe flanges. Anti-seize thread lubricant shall be applied to the threaded portion of all stainless steel bolts during assembly.

b. Flange bolt holes shall be oriented as follows, unless otherwise indicated on the spool drawings:
   1) Vertical flange face: Bolt holes to straddle the vertical centerline.
   2) Horizontal flange face: Both holes shall be aligned with connecting pipe.

c. Pipe sealants, thread compounds, or other coatings shall not be applied to flange gaskets unless recommended by the gasket manufacturer for the specified service and approved by Engineer.

d. Welds at orifice flanges shall have internal surfaces ground smooth to the pipe wall.

e. Slip-on flanges shall be welded inside and outside. There shall be a distance of approximately 1/16 to 1/8 inch between the edge of the fillet weld and the face of the flange. The seal weld shall be applied so that the flange face shall be free of weld spatter and does not require refacing.

f. Flat-faced flanges shall be used when mating to Class 125 flanges. Full-face gaskets shall be used with flat-faced flanges and ring gaskets shall be used with raised faced flanges.

g. Weld neck flanges shall be used with butt-weld fittings. The bore of weld neck flanges shall match the pipe wall thickness.

h. Insulating joints connecting submerged (buried) piping to exposed piping shall be installed above the maximum water surface elevation and before the first pipe support not having coated anchor bolts or adhesive-bonded concrete anchors. All submerged (buried) metallic piping shall be isolated from the concrete reinforcement. Insulating flanges shall be tested for electrical isolation after installation and bolt-up but prior to introduction of conducting fluid.

10. Welded

a. Welding shall conform to the specifications and recommendations contained in the "Code for Pressure Piping", ANSI B31.1.

b. Weld cross-sections shall be equal to or greater than the pipe wall thickness. Welds shall be smooth and continuous and shall have interior projections no greater than 1/16 inch . Backing strips or rings shall not be used except with specific prior review by Engineer as to use, material, and design. Root gap inserts

that are completely melted and consumed in the weld bead are acceptable only when reviewed in advance by Engineer.

c. Stainless steel welding shall be inert gas tungsten arc (TIG) or the direct current, straight polarity, inert gas metal arc process (MIG). Refer to section 15064 for additional stainless steel welding requirements.

d. Carbon steel welding shall be made by the shielded metal arc process.

e. For socket weld joints, fully engage the two pipe ends, then separate them by 1/16 inch prior to welding to all space for shrinkage.

11. Grooved Couplings

a. Grooves for grooved couplings shall be cut with a specially designed grooving tool. Grooves cut in steel pipe shall conform to flexible grooving dimensions, as set forth in AWWA C606, and shall be clean and sharp without burrs or check marks.

12. Push-on

a. Gasket installation and other jointing procedures shall be in accordance with the recommendations of the manufacturer. Each spigot end shall be suitably beveled to facilitate assembly. All joint surfaces shall be lubricated with a heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean.

13. Rubber-Gasketed

a. Rubber-gasketed joints for hub and spigot type cast iron soil pipe shall have plain spigot ends, without beads. Cut ends of all pipe shall be cut square, beveled, and all burrs shall be removed. Spigot ends shall be coated with a lubricant recommended by the gasket manufacturer and fully seated in the gasket. Clamps for hubless cast iron soil pipe shall be installed in accordance with the manufacturer's recommendations.

14. Other Pipe Joints

a. Coupled joints in tempered glass pipe, plastic joints in vitrified clay pipe, and other proprietary type joints shall be made in accordance with the manufacturer's recommendations and to the satisfaction of Engineer.

D. Pipe

1. Pipe shall be installed as specified, as indicated on the Drawings, or, in the absence of detail piping arrangement, in a manner acceptable to Engineer.

2. Piping shall be installed without springing or forcing the pipe in a manner which would induce stresses in the pipe, valves, or connecting equipment.

3. Piping shall be supported in conformance with the Pipe Supports section.

4. Piping shall be connected to equipment by flanges or unions as specified in the various piping sections. Piping connecting to equipment shall be supported by a pipe support and not by the equipment.

5. Water, gas, and air supply piping shall be provided with a shutoff valve and union at each fixture or unit of equipment, whether or not indicated on the Drawings, to permit isolation and disconnection of each item without disturbing the remainder of the system. Air supply piping shall be provided with sectionalizing valves and valved air inlet connections as needed for isolation of portions of the system for periodic testing. Gas supply lines to buildings shall be provided with a shutoff valve and union located above grade immediately outside the building. A capped drip leg shall be provided at the bottom of the vertical riser of gas supply piping adjacent to gas-fired appliances.

6. A union shall be provided within 2 feet of each threaded-end valve unless there are other connections which will permit easy removal of the valve. Unions shall also be provided in piping adjacent to devices or equipment which may require removal in the future and where required by the Drawings or the Specifications.

7. All air piping shall be graded to points of drainage collection where drip legs and drain valves shall be provided. Air piping shall be sized for the service conditions, with the indicated minimum sizes:

Service	Minimum Size
Air signal	1/4 inch OD
Compressed Air supply	1/2 inch OD
Bubbler drop pipes	3/4 inch
Buried piping	3/4 inch

8. Water supply piping within structures shall be arranged, and facilities provided, for complete drainage. All piping serving metering equipment shall be uniformly graded so that air traps are eliminated and complete venting is provided.

9. Stuffing box leakage from water sealed pumps shall be piped to the nearest point of drainage collection.

10. Taps for pressure gauge connections on the suction and discharge of pumping units shall be provided with a nipple and a ball type shutoff valve.

11. Drilling and tapping of pipe walls for installation of pressure gauges or switches will not be permitted.

12. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

13. Branch connections in horizontal runs of steam, air, and gas piping shall be made from the top of the pipe.

14. Buried PVC piping shall be "snaked" in the trench and shall be kept as cool as possible during installation. PVC pipe shall be kept shaded and shall be covered with backfill immediately after installation.

15. All chemical piping shall be installed so that lines are readily accessible for cleaning. Tees shall be provided at regular intervals in all chemical piping except chlorine piping, with extra openings plugged, to facilitate cleaning. Teflon thread tape or teflon thread sealer shall be applied to the threads of the plugs so that they can be easily removed. At each point where hose or reinforced plastic tubing is connected to rigid piping, a quick-disconnect coupling shall be provided.

16. Double-contained chemical feed piping shall be installed according to the manufacturer's recommendations. Joints shall be solvent cemented. Splitting and rewelding of fittings will not be acceptable. Suitable drains and vents shall be provided to permit complete drainage of both the primary and secondary containment piping. Interstitial supporting devices shall be designed to allow continuous drainage in the annular space to the drain ports. Drain fittings shall be designed to allow a valve attachment to be made so that the secondary containment compartment can be readily drained and manually inspected for leaks.

17. Polyethylene piping shall be installed in accordance with the manufacturer's recommendations. A continuous 12 AWG THHN insulated copper tracer wire shall be placed 6 inches above all portions of the buried pipe, but no more than 18 inches below the ground surface. Where the pipe extends above grade, a 2 foot length of wire shall be coiled and attached to the pipe.

18. Piping adjacent to flow sensors shall be installed in accordance with the requirements of the manufacturer of the flow sensor and commonly accepted design practices of the appropriate straight pipe runs both upstream and downstream.

19. Drains required for operation are shown on the Drawings. However, vents at all high points and drains at all low points in the piping that are required for complete draining for pressure test may not be shown on these Drawings. Contractor shall add such items as found to be necessary during detail piping design and/or piping installation.

E. Reducers

1. Eccentric reducers shall be installed flat on the bottom for steam, condensate return and digester gas services.

F. Valves

1. Isolation valves provided with equipment and instruments shall be located in a manner which will allow ease of access and removal of the items to be isolated. Prior to soldering or brazing valves, teflon and elastomer seats and seals shall be removed to prevent damage.

3.4 PIPING ASSEMBLY

A. General

1. Contractor shall only use labor that has been qualified by training and experience to capably perform the specified activities required to accomplish the work in a satisfactory manner

2. Any deviations from the Specifications or piping locations shown on the Drawings require prior review and approval by Engineer.

3.5 PROTECTIVE COATING

A. Standard weight steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating.

B. Where specified in the Miscellaneous Steel Pipe, Tubing, and Accessories section, extra strong steel pipe in buried locations will have exterior surfaces protected with a shop applied plastic coating or a shop applied tape wrap. Where not specified to be shop coated or wrapped in the Miscellaneous Steel Pipe, Tubing and Accessories section, a tape wrap shall be field applied. The exterior surfaces of all fittings, couplings, specials, and other portions of buried piping not protected with plastic coating shall be tape-wrapped in the field.

C. All surfaces to be tape-wrapped shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils . Joints in plastic-coated pipe shall be cleaned, primed, and tape-wrapped after installation.

D. Joints in galvanized steel piping in underground locations shall be field painted with two coats of coal tar epoxy coating.

E. Inspection

1. All shop-applied plastic coatings and tape wrap on pipe or fittings shall be inspected for holidays and other defects after receipt of the pipe or fitting on the job and immediately before installation. All field-applied tape wrap on pipe, joints, fittings, and valves shall be inspected for holidays and other defects following completion of wrapping. Inspection of plastic coatings after installation of the pipe or fitting in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged during installation. Holidays and defects disclosed by inspection shall be repaired in accordance with the recommendations of the coating or tape wrap manufacturer, as applicable.

2. The inspection shall be made using an electrical holiday detector. The detector and inspection procedures shall conform to the requirements of Section 4.4 of ANSI/AWWA C209.

3.6 PRESSURE AND LEAKAGE TESTING

A. All specified tests shall be made by and at the expense of Contractor in the presence, and to the satisfaction of Engineer. Each piping system shall be tested for at least 1 hour with no loss of pressure. The Contractor shall coordinate this section with the Pipeline Pressure and Leakage Testing section. Piping shall be tested at the indicated pressures:

Service	Test Pressure	Test Medium
Water supply	1-1/2 times working pressure but not less than 120 psi	Water
Gas supply	1-1/2 times working pressure but not less than 60 psi[	Compressed air
Compressed Air supply and signal (See paragraph 3-6.01)	1.2 times discharge pressure or 300 psi	Compressed air with 100 percent of all oil 0.025 micron and larger removed
Other piping	1-1/2 times working pressure but not less than 50 psi	Suitable fluid or gas; for distilled water piping, distilled water or filtered oil-free compressed air may be used

B. Compressed air or pressurized gas shall not be used for testing plastic piping unless specifically recommended by the pipe manufacturer.

C. Leakage may be determined by loss-of-pressure, soap solution, chemical indicator, or other positive and accurate method acceptable to Engineer. All fixtures, devices, or accessories which are to be connected to the lines and which would be damaged if subjected to the specified test pressure shall be disconnected and the ends of the branch lines plugged or capped as needed during the testing.

D. Unless otherwise required by the applicable codes, drainage and venting systems shall be water tested. For water testing, the drainage and venting system shall be filled with water to the level of the highest vent stack. For air testing, the system shall be charged with air to a minimum pressure of 5 psig . Openings shall be plugged as necessary for either type of test. To be considered free of leaks, the system shall hold the water or air for 30 minutes without any drop in the water level or air pressure.

E. All necessary testing equipment and materials, including tools, appliances and devices, shall be furnished and all tests shall be made by and at the expense of Contractor. Contractor shall give Engineer 5 working days advanced notice of scheduled testing.

F. All joints in piping shall be tight and free of leaks. All joints which are found to leak, by observation or during any specified test, shall be repaired, and the tests repeated.

G. Air Pressure Tests

1. Pressure tests shall be performed on all air piping systems as specified herein to conform to ASME B31.1.

2. The test pressure shall be as specified herein and shall not exceed the maximum allowable test pressure of any non-isolated component, such as vessels, compressors, blowers, or valves, in the system. The pressure in the system shall gradually be increased to not more than one-half of the test pressure, after which the pressure shall be increased in steps of approximately one-tenth of the test pressure until the required test pressure has been reached. The pressure shall be continuously maintained for a minimum duration of 10 min. It shall then be reduced to the blower rated discharge pressure held for such time as may be necessary to conduct the examination for leakage.

3. Examination for leakage detected by soap bubble or equivalent method shall be made at all joints and connections. The piping system, exclusive of possible localized instances at the compressor, blower, or valve packing, shall show no evidence of leaking.

4. Contractor shall be responsible for ensuring that all air piping is free of leaks. All joints which are found to be leaking shall be repaired and the test repeated.

3.7 CLEANING

A. The interior of all pipe, valves, and fittings shall be smooth, clean, and free of blisters, loose mill scale, sand, dirt, and other foreign matter when installed. Before being placed in service, the interior of all lines shall be thoroughly cleaned, to the satisfaction of Engineer.

B. Tin-lined copper tubing for distribution of distilled water shall be flushed and cleaned with distilled water in accordance with the tubing manufacturer's recommendations.

3.8 ACCEPTANCE

A. Owner reserves the right to have any section of the piping system which he suspects may be faulty cut out of the system by Contractor for inspection and testing. Should the joint prove to be sound, Owner will reimburse Contractor on a time-and-material basis as specified in the Contract. Should the joint prove to be faulty, the destructive test will continue joint by joint in all directions until sound joints are found. Costs for replacement of faulty work and/or materials shall be the responsibility of Contractor.

End of Section

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SECTION 15050 - BASIC MECHANICAL BUILDING SYSTEMS MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers general mechanical building system requirements as referenced from other sections and furnishing and installation of:

1. Mechanical identification

2. Seismic restraints

1.2 GENERAL

A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by the Engineer.

B. Coordination

1. Where two or more units of the same class of materials are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable local codes and ordinances, laws, and regulations which pertain to such work. In case of a conflict between these specifications and any state law or local ordinance, the latter shall govern.

E. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete information, detailed specifications, and data covering materials, parts, devices, and accessories forming a part of the materials furnished, shall be submitted in accordance with the Submittals Procedures section.

Number Plates

Product data on number plates.

A listing of equipment to receive number plates shall be submitted.

Equipment Motors

Name of Manufacturer.

Type and Model.

Horsepower (kW) rating and service factor.

Temperature rise and insulation rating.

Full load rotative speed.

Type of bearings and method of lubrication.

Net weight.

Overall dimensions.

Efficiency at full, 3/4, and 1/2 loads.

Full load current and power factor.

Locked rotor current.

Adjustable Frequency Drives

Type and model.

Name of manufacturer.

Operating speed range, rpm.

Rated bhp at maximum speed.

Efficiency at maximum speed, percent.

Maximum heat output, BTUH.

Speed at maximum heat output, rpm.

Dimensions and net weight of complete panel.

Catalog and data sheets on all components.

Electrical schematics and wiring diagrams.

B. Samples

1. Samples shall be submitted in accordance with the Submittals Procedures section.

2. Samples of color, lettering style, and other graphic representation required for each type of identification material and device shall be submitted.

3. Samples of protective coatings for equipment shall be submitted to Engineer for approval. The samples shall be at least 3 inches by 3 inches in size.

1.4 QUALITY ASSURANCE

A. Welding Qualifications

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

B. Manufacturer's Experience

1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

1.5 EXTRA MATERIALS

A. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

1. Dimensional Restrictions

a. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout

drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2. Elevation

   a. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

3. Equipment Efficiencies

   a. Unless otherwise indicated in the respective equipment paragraph, the equipment efficiency shall be in accordance with the requirements of ASHRAE Energy Standard 90.1.

4. Drive Units

   a. Drive units shall be designed for 24 hour continuous service.
      1) V-Belt Drives
         a) Each V-belt drive shall include a sliding base or other suitable belt tension adjustment. V-belt drives shall have a service factor of at least 1.5 at maximum speed based on the nameplate horsepower of the drive motor unless otherwise indicated in the specific equipment paragraph. Multiple belts shall be provided in matched sets and shall be oil resistant, non-static type. External belts and drive assemblies shall be protected by a belt safety guard constructed in accordance with OSHA requirements. The guard shall be provided with a tachometer opening.
         b) Unless otherwise indicated in the specific equipment paragraph, equipment with smaller than 10 horsepower motors shall have adjustable pitch sheaves and equipment with 10 horsepower and larger motors shall have fixed sheaves. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is selected at the mid-position of the sheave range. Fixed sheaves shall be replaced as necessary with sheaves of the proper size during the air system balancing to provide the required speed for the specified airflow.
      2) Electric Motors
         a) Motor horsepower scheduled on the Drawings are minimum motor horsepower. Larger motors shall be provided if required to meet the specified capacities for the equipment furnished. Motors furnished with equipment shall meet the following requirements.

            1. Premium efficient motors with a minimum efficiency of at least that specified in the Common Motor Requirements for Process Equipment section shall be provided where available as a standard option. All other motors shall meet the minimum efficiency standards required by the 2007 Energy Independence and Security Act.

            2. Designed and applied in accordance with NEMA, ANSI, IEEE, AFBMA, and NEC for the duty service imposed by the driven

equipment, such as frequent starting, intermittent overload, high inertia, mounting configuration, or service environment.

3. Rated for continuous duty at 40° C ambient.

4. Motors used in applications which exceed the usual service conditions as defined by NEMA, such as higher than 40° C ambient, altitude exceeding 3,300 feet , explosive or corrosive environments, departure from rated voltage and frequency, poor ventilation, frequent starting, or adjustable frequency drive applications, shall be properly selected with respect to their service conditions and shall not exceed specified temperature rise limits in accordance with ANSI/NEMA MG 1 for insulation class, service factor, and motor enclosure type.

5. To ensure long life, motors shall have nameplate horsepower equal or greater than the maximum load imposed by the driven equipment and shall carry a service factor rating as follows:

Motor Size	Enclosure	Service Factor
Fractional hp	Open	1.15
	Other Than Open	1.0
Integral hp	Open	1.15
	Other Than Open	1.0

Motors used with adjustable frequency drives shall have a 1.15 service factor on sine wave power and a 1.0 service factor on drive power.

6. Designed for full voltage starting.

7. Designed to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

8. Totally enclosed motors shall have a continuous moisture drain that also excludes insects.

9. Bearings shall be either oil or grease lubricated.

10. Motor nameplates shall indicate as a minimum the manufacturer name and model number, motor horsepower, voltage, phase, frequency, speed, full load current, locked rotor current, frame size, service factor, power factor, and efficiency.

11. Dripproof motors, or totally enclosed motors at Contractor's option, shall be furnished on equipment in indoor, above-grade, clean, and dry locations.

12. Totally enclosed motors shall be furnished on:
    (A) Outdoor equipment.
    (B) Equipment for installation below grade.
    (C) Equipment operating in chemical feed and chemical handling locations.
    (D) Equipment operating in wet or dust-laden locations.

13. Explosionproof motors shall be furnished as specified by applicable codes or as specified in other sections.

14. A manufacturer's standard motor may be supplied on packaged equipment and fans in which case a redesign of the unit would be required to furnish motors of other than the manufacturer's standard design. However, in all cases, the motor types indicated are preferred and shall be furnished if offered by the manufacturer as a standard option.

15. Motors used with adjustable frequency drives shall have insulation system meeting the requirements of NEMA MG 1, Part 31.

B. Adjustable Frequency Drives

1. Adjustable frequency drives shall be provided as indicated on the Drawings and shall be coordinated with the requirements of the associated equipment. The equipment manufacturer shall be responsible for furnishing the adjustable frequency drive, for matching the motor and the drive, and for coordinating the collection of data and the design to limit harmonics to the levels specified.

2. Adjustable frequency drives shall be as covered in the Adjustable Frequency Drives section.

2.3 MANUFACTURE AND FABRICATION

A. Welding

1. All welds shall be continuous (seal type) on submerged or partially submerged components.

B. Anchor Bolts and Expansion Anchors

1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage in Concrete and Masonry section unless otherwise indicated on the Drawings.

C. Edge Grinding

1. Sharp corners of cut or sheared edges which will be submerged in operation shall be dulled by at least one pass of a power grinder to improve paint adherence.

D. Surface Preparation

1. All iron and steel surfaces, except motors, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

2.4 MATERIALS

A. Mechanical Identification

1. Mechanical identification consisting of equipment number plates, equipment information plates, valve tags, and ductwork identification shall conform to the requirements of the Equipment and Valve Identification section and as indicated herein.

2. Number Plates

a. Hand-lettered or tape labels will not be acceptable.
b. Number plates for control equipment such as but not limited to thermostats, control stations, and emergency ventilation shutoff switches shall in addition to the specific device identification list the controlled equipment in parenthesis below the device number.

3. Piping

a. Piping identification shall be as specified in the Protective Coatings section. The lettering size, length of color field, colors, and viewing angles of identification devices shall be in accordance with ASME A13.1.

4. Valves

a. Valve tags shall indicate if the valve is normally open or normally closed.

5. Ductwork

a. Ductwork shall be identified with nameplates as specified herein, or stenciled painting. Ductwork shall be identified with the equipment number and area served, direction of airflow, and service (supply, return, mixed, exhaust, and outside air). The identification shall be located at equipment, at each side of structure or enclosure penetrations, and at each obstruction.

B. Seismic Design

1. All ductwork and piping associated with the plumbing and HVAC systems shall be provided with seismic restraints in accordance with Seismic Hazard Level (SHL) of the latest edition of the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems as specified and in accordance with the applicable building code. The seismic hazard level used to design the restraints shall be level C. Water heaters shall be restrained in accordance with the applicable plumbing code. Equipment and associated attachments and restraints shall be in accordance with the Meteorological and Seismic Design Criteria section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the manufacturer, unless exceptions are noted by the Engineer.

B. The installation of identifying devices shall be coordinated with the application of covering materials and painting where devices are applied to surfaces. All surfaces to receive adhesive number plates shall be cleaned before installation of the identification device.

End of Section

SECTION 15060 - MISCELLANEOUS PIPING AND PIPE ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous piping and pipe accessories. Miscellaneous piping shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certifications

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Miscellaneous piping materials shall be as specified herein.

B. Material Classification BR-1

BR-1 – Regular Weight	Pipe	ASTM B43, red brass, seamless, regular

Brass Pipe Gauge piping for hot/cold water.		weight.
	Fittings	ANSI/ASME B16.15, Class 125.

C. Material Classification TG-1

TG-1 – Tempered Glass Pipe Chemical resistant waste and vent piping, for plumbing systems, in non-buried locations and air plenums.	Pipe	Borosilicate glass, ASTM C 1053. Schott "Kimax", or equal.
	Fittings	Borosilicate glass, drainage pattern. Fittings and pipe shall be provided by the same manufacturer.
	Joints	Manufacturers' standard drainline coupling with compression liner, seal ring, and stainless steel band and bolt. Joints shall be "bead to bead" or "bead-to plain end" type.

D. Accessories

1. Accessories for the miscellaneous piping systems shall be as indicated.

a. Unions for brass pipe Fed Spec A-A-59617, Class 125.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 15061 - DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of ductile iron pipe. Ductile iron pipe shall be furnished complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasement, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.

B. The size, service, and locations of ductile iron pipelines are covered in the Ductile Iron Pipe Schedule. For other materials permitted as an alternative to ductile iron pipe, see the Pipeline Schedule section.

C. Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment furnished by Owner or others for installation under this Contract.

D. Pipe hangers and supports, pressure and leakage testing, cathodic protection, and cleaning and disinfection are covered in other sections. Cast iron soil pipe is covered in the Cast Iron Soil Pipe and Accessories section. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

1.2 GOVERNING STANDARDS

A. Except as modified or supplemented herein, all ductile iron pipe, fittings, and specials shall conform to the applicable requirements of the following standards and other standards named in this section:

ANSI/AWWA Standards	Title
C151	Ductile-Iron Pipe, Centrifugally Cast, For Water
C600	Installation of Ductile Iron Water Mains and Their Appurtenances
M41	Ductile Iron Pipe and Fittings - Manual of Water Supply Practices
C104	Cement Mortar Lining for Ductile Iron Pipe and Fittings
C105	Polyethylene Encasement for Ductile Iron Pipe Systems
C110	Ductile-Iron and Gray-Iron Fittings

ANSI/AWWA Standards	Title
C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C115	Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
C153	Ductile-Iron Compact Fittings

1.3 PIPE MANUFACTURER AND FIELD SERVICES

A. All ductile iron pipe, fittings, specials, bolts, gaskets, other jointing materials, and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer responsibilities, which shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials, and pipe appurtenances (except for furnished coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified test pressures and service conditions; ensuring and certifying that all pipe, fittings, specials, and other pipe materials, pipe gaskets and bolts specified herein, are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.

B. The pipe manufacturer's minimum required experience qualifications shall include manufacture of interior and buried plant piping of similar diameters of at least two water or wastewater plants with joints, linings, and coatings suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.

C. All ductile iron pipe shall be installed in accordance with the pipe manufacturer's recommendations.

D. All costs for these services shall be included in the Contract Price.

1.4 SUBMITTALS

A. General Submittals.

1. Drawings, details, specifications, and installation schedules covering all ductile iron pipe and accessories shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the submittals listed in this section.

B. ANSI/AWWA Certification

1. Certification by manufacturer (affidavit of compliance) for each item furnished in accordance with the ANSI/AWWA Standards.

C. Restrained joints details.

D. Emergency Repair Contact Info

1. Relevant contact information for emergency repair assitance, including names and telephone numbers of emergency contact persons.

E. Gasket Certifications

1. Certification of gaskets by pipe manufacturer, certifying that gasket material is suitable for test pressures and services intended.

F. ANSI/NSF 61 Certification.

1. Certification that all materials in contact with treated or potable water are ANSI/NSF 61 approved.

G. Certification of Joint Lubricant.

H. Joint Test Certification

1. Certification of proof-of-design tests for joints, including restrained joints.

I. Pipe Laying Schedule.

1. Pipe laying schedule complete with a sequence of laying and an explanation of all abbreviations used in the schedule. For long, straight pipe runs, the pipe laying schedule shall list the pipeline station and either the pipe centerline or invert elevation coordinated with the Drawings at least every 100 feet.

J. Encasement Samples

1. Two samples of the polyethylene encasement, each sample clearly identified as required by the Governing Standards and test results from an independent third party laboratory of the requirements specified in ANSI/AWWA C105/A21.5.

K. Deflection Measurement

1. The method that the Contractor proposes to use for measuring deflection of pipe joints.

L. Other Data

1. Submittal data shall clearly indicate the country of origin of pipe, fittings, flanges, restraining devices, and accessories. When requested by Engineer, certified copies of physical and chemical test results as outlined in ANSI/AWWA C151/A21.51 shall be submitted for the materials to be provided.

1.5 SHIPPING, HANDLING, AND STORAGE

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

B. Pipe, fittings, and accessories shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Hooks inserted in ends of pipe shall have broad, well-padded contact surfaces. Unpadded hooks, wire brushes or other abrasive tools shall not be permitted to come into contact with polyethylene lining if such lining is specified.

C. Contractor-furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired.

PART 2 - PRODUCTS

2.1 PIPE CLASS

A. The class of ductile iron pipe shall be as indicated in the Ductile Iron Pipe Schedule. The specified class includes service allowance and casting allowance.

Pipe Size	ANSI/AWWA Pressure Class
inches	
24	200
20 thru 14	250
12 and smaller	350

B. Pipe wall thickness for grooved and threaded end pipe shall be increased if necessary to comply with the following minimum thickness:

Pipe Size	Minimum Thickness Class	
inches	Threaded Ends (1)	Grooved Ends (2)
4-16	53	53
18	53	54
20	53	55
24	53	56

(1) Complies with ANSI/AWWA C115/A21.15 for minimum pipe wall thickness for threaded flanges.

(2) Complies with ANSI/AWWA C606 for grooved and shouldered joint ductile iron pipe.

2.2 MATERIALS

Pipe	Ductile iron, ANSI/AWWA C151/A21.51
Gaskets – All Joint Types	Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer unless another manufacturer's product is indicated. Pipe manufacturer shall submit certificates of gasket suitability certifying that the gasket materials are compatible with the joints specified, are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall be certified for chlorinated and chloraminated potable water. Gas and oil-resistant gaskets shall be made of Nitrile (NBR [Acrylonitrile Butadiene]) rubber. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.
Joint Lubricant	Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal-based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.
Fittings	ANSI/AWWA C110/A21.10 (except shorter laying lengths will be acceptable for U.S. Pipe), or ANSI/AWWA C153/A21.53, minimum working pressure rating as follows, unless indicated otherwise on the Drawings.

Fitting Size, inches	Material	Type	Min. Working Pressure Rating, psi
4 to 24	DI	Mechanical and Push-on joints	350
4 to 24	DI	Flanged joints	250

All fittings shall be ductile iron and suitable for the rated working pressure plus a surge or test pressure allowance of 100 psi or 1.5 times rated working pressure, whichever is less, without leakage or damage.

Flanged Joints	ANSI/AWWA C115/A21.15
Flanges	
Class 250 (Where identified on the Drawings)	Ductile iron, flat faced, with ANSI/ASME B16.1, Class 250 diameter and drilling.
All others	Ductile iron, Class 125, ANSI/AWWA C115/A21.15.
Flanges	All flanges shall be suitable for test pressure of 1.5 times rated pressure without leakage or damage.
Bolts	ASTM A307, chamfered or rounded ends projecting 1/4 to 1/2 inch beyond outer face of nut.

Nuts	ASTM A563, hexagonal, ANSI/ASME B18.2.2, heavy semifinished pattern.
Gaskets	ASTM D1330, Grade I rubber, full face type, 1/8 inch thick unless otherwise required by pipe manufacturer and accepted by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Mechanical Joints	ANSI/AWWA C111/A21.11, with ductile iron glands
Restrained Mechanical Joints (factory prepared spigot), 4 inch through 48 inch, working pressure rating at least 250 psi.	American "MJ coupled Joints," or Griffin U.S. Pipe "Mech-Lok." (thru 36" size only)
Restrained Mechanical Joints, (field cut spigot), 4 inch through 24 inch, working pressure rating 350 psi for 4 through 16 inch and at least 250 psi for 18 through 24 inch.	EBAA Iron "Megalug" Series 1100, Sigma "One Lok" SLDE series, or Star Pipe Products "StarGrip 3000" without exception.

Restrained mechanical joints shall be suitable for a test or working pressure plus surge pressure of the rated working pressure plus 100 psi

Wall Pipes or Castings	Mechanical joint with water stop and tapped holes; single casting or fabricated ductile iron pipe; holes sized in accordance with the details on the Drawings and provided with removable plugs.
Mechanical Joints with Tie Rods	As indicated in the Drawings.
Tie Rods	ASTM A307.
Steel Pipe	ASTM A53, Schedule 40 as indicated on the Drawings.
Washers	ANSI/ASME B18.22.1, plain steel.
Threaded Connections	ANSI/ASME B1.20.1, NPT; with boss or tapping saddle wherever wall thickness minus the foundry tolerance at the tapped connection is less than that required for 4-thread engagement as set forth in Table A.1, Appendix A, of ANSI/AWWA C151/A21.51.
Mechanical Couplings	
Couplings	Dresser "Style 38"; Smith-Blair "411 Steel Coupling"; or Romac "Style 400" or "Style 501"; without pipe stop.

Gaskets	Oil-resistant synthetic rubber gaskets shall be as recommended by the coupling manufacturer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets - All Joint Types.
Restrained Mechanical Couplings	American Pipe “Restrained Coupling Gland Joint” coordinated with mechanical couplings furnished.
Tapping Saddles	Ductile iron, with stainless steel straps and synthetic rubber sealing gasket, 250 psi pressure rating.
Watertight/Dusttight Pipe Sleeves	GPT " Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and stainless steel bolts and nuts.
Shop Coating and Lining	
Cement Mortar Lining with Seal Coat	ANSI/AWWA C104/A21.4.
Universal Primer	Manufacturer’s standard. If in contact with treated or potable water, certify as being in compliance with ANSI/NSF 61.
Asphaltic Coating	Manufacturer’s standard.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize."
Corrosion Protection	
Polyethylene Encasement	Seamless, ANSI/AWWA C105/A21.5; LLDPE - 8 mil or HDCLPE - 4 mil.
Heat-shrinkable Coating and Primer (Shrink Sleeve)	ANIS/AWWA C216, cross-linked polyethylene sheeting precoated with adhesive; minimum 80 mils; type and recovery as recommended by Shrink Sleeve manufacturer; Canusa-CPS or Berry Plastics Water Wrap.
Wax Tape and Primer	ANSI/AWWA C217, cold-applied petroleum wax primer and cold-applied petroleum wax tape; Trenton Wax-Tape and Primer.
Medium Consistency Coal Tar	Carboline "Bitumastic 50" or Tnemec "46 465 H.B. Tnemecol."

2.3 OUTLETS

A. Where a 12 inch or smaller branch outlet is indicated and the diameter of the parent pipe is at least twice the diameter of the branch, a tee, a factory welded-on boss, or a tapping saddle will be acceptable.

B. Where a 4 inch or larger branch outlet is indicated on the Drawings and the diameter of the branch pipe for a given diameter of parent pipe is less than or equal to the maximum diameter listed herein, a factory welded-on outlet fabricated from centrifugally cast ductile iron pipe will be acceptable.

Parent Pipe Diameter, inches	Max Branch Pipe Diameter, inches
8	4
10	6
12	8
14	8
16	10
18	12
20	14
24	16

C. All 30 inch and smaller branch pipe diameter welded-on outlets shall be rated for a working pressure of 250 psi, 36 inch branch diameter welded-on outlets shall be rated for a working pressure of 200 psi, and all outlets shall have a minimum factor of safety of 2.0. The pipe manufacturer shall provide test data and certification of proof of design. It is not necessary that these tests be performed on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design.

D. Welded-on outlets may be provided as a radial (tee) outlet, a tangential outlet, or a lateral outlet fabricated at a specific angle to the parent pipe (in 15 degrees increments between 45 degrees and 90 degrees from the axis of the parent pipe), as indicated on the Drawings. The fillet weld dimensions for welded-on outlets shall be as specified herein. Parent pipe and branch pipe shall meet hydrostatic test requirements in accordance with ANSI/AWWA C151/A21.51 prior to fabrication.

Radial and Lateral Outlets

Parent Pipe Diameter, inches	Branch Pipe Diameter, inches	Weld Fillet Size, inches
24 and smaller	24 and smaller	1 x 1

E. All joints on welded-on branch outlets shall be made in accordance with the latest revision of ANSI/AWWA C111/A21.11 and/or ANSI/AWWA C115/A21.15, as applicable. All outlets shall be fabricated from centrifugally cast ductile iron pipe designed in accordance with ANSI/AWWA C150/A21.50 and manufactured and tested in accordance with ANSI/AWWA C151/A21.51. Ni-Rod FC 55® electrodes manufactured by International Nickel Corporation (or an electrode with equivalent properties) shall be used in the manufacture of the fillet welds. Carbon steel electrodes will not be acceptable. Special Thickness Class 53 pipe shall be used for all branch pipe and parent pipe in 4 to 54 inch sizes. Pressure Class 350 pipe shall be used for 60 inch and 64 inch parent pipe. After welding, each fabricated outlet shall be subjected to a 15 psi air test. A soap and water solution shall be applied during the testing procedure to inspect the weld for leakage. Any welds that show air seepage shall be refabricated and retested.

F. Welded-on outlets shall be fabricated by the pipe manufacturer at its production facilities. Manufacturers of welded-on outlets shall have at least 5 years of satisfactory experience in the manufacture and performance of these products. The manufacturer shall have a documented welding quality assurance system and shall maintain resident quality assurance records based on ANSI/AWS D11.2, the Guide for Welding Iron Castings. The manufacturer shall also maintain appropriate welding procedure specifications (WPS) and procedure qualification (PQR), and welder performance qualification (WPQR) records.

G. The type of pipe end for the branch outlet shall be as specified or indicated on the Drawings. The maximum size and laying length of the welded-on branch outlet shall be as recommended by the pipe manufacturer and shall be acceptable to Engineer for the field conditions and the connecting pipe or valve.

H. At locations acceptable to Engineer, drilling and tapping of the pipe wall for

I. 2 inch and smaller pipe connections will also be acceptable, provided that the wall thickness, minus the casting allowance, at the point of connection equals or exceeds the wall thickness required for 4-thread engagement in accordance with Table A.1, Appendix A of ANSI/AWWA C151/A21.51.

2.4 JOINTS

A. Joints in buried and tunnel locations shall be mechanical or push-on type unless otherwise indicated on the Drawings or where required to connect to existing piping or to valves. Bells on wall castings and wall sleeves shall be mechanical joint type, with tapped holes for tie rods or stud bolts. All other joints shall be flanged unless otherwise indicated on the Drawings.

B. Certification of joint design shall be provided in accordance with ANSI/AWWA C111/A21.11, Performance Requirements, as modified herein. The joint test pressure shall be not less than 2

times the working pressure rating of the joint. The same certification and testing shall also be provided for restrained joints. For restrained joints, the piping shall not be blocked to prevent separation and the joint shall not leak or show evidence of failure. It is not necessary that such tests be made on pipe manufactured specifically for this project. Certified reports covering tests made on other pipe of the same size and design as specified herein and manufactured from materials of equivalent type and quality may be accepted as adequate proof of design. Any new proof-of-design testing to meet the requirements for this project shall be independently verified and the Owner shall be given the opportunity to witness the testing.

C. Unless otherwise indicated on the drawings or acceptable to the Engineer, field closure pieces shall be located away from the bends or dead ends beyond the length over which joints are to be restrained.

D. The length of pipe having restrained joints shall be as indicated on the drawings or specified. All vertical bends and eccentric reducers shall have restrained joints.

E. Flanged Joints

1. Pipe shall extend completely through screwed-on flanges. The pipe end and flange face shall be finish machined in a single operation. Flange faces shall be flat and perpendicular to the pipe centerline.

F. Mechanical Couplings

1. The piping layout for mechanical couplings shall provide a space of at least 1/4 inch, but not more than 1 inch, between the pipe ends.

2. All surfaces, including the interior surfaces of the middle rings, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall be shop coated with 16 mils liquid epoxy in accordance with ANSI/AWWA C210.

3. A ductile iron pipe factory spacer shall be provided for the piping where indicated on the drawings. The spacer shall be shop lined and coated with 16 mils of liquid epoxy. Piping surfaces within the coupling shall be shop coated with 16 mils of liquid epoxy.

4. Tie bolts shall be provided to restrain mechanical coupling connections where indicated on the Drawings. The connecting pipe shall be furnished with welded retainer rings as recommended by pipe manufacturer. The pipe manufacturer shall also coordinate the restrained connection with the pressure rating, length, and diameter dimensions of the mechanical coupling being furnished to assure proper clearance is provided for completing the restrained coupling installation.

2.5 REDUCERS

A. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

2.6 BLOWOFFS

A. Each blowoff shall be located and arranged as indicated on the Drawings.

2.7 WALL AND FLOOR PIPES

1. Wall and floor pipes shall be installed where ductile iron pipes pass through concrete walls or floors, unless otherwise indicated on the Drawings.

2. Where a flange and mechanical joint pipe piece is to connect to a mechanical joint wall pipe or casting, the bolt holes in the bell of the wall pipe or casting shall straddle the top centerline of the horizontal pipe or casting and shall align with the bolt holes in the flange and mechanical joint piece. The top centerline shall be marked on the wall pipe or casting at the foundry or fabrication shop.

3. In vertical piping, the bolt holes of flanged and mechanical joint floor pipes or castings shall be aligned with the bolt holes of the flange or mechanical joint connecting piece. The required centerline alignment and orientation of the floor pipe or casting shall be marked on the floor pipe or casting at the foundry or fabrication shop.

2.8 WALL AND FLOOR SLEEVES

A. Wall and floor sleeves shall be installed where indicated on the Drawings and shall be installed where ductile iron pipe passes through concrete walls and floors or masonry walls, unless otherwise noted. To minimize sleeve size, piping on either side of the sleeve shall be provided with a screw-on flange, grooved coupling, or mechanical coupling with anchor studs to allow the pipe to pass through the sleeve. Where required, sleeves in masonry walls may be enlarged enough for flange or other joint restraint to pass through the sleeve.

B. Where specified or indicated on the Drawings, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall or floor sleeves with the modular casing seal manufacturer. When soil may be present at wall sleeves, two sets of modular casing seals shall be installed, one at each face of the wall. Unless otherwise indicated on the Drawings, modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inch size.

2.9 SHOP COATING AND LINING

A. The interior of all pipe and fittings, unless noted otherwise, shall be cement mortar lined.

B. The exterior surfaces of all pipe and fittings which will be exposed in both interior and exterior locations shall be shop primed. Field painting of exposed exterior surfaces is covered in the Protective Coatings section. Flange faces shall be coated with a suitable rust-preventive compound. Exterior surfaces of all other pipe and fittings shall be coated with asphaltic coating.

PART 3 - EXECUTION

3.1 INSPECTION

A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation; pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the site.

3.2 PROTECTION AND CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work is completed. Before jointing, all joint contact surfaces shall be wire brushed if necessary and wiped clean.

B. Precautions shall be taken to prevent foreign material from entering the pipe during installation. Debris, tools, clothing, or other objects shall not be placed in or allowed to enter the pipe.

C. Whenever pipe laying is stopped, the open end of the pipe shall be closed to prevent entry of dirt, mud, rodents, and other material. All water in the trench shall be removed prior to removing the closure.

3.3 CUTTING PIPE

A. Cutting shall be done in a neat manner, without damage to the pipe or the lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the ends of the pipe shall be dressed with a file or a power grinder to remove all roughness and sharp edges. The cut ends of push-on joint pipe shall be suitably beveled.

B. All field cutting of existing gray cast iron pipe shall be done with mechanical pipe cutters, except where the use of mechanical cutters would be difficult or impracticable.

C. Ends of ductile iron pipe shall be cut with a portable guillotine saw, abrasive wheel, saw, milling cutter, or oxyacetylene torch. The use of hydraulic squeeze type cutters will not be acceptable. Field-cut holes for saddles shall be cut with mechanical cutters; oxyacetylene cutting will not be acceptable.

D. Contractor shall use factory prepared pipe ends unless a field cut is required for connections.

3.4 ALIGNMENT AND GRADE

A. Buried piping shall be laid to the lines and grades indicated on the Drawings and as specified. Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the values stipulated for full-length push-on joint pipe for full-length mechanical joint pipe of AWWA C600, unless specially designed bells and spigots are provided. Contractor shall submit his proposed methods to measure deflection of deflected joints in accordance with the Submittal section.

B. Whenever deflections would exceed the values stipulated in AWWA C600, either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the Drawings and as acceptable to the Engineer.

C. Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

D. Additional requirements for alignment and grade are covered in the Project Requirements and Trenching and Backfilling sections and on the Drawings.

E. Tolerances

1. Each section of pipe shall be laid to the alignment and grade indicated on the Drawings and pipe laying schedule with pipe ends within the following tolerances;

   a. +/- 0.10 foot in grade at any point
   b. +/- 0.20 foot in alignment at any point

2. In addition, piping shall be visually straight or on a smooth curve between the points of defection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances, to make connections to existing pipe, to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

3.5 LAYING PIPE

A. Buried pipe shall be protected from lateral displacement by placing the specified pipe embedment material installed as specified in the Trenching and Backfilling section. Under no circumstances shall pipe be laid in water, and no pipe shall be laid under unsuitable weather or trench conditions. Pipe embedment material and trench backfill shall be placed and compacted under and around each side of outlets and fittings to hold the pipe in proper position and alignment during the subsequent pipe jointing, embedment, and backfilling.

B. Pipe shall be laid with the bell ends facing the direction of laying, except where reverse laying is specifically acceptable to Engineer.

C. The pipe laying schedule shall be annotated during the progress of the work to show all changes made during construction for record documentation. Upon completion of the installation of the piping, the annotated pipe laying schedule shall be submitted to Engineer in accordance with the Submittals Procedures section.

3.6 JOINTS

A. Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly. Restrained joints shall be extended after they are assembled to minimize further take-up.

3.7 MECHANICAL JOINTS

A. Mechanical joints shall be carefully assembled in accordance with the pipe manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Bolts shall be uniformly tightened to the torque values listed in Appendix A of ANSI/AWWA C111/A21.11. Over tightening of bolts to compensate for poor installation practice will not be acceptable.

B. The holes in mechanical joints with tie rods shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint pieces, holes in the mechanical joint bells and the flanges shall straddle the top centerline for horizontal piping.

3.8 PUSH-ON JOINTS

A. The pipe manufacturer's instructions and recommendations for proper jointing procedures shall be followed. All joint surfaces shall be lubricated with a soap solution provided by the pipe manufacturer immediately before the joint is completed. Lubricant shall be suitable for use in potable water, shall be stored in closed containers, and shall be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

B. Pipe ends for restrained joint pipe shall be prepared in accordance with the pipe manufacturer's recommendations.

3.9 FLANGED JOINTS

A. When bolting flanged joints, care shall be taken to avoid restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern and at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer's recommendations.

B. Special care shall be taken when connecting piping to any pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges before any bolts are installed in the flanges.

C. Pump connection piping shall be free to move parallel to its longitudinal centerline while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe, so that the pump may be shifted on its foundation if necessary to properly install the

connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.

D. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts shall then be loosened and the process repeated until no movement is observed.

3.10 MECHANICAL COUPLINGS

1. Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch, but not more than 1 inch, shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

3.11 GAS AND OIL-RESISTANT GASKETS

A. Gas and oil-resistant gaskets shall be installed where specified, indicated on the Drawings, or directed by Engineer where jointing gaskets may be subject to permeation when piping passes through areas where soil may be contaminated with gas or petroleum (oil) products or organic solvents or their vapors.

3.12 CORROSION PROTECTION

A. Polyethylene Encasement

1. All buried pipe including all straight pipe, bends, tees, adapters, closure pieces, and other fittings or specials, shall be provided with at least one wrap of polyethylene encasement. Other locations where ductile iron pipe and accessories shall be double wrapped with polyethylene encasement shall be as specified herein. Where ductile iron pipe is also embedded or encased in concrete, including in locations beneath structures, the polyethylene encasement shall be installed around the pipe for 5 feet extending into each end of the concrete encasement.

2. Where the ductile iron pipe is embedded within a concrete structure wall, floor or footing, the polyethylene encasement for the pipe shall end at the outside faces of the structure. Ductile iron pipe embedded within concrete structures shall not be wrapped with polyethylene encasement.

3. All buried flanged valves, mechanical joint couplings with tie rods, mechanical couplings, restrained mechanical couplings and other pipe hamess assemblies at valves or

structure walls shall be provided with two wraps of polyethylene encasement in addition to other corrosion protection coatings as specified herein.

4. Polyethylene tube protection shall be installed in accordance with ANSI/AWWA C105/A21.5, Method A. Preparation of the pipe shall include, but shall not be limited to, removal of lumps of clay, mud, cinders, etc., prior to installation.

5. The terms "polyethylene tube protection" and "polyethylene encasement" are interchangeable and shall have the same meaning in these Contract Documents.

a. Inspection and Testing

1) Tests for preliminary acceptance of polyethylene encasement materials as required in the submittal paragraph shall be made at the expense of the Contractor.

2) At the Owner's expense, the Owner may obtain samples from the material supplied in the field and have test conducted of the requirements specified in ANSI/AWWA C105/A21.5 by an independent third-party laboratory.

B. Mechanical Joint Couplings with Tie Rods

1. The mechanical joint tie rods, bolt studs, pipe spacers and washers of buried mechanical joint couplings shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following application of the wax tape protection, the entire mechanical joint coupling assembly shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the coupling assembly.

C. Flanged Joints

1. The flange bolts and nuts on buried flanges, including valve flanges, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following application of the wax tape protection, the entire flanged joint shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene encasement shall be lapped a minimum of 12 inches with the polyethylene encasement on each side of the joint.

D. Valves

1. Buried portions of the valve and the actuator to the wrench nut shall be wrapped with two layers of polyethylene encasement as specified herein. The two wraps of polyethylene

encasement shall be lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the valve.

E. Mechanical Couplings

1. The tie bolts and nuts on all buried mechanical couplings shall be coated with two coats of medium consistency coal tar.

2. After the protective coating has been applied to the tie bolts, the entire mechanical coupling shall be encapsulated with a shrink sleeve. The shrink sleeve shall extend a minimum of 6 inches on to the pipe on each side of the coupling. A primer shall be applied to the piping on each side of the coupling prior to installing the shrink sleeve. The application of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces. Following installation of the shrink sleeve, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

F. Restrained Mechanical Couplings

1. The corrosion protection for the mechanical coupling and its tie bolts and nuts of all buried restrained mechanical coupling assemblies shall be protected with two coats of medium consistency coal tar and shrink sleeve as specified herein for buried mechanical couplings.

2. The tie rods and bolts of the coupling assembly shall be protected by wrapping them with wax tap in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

3. Following the application of the wax tape, the entire restrained mechanical coupling assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

G. Other Assemblies

1. All ferrous metal clamps, tie rods, bolts, and other components of buried joint harnesses, tapping saddles, or pipe reaction anchorages in contact with earth or other fill material and not encased in concrete, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

2. Following the application of the wax tape, the entire assembly shall be encapsulated with two wraps of polyethylene encasement lapped a minimum of 12 inches with the polyethylene encasement of the piping on each side of the assembly as specified herein.

H. Surfaces Exposed in Manholes and Vaults

1. Unless otherwise specified, all uncoated surfaces exposed in manholes and vaults shall be cleaned and coated with two coats of medium consistency coal tar. The first coat shall be dry and hard before the second coat is applied. There shall be no unprotected, bare, or uncoated ferrous metal surfaces.

3.13 CONNECTIONS WITH EXISTING PIPING

A. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner. Facilities shall be provided for proper dewatering and for disposal of all water removed from dewatered lines and excavations without damage to adjacent property.

B. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then all connections with potable water pipelines shall be cleaned and disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

3.14 CONCRETE ENCASEMENT

A. Concrete encasement shall be installed where indicated on the Drawings. A pipe joint shall be provided within 12 inches of each end of the concrete encasement. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent flotation.

3.15 REACTION ANCHORAGE AND BLOCKING

A. Concrete blocking shall be installed where indicated on the Drawings. Concrete and reinforcing steel shall be as specified in the Cast-in-Place Concrete section.

B. The blocking size shall be of the dimensions indicated on the Drawings, shall extend from the fitting to solid, undisturbed earth, and shall be installed so that all joints are accessible for repair. If adequate support against undisturbed ground cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

C. Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as indicated on the Drawings.

D. All ferrous metal clamps, rods, bolts, and other components of tapping saddles, reaction anchorages, or joint harness, subject to submergence or in contact with earth or other fill material and not encased in concrete, shall be protected from corrosion as specified in the Corrosion Protection paragraph of this section.

3.16 PRESSURE AND LEAKAGE TESTS

A. After installation, pipe and fittings shall be subjected to a pressure test and a leakage test in accordance with the Pipeline Pressure and Leakage Testing section.

B. All pipe, fittings, valves, pipe joints, and other materials which are found to be defective shall be removed and replaced with new and acceptable materials, and the affected portion of the piping shall be retested by and at the expense of Contractor.

C. All joints shall be watertight and free from visible leaks. Any visible leak which is discovered within the correction period stipulated in the General Conditions shall be repaired by and at the expense of Contractor.

3.17 CLEANING AND DISINFECTION

A. The interior of all pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean of any foreign matter until the work has been accepted. All joint contact surfaces shall be kept clean until the joint is completed.

B. After installation, all potable water pipelines shall be cleaned and disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

End of Section

SCHEDULE 15061-S01-DUCTILE IRON PIPE SCHEDULE

Size (in.)	Service	Location	ANSI/AWWA Pressure Class	Lining Material
24	Emergency Flood Drain	Buried	150	Cement Mortar
6	Potable Service Water	Buried	350	Cement Mortar

End of Schedule

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SECTION 15062 - STEEL PIPE

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of steel pipe 6 inches in diameter and larger. Steel pipe shall be furnished and installed complete with all fittings, specials, adapters, closure pieces, blowoffs, outlets, caps and plugs, temporary bulkheads, access manholes, jointing materials, pipe hangers and supports, anchors, blocking, encasements, cathodic protection, appurtenances, and accessories specified and indicated on the Drawings, and as required for proper installation and functioning of the piping.

B. Steel pipe smaller than 6 inches in diameter, light wall steel pipe, miscellaneous small piping, pipe hangers and supports, cathodic protection, pressure and leakage tests, and cleaning and disinfection are covered in other sections. Pipe trenching, embedment, and backfill are covered in the Trenching and Backfilling section.

C. The size, service, and location of steel pipelines are covered in the Pipeline Schedule section. For other materials permitted as an alternative to steel pipe, see the Pipeline Schedule section. will be permitted as an altemative to steel pipe.

D. Piping furnished hereunder shall be complete with all joint gaskets, bolts, nuts and other jointing materials required for installation of any valves and equipment, including any valves and equipment furnished by Owner or others for installation under this Contract.

1.2 GOVERNING STANDARDS.

A. Except as modified or supplemented herein, all steel pipe, fittings, and specials shall conform to the applicable requirements of the following standards:

ANSI/AWWA Standards	Title
C200	Steel Water Pipe - 6 inches and Larger
C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 inches and Larger - Shop Applied
C206	Field Welding of Steel Water Pipe
C207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. through 144 In.
C208	Dimensions for Fabricated Steel Water Pipe Fittings.
C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines

C216	Heat-Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines
C217	Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines
C602	Cement Mortar Lining of Water Pipelines in Place – 4 inches and Larger
C604	Installation of Steel Water Pipe – 4 inches and Larger
C606	Grooved and Shouldered Joints
M11	Steel Pipe – A Guide for Design and Installation

ANSI/ASME Standards	Title
B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)
B16.47	Large Diameter Steel Flanges NPS 26 through NPS 60
B18.2.1	Square and Hex Bolts and Screws (Inch Series)
B18.2.2	Square and Hex Nuts (Inch Series)
B36.10	Welded and Seamless Wrought Steel Pipe

1.3 QUALIFICATIONS

A. Pipe manufacturer shall be ISO-9001 or SPFA certified with 5 years' experience in the manufacture of steel pipe, fittings, coatings, and linings specified. All pipe, fittings, specials, coatings, linings, and appurtenances shall be fabricated at one company facility for quality control purposes, unless otherwise acceptable to the Engineer.

B. Pipe Manufacturer's Experience and Services

1. All steel pipe, fittings, specials, bolts, gaskets, other jointing materials and appurtenances shall be fabricated, lined, coated, and furnished under the direction and management of one pipe manufacturer. The pipe manufacturer's responsibilities, shall include, at a minimum; coordinating and furnishing all pipe materials, gaskets, bolts, and other jointing materials and pipe appurtenances (except for furnishing coupled joints and other similar products by a specified manufacturer) for a complete piping system that meets the specified pipe test pressure and service conditions; certifying that all pipe, fittings, specials, and other pipe materials, gaskets, and bolts specified herein are being manufactured in full accordance with the Contract Documents; preparing and submitting all submittal information and shop drawings; and making any corrections that may be required to submittal information and shop drawings.

2. The pipe manufacturer's minimum required experience qualifications shall include manufacture of interior and buried steel plant piping of similar diameters for at least two water or wastewater plants with the same type joints, linings, and coatings and suitable for the same or higher pressure rating, which has performed satisfactorily for the past 5 years.

3. All steel pipe shall be installed as specified herein and indicated on the drawings, in accordance with the pipe manufacturer's recommendations.

4. The pipe manufacturer shall provide the services of an experienced, competent, and authorized field service representative acceptable to Owner to perform all field services specified herein. The field service representative minimum required experience shall include 5 years of practical knowledge and experience installing steel pipe with joints, linings, and coatings of the pipe to be furnished. The resume of the proposed field service representative which meets the specified minimum required experience qualifications shall be submitted for review in accordance with the Submittals paragraph.

5. The field service representative shall visit the Site to advise and consult with the Contractor and check, instruct, and guide Contractor's procedures for pipe handling, laying, and jointing at the start of pipe installation for each crew and shall coordinate his services with Contractor. The field services representative shall not directly supervise the Contractor's personnel. The Contractor shall remain responsible for the piping installation work. The field service representative shall revisit the Site as often as necessary to perform an installation check.

6. Contractor shall submit a written report prepared and furnished by the field service representative certifying that Contractor's installation personnel have been properly instructed and have employed the proper pipe handling and installation procedures. Contractor shall also submit a written report prepared and furnished by the field service representative of each site visit. All reports shall be submitted in accordance with the Submittals paragraph.

7. All costs for these services shall be included in the Contract Price.

1.4 SUBMITTALS

A. General Submittals.

1. Drawings, details, specifications, installation schedules, welding procedures and welder qualifications, and other data showing complete details of the fabrication, construction, weld locations, joint details and certification, and installation of pipe, fittings, specials, and connections, together with complete data covering all materials proposed for use, shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the items listed in this Section.

B. Pipe Data and Certifications.

1. Submittals shall indicate the ASTM designation for the material from which each class of pipe is fabricated and calculations including pipe thickness, fitting reinforcement, and field welds. The following data and certifications shall be submitted:

a. Certification by pipe manufacturer for each item furnished in accordance with ANSI/AWWA Standards.
b. Restrained joint details.
c. Certification of pipe manufacturer's field services, including a copy of the initial services, and all subsequent inspection reports.
d. Field service representative's resume.
e. Emergency Repair Manual, including names and telephone numbers of emergency contact persons.
f. Certification of each type of gasket.
g. Certification of joint lubricant.
h. Certification of the proof-of-design tests for joints, including restrained joints.
i. Certification of pipe manufacturer or fabricator and certification of proof-of-design tests for welded-on outlets.
j. Fabrication schedule covering each stage of the fabrication of the pipe.
k. Laying schedule complete with a sequence of laying, and an explanation of all abbreviations used in the schedule. For long, straight pipe runs, the laying schedule shall list the pipeline station and centerline elevation at least every 100 feet.
l. The method that the Contractor proposes to use for measuring deflection of pipe joints.

C. Gasket Material Certifications.

1. The pipe manufacturer shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are suitable for the specified field test pressures and service conditions.

D. Certifications and Affidavits of Compliance:

1. Contractor shall submit all certifications and affidavits of compliance. Performing and paying for sampling and testing as necessary shall be the Contractor's responsibility. The following certifications and affidavits of compliance are required for all pipe and other products or materials furnished, as specified in ANSI/AWWA C200 and herein.

a. Mill Certificates. Material lists and steel reinforcement schedules which describe all materials to be utilized. Metallurgical test reports for steel proposed for use on the project. Chemical and physical test reports from each heat of steel that indicate the steel conforms to the Contract Documents. Records shall indicate heat of steel for each pipe joint listed in the pipe laying schedule.
b. List cross-referencing pipe mark numbers with pipe sequence numbers, heat numbers, and can numbers.
c. Hydrostatic test reports.
d. Results of production weld tests.
e. Sand, cement and mortar tests.
f. Rubber gasket tests and gaskets certification by pipe manufacturer, including a written statement from the gasket material manufacturer, certifying that the gasket materials are compatible with the joints specified and are recommended for the specified field test pressure and service conditions.
g. All materials in contact with treated or potable water are ANSI/NSF 61 approved.

h. Certification of the proof-of-design tests for rubber gasketed bell and spigot joints (stab joints), or field experience documentation, as specified.
i. Pipe temperature complies with Contract Documents prior to placing backfill material and prior to and during welding.
j. All welds were performed in conformance with these Contract Documents.
k. Affidavit of compliance for each ANSI/AWWA standard covering materials and work furnished for the project.

E. Shop Drawings

1. The Contractor shall submit Shop Drawings of piping in accordance with the requirements of ANSI/AWWA C200 and the following supplemental requirements:

a. Certified dimensional drawings of all pipe, fittings, specials, and appurtenances. The ASTM designation for the material from which each class of pipe is fabricated.
b. Production schedule for manufacturing/fabricating pipe for the work as part of Contractor's Progress Schedule. Steel pipe production schedule shall be included in all versions of the Contractor's Progress Schedule beginning with the first Progress Scheduled submittal.
c. Joint and pipe wall construction details which indicate the type and thickness of cylinder; the position, type, size and area of wire or other reinforcement; coatings and linings including holdbacks; manufacturing tolerances; maximum angular joint deflection limitations; and all other pertinent information required for the manufacture and installation of the product. Joint details and design criteria shall be submitted for all welded joint types, including beveled ends for alignment conformance and any deep butt strap joints required for control of temperature stresses.
d. Pipe design criteria sufficient to ascertain conformance of pipe and fittings with the Contract Documents. Pipe design criteria shall include, but shall not be limited to, minimum pipe diameter, minimum pipe wall thickness, pressures, external loads, yield strength, allowable fiber stress, longitudinal stress for restraint, temperature changes, lining and coating materials, and other factors used for pipe design.
e. Table(s) showing E', K, soil weight, deflection lag factor, external loads, and percent deflection from minimum to maximum cover depth shown in the Steel Pipe Schedule in one foot increments covering each size and class of pipe. Two tables shall be submitted for each size and class of pipe, one with live load and the design deflection lag factor specified herein and one without live load and a deflection lag factor of 1.0.

F. Ground Elevation and Utility Locations:

1. Prior to preparation of the pipe laying schedule, Contractor shall verify the existing ground elevations and the location and depth of all underground utilities using centerline stakes set by the Contractor at no more than 100 feet intervals. Contractor shall carefully locate and excavate utility, survey, document and submit this information to the Engineer.

2. Engineer will review this information and if necessary make adjustment to the pipeline profile. Any Drawings that are modified by the Engineer shall be reissued to the Contractor.

G. Pipe Laying Schedule Information:

1. Pipe laying schedule and marking diagrams compatible with the requirements of AWWA Manual 11 (M11) which indicate the specific number of each pipe, fitting, and special and the location and direction of each pipe fitting, and special in the completed pipeline. In addition, the pipe laying schedule shall include: the station and centerline or invert elevation coordinated with the Drawings to which the bell end of each pipe will be laid; all elements of curves and bends, both in horizontal and vertical alignment; and the limits within each reach of restrained and/or welded joints or of concrete encasement. The location of all mitered pipe sections, beveled ends for alignment conformance, and any deep butt strap joints for temperature stress control shall be clearly indicated on the diagrams.

2. The pipe laying schedule shall have a sequence of laying and an explanation of all abbreviations used in the schedule. For long, straight pipe runs, the pipe laying schedule shall list the pipeline station and either the pipe centerline or invert elevation coordinated with the Drawings at least every 100 feet.

3. Drawings showing the location and details of bulkheads for hydrostatic testing of the pipeline including details for removal of test bulkheads and repair of the lining.

4. Details and locations of closures and cutoffs for length adjustment, temporary access manholes, vents and weld lead pass holes as specified or indicated on the Drawings, and as required for construction convenience.

5. The method that the Contractor proposes to use for measuring deflection of pipe joints.

6. Annotated laying schedule showing all changes made during the progress of the Work.

H. Welding Information:

1. Submit the following prior to performing any welding work:

a. Full and complete information regarding location, type, size and extent of all welds with reference called out for Welding Procedure Specifications (WPS) numbers shall be shown on the Shop Drawings. The Shop Drawings shall distinguish between shop and field welds. Shop Drawings shall indicate welding symbols for the details of the welded joints, and the preparation of parent metal required to make them. Joints or groups of joints in which welding sequence or technique are especially important shall be carefully controlled to minimize shrinkage stresses and distortion.

b. Written welding procedures for shop and field welds (including Welding Procedure Specifications (WPS's) and Procedure Qualification Records (PQR's). All WPS used to fabricate and install pipe shall be qualified under the provisions of ANSI/AWS D1.1 – Structural Welding code – Steel or the ASME Boiler and Pressure Vessel Code (BPVC) for shop welds and ANSI/AWS D1.1 for field welds. Written WPS shall be required for all welds, both shop and field. WPS's

qualified per the ASME BPVC shall include Supplementary Essential Variables for notch-tough welding. All provisions of ANSI/AWS D1.1 pertaining to notch-tough welding shall apply.

c. Written nondestructive testing (NDT) procedure specifications and NDT personnel qualifications.

d. Current welder performance qualifications (WPQ'S) shall be submitted for each welder prior to performing any work either in the shop or field. Qualification testing shall be in accordance with ASME Section IX or AWS B2.1 and as defined in Section 4 of ANSI/AWWA C206 or ANSI/AWWA C200, as applicable.

e. Credentials of the Contractor's certified welding inspectors (CWI's) and quality control specialists for review prior to starting any welding in the shop or field. The credentials shall include, but not be limited to, American Welding Society QC-1 Certification. Other NDT quality control personnel shall be certified as required by AWS D1.1 and in accordance with written practice ASNT SNT-TC-1A.

f. All NDT data for each shop-welded and field-welded joint. This data shall include all testing on each weld joint, including re-examination of repaired welds, using visual, radiographic, magnetic particle, dye penetrant examination, ultrasonic or air test examination methods specified. Test data shall be reviewed and signed by the welding inspector(s).

g. Welder logs for field and shop welding. Logs shall list all welders to be used for the work, the welding process, position, welder stamp number, certification date and certification status for each welder.

h. A welding map showing the sequence of welds for all field welds.

i. A written weld repair procedure for each type of shop and field weld proposed for use on the project.

j. A written rod control procedure for shop and field operations demonstrating how the Contractor intends to maintain rods in good condition throughout the work. The rod control procedure shall also demonstrate how the Contractor intends to ensure that the proper rods are used for each weld.

I. Control of Temperature Stresses for Welded Joints:

1. Plan and installation instructions to avoid the accumulation of expansion and contraction to minimize temperature stresses in the pipe wall during installation and when the pipeline is in service. The plan and installation instructions shall include the sequencing of events during and after installation, including backfilling and welding, use of a lengthened bell, and other methods to control temperature stresses in the pipeline.

2. Plan for monitoring pipeline temperatures.

J. Detail Drawings.

1. Detail drawings indicating the type, number and other pertinent details of slings, strutting, and other methods proposed for pipe support and handling during manufacturing, transport, and installation. The recommended methods of handling and placement of the pipe shall be submitted as a record copy prior to transporting any pipe to the Site. All pipe handling equipment and methods shall be acceptable to the Engineer.

K. Loading and Shipping Drawings.

1. For record copy, detailed drawings indicating loading and shipping procedures that are designed to minimize damage to coating.

L. Pipe manufacturer's written Quality Assurance/Control Program.

M. Field Service.

1. Certification of pipe manufacturer's field services, including a copy of the initial services, and all subsequent inspection reports.

2. Field service representative resume.

N. Emergency Repair Manual

1. Contractor shall submit an emergency repair manual prepared and furnished by the pipe manufacturer. The manual shall include procedures for handling emergency calls and repairs; a list of stock replacement pipe sections, closures, and other parts needed for emergency repairs; names and emergency telephone numbers of pipe manufacturer's engineering staff and factory-trained field service representatives who can be contacted day or night during an emergency; response and delivery times; and installation instructions for the materials and methods used in making repairs.

1.5 SHIPPING, HANDLING, AND STORAGE

1. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section, and as specified herein.

2. Pipe, fittings, and accessories shall be handled and stored as recommended by the pipe manufacturer and shall be handled in a manner that will ensure installation in sound, undamaged condition. Equipment, tools, and methods used in handling and installing pipe and fittings shall not damage the pipe and fittings. Forks and other lifting devices shall have broad, well-padded contact surfaces.

3. Contractor-furnished pipe and fittings in which the lining has been damaged shall be replaced by and at the expense of Contractor. With the concurrence of Engineer, small and readily accessible damaged areas may be repaired as recommended by the pipe manufacturer.

4. Contractor shall repair any damage to pipe coatings and linings before the pipe is installed.

B. Stulling

1. Adequate stulling shall be designed and provided by the pipe manufacturer on all specials, fittings, and straight pipe so as to avoid damage to the pipe during handling, storage, hauling, and installation. The stulling shall be tight fitting to prevent pipe deflection and to maintain roundness of +/- 1.0 percent. Stulling shall not damage the lining. The stulling shall be placed as soon as practicable after the pipe lining is applied

and shall remain in place while the pipe is loaded, transported, unloaded, and installed at the site.

PART 2 - PRODUCTS

2.1 BASIS OF DESIGN

A. Steel pipe, fittings, and specials shall be fabricated type for pipe 14 inches and larger, and may be either fabricated or mill type for pipe 12 inches and smaller. All items shall be the sizes, dimensions, and shapes indicated on the Drawings or specified herein.

B. The specified size of fabricated pipe, fittings, and specials shall be the nominal inside diameter, in inches, where 12 inches and smaller, and the actual inside diameter of pipe lining, where 14 inches and larger. Where stab joint pipe is permitted and two or more wall thicknesses are required for pipe of the same size, pipe size may be adjusted slightly to allow the different classes of pipe to be stabbed together.

C. The specified size of mill pipe, fittings, and specials shall be the nominal pipe size as set forth in ANSI/ASME B36.10.

D. Pipe ellipticity (out-of-roundness) shall not exceed one percent.

E. Pipe design shall be performed by the pipe manufacturer. Minimum design criteria shall be as specified.

F. Pipe Wall Thickness

1. Pipe shall be designed for all conditions indicated in the Steel Pipe Schedule and on the drawings.

2. The wall thickness for internal pressure due to hoop stress shall be determined by the following formula.

   $t = (PD)/(2s)$,

   where

   t = the pipe wall thickness in inches

   s = the allowable fiber stress in psi, shall not exceed 50 percent of the minimum yield strength of the steel plate at working pressure or 75 percent of the minimum yield strength at the larger of field test pressure or working pressure plus surge pressure. The yield strength used in the calculation for cement mortar coated pipe shall not exceed 36,000 psi.. The yield strength used in the calculation for cement mortar lined pipe shall not exceed 46,000 psi..

P = the pipe working pressure or the larger of field test pressure or working pressure plus surge pressure in psi.

D = the pipe outside diameter, in inches, of straight pipe sections or the larger outside diameter of tapered sections.

3. Unless otherwise indicated, the working pressure and the working pressure plus surge pressure shall be as indicated in the Steel Pipe Schedule.

4. The pipe wall thickness shall be in accordance with ANSI/AWWA M11, except that all pipe shall have a wall thickness of at least 1/4 inch, and a diameter to wall thickness ratio not to exceed 165 unless otherwise indicated in the steel pipe schedule.

5. Pipe wall thickness shall be constant for the entire length of pipe for each pipe class, location, or service indicated in the Steel Pipe Schedule unless otherwise indicated on the drawings or specified.

6. External loads on buried pipe shall be based on the prism load and the following design conditions.

Maximum pipe deflection, percent of nominal pipe diameter	2.5 percent
Minimum design cover depth	See Steel Pipe Schedule
Maximum design cover depth	See Steel Pipe Schedule
Total design external load on pipe	See Steel Pipe Schedule
E', Modulus of Soil Reaction	1,400 psi
K, Bedding Constant	0.090
Weight of soil	120 lbs/cu. ft.
Deflection Lag Factor	1.25
Live load	AASHTO HS-20
Impact Factor	1.5

7. The maximum pipe deflection shall be reduced if required by the jointing system furnished.

8. Cement mortar lining or coating shall not be used in the pipe deflection calculations.

9. The pipe shall be designed to withstand full internal vacuum (0 psia) under the buried conditions and for external loading under the flood conditions at ground surface or as otherwise indicated on the Drawings, when empty.

G. Fitting Dimensions

1. The dimensions of steel pipe fittings shall be as indicated on Figures 1-15062(A) and 1-15062(B) and shall be designed by the pipe manufacturer. Any fittings used for buried vertical bends and buried eccentric reducers shall be restrained.

H. Reinforcement of Fittings and Specials

1. Whether or not shown on the drawings, all bends, fittings, branch connections, reducers, and special sections shall be reinforced, or the pipe wall thickness shall be increased, so that the combined stresses due to internal pressure (circumferential and longitudinal) and bending will not exceed the allowable stresses specified in the Pipe Wall Thickness paragraph. Where external piping reinforcement interferes with other construction the pipe wall thickness shall be increased and external reinforcement eliminated as necessary for acceptable clearances.

2. Where suspended, the design of reinforcement or wall thickness shall also take into consideration the weight of the piping and appurtenances full of water. Where buried, the design of reinforcement or wall thickness shall also take into consideration the external load.

3. Wall thicknesses of reducing sections shall be not less than the required thicknesses for the larger ends.

I. Joints

1. Acceptable joints of the type indicated on the Drawings and as specified herein shall be provided for all pipe installations in the locations indicated or accepted by Engineer. To facilitate installation, additional field-welded or mechanically coupled joints may be provided, but shall be kept to a minimum, and their locations shall be acceptable to Engineer. Field-welded joints shall not be used in pipe smaller than 30 inches, except in locations where the interior coating can be satisfactorily repaired and inspected.

2. Buried pipelines shall have lap-welded joints unless otherwise specified or indicated on the drawings. Restrained joints shall be lap-welded unless otherwise specified or indicated on the drawings.

3. Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly. The pipe manufacturer shall furnish a metal gauge or other tools as required to measure joints.

2.2 MATERIALS.

Pipe, Fittings, and Specials	ANSI/AWWA C200. All steel shall be fully killed, with a maximum carbon content of 0.25 percent, made to a fine austenitic grain size practice, and manufactured from continuous cast steel. Minimum yield strength (point) for the grade of steel used shall not exceed 46,000 psior be less than 36,000 psi
Gaskets – All Joint Types	Synthetic rubber unless otherwise specified; natural rubber will not be acceptable. All gaskets shall be furnished by the pipe manufacturer, unless another manufacturer's product is specified. Pipe manufacturer shall submit certificates of gasket suitability, certifying that the gasket materials are compatible with the joints specified and are recommended for the specified field test pressure and service conditions. Gaskets for treated or potable water service shall also be certified for chlorinated and chloraminated potable water.
	Gas and oil-resistant gaskets shall be made of Nitrile (NBR) rubber unless a different gasket material is recommended by the pipe manufacturer and accepted by the Engineer. The name of the material shall be permanently marked or molded on the gasket. Gaskets shall also be certified as suitable where soils may be contaminated with gas and oil products.
Joint Lubricant	Vegetable-based lubricant recommended by the pipe manufacturer. Petroleum or animal-based lubricants will not be acceptable. Lubricants that will be in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.
Flanged Joints	
Flanges	ANSI/AWWA C207, slip-on, except where otherwise specified or indicated on the Drawings.
Dimensions and Drilling	ANSI/AWWA C207, Class D except as otherwise indicated on the Drawings or specified.
Blind Flanges	ANSI/AWWA C207, Class D except as otherwise indicated on the Drawings or specified.
Gaskets	ANSI/AWWA C207. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets – All Joint Types.
Insulated Flanges	
Flanges	As specified herein, except bolt holes shall be enlarged as needed to accept bolt insulating sleeves.

Insulation Kits	As manufactured by Advanced Products or Pipeline Seal and Insulator, Inc.
Insulating Gaskets	Type E, G10, 1/8 inch thick, with Nitrile or EPDM sealing element unless otherwise required by pipe manufacturer and acceptable by Engineer. Pipe manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets – All Joint Types.
Bolt Insulating Sleeves	G-10, 1/32 inch thick.
Insulating Washers	G-10, 1/8 inch thick, two for each flange bolt.
Backing Washers	Steel, 1/8 inch thick, two for each flange bolt.
Flange Bolting	
Material	ANSI/AWWA C207, unless otherwise required by the pipe manufacturer including higher strength and accepted by the Engineer.
Type	Bolt and nut; bolt-stud and two nuts permitted for 1 inch and larger.
Bolts and Bolt-Studs	
Length	As required for ends to project 1/4 to 1 inch beyond outer face of nut.
Ends	Chamfered or rounded.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2A fit. Bolt-studs may be threaded full length.
Bolt Head Dimensions	ANSI/ASME B18.2.1; regular pattern for square, heavy pattern for hexagonal.
Nuts	Hexagonal.
Dimensions	ANSI/ASME B18.2.2, heavy, semi-finished pattern.
Threading	ANSI/ASME B1.1, coarse thread series, Class 2B fit.
Coupled Joints	
Mechanical Couplings	

Gaskets	Gaskets shall be as recommended by the coupling manufacturer. Coupling manufacturer shall submit certification of gaskets furnished as indicated above under Gaskets – All Joint Types.
Full Ring Type	
Insulating	Baker "Series 216", Dresser "Style 39", or Smith-Blair "416"; without pipe stop.
All Others	Baker "Series 200", Dresser "Style 38", or Smith-Blair "411 Steel Coupling"; without pipe stop.
Dismantling Joints	
Restrained 3 inch and larger. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.	Romac "DJ400", Dresser "Style 131 Dismantling Joint", or Viking Johnson. For use in potable water systems, coating to be in accordance with NSF-61.
Restrained Joints	
Welded	ANSI/AWWA C200 and C206.
Lugs or Collars	ASTM A283, Grade B or C; or ASTM A36.
Tie Bolts	ASTM A193, Grade B7.
Threading	ANSI/ASME B1.1, Class 2A fit, coarse thread series for 7/8 inch and smaller, and 8-thread series for 1 inch and larger.
Ends	Chamfered or rounded.
Nuts	Hexagonal, ASTM A194, Grade 2H or better.
Threading	As specified for tie bolts, except Class 2B fit.
Dimensions	ANSI/ASME B18.2.2, heavy semifinished pattern.
Flat Washers	Hardened steel, ASTM A325.
Small Branch Connections	
Pipe Nipples	Seamless black steel pipe, ASTM A53, standard weight (Schedule 40).
Welding Fittings	

Threaded Outlets	Bonney Forge "Thredolets" or Flowserve/Vogt "Weld Couplets".
Welded Outlets	Bonney Forge "Weldolets" or Flowserve/Vogt "Weld Couplets".
Coatings and Linings	All materials in contact with treated or potable water shall be certified as being in compliance with ANSI/NSF 61.
Liquid Epoxy	ANSI/AWWA C210.
Polyurethane	AWWA C222
Cement Mortar	ANSI/AWWA C205 and C602.
Cement	ASTM C150, Type II.
Sand	ANSI/AWWA C205, Section 4.2.3, except sand for field-applied lining shall pass a No. 16 sieve.
Epoxy Bonding Agent	ASTM C881, Type II, moisture insensitive and suitable for service conditions.
Latex Admixture	Euclid "Flex-Con" or Sika "SikaLatex".
Universal Primer	Pipe manufacturer's standard.
Watertight/Dusttight Pipe Sleeves	"GPT Link-Seal", insulating type with modular rubber sealing elements, nonmetallic pressure plates, and stainless steel bolts and nuts.
Anti-Seize Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Bostik/Never-Seez "Pure Nickel Special" or Permatex "Nickel Anti-Seize".
Anchor Bolts	ASTM A307.
Corrosion Protection	
Heat–shrinkable Coating and Primer (Shrink Sleeve)	ANSI/AWWA C216, cross-linked polyethylene sheeting precoated with adhesive; minimum 80 mils; type and recovery as recommended by Shrink Sleeve manufacturer; Canusa-CPS or Berry Plastics Water Wrap.
Underlying Sleeve	Heavy cross-linked polyethylene backing; Canusa-CPS I2/PE Backing.
Wax Tape and Primer	ANSI/AWWA C217. Cold-applied petroleum wax primer and cold-applied petroleum wax tape; Trenton Wax-Tape and Primer.
Medium Consistency Coal	Carboline "Bitumastic 50" or Tnemec "46-465 H.B. Tnemecol".

Tar	

2.3 ENDS OF SECTIONS.

A. For Field Welding

1. Ends of pipe, fittings, and specials for joints butt-welded in the field shall have the ends beveled for butt welding in accordance with the governing standards.

2. Ends of pipe, fittings, and specials for field-welded lap joints, Figures 3-15062(A) and 3-15062(B), shall have both the bell and the spigot expanded by pressing, if necessary, (not rolling) to obtain the required shape and welding tolerances.

B. For Fitting with Flanges

1. Ends to be fitted with slip-on flanges shall be prepared to accommodate the flanges in accordance with the governing standards.

C. For Mechanical Couplings

1. Ends to be joined by mechanical couplings shall be plain end type. Pipe seam welds on ends to be joined by mechanical couplings without pipe stops shall be ground flush to permit slipping the coupling in at least one direction to clear the pipe joint. The welds on ends to be joined by split ring type couplings shall be ground flush to allow uniform contact of the shoulder and pipe wall. Outside diameter and out-of-round tolerances shall be within the limits specified by the coupling manufacturer.

2. Where retainer rings for split ring mechanical couplings are required to be fixed to the ends of pipe to provide restraint within a mechanical coupling, at least one of the restraint rings shall be welded in place in the field to assure the coupling is installed with the pipe in a fully-extended position.

D. For Connection to Dissimilar Pipe Materials

1. Steel pipe connections to buried cast or ductile iron pipe shall be made with insulated flanges.

2.4 SEAMS

A. Except for seamless mill-type pipe, all piping shall be made from steel plates rolled into cylinders or sections thereof with the longitudinal seams butt-welded, or shall be spirally formed and butt-welded. There shall be not more than two longitudinal seams. Girth seams shall be butt-welded and shall be spaced not closer than 10 feet apart except in specials and fittings.

2.5 PIPE LENGTHS

A. Straight pipe section lengths shall be pipe manufacturer's standard lengths, unless otherwise indicated on the Drawings.

B. All pipe to be connected with mechanical couplings shall be fabricated so that the space between pipe ends within the couplings will not exceed the amount recommended by the coupling manufacturer, but shall be at least 1/2 inch.

2.6 SMALL BRANCH CONNECTIONS

A. Branch connections 2-1/2 inches and smaller shall be made with welding fittings with threaded outlets. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch, a 1 inch outlet shall be provided and reducing bushings used as needed.

B. Branch connections sized 3 through 12 inches shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing requirements.

C. Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.

2.7 DRAINS AND VENTS

A. Pipe used for drain and vent piping shall be ASTM A53, standard weight, black steel pipe. Drain and vent valves shall comply with the requirements of the valves section.

2.8 FLANGED JOINTS

1. Flange faces of flanged joints shall be normal to the pipe axis. Angular deflection (layback) of the flange faces shall not exceed the allowable set forth in ANSI/AWWA C207. All flanges shall be refaced after welding to the pipe, if necessary to prevent distortion of connecting valve bodies from excessive flange bolt tightening and to prevent leakage at the joint.

2. Pipe lengths and dimensions and drillings of flanges shall be coordinated with the lengths and flanges for valves, pumps, and other equipment to be installed in the piping. All mating flanges shall have the same diameter and drilling and shall be suitable for the pressures to which they will be subjected.

3. Flanges shall be of the slip-on type, except that welding-neck or slip-on flanges welded to short lengths of pipe shall be used where installation of flanges in the field is permitted or required.

4. For welding neck flanges, the pipe shall be concentrically reduced as necessary for proper alignment of the pipe wall with the welding neck flange for butt welding. The interior of the weld joint and flange shall be cement lined in the shop as specified in ANSI/AWW C205.

2.9 MECHANICAL COUPLINGS

A. The middle ring of mechanical couplings shall have a thickness at least equal to the wall thickness specified herein for the size of pipe on which the coupling is to be used. If the coupling manufacturer's standard thickness is less, that thickness may be used unless allowable pressures are exceeded. The length of each middle ring shall be not less than 10 inches for 36 inches and larger pipe and not less than 7 inches for pipe smaller than 36 inches.

B. Middle rings shall be shop galvanized and the remaining components shall be cleaned and shop primed with 2 mils of a universal primer.

C. All surfaces, including the interior surfaces of the middle rings, shall be prepared for coating in accordance with the coating manufacturer's instructions and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210.

D. Factory pipe spacers shall be provided where indicated on the drawings. The spacers shall be factory coated and lined with 16 mils of liquid epoxy.

2.10 DISMANTLING JOINTS

A. Dismantling joints shall be provided for restrained couplings 6 inches and larger. Dismantling joints shall comply with AWWA C219 and shall be restrained flange by flange couplings manufactured as a single unit. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.

B. The inner and outer surfaces of dismantling joints, except flange mating surfaces, shall be prepared for coating in accordance with instructions of the coating manufacturer and shall then be coated with liquid epoxy in accordance with ANSI/AWWA C210. The flange mating surfaces shall be cleaned and shop primed with universal primer.

2.11 RESTRAINED JOINTS

A. Restrained joints shall be flanged, welded, flanged coupling adapters with anchor studs, split ring fixed type couplings, rigid groove couplings, or harnessed, as specified or as indicated on the Drawings.

B. Where indicated on the Drawings, mechanically coupled or stab type joints shall be restrained with harness bolts and lugs or collars. Joint harnesses shall conform to the details indicated on the Drawings. Lugs or collars shall be shop welded to the pipe and coated as specified for the adjacent pipe.

C. Any fittings used for buried vertical bends and eccentric reducers shall be restrained.

2.12 PROTECTIVE COATINGS AND LININGS

A. All steel pipe, fittings, specials, wall fittings, and accessories shall be lined, coated, or wrapped as specified herein.

B. Type of Coating and Lining

1. Surface preparation shall be in accordance with the pipe manufacturer's and coating and lining manufacturer's instructions. Types of protective coating and lining shall be as follows:

Exterior Surfaces in Interior Locations	Shop-applied universal primer. Field painting is covered in the Protective Coatings section.
Exterior Surfaces Underground, Including those Encased in Concrete	Polyurethane, AWWA C222. The governing standards shall be as modified herein.
Interior Surfaces	Cement mortar - shop applied, ANSI/AWWA C205. The governing standards shall be as modified herein.
Pipe Joints	
Couplings	Shop coating as specified for each type of coupling. Field coating as specified for ends of sections in the Joint Holdbacks and Coatings and Linings paragraph and the Corrosion Protection paragraph for buried couplings.
Ends of Sections	As specified in the Joint Holdbacks and Coatings and Linings paragraph.
Machined Surfaces	Rust-preventive compound.
Blind Flanges	Shop coat with 20 mil dry film thickness of liquid epoxy in accordance with ANSI/AWWA C210.

C. Modifications to the Governing Standards

1. Cement Mortar Lining

a. Cement mortar lining for all pipe shall be shop applied Except as modified herein, shop-applied mortar linings shall comply with ANSI/AWWA C205.

1) Specials. Wire fabric reinforcement shall be used in the lining of fittings and specials in accordance with ANSI/AWWA C205.

2) Adjacent to Valves. If the specified nominal pipe size is the actual outside diameter, cement mortar lining installed in steel pipe adjacent to butterfly valves shall be tapered so that the lining material will not interfere with the valve disc during valve operation.

2.13 MARKING

A. In addition to the pipe markings required by ANSI/AWWA C200, each pipe section, fitting, and special shall be clearly marked to indicate the service, the wall thickness, and the minimum yield strength of the pipe material. Pipe piece identification shall be shown on both the inside and outside of each pipe section, fitting, and special.

2.14 SHOP INSPECTION AND TESTING

A. Except as otherwise indicated or acceptable to Engineer, all materials and work shall be inspected and tested by the pipe manufacturer in accordance with ANSI/AWWA C200. All costs in connection with such inspection and testing shall be borne by Contractor.

B. Copies of all test reports shall be submitted in accordance with the Submittals Procedures section.

C. Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

D. Steel greater than or equal to 1/4 inch thickness used in production manufacturing of pipe and specials shall be tested for notch toughness using Charpy V-Notch tests in accordance with ASTM A370 – Test Methods and Definitions for Mechanical Testing of Steel Products. The test acceptance for full size specimens (0.394 in. by 0.394 in. size) shall be 25 foot-pounds at a test temperature of 32 degrees F; tests shall include three impact specimens and shall be conducted in the direction transverse to the final direction of rolling. When full-size specimens are not obtainable, the minimum required Charpy value is permitted to be reduced by multiplying the ratio of the (actual width along the notch / 0.394 in.) x 25 ft-lbs. For sub size specimens the test temperature shall be reduced as follows: Width along the notch > 0.296 in. (no reduction required); 0.295 in. (3/4 size bar): 5 degrees F reduction; 0.236 in.: 15 degrees F reduction. Straight line interpolation for intermediate values shall be used. Tests shall be conducted in accordance with ASTM A20 for two coils of each heat. Only welding consumables that are classified by the applicable AWS filler metal standard (e.g. A5.1, A5.17, A5.18, A5.20) with Charpy impact test requirements at a temperature 32 degrees F or lower are permitted.

E. Owner's Inspection at the Shop

1. If Owner elects to inspect any work or materials, as permitted under Section 5.1 of ANSI/AWWA C200, all costs in connection with the services of Owner's inspector will be paid for by Owner.

2. A fabrication schedule shall be submitted to Owner at least 30 days prior to fabrication activities. Each time the schedule is changed, the Contractor shall revise and resubmit the schedule. The Contractor shall notify the Engineer at least 5 days prior to any change in the revised and current schedule. If the Owner's representatives make an inspection and the manufacturer is not performing the work as indicated in the revised and current schedule for that date, the expense shall be the sole responsibility of the Contractor.

3. Additional weld test specimens shall be furnished to Owner's inspector for testing by an independent testing laboratory whenever, in the judgment of Owner's inspector, a

satisfactory weld is not being made. Test specimens shall also be furnished when Owner's inspector desires. The entire cost of obtaining, inspecting, and testing of such additional specimen plates, welds, or materials will be borne by Owner. If any specimen is found not to conform to the specified requirements, the materials represented by the specimen will be rejected. The expense of all subsequent tests due to failure of original specimens to comply with the specifications shall be the responsibility of Contractor.

4. In addition to making or witnessing specified tests and submitting any required reports to Engineer and Owner, Owner's inspector will submit written reports to Contractor concerning all materials rejected, noting the reason for each rejection.

5. Inspection by Owner's inspector, or Owner's option not to provide inspections, shall not relieve Contractor of his responsibility to provide materials and to perform the work in accordance with the Contract Documents.

6. The Owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to meet with the specified requirements.

F. Welding Procedures, Welder Qualifications, and Testing

1. All welding procedures, welders, welding operators, and tackers shall be qualified in accordance with ASME Section IX or AWS B2.1 as defined in ANSI/AWWA C200. All qualifications shall be in accordance with the position in which the welding is to be accomplished.

2. All shop welds shall be visually inspected by a Certified Welding Inspector (CWI). All shop welds shall be visually inspected in accordance with the requirements of AWS D1.1, Table 6.1, Visual Inspection Acceptance Criteria table for statically loaded nontubular connections. All shop butt welds on steel pipe and fittings, except cylinders that are hydrostatically tested, shall be ultrasonically or radiographically tested by qualified and certified personnel. Shop ultrasonic weld tests and evaluation shall be in accordance with Section 9 of API 5L or ASME Section VIII, Division 1, Part UW-53. Radiographic weld tests and evaluation shall be in accordance with ASME Section VIII, Division I, Part UW-51. All other shop welds shall be either liquid penetrant examined in accordance with ASTM E 165, or magnetic particle examined in accordance with ASTM E 709. Acceptance criteria shall be in accordance with ASME Code, Section VIII, Division I, Appendix 6 for magnetic particle examination and Appendix 8 for liquid penetrant examination.

3. Personnel performing visual inspection of welds shall be qualified and currently certified as Certified Welding Inspectors (CWI) in accordance with AWS QC1, Standard for Qualification and Certification of Welding Inspectors. Personnel performing ultrasonic and radiographic tests shall be qualified and certified in accordance with written practice ASNT SNT-TC-1A.

4. Nondestructive examination procedures shall be submitted in accordance with the Submittals Procedures section at the time welding procedures are submitted. Records of inspection, nondestructive examination, and material certification shall be submitted to Engineer.

5. The welder and welding operator qualification records shall be available at the shop facility or Site and shall be made available for review when requested.

6. All costs for inspection and testing of shop welds shall be paid by Contractor.

PART 3 - EXECUTION

3.1 INSPECTION

A. Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Pipe ends shall be examined with particular care. All defective pipe and fittings shall be removed from the Site.

B. All shop-applied exterior tape or other dielectric coatings on pipe, fittings, or specials shall be electrically inspected for holidays and other defects, and repaired if necessary. All electrical inspection shall be made in accordance with the standard to which the coating was applied.

C. Inspection and repair of linings and coatings shall be performed by and at the expense of Contractor, after receipt of the pipe, fittings, or specials on the Site and before installation. Electrical inspection of exterior tape or other dielectric coatings after installation of the pipe, fitting, or special in the trench shall be made where, in the opinion of Engineer, the coating may have been damaged by handling during installation.

D. Confined Space Entry Supervision

1. Contractor shall provide above ground confined space entry supervision whenever Engineer is required to enter the pipe to verify Contractor's deflection measurements, inspect joints, or any other time the Engineer is required to enter the pipe.

3.2 PROTECTION AND CLEANING

A. The interior of all pipe and fittings shall be thoroughly cleaned of all foreign material prior to installation and shall be kept clean until the work has been accepted. Before jointing, all joint contact surfaces shall be wiped clean.

B. Precautions shall be taken to prevent foreign material from entering the pipe during installation and until the work has been accepted.

C. Whenever pipe laying is stopped, the open end of the pipe shall be closed to prevent entry of dirt, mud, rodents, and other material. All water in the trench shall be removed prior to removing the closure.

3.3 ALIGNMENT AND GRADE

A. Buried pipe shall be laid to the lines and grades as specified and indicated on the Drawings. Pipelines or runs intended to be straight shall be laid straight. Curves in stab joint pipe may be formed by opening the joint. Maximum joint openings and deflections shall be as recommended

by the pipe manufacturer. For welded lap joints, deflections up to 4-1/2 degrees may be made by shop-mitering the bell end of one pipe. For welded butt joints, deflections up to 22-1/2 degrees may be made by shop-mitering the ends of two adjacent sections of pipe by equal amounts. Deflections greater than 22-1/2 degrees shall be made by use of fabricated bends.

B. Where deflections would exceed the pipe manufacturer's recommendations, either shorter pipe sections or fittings shall be installed where needed to conform to the alignment or grade indicated on the Drawings and as acceptable to the Engineer.

C. High points which allow air to collect in pipelines will not be permitted unless an air release valve is indicated on the Drawings at that location.

D. Unless otherwise specified or acceptable to Engineer, laser beam equipment, surveying instruments, or other suitable means shall be used to maintain alignment and grade. At least one elevation reading shall be taken on each length of pipe. If laser beam equipment is used, periodic elevation measurements shall be made with surveying instruments to verify accuracy of grades. If such measurements indicate thermal deflection of the laser beam due to differences between the ground temperature and the air temperature within the pipe, precautions shall be taken to prevent or minimize further thermal deflections.

E. Additional requirements for alignment and grade are covered in the Project Requirements and Trenching and Backfilling sections and on the Drawings.

F. Tolerances

1. Each section of pipe shall be laid to the alignment and grade indicated on the Drawings and pipe laying schedule with pipe ends within the following tolerances;

   a. +/- 0.10 foot in grade at any point
   b. +/- 0.20 foot in alignment at any point

2. In addition, piping shall be visually straight or on a smooth curve between the points of deflection or curvature indicated on the Drawings. Stricter tolerances than specified above shall be used as necessary to maintain minimum cover, to maintain required clearances, to make connections to existing pipe,]to maintain the correct slope to avoid high or low points along the pipeline other than at locations indicated on the Drawings, or to meet other restrictions as required or directed by the Engineer.

G. Annotated Pipe Laying Schedule

1. The pipe laying schedule shall be annotated during the progress of the Work to show all changes made during construction for record documentation. Upon completion of the installation of the piping, the annotated pipe laying schedule shall be submitted to Engineer in accordance with the Submittals Procedures section.

3.4 INSTALLATION

A. Buried Piping

1. Field installation of buried steel water piping shall be in accordance with ANSI/AWWA C604 unless otherwise specified or indicated on the Drawings.

2. For buried piping, all trenching, embedment, and backfilling shall conform to the Trenching and Backfilling section and the details indicated on the Drawings.

3. Pipe embedment and backfilling shall closely follow the installation and jointing of steel pipe in the trench to prevent floatation of the pipe by water and minimize longitudinal movement caused by thermal expansion or contraction of the pipe. Pipe shall be protected from floatation during installation when subjected to groundwater or flood conditions.

4. Each joint, including restrained joints, shall be checked by Contractor as recommended by the pipe manufacturer to verify that the joint and the restraints are installed properly.

5. For restrained joint pipe, not more than 160 feet of pipe shall be exposed ahead of the backfilling in any section of trench. The backfill adjacent to field joints may be temporarily omitted to provide adequate space for field coating the joints. Closure welds on restrained joint pipe shall be made during the cool part of the day**.**

B. Pipe Deflection

1. All buried pipe larger than 30 inches in diameter shall be tested for excessive deflection.

2. Deflection Measurements

a. Pipe deflection for all buried pipe shall be determined by measuring initial pipe vertical and horizontal inside diameters before the backfill load is supported by the pipe and a second vertical and horizontal inside diameters at least 24 hours after the backfill load is supported by the pipe. The second pipe deflection measurement shall be taken and the results determined before 100 feet of pipe is laid ahead of the initial measurement. Initial and second measurements shall be made for at least two locations on each piece of pipe and approximately equally spaced along the pipe. The points of initial deflection measurements shall be marked so that final deflection measurements are at the same points. The tolerance for deflection measurements shall be 1/8 inch. The percent deflection shall be the largest difference between the initial and second measurements at each point divided by the nominal pipe diameter. Pipe embedment and backfill not exceeding one foot above the top of pipe shall be in place during initial measurements. Struts that allow access may remain in place during initial measurements but shall be removed after initial measurements. Pipe deflection will be measured and documented by Contractor and verified by Engineer for each piece of pipe. Engineer shall be notified in advance of when deflection measurements are made. The deflection documentation shall be submitted daily unless otherwise acceptable to the Engineer.

b. Allowable Deflection

1) The allowable deflection shall be the calculated design percent of nominal diameter with a deflection lag factor of 1.0 and excluding live load, for the depth of the installed pipe to the nearest foot. Pipe exceeding the allowable deflection shall be uncovered and the embedment and backfill replaced as needed to prevent excessive deflection. After replacing embedment and backfill, the pipe shall be retested. Pipe damaged by over deflection or otherwise shall be satisfactorily repaired or removed and replaced with new pipe. All pipe shall have a maximum allowable deflection of 2.5% of the pipe outside diameter under any loading case.

C. Flanged Joints

1. Flange faces shall be flat and perpendicular to the pipe centerline. The rust-preventive coating on the flange faces shall be soluble and shall be removed before the joint is made.

2. Care shall be taken in bolting flanged joints to avoid restraint on the opposite end of the pipe or fitting, which would prevent uniform gasket compression or would cause unnecessary stress in the flanges. The pipe or fitting shall be free to move in any direction while the flange bolts are being tightened. Bolts shall be tightened gradually in a crisscross pattern at a uniform rate, to ensure uniform compression of the gasket around the entire flange. All flange joint bolting procedures shall be in accordance with the pipe manufacturer's recommendations.

3. Care shall be taken when connecting piping to pumping equipment to ensure that piping stresses are not transmitted to the pump flanges. All connecting piping shall be permanently supported to obtain accurate matching of bolt holes and uniform contact over the entire surface of flanges is obtained before any bolts are installed in the flanges.

4. Pump connection piping shall be free to move parallel to its longitudinal center line while the bolts are being tightened. Each pump shall be leveled, aligned, and wedged into position which will fit the connecting piping, but shall not be grouted until the initial fitting and alignment of the pipe so that the pump may be shifted on its foundation if necessary to properly install the connecting piping. Each pump shall, however, be grouted before final bolting of the connecting piping.

5. After final alignment and bolting, the pump connections shall be tested for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. If any movement is observed, the piping shall be loosened and re-aligned as needed and then the flanges bolted back together. The flange bolts then shall be loosened and the process repeated until no movement is observed.

D. Insulated Flanged Joints

1. Insulated flanged joints shall be installed where indicated on the Drawings. In addition to one full-faced insulating gasket, each flange insulating assembly shall consist of one full-length sleeve, two insulating washers, and two backing washers for each flange bolt.

The insulating gasket ID shall be 1/8 inch less than the ID of the flange in which it is installed. The insulated flanged joint accessories shall be installed in accordance with the instructions and recommendations of the insulating kit manufacturer.

E. Welded Joints

1. All welds shall be sound and free from embedded scale or slag and shall be watertight. Butt welds shall have tensile strength across the weld not less than that of the thinner of the connected sections., Butt welds shall be used for all welded joints in pipe assemblies and in the fabrication of bends and other specials. Field-welded joints, where permitted, shall be either butt-welded or lap-welded Lap-welded joints shall have full fillet welds. Any weld that undercuts the parent metal shall be cut out, filled, and ground smooth.

2. Field welding of joints shall conform to ANSI/AWWA C206 and M11. Where acceptable to the Engineer, single field-welded butt joints with outside backing rings may be used for pipe larger than 30 inches in diameter. Backing rings will not be permitted for 30 inches and smaller pipe. Butt straps shall be welded on both the inside and outside of the pipe and at each end of the pipe and strap to avoid stress multiplication.

3. Field-welded lap joints may have only a single fillet weld on the inside of the pipe joint as detailed in Figure 3-15062(B), except where double-welded joints as detailed in Figure 3-15062(A) are indicated on the Drawings or specified. The interior joint may be welded after the exterior joint has been coated with a shrinkable wrapped sleeve or other specified coating and backfilled with at least 3 feet of backfill material. The field welding shall be performed so that the interior lining, the exterior coating, and the field applied joint coating are not damaged.

4. A field test, including excavation of a welded joint for inspections, shall be performed to verify that the interior lining, the exterior coating, and the field applied joint coating are not damaged by the interior welding at the start of the project. The field test shall be repeated if welding procedures are modified.

5. Provisions shall be made to minimize stresses in welded steel pipe to account for temperature changes and to avoid the accumulation of expansion and contraction during installation and after the pipe is in service as recommended by the pipe manufacturer and in accordance with ANSI/AWWA M11 and C604. The allowable temperature range of the pipe during welding shall be established by the pipe design and monitored during installation as recommended by the pipe manufacturer.

F. Standard Inspection and Testing

1. Standard shop inspection and testing shall be in accordance with the shop inspection and testing provisions specified herein.

2. Field weld test specimens shall be furnished to Engineer for testing by an independent testing laboratory whenever, in the judgment of Engineer, a satisfactory weld is not being made. Test specimens shall also be furnished when Engineer desires. All costs for this testing will be paid by Owner.

G. Couplings

1. Surfaces of pipe ends and couplings in contact with the sealing gasket shall be clean and free from foreign material when the coupling is installed on the pipe. Wrenches used in bolting couplings shall be of a type and size recommended by the coupling manufacturer. All bolts shall be tightened by approximately the same amount, with all parts of the coupling square and symmetrical with the pipe. Following installation, the exterior coating of each coupling shall be touched up or re-primed.

2. Where restraint is required, Contractor shall verify that tie bolts have been stressed to assure the pipe will not creep when pressurized. When split ring, fixed type couplings are installed, piping shall be in a fully-extended position to engage the restraint rings at the pipe ends.

H. Dismantling Joints

1. Dismantling joints shall be installed in accordance with the coupling manufacturer's recommendations. Unless otherwise indicated on the Drawings, dismantling joints shall be restrained.

I. Mechanical Couplings

1. Mechanical couplings shall be installed in accordance with the coupling manufacturer's recommendations. A space of at least 1/4 inch, but not more than 1 inch, shall be left between the pipe ends. Pipe and coupling surfaces in contact with gaskets shall be clean and free from dirt and other foreign matter during assembly. All assembly bolts shall be uniformly tightened so that the coupling is free from leaks, and all parts of the coupling are square and symmetrical with the pipe. Following installation of the coupling, damaged areas of shop coatings on the pipe and coupling shall be repaired to the satisfaction of Engineer.

3.5 WALL SLEEVES AND WALL PIPES

A. Wall sleeves and wall pipes shall be installed as indicated on the Drawings and shall be installed where steel pipe passes through concrete or masonry walls, unless otherwise noted.

B. Where harness lugs are attached to wall sleeves, the sleeves shall be carefully aligned to permit installation of the tie rods. In flange and mechanical joint wall sleeves and wall pipe, holes in the mechanical joint bells and flanges shall straddle the top (or side for vertical piping) center line. The top (or side) center line shall be marked on each flange and mechanical joint piece at the fabricating shop.

C. Where specified or indicated on the Drawings for sleeves detailed, one or two sets of modular casing seals shall be installed at the face of walls to seal against soil or provide a dust or water tight seal. Contractor shall coordinate the diameter of wall sleeve with the modular casing seal manufacturer. When soil may be present at wall sleeves, a set of modular casing seals shall be installed at each face of the wall. Modular casing seals shall not be used in submerged conditions unless the hydrostatic pressure is less than 20 feet and piping is less than 24 inches size.

3.6 REDUCERS

A. Reducers shall be eccentric or concentric as indicated on the Drawings. Reducers of eccentric pattern shall be installed with the straight side on top, so that no air traps are formed.

3.7 GAS AND OIL-RESISTANT GASKETS

A. Gas and oil-resistant gaskets shall be installed where specified, indicated on the Drawings, or directed by Engineer where jointing gaskets may be subject to permeation when piping passes through areas where soil may be contaminated with gas or petroleum (oil) products or organic solvents or their vapors.

3.8 PIPE ANCHORS, BLOCKING, CONCRETE ENCASEMENT, HANGERS, AND SUPPORTS

A. Pipe anchors, blocking, hangers, and supports shall be installed as specified and where indicated on Drawings and shall be fabricated in accordance with the Pipe Supports section and the details indicated on the Drawings, and shall be furnished and installed complete with all concrete bases, anchor bolts and nuts, plates, rods, and other accessories required for proper support of the piping. All piping shall be rigidly supported and anchored so that there is no movement or visible sagging between supports. Where the details must be modified to fit the piping and structures, all such modifications shall be subject to acceptance by Engineer. Unless otherwise permitted, lugs for lateral or longitudinal anchorage shall be shop welded to the pipe.

B. Concrete reaction anchorage, blocking, encasements, and supports shall be installed as indicated on the Drawings or as permitted by Engineer. Concrete and reinforcing steel for anchorages, blocking, encasements, and supports shall conform to the Cast-in-Place Concrete section. All pipe to be encased shall be suitably supported and blocked in proper position, and shall be anchored to prevent floatation. A pipe joint shall be provided within 12 inches of each end of the concrete encasement.

C. The concrete blocking size shall be of the dimensions indicated on the Drawings, shall extend from the fitting to solid undisturbed earth, and shall be installed so that all joints are accessible for repair. If adequate support against undisturbed earth cannot be obtained, restrained joints shall be installed to provide the necessary support. If the lack of suitable solid vertical excavation face is due to improper trench excavation, restrained joints shall be furnished and installed by and at the expense of Contractor.

D. Reaction blocking, anchorages, or other supports for fittings installed in fills or other unstable ground, installed above grade, or exposed within structures, shall be provided as indicated on the Drawings.

E. All ferrous metal clamps, rods, bolts, and other components of reaction anchorages or joint harness, subject to submergence or in contact with earth or other fill material and not encased in concrete, shall be protected from corrosion as specified in the Corrosion Protection paragraph of this section.

3.9 JOINT HOLDBACKS AND COATINGS AND LININGS

A. Shop Holdbacks and Coatings and Linings and Field Repair

1. Entry into the pipe or pipeline for application of interior linings to unlined ends shall be from open ends or through access manholes, except as otherwise permitted by Engineer. Pour holes, where allowed by the Engineer, shall consist of 4-inch standard weight black steel pipe welded to the pipe to be lined and covered with a bolted blind flange.

2. Holdbacks, coatings and linings for pipe ends at joints shall conform to the following:

For Field-Welded Joints	
Cement Mortar	Hold back coating and lining 4 to 6 inches from joint. Field repair in accordance with ANSI/AWWA C205 as modified herein.
For Flanged Joints	Extend lining to ends of pipe. Field coat buried exterior surfaces as specified in the Corrosion Protection paragraph for flanges.
For Mechanically Coupled Joints	
Cement Mortar	Hold back coating 16 inches (or greater if required to clear harness lugs) from joints. Shop coat exposed surfaces with liquid epoxy to end of pipe in accordance with ANSI/AWWA C210 Epoxy. Lining shall extend to end of pipe. Field coat buried exterior surfaces as specified in the Corrosion Protection paragraph for mechanical couplings.
Liquid Epoxy or Polyurethane	Epoxy or polyurethane shop coating shall extend to ends of pipe; in accordance with ANSI/AWWA C210 . Field coat buried exterior surfaces as specified in the Corrosion Protection paragraph for mechanical couplings.
For Other Type of Joints and Exposed Buried Surfaces	Other types of joints and exposed buried surfaces that cannot be shop coated with the primary coating and lining system shall be shop coated and lined with 20 mil dry film thickness of liquid epoxy in accordance with ANSI/ASSA C210 Epoxy.

B. Modifications to the Governing Standards.

1. Field Repair of Cement Mortar Lining

a. Field repair of interior joint surfaces shall be done in accordance with ANSI/AWWA C205, except that an epoxy bonding agent and latex admixture shall be used in conjunction with the sand and cement mortar. The addition of lime or pozzolan will not be permitted.

b. The exposed steel shall be thoroughly cleaned and all grease shall be removed. A coat of epoxy bonding agent shall be applied over the area to be lined in accordance with the coating manufacturer's recommendations. A soupy mixture of cement and water shall be applied over the epoxy after it becomes tacky. Cement mortar to which the latex admixture has been added shall then be packed into the area to be patched and screeded off level with the adjacent cement mortar lining. The patched area shall be given an initial floating with a wood float, followed by a steel trowel finish.

c. Defective or damaged cement mortar linings shall be removed, the surfaces cleaned, and the lining repaired as specified above for joint repair. Wire fabric reinforcement shall be used in the lining of fittings and specials in conformance with ANSI/AWWA C205.

3.10 CORROSION PROTECTION

A. Flanged Joints

1. The flange bolts and nuts on buried flanged joints shall be protected by wrapping them with wax tap in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer.

2. Following application of the wax tape protection, the entire flanged joint shall be encapsulated with a shrink sleeve. The shrink sleeve shall extend a minimum of 6 inches onto the shop coated pipe on each side of the flange. A primer shall be applied to the piping on each side of the flange prior to installing the shrink sleeve. The installation of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

3. Corrosion protection of buried insulated flanges shall be as specified herein unless otherwise shown on the Drawings.

B. Valves

1. Buried valve flanges shall be protected as specified herein for buried flange joints. The corrosion protection for the entire remaining buried valve and actuator to the wrench nut shall be wax tape or shrink sleeve.

C. Restrained Mechanical Couplings

1. Buried mechanical couplings shall be protected with two coats of medium consistency coal tar and shrink sleeve as specified herein for buried mechanical couplings.

2. The tie rods and bolts of the harness rings or lugs of the restrained coupling assembly shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application of the wax tape shall be as recommended by the wax tape manufacturer.

3. Following the application of the wax tape, the entire restrained mechanical coupling assembly, including coupling, tie bolts and nuts, pipe, and harness rings or lugs, shall be encapsulated with an underlying sleeve covered by a shrink sleeve. The underlying sleeve shall extend a minimum of 6 inches onto the pipe beyond each end of the tie rods. The shrink sleeve shall extend a minimum of 6 inches onto the shop coated pipe beyond each end of the underlying sleeve. A primer shall be applied to the piping on each side of the harness assembly prior to installing the shrink sleeve. The application of the shrink sleeve shall be in accordance with ANSI/AWWA C216 and as recommended by the shrink sleeve manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

D. Other Assemblies

1. All ferrous metal clamps, tie rods, bolts, and other components of buried joint harnesses, mechanical joints, wall fittings, or pipe reaction anchorages in contact with earth or other fill material and not encased in concrete, shall be protected by wrapping them with wax tape in accordance with ANSI/AWWA C217. A primer shall be applied prior to applying the wax tape. The application for the wax tape shall be as recommended by the wax tape manufacturer. There shall be no bare or unprotected ferrous metal surfaces.

E. Surfaces Exposed in Manholes and Vaults

1. Unless otherwise specified, all uncoated metal surfaces exposed in manholes and vaults shall be cleaned and coated with two coats of medium consistency coal tar. The first coat shall be dry and hard before the second coat is applied. There shall be no unprotected, bare, or uncoated ferrous metal surfaces.

3.11 CONNECTIONS WITH EXISTING PIPING

A. Connections between new work and existing piping shall be made using fittings suitable for the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will least interfere with service to customers, and as authorized by Owner.

B. Facilities shall be provided for dewatering and for disposal of the water removed from the dewatered lines and excavations without damage to adjacent property.

C. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with potable water piping. Trench water, mud, or other contaminating substances shall not be permitted to enter the lines. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and then swabbed with or dipped in a 200 mg/L chlorine solution.

3.12 PROVISIONS FOR CATHODIC PROTECTION

A. Cathodic protection shall be provided for buried piping as specified in the Cathodic Protection section.

3.13 PRESSURE AND LEAKAGE TESTS

A. After installation, pipe and fittings shall be subjected to a pressure test and a leakage test in accordance with the Pipeline Pressure and Leakage Testing section.

3.14 DISINFECTION

A. After installation, all potable water pipelines shall be disinfected as specified in the Cleaning and Disinfection of Water Pipelines section.

End of Section

SCHEDULE 15062-S01 -STEEL PIPE SCHEDULE

Location	Service	Size (in)	Working Pressure (psi)	Field Test Pressure (psi)	Total External Load (lb/in)	Maximum D/T ratio	Min. Wall Thickness (in)*
Buried	Treated Water (TW)	60	60	110	1140	165	0.36
Buried	FW (Springdale)	48	110	165	490	165	0.29
Buried	FW (Fayetteville)	48	140	210	510	165	0.29
Buried	FW (Bentonville)	48	90	140	455	165	0.29
Buried	FW (Rogers)	36	115	195	446	165	0.25
Interior	Treated Water (TW)	60	60	110	-	165	0.37
Interior	FW Fayetteville (Pump Discharge)	20	140	210	-	165	0.25
Interior	FW Springdale (Pump Discharge)	20	110	165	-	165	0.25
Interior	FW Pump Suction	24	60	110	-	165	0.25
Interior	FW Fayetteville (Pump Discharge)	36	140	210	-	165	0.25
Interior	FW Springdale (Pump Discharge)	36	110	165	-	165	0.25
Interior	FW Pump Suction	18	60	110	-	165	0.25
Interior	Fayetteville Surge Tank	16	140	210	-	165	0.25
Interior	Springdale Surge Tank	16	110	165	-	165	0.25

*Wall thickness shall include zero minus tolerance. Minimum wall thickness based on larger of specified maximum D/t ratio or t = (PD)/(2s) with maximum yield strength of 42,000 psi. Lower yield strength steel will result in increased thickness where yield strength controls thickness.

End of Schedule

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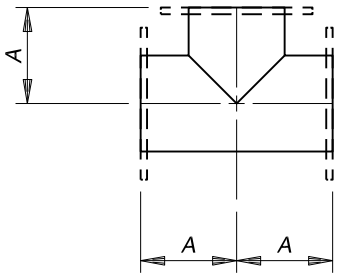

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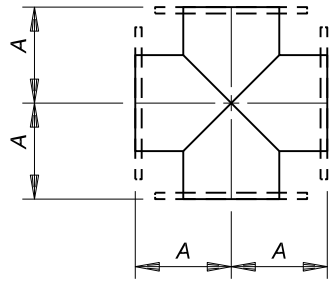
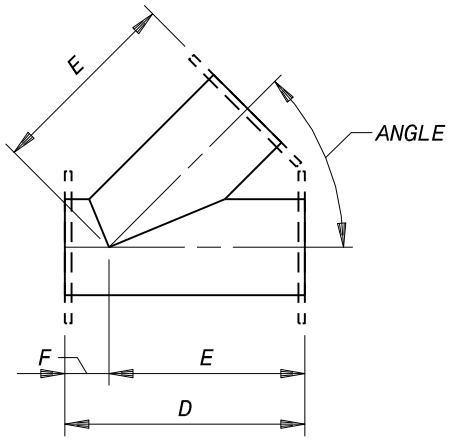
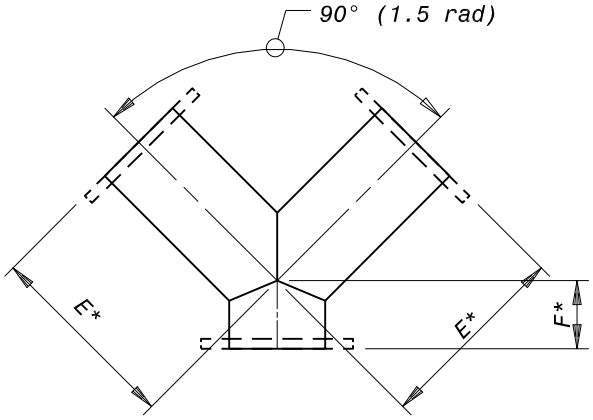


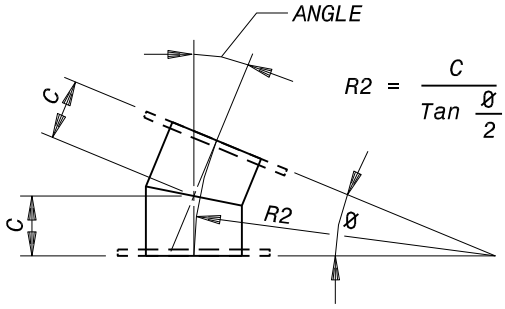
CROSS



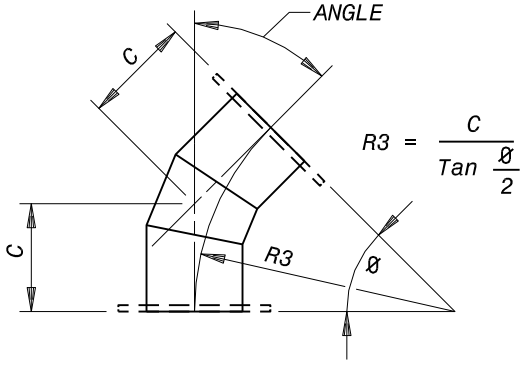
LATERAL 45° (0.7 rad) MIN; 75° (1.3 rad) MAX



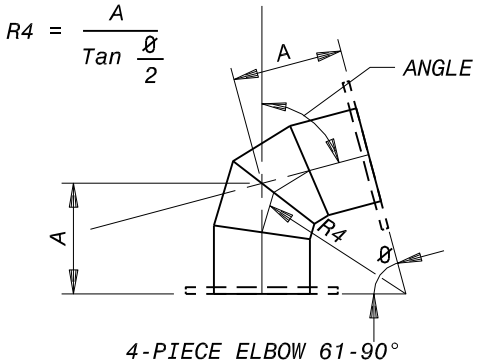
TRUE WYE-90° (1.5 rad)



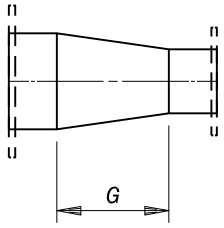
2-PIECE ELBOW
0-30° (0-0.52 rad)



3-PIECE ELBOW 31-60°
(0.54-1.0 rad)



4-PIECE ELBOW 61-90°
(1.1-1.5 rad)



REDUCER

NOTE:
SEE FIGURE 1-15062(B) FOR DIMENSIONS.

STEEL PIPE FITTINGS

BLACK & VEATCH	STEEL PIPE	FIG 1-15062(A)

BLACK & VEATCH

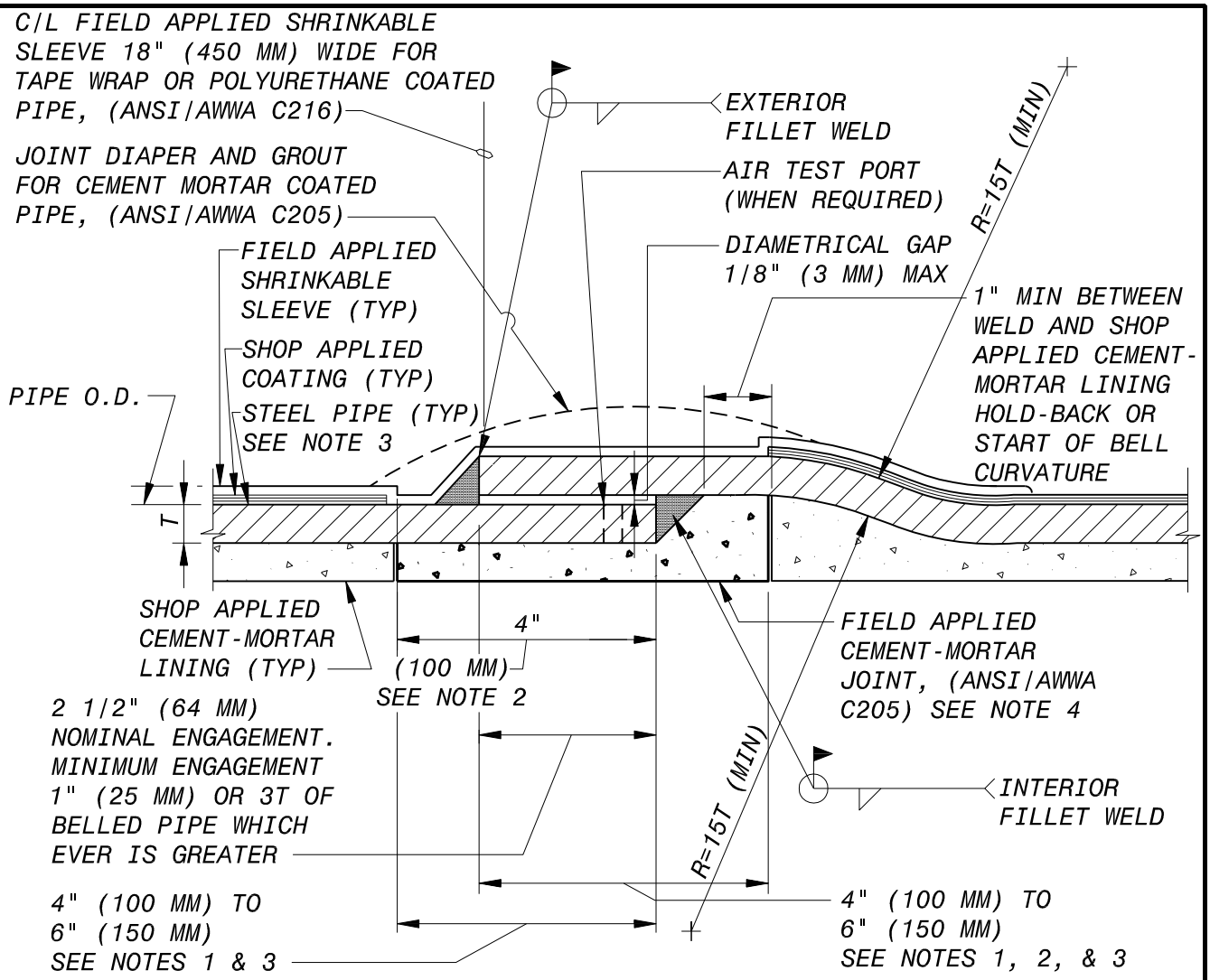
STEEL PIPE

FIG 1-15062(B)

DIMENSIONS FOR STEEL PIPE FITTINGS

DIMENSIONS IN INCHES (MILLIMETERS)

NOMINAL DIA	TEE		CROSS A+A	LATERAL (45–75\) (0.7–1.3 rad)		TRUE WYE (90\) (1.5 rad)		ELBOWS			REDUCER CONE G
	RUN A+A	OUTLET A		RUN D	OUTLET E	E*	F*	2–PIECE (0–30\) (0.0–0.52 rad) C	3–PIECE (31–60\) (0.54–1.0 rad) C	4–PIECE (61–90\) (1.1–1.5 rad) A	
4 (100)	13 (330)	6.5 (165)	13 (330)	15 (381)	12 (305)	6.5 (330)	3 (76)	4 (102)	4 (102)	6.5 (162)	7 (178)
6 (150)	16 (406)	8 (203)	16 (406)	18 (457)	14.5 (368)	8 (203)	3.5 (89)	5 (127)	5 (127)	8 (203)	9 (229)
8 (200)	18 (457)	9 (229)	18 (457)	22 (559)	17.5 (445)	9 (229)	4.5 (114)	5.5 (140)	5.5 (140)	9 (229)	11 (279)
10 (250)	22 (559)	11 (279)	22 (559)	25.5 (648)	20.5 (521)	11 (279)	5 (127)	6.5 (165)	6.5 (165)	11 (279)	12 (305)
12 (300)	24 (610)	12 (305)	24 (610)	30 (762)	24.5 (622)	12 (305)	5.5 (140)	7.5 (191)	7.5 (191)	12 (305)	14 (356)
14 (350)	28 (711)	14 (356)	28 (711)	33 (838)	27 (686)	14 (356)	6 (152)	7.5 (191)	7.5 (191)	14 (356)	16 (406)
16 (400)	30 (762)	15 (381)	30 (762)	36.5 (927)	30 (762)	15 (381)	6.5 (165)	8 (203)	8 (203)	15 (381)	18 (457)
18 (450)	33 (838)	16.5 (419)	33 (838)	39 (991)	32 (813)	16.5 (419)	7 (178)	8.5 (216)	8.5 (216)	16.5 (419)	19 (483)
20 (500)	36 (914)	18 (457)	36 (914)	43 (1092)	35 (889)	18 (457)	8 (203)	9.5 (241)	9.5 (241)	18 (457)	20 (508)
22 (550)	40 (1016)	20 (508)	40 (1016)	46 (1168)	37.5 (953)	22 (559)	9 (229)	10 (254)	10 (254)	20 (508)	22 (559)
24 (600)	44 (1118)	22 (559)	44 (1118)	49.5 (1257)	40.5 (1029)	25 (635)	10 (254)	11 (279)	11 (279)	22 (559)	24 (610)
30 (750)	50 (1270)	25 (635)	50 (1270)	59 (1499)	49 (1245)			15 (381)	15 (381)	25 (635)	30 (762)
36 (900)	56 (1422)	28 (711)	56 (1422)	84 (2134)	60 (1524)			18 (457)	18 (457)	28 (711)	36 (914)
42 (1050)	62 (1575)	31 (787)	62 (1575)	95 (2413)	69 (1753)			21 (533)	21 (533)	31 (787)	42 (1067)
48 (1200)	68 (1727)	34 (864)	68 (1727)	104 (2642)	77 (1956)			24 (610)	24 (610)	34 (864)	48 (1219)
54 (1350)	74 (1880)	37 (940)	74 (1880)					27 (686)	27 (686)	37 (940)	54 (1372)
60 (1500)	80 (2032)	40 (1016)	80 (2032)					30 (762)	30 (762)	40 (1016)	60 (1524)



DOUBLE WELDED BELL/SPIGOT DETAIL

NO SCALE (INTERIOR WELD AFTER BACKFILL)

NOTES:

1. HOLD TAPE MATERIALS BACK 4" (100 MM) TO 6" (150 MM) ON THE SPIGOT OD AND ON BELL OD. LEAVE CUT-BACK BARE STEEL.

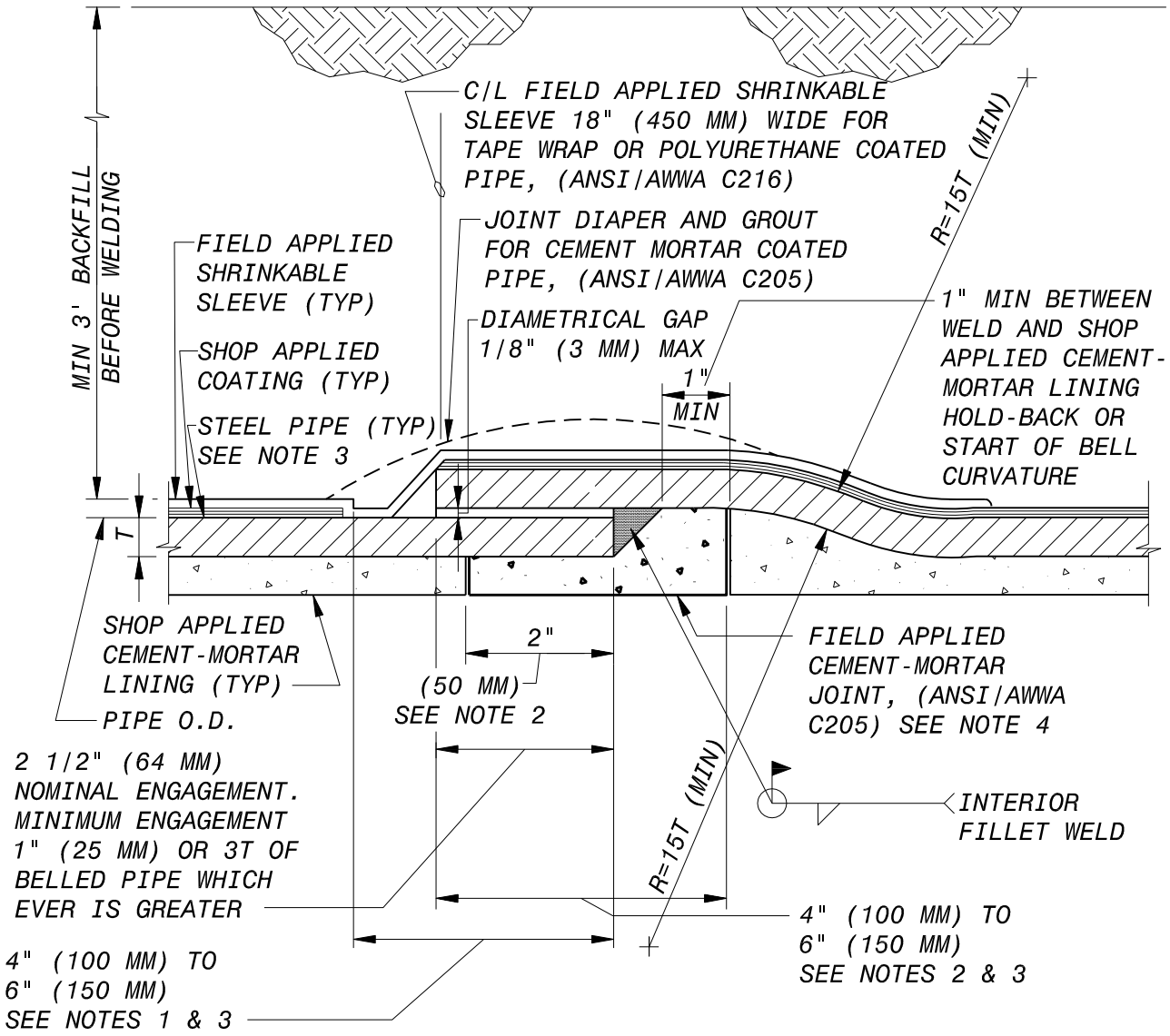
2. HOLD CEMENT-MORTAR LINING BACK 4" (100 MM) TO 6" (150 MM) ON BELL ID AND 4" (100 MM) ON SPIGOT ID. LEAVE CUT-BACK BARE STEEL.

3. GRIND SPIRAL WELD BACK 18" (450 MM) ON BELL AND SPIGOT OD. GRIND SPIRAL WELD BACK 4" (100 MM) TO 6" (150 MM) ON BELL ID.

4. FILL JOINT GAP IN LINING BY FIELD APPLIED CEMENT-MORTAR PER ANSI/AWWA C205.

FIELD-WELDED LAP JOINT DETAIL

BLACK & VEATCH	STEEL PIPE	FIG 3-15062(A)



SINGLE WELDED BELL/SPIGOT DETAIL

(WELD AFTER BACKFILL)

NO SCALE

NOTES:

1. HOLD TAPE MATERIALS BACK 4" (100 MM) TO 6" (150 MM) ON THE SPIGOT OD. LEAVE CUT-BACK BARE STEEL.

2. HOLD CEMENT-MORTAR LINING BACK 4" (100 MM) TO 6" (150 MM) ON BELL ID AND 2" (50 MM) ON SPIGOT ID. LEAVE CUT-BACK BARE STEEL.

3. GRIND SPIRAL WELD BACK 18" (450 MM) ON BELL AND SPIGOT OD. GRIND SPIRAL WELD BACK 4" (100 MM) TO 6" (150 MM) ON BELL ID.

4. FILL JOINT GAP IN LINING BY FIELD APPLIED CEMENT-MORTAR PER ANSI/AWWA C205.

FIELD-WELDED LAP JOINT DETAIL

BLACK & VEATCH	STEEL PIPE	FIG 3-15062(B)

SECTION 15064 - STAINLESS STEEL PIPE AND ALLOY PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of stainless steel pipe and alloy pipe, tubing and accessories through 24" diameter for the services as indicated herein. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certifications.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

C. Welding Procedures and Qualifications.

1. All welding and brazing procedures and operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of Section IX of the ASME Code. All procedure and operator qualifications shall be in written form and submitted to the Engineer for review.

D. Compliance Data.

1. Pipe for liquid chemical service shall comply with ASME B31.3. Pipe for all other services shall comply with ASME B31.1.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless steel pipe and alloy pipe materials shall be as specified herein.

B. Material Classification SS-3

SS-3 – Schedule 10S with Beveled Ends. Engine exhaust piping. 2-1/2 inch and larger.	Pipe Fittings	ASTM A312, Grade TP304L. Buttwelded, ASTM A403 WP304L. Fittings shall conform to ANSI/ASME B16.9, Schedule 10S with beveled ends.

C. Material Classification SS-6

SS-6 – Schedule 40S with Threaded Ends. Gauge piping in stainless steel piping systems (to match pipe). 2 inch and larger.	Pipe Fittings	ASTM A312, **[**TP304**][**TP316**]**. Threaded, material to match pipe. Fittings shall conform to ANSI/ASME B16.3, Class 150.

D. Material Classification SS-7

SS-7 – Schedule 40S with Plain Ends. Gauge piping in stainless steel piping systems. Compressed air piping. 2 inch and smaller with press connection ends.	Pipe Fittings Manufacturer	ASTM A312, Grade TP304L, Press Connection Type 304 as indicated or required, ASTM A182, F304L. Fittings shall conform to ANSI/ASME B16.11, Class 3000. Double press connection for ½" thru 2" size. Elastomeric sealing elements shall be FKM. Viega

E. Accessory Materials

1. Accessory materials for the stainless steel pipe systems shall be as indicated. Flanges shall be flat faced for water service and shall be raised face for air or gas service except when connecting to flat face equipment or valve flanges.

   Flanges

SS-3 Pipe Backing Flanges

Stainless steel plate, AISI Type 304 or 316 to match fittings. Provide stub ends or angle face rings with material and thickness to match fittings. The angle or radius between the angle face ring or stub end and the pipe shall match the angle or radius of the backing flange for proper seating. Flanges shall conform with ANSI/ASME B16.5, Class 150 diameter and drilling; with the following thicknesses:

Nominal Pipe Size inches	Flange Thickness inches
1/2-8	1/2
10-16	5/8
18-20	3/4
24-30	1
36	1-1/4

Nominal Pipe Size inches	Flange Thickness inches
1/2-8	1/2
10-16	5/8
18-20	3/4
24-30	1
36	1-1/4

Flange Bolts

ASTM A193 Class 2, AISI Type 304, ANSI B18.2.1, heavy hex head, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.

Flange Nuts

ASTM A194, AISI Type 304, ANSI/ASME B18.2.2, heavy hex pattern. Washers shall be installed under the nuts.

Flange Gaskets

Process air

Raised Face Flanges

Non-asbestos inorganic fiber with EPDM binder; dimensions to suit flange contact face, 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces, rated for 275°F service; Garlock “IFG 5507.”

Flat Faced Flanges

Premium Grade, EPDM, full face type, 1/8 inch thick, rated for 275°F service; Garlock “8314.”

All other services.

Flexitalic “Style CG,” spiral wound, AISI Type 304 stainless steel, non-asbestos filler, 3/16 inch nominal thickness, with compression ring 1/8 inch thick to match required flange dimensions.

Elbows

Except for elbows in chemical service lines 4 inches and smaller, elbows shall be long radius type for which the laying length is 1.5 times the pipe diameter.

Expansion Joints

Insulating Fittings

Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, polypropylene lined, zinc plated; Perfection Corp. "Clearflow Fittings."
Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions."

2. Branch Connections

   a. Branch connections 2-1/2 inches and smaller shall be made with welding fittings. [Welded][Threaded] outlets shall be used. Where the exact outlet size desired is in doubt, but is known to be less than 1 inch, a 1 inch outlet shall be provided and reducing bushings used as needed.
   b. Branch connections sized 3 and larger shall be made with pipe nipples or with welding fittings with welded outlets. Pipe nipples and welding fittings shall be welded to the pipe shell and reinforced as needed to meet design and testing requirements. The pressure rating of branch and branch connections shall equal or exceed the pressure rating of the main pipe it is connected to.
   c. Small branch connections shall be so located that they will not interfere with joints, supports, or other details, and shall be provided with caps or plugs to protect the threads during shipping and handling.

2.2 WELDING OF STAINLESS STEEL AND ALLOYS

A. Filler metal for welding austenitic stainless steel and alloys, P-number 8 base materials shall be in accordance with the following:

   1. Material Type/Grade 304 shall use Type 308 filler metal.

   2. Material Type/Grade 304L shall use Type 308L filler metal.

   3. Material Type/Grade 316, shall use Type 316 filler metal.

   4. Material Type/Grade 316L shall use Type 316L filler metal.

   5. Material Type/Carpenter 20 shall use Carpenter 20 filler metal.

   6. Material Type/Hastelloy C276 shall use Hastelloy C276 filler metal.

B. The following requirements shall apply when fabricating austenitic stainless steel and alloy components.

C. Grinding shall be by aluminum oxide, zirconium oxide, or silicon carbide grinding wheels that shall not have been used on carbon or low alloy steels. Hand or power wire brushing shall be by stainless steel brushes that shall not have been used on carbon or low alloy steels for stainless steel pipe. Hand or power wire brushing shall be by Carpenter 20 brushes that shall not have been used on carbon or low alloy steels for Carpenter 20 pipe. Hand or power wire brushing

shall be by Hastelloy C276 brushes that shall not have been used on carbon or low alloy steels for Hastelloy C276 pipe. All tools used in fabrication shall be protected to minimize contact with steel alloys or free iron. Grinding wheels and brushes shall be identified and controlled for their use on these materials only to ensure that contamination of these materials does not occur.

D. Antispatter compounds, marking fluids, marking pens, tape, temperature indicating crayons, and other tools shall have a total halogen content of less than 200 parts per million.

E. Heat input control for welding shall be specified in the applicable WPS and shall not exceed 55,000 joules per inch as determined by the following formula:

$$\text{Heat Input } \left(J/_{\text{in.}}\right) = \frac{\text{Voltage x Amperage x 60}}{\text{Travel Speed } \left(^{\text{in.}}/_{\text{min.}}\right)}$$

F. Complete penetration pressure retaining welds shall be made using the Gas Tungsten Arc Welding (GTAW) process for the root and second layer as a minimum.

G. Austenitic stainless steel instrument tubing shall be welded using only the GTAW process.

H. Socket welds or butt welds in all austenitic stainless steel instrument tubing lines shall require an inert gas backing (purge) using argon during welding to avoid oxidation.

I. The application of heat to correct weld distortion and dimensional deviation without prior written approval from the Engineer is prohibited.

J. Unless otherwise approved in writing, the GTAW process shall require the addition of filler metal.

K. The maximum preheat and interpass temperature for austenitic stainless steel shall be 350° F . The minimum preheat temperature shall be 50° F .

L. Complete joint penetration welds welded from one side without backing, weld repairs welded from one side without backing, or weld repairs in which the base metal remaining after excavation is less than 0.1875 inch from being through wall, which are fabricated from austenitic stainless steel ASME P-number 8 base metal or unassigned metals with similar chemical compositions, shall have the root side of the weld purged with an argon backing gas prior to welding. Backing gas (purge) shall only be argon. The argon backing gas shall be classified as welding grade argon or shall meet Specification SFA-5.32, AWS Classification SG-A. The backing gas (purge) shall be maintained until a minimum of two layers of weld metal have been deposited.

2.3 SHOP CLEANING AND PICKLING OF STAINLESS STEEL PIPING AND WELDS

A. All stainless steel piping shall be thoroughly cleaned and pickled at the mill in accordance with ASTM A380.

B. Pickling shall produce a modest etch and shall remove all embedded iron and heat tint. After fabrication, pickled surfaces shall be subjected to a 24 hour water test or a ferroxyl test to detect the presence of residual embedded iron. All pickled surfaces damaged during fabrication including welded areas shall either be mechanically cleaned or repickled or passivated in

accordance with ASTM A380. Materials that have been contaminated with steel alloys or free iron shall not be used until all contamination is removed. When cleaning to remove steel or iron contamination is required, it shall be performed in accordance with ASTM A380, Code D requirements. All stainless steel surfaces shall be adequately protected during fabrication, shipping, handling, and installation to prevent contamination from iron or carbon steel objects or surfaces. Particulate matter shall be removed from piping and welds. Labels shall be affixed to the piping sections to indicate shop cleaning has been performed. Welds shall be either mechanically cleaned or pickled or passivated on the exterior of the pipe.

C. For buried piping, at least the exterior of all welds shall be passivated.

2.4 INSULATING FITTINGS

A. In all piping, insulating fittings shall be provided to prevent contact of dissimilar metals, including but not limited to, contact of copper, brass, or bronze pipe, tubing, fittings, valves, or appurtenances, or stainless steel pipe, tubing, fittings, valves, or appurtenances with iron or steel pipe, fittings, valves, or appurtenances. Insulating fittings shall also be provided to prevent contact of copper, brass, or bronze pipe, tubing, fittings, valves or appurtenances with stainless steel pipe, tubing, fittings, valves, or appurtenances.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 15065 - MISCELLANEOUS STEEL PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous steel pipe, tubing and accessories that for pipe diameters 24 inches and smaller. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

B. Steel pipe for potable and non-potable water conveyance are covered in the Steel Pipe section.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

   a. Name of Manufacturer
   b. Type and model
   c. Construction materials, thickness, and finishes
   d. Pressure and temperature ratings

B. Gasket Material Certification

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Coated Pipe

1. Handling methods and equipment used shall prevent damage to the protective coating and shall include the use of end hooks, padded calipers, and nylon or similar fabric slings with spreader bars. Bare cables, chains, or metal bars shall not be used. Coated pipe shall be stored off the ground on wide, padded skids. Plastic coated pipe shall be covered or otherwise protected from exposure to sunlight.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL PIPE

A. Galvanized steel pipe materials and service shall be as specified herein.

B. Material Classification CSG-1

CSG-1 – Standard Weight Galvanized Steel with Threaded Fittings All pipe sleeves except where plastic sleeves are required.	Pipe	ASTM A63, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized.
	Fittings	Cast iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.4, Class 125.

C. Material Classification CSG-2

CSG-2 – Standard Weight Galvanized Steel with Threaded Fittings Grease piping – pumping units. Sump pump discharge piping in interior locations except where buried. Drain piping from equipment. Condensate drain piping.	Pipe	ASTM A63, Type E, standard weight, Grade A or B; or ASTM A106, of equivalent thickness, galvanized.
	Fittings	Malleable iron threaded, galvanized. Fittings shall conform to ANSI/ASME B16.3, Class 150, or Fed Spec WW-P-521, Type II.

D. Accessory Materials

1. Accessory materials for galvanized steel pipe shall be as indicated in the Steel Pipe section of the specification.

2.2 STEEL PIPE

A. Steel pipe materials and service shall be as specified herein.

B. Material Classification CS-2

CS-2 – Standard Weight Steel with Socket Welded Fittings. Natural gas piping, buried, or interior locations. Engine-generator cooling water. 2 inch and smaller.	Pipe	ASTM A53/A106, Type S, standard weight, Grade B; plain ends.
	Fittings	Forged steel socket welded. Fittings shall conform to ANSI/ASME B16.11, Class 3000; Bonney, Crane, Ladish, or Vogt.

C. Material Classification CS-3

CS-3 – Standard Weight Steel with Buttwelded Fittings. Natural gas piping, buried or interior locations. Engine-generator cooling water. 2-1/2 inch and larger.	Pipe	ASTM A53/A106, Type S, standard weight, Grade B; beveled ends.
	Fittings	Buttwelded. Fittings shall conform to ANSI/ASME B16.9, standard weight.

D. Accessory Materials

1. Accessory materials for the miscellaneous steel pipe and tubing systems shall be as indicated.

Nipples	ASTM A733, seamless, extra strong (Schedule 80); "close" nipples will be permitted only by special authorization in each case.
Unions (Malleable Iron)	Fed Spec WW-U-53l, Class 2; Type B (galvanized) for galvanized pipe or Type A (black) for ungalvanized pipe.
Flanges	
Standard Weight Pipe	ANSI/ASME B16.5, Class 150, flat faced when connected to flat faced flanges; otherwise, raised face.

Flange Bolts and Nuts	ASTM A193, Grade B7 with ASTM A194 Grade 2H nuts. Length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.
Flange Gaskets	
For Oil Service	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
For Water Service	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch thick.
For Other Services	
Flat Faced Flanges	Non-asbestos filler with neoprene or nitrile binder; dimensions to suit flange contact face; 1/16 inch minimum thickness for plain finished surfaces, 3/32 inch minimum thickness for serrated surfaces.
Raised Face Flanges	Continuous stainless steel ribbon wound into a spiral with non-asbestos filler between adjacent coils with a carbon steel gauge ring. Compressed gasket thickness shall be 0.095 inch ±0.005 inch .
Grooved Couplings	
Rigid	AWWA C606; Gustin-Bacon "No. 120 Rigid" or Victaulic "07 Zero-Flex".
Standard	AWWA C606; Gustin-Bacon "No. 100 Standard" or Victaulic "Style 77".
Expansion Joints	
Heating water, engine-generator cooling water, chilled water, and other services not specified.	FLEXONICS "MODEL H EXPANSION COMPENSATORS" FOR 3 INCH OR SMALLER; FLEXONICS "MID-CORR, SERIES MCB" WITH FLANGED ENDS AND STAINLESS STEEL BELLOWS FOR 4 INCH OR LARGER. EXPANSION JOINTS SHALL BE SUITABLE FOR WORKING PRESSURES UP TO 150 PSIG .

2.3 COATINGS

A. Standard weight steel pipe in buried locations, except hot piping such as aeration air piping, shall have exterior surfaces protected with a shop applied plastic coating. Coatings for hot piping shall be as specified.

B. All surfaces to be tape-wrapped in the shop shall be thoroughly cleaned and primed in accordance with the tape manufacturer's recommendations immediately before wrapping. The tape shall be applied by two-ply (half-lap) wrapping or as needed to provide a total installed tape thickness of at least 60 mils .

C. Shop applied coatings shall be as follows:

1. External Coatings

a. Plastic: Liberty Coating Company "Pritec" or Bredero-Shaw "Entec." The products of other manufacturers will not be acceptable.
b. Tape Wrap: ANSI/AWWA C209, except single ply tape thickness shall not be less than 30 mils ; Protecto Wrap "200" or Tapecoat "CT."
c. High temperature epoxy for aeration and process air piping: Shop or field applied high solids epoxy; suitable for protection at continuous pipe wall temperatures up to 300 F. Coating shall be abrasion resistant. The finished coating shall have a minimum total film thickness of 10 mils. The surface shall be prepared in accordance with SSPC-SP7 as a minimum unless otherwise recommended by the coating manufacturer. The coating shall be Carboline "Thermaline 450," Ameron "Amerlock 400 with Amercoat 880 Additive," or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 15067 - MISCELLANEOUS PLASTIC PIPE, TUBING, AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous plastic pipe, tubing, and accessories. Pipe and tubing shall be furnished complete with all fittings, flanges, unions, jointing materials and other necessary appurtenances.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

    a. Name of Manufacturer
    b. Type and model
    c. Construction materials, thickness, and finishes
    d. Pressure and temperature ratings

B. Gasket Material Certifications.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

B. Pipe, tubing, and fittings shall be stored between 40°F and 90°F .

PART 2 - PRODUCTS

2.1 PVC PIPE MATERIALS

A. PVC pipe materials and services shall be as specified herein.

B. Material Classification PVC-1

PVC-1 – Schedule 40 PVC Pipe with Solvent Welded Joints. Septic system piping.	Pipe Fittings	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 40. ASTM D2466, Cell Classification 12454, bearing NSF seal.

C. Material Classification PVC-2

PVC-2 – Schedule 80 PVC Pipe with Solvent Welded Joints. Sample lines. Sleeves for copper tubing. Carrier pipe in concrete.	Pipe Fittings	ASTM D1785, Cell Classification 12454, bearing NSF seal, Schedule 80. ASTM D2467, Cell Classification 12454, bearing NSF seal. Flanges or unions shall be provided where needed to facilitate disassembly of equipment or valves. Flanges or unions shall be joined to the pipe by a solvent weld. When acceptable to Engineer, threaded joints may be used instead of solvent welded joints in exposed interior locations for the purpose of facilitating assembly. The use of threaded joints in this system shall be held to a minimum.

D. Material Classification PVC-4

PVC-4 – PVC DWV Pipe (Single Wall) with Solvent Welded Joints. Chemical resistant waste and vent piping for plumbing systems.	Pipe Fittings	ASTM D1785, cell classification 12454, bearing NSF seal. ASTM D2665 and ASTM D3311, cell classification 12454, bearing NSF seal.

E. Material Classification PVC-6

PVC-6 – PVC Underdrain Pipe Septic Laterals	Pipe Fittings	ASTM F758, perforated wall, Cell Classification 12454 or 12364, Type PS 46. ASTM D3034, Cell Classification 12454, wall thickness SDR 35, with solvent welded joints.

F. Material Classification PVC-8

PVC-8 – Flexible PVC Tubing with Nylon Braiding. Sample Water Lines in Carrier Pipe	Tubing Fittings	Kentak Products Company, "K-6100". Connections shall be accomplished with hose barbs constructed of a suitable material and hose clamps constructed of stainless steel.

G. Accessory Materials

1. Accessory materials for the PVC Pipe systems shall be as indicated.

Flanges	Diameter and drilling shall conform to ANSI/ASME B16.5, Class 150. Schedule 80 for DWV systems.
Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. Stainless steel for DWV and chemical feed systems, galvanized steel for all other systems.
Flat Washers	ANSI B18.22.1, plain. Same material as bolts and nuts.
Flange Gaskets	Full face, 1/8 inch thick, chemical-resistant elastomeric material suitable for the specified service.
Expansion Joints	Edlon "Thermo-molded TFE" or Resistoflex "Style R6905" molded expansion joint.

2.2 PE PIPE

A. PE pipe materials and services shall be as specified herein.

B. Material Classification PE-1

PE-1 – Polyethylene Pipe with Socket Fusion Joints.Natural gas, buried. 2 inch and smaller	Pipe Fittings	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. "Yellowstripe 8300". ASTM D3350, Cell Classification PE 345464C. ASTM D2683, socket type, with wall thickness same as for pipe.

C. Material Classification PE-2

PE-2 – Polyethylene Pipe with Butt Fusion Joints. Natural gas, buried. 3 inch and larger	Pipe Fittings	ASTM D3350, Cell Classification PE345464C. ASTM D2513, IPS, SDR11; CP Chem Performance Pipe Co. "Yellowstripe 8300". ASTM D3350, Cell Classification PE 345464C. ASTM D3261, butt heat fusion type, with wall thickness same as for pipe.

Material Classification PE-4

PE-4 – Polyethylene Pipe. Water Service 2 inch or smaller	Pipe Fittings	ASTM D3350, Cell Classification PE345464C. ASTM D2737, SDR-9, pressure rating Driscoplex "PE 3408". Molded or manufactured from pipe; cell classification of material and pressure rating same as for pipe.

E. Accessory Materials

1. Accessory materials for the PE Pipe systems shall be as indicated.

Flanges	Schedule 80 PVC; diameter and drilling shall conform to ANSI/ASME B16.5, Class 150.
Flange Bolts and Nuts	ANSI B18.2.1, ASTM A193, AISI Type 304, heavy hex head, length such that after installation the bolts will project 1/8 to 3/8 inch beyond outer face of the nut. ASTM A194, AISI Type, ANSI/ASME B18.2.2, heavy hex pattern.
Fittings and Flange Adapters	Molded or manufactured from the pipe; cell classification of material and pressure rating same as for pipe.

2.3 POLYPROPYLENE PIPE

A. Polypropylene pipe materials and services shall be as specified herein.

B. Material Classification PP-1

PP-1 – Schedule 80 Polypropylene Pipe with Socket Fusion Joints. Distilled water. Deionized water.	Pipe	ASTM D4101, Class 1, virgin, unpigmented homopolymer without additives or UV stabilizer; Enfield or Orion, Schedule 80. Dimensions in accordance with ASTM D2447.
	Fittings	Same material as pipe. Socket fusion type compatible with the pipe; Enfield or Orion.

C. Material Classification PP-2

PP-2 – Schedule 40 Polypropylene DWV Pipe with Heat Fused Joints. Chemical resistance waste and vent piping for plumbing systems.	Pipe	Schedule 40, ASTM D4101. Orion "Brownline" standard type where buried and "Blueline" flame retardant type where abovegrade, Enfield, or R&G Sloan.
	Fittings	Schedule 40, drainage pattern with manufacturers' standard heat fused socket joint. Solvent weld joints not permitted. Fittings and pipe shall be provided by the same manufacturer.

D. Material Classification PP-3

PP-3 – Schedule 40 Polypropylene DWV Pipe with Mechanical Joints. Chemical resistance waste and vent piping for plumbing systems, above grade locations.	Pipe	Schedule 40, ASTM D4101. Orion "Blueline" for flame retardant type, Enfield, or R&G Sloan.
	Fittings	Schedule 40, drainage pattern with manufacturers' standard mechanical joints. Fittings and pipe shall be provided by the same manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 15069 - CAST IRON SOIL PIPE AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of cast iron soil pipe and accessories for the service conditions as specified herein. Cast iron soil pipe shall be furnished complete with all fittings and other accessories.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Items requiring submittals shall include, but shall not be limited to, the following:

Pipe, Gaskets, and Couplings

Name of Manufacturer.

Type and Model.

Construction materials, thickness, and finishes.

Coating product data sheets.

Certification by manufacturer that the pipe and fittings furnished are in accordance with referenced standards. Certification shall include legal name and address of the manufacturer.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Product Marking

1. Pipe and fittings shall bear manufacturer's product marking as required by the referenced standards. Markings shall be plainly marked including but not limited to country of origin, manufacturer's name, and date of manufacturer.

B. Material Classification CI-1

CI-1 – Bell and Spigot Building sanitary drain, waste and vent piping, all locations. Building storm drain piping, all locations. Clear water waste piping, all locations.	Pipe and Fittings: Jointing Material:	ASTM A74 Rubber gaskets, ASTM C564.

C. Material Classification CI-2

CI-2 – Hubless Building sanitary drain, waste and vent piping, all locations except where buried. Building storm drain piping, all locations except where buried. Clear water waste piping, all locations except where buried.	Pipe and Fittings: Jointing Material:	CISPI 301. Heavy duty coupling, with neoprene rubber sleeve, 304 stainless steel shield, and stainless steel clamping bands, or bolted cast iron coupling with stainless steel bolts and neoprene gasket. Couplings shall be Clamp-All Products "HI-TORQ 125," Husky "SD 4000," Mission Rubber Company LLC "HeavyWeight Coupling," or MG Piping Products "MG Coupling," without exception.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

SECTION 15070 -- COPPER TUBING AND ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of copper tubing and accessories. Copper tubing shall be furnished complete with all fittings, flanges, unions, and other accessories specified herein.

1.2 SUBMITTALS

A. Drawings and Data

1. Complete specifications, data, and catalog cuts or drawings shall be submitted in accordance with the Submittals Procedures section. Submittals are required for all piping, fittings, gaskets, sleeves, and accessories, and shall include the following data:

a. Name of Manufacturer
b. Type and model
c. Construction materials, thickness, and finishes
d. Pressure and temperature ratings

B. Gasket Material Certification.

1. Contractor shall obtain and submit a written statement from the gasket material manufacturer certifying that the gasket materials are compatible with the joints specified herein and are recommended for the specified field test pressures and service conditions.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section. All materials shall be stored in a sheltered location above the ground, separated by type, and shall be supported to prevent sagging or bending.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Copper tubing materials and service shall be as specified herein.

B. Material Classification CU-2

CU-2 – Water Tubing with Brazed Joints Buried water supply, 2-1/2 and 3 inch .	Tubing Fittings	Hard drawn copper tubing, ASTM B88, Type K. Brazed joint, material to match tubing. Fittings shall conform to ANSI B16.18 or ANSI/ASME B16.22.

C. Material Classification CU-3

CU-3 – Water Tubing with Solder and Brazed Joints Potable, non-potable, and plant effluent water supply, 3 inch and smaller. Hot water supply. Tempered water supply. Differential pressure lines for flow transmitters. Laboratory vacuum.	Tubing Fittings Flanges	Hard drawn copper tubing, ASTM B88, Type L. Solder joint (smaller than 2 inch except compressed air piping), Brazed joint (2 inch and larger for piping other than compressed air and all sizes for compressed air piping), material to match tubing. Fittings shall conform to ANSI B16.18, or ANSI/ASME B16.22. Where required for connection to equipment, valves, and accessories, ANSI B16.24, class 150, cast bronze, brazed joint.

D. Material Classification CU-7

CU-7 – ARC Tubing with Brazed Fittings Refrigerant piping.	Tubing Fittings	Hard drawn ACR copper tubing, ASTM B280. Dimensions shall be in accordance with ASTM B280. Brazed.

E. Accessory Materials

1. Accessory materials for the copper tubing systems shall be as indicated.

Flange Bolts and Nuts	ASTM A307, Grade B, length such that, after installation, the bolts will project 1/8 to 3/8 inch beyond outer face of the nut.
Flange Gaskets	ASTM D1330, Grade I, red rubber, ring type, 1/8 inch thick.
Expansion Joints	Tempflex "Model HB Expansion Compensators" with copper tube ends.
Insulating Fittings	
Threaded	Dielectric steel pipe nipple, ASTM A53, Schedule 40, poly-propylene lined, zinc plated; Perfection Corp. "Clearflow Fittings".

Flanged	Epco "Dielectric Flange Unions" or Central Plastics "Insulating Flange Unions".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Miscellaneous Piping and Accessories Installation section.

End of Section

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SECTION 15091 - MISCELLANEOUS BALL VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) ball valves as specified herein.

B. Miscellaneous ball valves shall be provided where AWWA type ball valves are not required.

C. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If the requirements in this section are different from those in the General Equipment Stipulations, the requirements in the section shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. General Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Ball valves shown on the drawing, but not specified herein, shall be selected to match piping material they are installed in.

B. Valves Type VB-1

VB-1	Rating	500 psi nonshock cold WOG MSS SP-110
Ball valves indicated on the plumbing drawings for water service in metallic piping systems.	Code	In-line, two piece, end entry, full port
	Type	ASTM B584–C84400 bronze
	Body/Bonnet	
	Trim	Reinforced Teflon
2 inch and smaller	Seat	Brass, or chrome plated brass
	Ball	Brass or bronze
	Stem	Reinforced Teflon
	Thrust Washer	Teflon or Viton
	Stem Seal	Threaded End
	End Connection	-20 to 400°F
	Temp. Limitations	Lever
	Valve Operator	Conbraco Industries "Apollo 77-100
	Manufacturers	Series"; Powell "Fig 4210T"

C. Valves Type VB-2

VB-2	Rating	500 psi nonshock cold WOG MSS SP-110
Ball valves indicated on the plumbing drawings for water service for metallic piping systems	Code	In-line, three piece, end entry, full port
	Type	ASTM B584-C84400 Bronze
	Body/Bonnet	
	Trim	Reinforced Teflon
2-1/2 inch and 3 inch	Seat	Brass or chrome plated
	Ball	Brass or Bronze
	Stem	Reinforced Teflon
	Thrust Washer	Teflon or Viton
	Stem Seal	Threaded End
	End Connection	-20 to 400°F Lever
	Temp. Limitations	Conbraco Industries "Apollo
	Valve Operator	82-100 Series"
	Manufacturers	

D. Valves Type VB-4

VB-4	Rating	1000 psi nonshock cold WOG MSS SP-110, NACE MR-01-75
Compressed air	Code	In-line, three piece, bolted body,
	Type	regular port
2 inch and smaller		ASTM A351-CF8M, stainless steel
	Body/Bonnet	
Socket weld	Trim	Reinforced Teflon
	Seat	ASTM A276-316 stainless steel
	Ball	ASTM A276-316 stainless steel
	Stem	Reinforced Teflon
	Thrust Washer	Reinforced Teflon
	Stem Seal	Socket weld
	End Connection	-20 to 400°F
	Temp. Limitations	Lever
	Valve Operator	Conbraco Industries "Apollo 85-200
	Manufacturers	Series"; Neles-Jamesbury "Series

	4000"

E. Valves Type VB-5

VB-5	Rating	Class 150
	Code	
Water service	Type	In-line, split-body, full port
	Body/Bonnet	ASTM A216-WCB, cast steel
2-1/2 inch	Trim	
	Seat	Reinforced Teflon
	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Stem Packing	Manufacturer's standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-200 Series"

F. Valves Type VB-6

VB-6	Rating	Class 150
	Type	In-line, end entry, regular port
Water service		
	Body/Bonnet	ASTM A216-WCB, cast steel
3 inch and larger	Trim	
	Seat	Reinforced Teflon
Flanged	Ball	ASTM A216-WCB, steel, chrome plated
	Stem	ASTM A108-CS
	Thrust Washer	Reinforced Teflon
	Body Seal	Reinforced Teflon
	Stem Seal	Manufacturer's standard
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Conbraco Industries "Apollo 88A-100 Series", Neles-Jamesbury "5000 Series", Powell "Fig 4224T"

G.

H. Valves Type VB-8

VB-8	Rating	800 psi nonshock cold WOG
Water service	Code	ASME B16.34
	Type	In-line, three piece, bolted body, regular port
2-1/2 inch through 4 inch		

Butt weld	Body/Bonnet	ASTM A105, forged steel or ASTM A216-WCB, cast steel
	Trim	
	Seat	Reinforced Teflon
	Ball	Nickel or hard chrome plates carbon steel
	Stem	Nickel or hard chrome plated carbon steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Butt weld
	Temp. Limitations	-20 to 400°F
	Valve Operator	Lever
	Manufacturers	Worcester Controls “4546TTBW4”

I. Valves Type VB-10

VB-10	Rating	150 psig nonshock cold WOG
Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
4 inch and smaller	Seat	Teflon
Socket	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon
	Stem Seal	Viton O-ring
	Body Seals	Viton O-rings
	End Connection	Socket
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve TBH Series"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co "True Union 2000 Standard Series 3600 Ball Valve"

J. Valves Type VB-11

VB-11	Rating	150 psig nonshock cold WOG
Service as specified in Miscellaneous Plastic Pipe, Tubing, and Accessories section	Type	In-line, true union, full port (Schedule 80)
	Body/Bonnet	PVC or CPVC to match piping system
	Trim	
	Seat	Teflon
4 inch and smaller	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
Flanged	Thrust Washer	Teflon
	Stem Seal	Viton O-ring

	Body Seals	Viton O-rings
	End Connection	Flanged, ASME B16.5, Class 150, raised face
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Hayward Plastic Products "True Union Ball Valve TBH Series"; Nibco "Chemtrol TU Series Tru-Bloc Ball Valve"; Spears Manufacturing Co. "True Union 2000 Standard Series 3600 Ball Valve"

K. Valves Type VB-12

VB-12	Rating	150 psig at 73°F
	Type	In-line, Tru-union, end entry, regular port
Distilled water, deionized water service	Body/Bonnet	Virgin unpigmented Type 1 Homopolymer Polypropylene
1 inch and smaller	Trim	Virgin unpigmented Type 1 Homopolymer Polypropylene
	End Connection	Socket weld
	Valve Operator	Lever
	Manufacturers	Orion "Whiteline Riontite"

L. Valves Type VB-17

VB-17	Rating	2000 psi nonshock cold WOG
	Type	In-line, two piece, end entry, full port
Water service	Body/Bonnet	ASTM B548-C84400, bronze
	Trim	
2 inch and smaller	Seat	Reinforced Teflon
	Ball	ASTM A276-316, stainless Steel
	Stem	ASTM A276-316, stainless Steel
	Thrust Washer	Reinforced Teflon
	Stem Seal	Reinforced Teflon
	End Connection	Threaded End
	Temp. Limitations	-20 to 400°F
	Valve Operator	Electric Actuator
	Manufacturers	Conbraco Industries “Apollo 77-Arx-35-00 Series”

M. Valves Type VB-18

VB-18	Rating	150 psig nonshock cold WOG
	Type	True union, three-way valve (Schedule 80)
Three-way ball valves in anti-siphon loop service	Body/Bonnet	PVC or CPVC to match piping system
	Trim	Teflon
2 inch and smaller	Seat	PVC or CPVC to match piping system
	Ball	PVC or CPVC to match piping system
	Stem	PVC or CPVC to match piping system
	Thrust Washer	Teflon

	Stem Seal	Viton O-rings
	Body Seals	Viton O-rings
	End Connection	Socket
	Temp. Limitations	0 to 140°F
	Valve Operator	Lever
	Manufacturers	Asahi-America "Type 23 Multiport," Hayward "Three-Way Ball Valves," Nibco "3-Way Ball Valve," Spears "True Union 2000 Industrial 3-Way Valve"

N. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

O. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Coal Tar Epoxy	High-build coal tar epoxy; Ameron "Amercoat 78HB Coal Tar Epoxy", Carboline "Bitumastic 300 M", Tnemec "46H-413 Hi-Build Tneme-Tar", or Sherwin-Williams "Hi-Mil Sher-Tar Epoxy".
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves To Be Buried, Submerged, or Installed in Manholes or Valve Vaults	Coal tar epoxy.
Exterior Surfaces of all other valves	Universal primer.

2.2 VALVE ACTUATORS

A. Ball valve, except those which are equipped with power actuators or are designed for automatic operation, shall be provided with manual actuators. Unless otherwise specified or indicated on the drawings, each manual actuator shall be equipped with a lever operator. Ball valves with center lines more than 7'-6" above the floor shall be provided with chain levers.

B. Valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2.3 ACCESSORIES

A. If the drawings indicate the need for extension stems, stem guides; position indicator; floor boxes; valve boxes; or operating stands, refer to the Valve and Gate Actuator section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 15093 - CHECK VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of check valves as specified herein and as indicated in the Check Valve Schedule.

B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. All valves in contact with potable water to be NSF-61 certified.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Temporary Number Plates

1. Each check valve with an identifying number listed in the Check Valve Schedule, shall be tagged or marked in the factory with the identifying number.

F. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section.

Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

A. Valves VC-1

B.

VC-1 Pump Discharge 12” inch and larger pipe	Rating	Class 150
	Code	AWWA C508
	Type	Tilting disc type, metal seated, full body type capable of accepting bottom mounted oil dashpots.
	Body	The valve body shall consist of two sections bolted together as a central diagonal flange inclined at an angle of 55 degrees. The inlet body section shall contain a seat ring positioned and captured by the diagonal flange. The outlet body section shall accept eccentrically located pivot pin trunnions with sealed covers and lubrication grease fittings.
	Trunnions	The eccentric pivot trunnions shall be located to divide the disc into approximately 1/3 and 2/3 proportions and also allow the seating surface of the disc to rotate away from the seating surface of the seat ring without contact. Clearance shall be provided between the pivot pin and bushing when the disc is seated to prevent binding and to ensure a tight seal.
	Flow Area	The flow area through the valve body inlet and outlet shall be equal to the nominal pipe size and gradually increase to an area 40 percent greater at the valve seat. The valve flow way shall be contoured and unrestricted to provide full flow areas at all locations within the valve. Full flow shall be based on an open stroke of 40 degrees to assure stabilization of the disc when open.
	Dashpot	A bottom mounted oil dashpot shall be factory installed in the upstream inspection port to provide hydraulic control of the final 10% of valve closure and reduce water hammer normally associated with rapid flow reversal conditions on pump shut down. The dashpot shall consist of a high pressure

		hydraulic cylinder with a minimum bore size as shown below, adjustable external flow control valve, pressurized oil reservoir and piping designed to control the closing speed of the last 10% of travel in 1-5 seconds. A dashpot spacer which connects the cylinder to the valve shall have an air gap to prevent hydraulic fluid from entering the valve and contaminating the water system. A snubber rod fitted with O-ring seals and rod wiper scrapers shall make contact with the lower portion of the disc during closure.
	Materials	
	Body/Bonnet	ASTM A536 Grade 65-45-12 ductile iron
	Seat Ring	ASTM B271 Alloy C95500 centrifugally cast aluminum bronze
	Disc	ASTM A536 Grade 65-45-12 ductile iron
	Pivot Pins	ASTM B505 Alloy C95500 aluminum bronze
	Bushings	ASTM B505 Alloy C95400 aluminum bronze
	Cover Gasket	Manufacturer's standards.
	End Connection	Flanged, ASME B16.1 Class 125, flat faced
	Temp. Limitations	-20 to 125°F
	Manufacturers	ValMatic "Tilted Disc Check VM-9612B"; APCO "Slanting Disc CSD-800 BMB"

C. Accessories

1. Pump discharge check valves shall be provided with open limit switches as indicated on the Drawings.

   Each limit switch shall be heavy duty type, with a cast NEMA Type 3 enclosure, a spring return roller level, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts ds. The switches shall be Allen Bradly "802T" or Square D "9007 Type C".

D. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard°891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	NSF 61 Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

Schedule 15093-S01
Check Valves Schedule

1.010	1.020	1.030	1.040	1.050	1.060
Tag Number	**Size**	**Type of Valve**	**Service**	**Design Capacity**	**Ends(1)**
	(in)			(gpm)	
42-VCK-301	20	VC-1	Finished Water	9,900	F
42-VCK-302	20	VC-1	Finished Water	9,900	F
42-VCK-303	20	VC-1	Finished Water	9,900	F
42-VCK-401	20	VC-1	Finished Water	10,300	F
42-VCK-402	20	VC-1	Finished Water	10,300	F
42-VCK-403	20	VC-1	Finished Water	10,300	F

Notes:

(1) Abbreviations for valve ends are as indicated:

F
MJ
P

END OF SCHEDULE

SECTION 15094 - BACKFLOW PREVENTERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of backflow preventers and associated appurtenances, as indicated herein. Backflow preventers for fire protection service shall be as specified in the fire sprinklers systems section.

B. Piping, pipe supports, insulation, and accessories which are not an integral part of the backflow preventers or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Equipment specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to the following:

a. Name of manufacturer.
b. Type and model.
c. Construction materials and finishes.
d. Net weight.
e. Unit dimensions.
f. Performance curves indicating flow capacity versus pressure drop.

B. Operations and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Backflow preventers shall be designed to meet the requirements as indicated herein and in the Backflow Preventer Schedule on the Drawings.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and specific products are listed in the Design and Construction paragraph.

2.3 DESIGN AND CONSTRUCTION

A. Backflow prevention device type shall be as indicated herein.

B. Reduced Pressure Zone Backflow Preventers

1. Reduced pressure zone (RPZ) backflow preventers shall consist of isolation valves, two independent check valves, and differential relief valve. The assembly shall automatically reduce the pressure in the zone between the check valves. In the event that the reduced pressure is not maintained, the differential relief valve shall open, maintaining the proper zone differential. RPZ backflow preventers shall comply with AWWA C511 and ASSE Standard 1013 requirements and shall be suitable for horizontal installation. Backflow preventers shall comply with the requirements of ANSI/NSF 61, Annex G for low lead. Each RPZ backflow preventer shall be provided with a relief valve air-gap drain fitting.

2. RPZ backflow preventers in 2 inch and smaller sizes shall be provided with bronze bodies and with a threaded bronze bodied ball valve on each end of the device. Two inch and smaller RPZ backflow preventers shall be Febco “Model LF860,” Wilkins “Model 975XL2,” or Watts Regulator “Series LF919.”

3. RPZ backflow preventers in 2-1/2 inch and larger sizes shall be provided with 304 stainless steel or ductile iron bodies with epoxy-coated interior and exterior, and a flanged, resilient-seated gate valve on each end of the device. Flange diameter and

drilling shall conform to ANSI/ASME B16.1, Class 125. 2-1/2 inch and larger RPZ backflow preventers shall be Wilkins "Model 375" or Watts Regulator Company "Series 957."

C. Hose Connection Vacuum Breakers

1. Hose connection vacuum breakers shall be provided with 3/4 inch hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, manual drain feature, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be Febco "Series 731," Watts Regulator Company "Series 8" or Wilkins "Model BFP 8."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

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SECTION 15096 - GLOBE VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) globe valves as specified herein.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the drawings, specified, otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. All valves in contact with potable water to be NSF-61 certified.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

E. Coordination

1. All equipment provided under this section shall be furnished by or through a single manufacturer who shall be responsible for the design, coordination, and satisfactory performance of all components over the full operating range.

F. Tagging

1. Each item of equipment and each part shipped separately shall be tagged and identified with indelible markings for the intended service. Tag number shall be clearly marked on all shipping labels and on the outside of all containers.

G. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION.

A. Valves VGL-1

VGL-1 Instrument air, clear water service 1/2 inch pipe and smaller	Rating	Class 200
	Code	MSS SP-80
	Type	In-line, union or threaded bonnet, rising stem, needle
	Body/Bonnet	Bronze or brass
	Trim	
	Seat	Manufacturer's standard
	Stem	Bronze
	Bonnet Gasket	Manufacturer's standard
	Stem Packing	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	0 to 400°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "600", Powell "Fig 180", Stockham "B-64".

B. Valves VGL-4

VGL-4 Instrument air compressed air service 3/4 to 2 inch pipe Threaded	Rating	Class 150
	Code	MSS SP-80, Type 2
	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
	Trim	
	Seat	Integral to body
	Stem	Teflon
	Bonnet Gasket	Bronze
	Stem Packing	Manufacturer's standard
	End Connection	Threaded
	Temp. Limitations	0 to 350°F
	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590", Stockhalm "B-22T",

	Walworth “Fig 3095”.

C. Valves VGL-5

VGL-5	Rating	Class 150
	Code	MSS SP-80, Type 2
	Type	In-line, composition disc, union bonnet, rising stem
	Body/Bonnet	ASTM B62, bronze
Instrument air compressed air service	Trim	
	Seat	Integral to body
	Disc	Teflon
	Stem	ASTM B62, Bronze
	Bonnet Gasket	Manufacturer’s standard
	Stem Packing	Teflon impregnated
	End Connection	Soldered
	Temp. Limitations	0 to 250°F
3/4 to 2 inch pipe	Valve Operator	Handwheel
	Manufacturers	Milwaukee "1590"
Soldered		

D. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

E. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer’s standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials

Asphalt Varnish	Fed Spec TT-C-494.
Epoxy Enamel (for liquid service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.

Surfaces To Be Coated

Unfinished Surfaces

Interior Surfaces	
Liquid Service	Asphalt varnish (two coats) or epoxy enamel.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS

A. Unless otherwise specified, globe valves shall be provided with handweel type manual actuators. Handwheel diameter shall be manufacturers standard size.

B. Unless otherwise specified, valves indicated to be electric motor operated on the drawings shall have reversible electric motor operators designed for 120 volt ac, single phase operation. Actuators shall include integral thermal overload protection and a declutchable manual override. Actuators shall be equipped with motor operation limit switches and two additional single-pole, double-throw limit switches for auxiliary open and closed indication. An internal heater and thermostat shall be provided in each actuator housing to prevent condensation. Actuators in Class I, Division 1 or Division 2, Group D hazardous areas indicated on the drawings shall have NEMA Type 7 housings. Actuators in other areas shall have NEMA Type 4X housings.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides; position indicators; floor boxes; valve boxes; and operating stands shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with Valve Installation section.

End of Section

SECTION 15098 - PLUG VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of manually operated or remote activated two position (open-close) plug valves.

B. Piping, pipe supports, insulation, and accessories that are not an integral part of the valves or are not specified herein are covered in other sections. Valve actuators are covered in the Valve and Gate Actuator section.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft. Submittal drawings shall clearly indicate the country of origin of all cast gray iron and ductile iron valve components.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Valves VP-2

VP-2	Rating	175 WOG
	Code	AGA Approved
Natural gas,	Body	Cast iron

propane service 3 and 4 inch pipe	Trim	
	Plug Seal	Hycar
	Plug	Bronze or nickel plated cast iron
	Stem Seal	Buna
	End Connection	Flanged, ASME B16.1, Class 125
	Temp. Limitations	-20 to 180°F
	Valve Operator	Lever
	Manufacturers	Key Port "Fig 425-RS51"

B. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within plus or minus 1/16 inch of the specified or theoretical length.

C. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Epoxy Enamel	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuators section.

2.3 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, and valves boxes shall be as specified in Valve and Gate Actuators section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

End of Section

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1.010	1.020	1.030	1.041	1.050	1.060	1.080	1.090	2.010
Tag Number	Size	Rated Working Pressure	Application	Type of Installation(2)	Ends(3)	Maximum Differential Pressure Across Valve	High Pressure Side of Plug(5)	Type of Manual Actuator(4)
	(in)	(psi)				(psi)		
43-VPL-101	4	45	Natural Gas	IP	F	5		HW
43-VPL-102	4	45	Natural Gas	IP	F	5		HW
43-VPL-103	4	45	Natural Gas	IP	F	5		HW

Notes:
(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet [1.2 m] or less
B20	Buried, depth greater than 4 feet [1.2 m] but 20 feet [6.1 m] or less
B	Buried, depth greater than 20 feet [6.1 m], actual depth of xx feet(Bxx)
SV20	Submerged or vaulted, depth 20 feet [6.1 m] or less
SV	Submerged or vaulted, depth greater than 20 feet [6.1 m], actual depth of xx feet(SVXX)
IP	In plant

(3) Abbreviations for valve ends are as indicated:

F	Flanged
MJ	Mechanical joint
P	Push-on joint

(4) Abbreviations for manual actuator types are as indicated:

WN	Wrench Nut
LVR	Lever
CW	ChainWheel
HW	HandWheel

(5) Abbreviations for high pressure side of plug are as indicated:

S	Seating (plug shaft side)
U	Unseating (plug seat side)

(6) Abbreviations for limit switches on manual and cylinder operated valves.

EOT	End of travel (open - close)
PSS	Pump start - stop (two intermediate positions)
ELSCH	See electrical schematics

(7) Abbreviations for electronic or electric actuator housing.

WP	Weatherproof
SUB	Submersible [xx = depth of submergence](SUBxx)
EXP	Explosion proof

(8) Abbreviations for control devices are as indicated.

Table 1: Control Devices				
Abbreviations	Open-Close Push Button	Open-Stop-Close Push Button	Local-Off-Remote	Red and Green Indicator Lights
A	Required		Required	Required
B	Required		Required	
C		Required	Required	Required
D		Required	Required	
E		Required		
F	Required			
G	Required			Required
H		Required		Required

(10) Abbreviations for electric actuator types are as follows:

SE Standard Electric
IE Intelligent Electric
NE Networked Electric

(11) Abbreviations for remote control station types:

CS Control Station without indicating lights.
CIS Control Station with indicating lights.

END OF SCHEDULE

SECTION 15099 - PRESSURE REDUCING VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of pressure reducing valves as specified herein.

B. Piping, pipe supports, insulation, and accessories which are not an integral part of the valves or are not specified herein are covered in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be identified in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Net weight of each valve and accessory
b. Name of manufacturer.
c. Type and model.
d. Construction materials and finishes.
e. Unit dimensions.
f. Performance curves indicating flow capacity versus pressure drop.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance

manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. Pressure reducing valves shall be designed to meet the service requirements as indicated herein and in the Pressure Reducing Valves Schedule on the Drawings.

B. Each pressure reducing valve shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be selected and sized as recommended by the valve manufacturer. Valve pressure setpoint shall be adjustable to at least 20 percent above and below the reduced pressure setpoint.

2.2 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers and specific products are listed in the Construction paragraph.

2.3 MATERIALS

A. Valve materials shall be as indicated below and in the Construction paragraph.

Shop Coatings

Epoxy Enamel, NSF certified (Liquid Service)	Ameron "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", or Tnemec "Series N140 Pota-Pox Plus"; immersion service.
Epoxy Enamel (Gas and Air Service)	Ameron "Amercoat 385 Epoxy", Carboline "Carboguard 890", or Tnemec "Series N69 Hi-Build Epoxoline II".

2.4 CONSTRUCTION.

A. Water Service

1. Pressure reducing valves for water service shall be direct-acting or pilot-operated type as indicated in the Pressure Reducing Valve Schedule.

2. Direct-acting valves shall be globe type with threaded connections and union assembly. The valves shall be provided with bronze body and cover, stainless steel trim, reinforced neoprene diaphragm, Buna-N disc, and stainless steel strainer. Direct-acting pressure reducing valves shall be Cla-Val “Model 50-01”, Cash-Acme, or Watts.

B. Air Service

1. Pressure reducing valves for air service shall have a cast iron or steel body with stainless steel trim and a composition disc. Pressure reducing valves shall be furnished with integral or line mounted inlet filters/strainers and discharge pressure gauges. Valves shall be provided with flanged or socket weld connections. Socket weld locations shall be at sufficient to prevent damage to elastomeric valve components. Valves shall be as manufactured by Fisher Controls; O. C. Keckley Co.; Leslie Controls, Inc.; Spirax Sarco, Inc; or equal.

2.5 SAFETY VALVES FOR AIR SERVICE

A. Safety valves for air service shall be ASME labeled and shall have carbon steel bodies with stainless steel seats and discs, packed lifting levers, and integral spring enclosures. Gauges shall be provided for all valves. The safety valves shall be located as indicated on the drawings. The safety valves shall be as manufactured by Consolidated or Crosby.

B. Safety Valves shall be selected and sized as recommended by the valve manufacturer.

Valve Tag No.	42-VSP-301 42-VSP-401

C. Safety valves shall be suitable for operation under the following conditions:

Performance and Design Requirements	
Service	Air
Tags Nos.	42-VSP-301, 42-VSP-401
Specific gravity of gas	1.0
Minimum design rating, psig	250
Pressure relief setting, psig	100
Capacity, scfm	42

2.6 Note: Actual size to be confirmed and selected by valve manufacturer.

2.7 SHOP PAINTING

A. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop painted for corrosion protection in accordance with the following list. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the field painting specified in the Protective Coatings section.

Interior Surfaces

Liquid Service — Epoxy (NSF certified).

Gas and Air Service — Epoxy.

Exterior Surfaces	Universal primer with epoxy finish coat.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section will be installed in accordance with the Valve Installation section.

End of Section

Schedule 15099-S01
Pressure Reducing Valves Schedule

1.010	1.020	1.030	1.040	1.050	1.060	1.070	1.080	1.090	1.010	1.110
Tag Number	**Location**	**Type of Servic(1)**	**Type(2)**	**Maximum Inlet Pressure**	**Minimum Inlet Pressure**	**Reduced Pressure Setting**	**Maximum Flow(3)**	**Ordinary Flow(3)**	**Minimum Flow(3)**	**Minimum Permissible Pressure at Maximum Flow**
				(psig)	(psig)	(psig)	(3)	(3)	(3)	(psig)
42-VPC-301	Pump Station	A	DO	250	205	90	35	15	5	85
42-VPC-401	Pump Station	A	DO	250	205	90	35	15	5	85

Notes:

(1) Abbreviations for types of service are as follows:

W	Water
NG	Natural Gas
PG	Propane Gas
DG	Digester Gas
A	Air

(2) Abbreviations for Pressure reducing value type are as follows:

DO	Direct-operated
PO	Pilot-operated

(3) Units of flow are as follows:

Water service	Gallons per minute (gpm)
Gas Service	Cubic feet per hour (cfh)
Air Service	Cubic feet per minute (cfm)

End of Schedule

SECTION 15100 - MISCELLANEOUS VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing of miscellaneous valves as specified herein, except where specific requirements are stipulated in other sections.

1.2 GENERAL

A. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Identification

1. Valves specified herein shall be tagged in accordance with the Equipment and Valve Identification section.

C. All valves in contact with potable water to be NSF-61 certified.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications, covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Length Tolerance

1. Unless otherwise specified, the actual length of valves shall be within ±1/16 inch of the specified or theoretical length.

B. Shop Coatings

1. All ferrous metal surfaces of valves and accessories, both interior and exterior, shall be shop coated for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating.

Coating Materials	
Epoxy (for liquid service)	PPG Amercoat "Amerlock 400 High-Solids Epoxy Coating", Carboline "Carboguard 891", Sherwin-Williams "Macropoxy 646NSF"or Tnemec "Series N140 Pota-Pox Plus".
Rust-Preventive Compound	As recommended by the manufacturer.
Surfaces To Be Coated	
Unfinished Surfaces	
Interior Surfaces	
Liquid Service	Epoxy enamel.
Exterior Surfaces of Valves to be Buried, Submerged, or Installed in Manholes or Valve Vaults	Epoxy.
Exterior Surfaces of all Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.
Actuators and Accessories	Universal primer.

2.2 HOSE FAUCETS, HYDRANTS, AND CURB STOPS.

A. Fire Hydrants

1. Fire hydrants shall conform to ANSI/AWWA C502. The information required by Paragraph III. A. of the ANSI/AWWA C502 foreword shall be as indicated below.

Affidavit of compliance	Not required.
Catalog and maintenance data	Required.
Type of shutoff	Gate.
Size of hydrant (valve opening)	5-1/4 inches .
Inlet connection	6 inch , locked push-on.

Harnessing lugs	Not required.
Depth of bury	3 ft.
Outlet nozzles	Two 2-1/2 inch hose nozzles and one 4-1/2 inch pumper nozzle.
Outlet nozzle threads	See Note 1.
Direction to open	Counterclockwise.
Stem seals	O-ring.
Outlet nozzle cap chains	Required, per Springdale Water standard
Drain outlet	Required, per Springdale Water standard
Operating nut	See Note 2.
Outlet nozzle cap nut	See Note 2.

Notes

1. Outlet nozzle threads shall be the Springdale Water standard thread.

2. The operating nut and outlet nozzle cap nut shall be of the Springdale Water standard shape and size.

2.3 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified in the Valve and Gate Actuator section.

2.4 ACCESSORIES

A. When the Drawings indicate the need for extension stems; position indicator; floor boxes; or operating stands, refer to the Valve and Gate Actuator section.

B. Valve Boxes

1. Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch thick, and shall be provided with suitable cast iron bases and covers.

2. Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and base, and a 6 inch cast iron pipe section. The cover and base shall be

Clay & Bailey "No. 2193NS". The pipe shaft shall extend from the valve to 5 inches inside the valve box base.

3. All parts of valve boxes, bases, and covers shall be shop coated with the manufacturer's standard coating.

4. Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Materials furnished under this section shall be installed in accordance with the Valve Installation section.

B. Installation Check

1. An installation check by an authorized representative of the manufacturer is not required.

2. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

3. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

4. All costs for these services shall be included in the contract price.

End of Section

SECTION 15101 - AWWA BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing of AWWA butterfly valves for cold water service as indicated in the AWWA Butterfly Valve Schedule.

B. AWWA butterfly valves shall be furnished complete with actuators and accessories as specified herein, as indicated in the schedule, and as specified in the Valve and Gate Actuators section.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all butterfly valves and manual actuators shall conform to the applicable requirements of ANSI/AWWA C504.

E. Marking

1. Supplementing the requirements of Section 6.1 of the governing standard, the country of origin of all castings and an identifying serial number shall be stamped on a corrosion-resistant plate attached to the valve body.

F. Temporary Number Plates

1. Each butterfly valve shall be tagged or marked in the factory with the identifying number indicated on the Drawings.

G. Identification

1. AWWA butterfly valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data – General

1. Complete drawings, details, and specifications covering the valves and their appurtenances shall be submitted in accordance with the Submittals Procedures section. Included in the submittal shall be drawings by the valve manufacturer to indicate the position of the valve actuator and valve shaft.

B. Drawings and Data – Electrical and Wiring Diagrams

1. Drawings shall include separate wiring diagrams for each electrically operated or controlled valve and the electrical control equipment. Each drawing shall be identified with the valve number or name as specified in this section.

C. Certified Test Results.

1. Certified copies of test results for tests described in Section 5 of the governing standard, shall be submitted to Engineer before the valves are shipped. An affidavit of compliance with the governing standard.

PART 2 - PRODUCTS

2.1 ACCEPTABLE PRODUCTS

A. Butterfly valves shall be by the manufacturers listed below.

1. DeZurik

2. Pratt (Mueller)

3. M&H

4. Val-Matic

5. Rodney Hunt

2.2 MATERIALS

A. Acceptable shop coatings are listed in the following table.

Epoxy

For Raw or Treated Water Service in potable water facilities (NSF certified)	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams "Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 VALVE CONSTRUCTION.

A. Valve Bodies

1. Valves shall be short-body type unless otherwise specified in the AWWA Butterfly Valve Schedule. The use of a stop or lug cast integrally with or mechanically secured to the body for the purpose of limiting disc travel by means of direct contact or interference with the valve disc (in either the open or closed position) will not be acceptable.

B. Flanges

1. Flanges shall be finished to true plane surfaces within a tolerance limit of 0.005 inch. The finished face shall be normal to the longitudinal valve axis within a maximum angular variation tolerance of 0.002 inch per foot (0.017 percent) of flange diameter.

C. Mechanical Joint Ends

1. Mechanical joint ends shall be either mechanical joint or push-on ends conforming to ANSI/AWWA C111/A21.11.

D. Valve Shafts

1. Valve shafts shall be fabricated of AISI Type 304 or 316 stainless steel. The use of shafts having a hexagonal cross section will not be acceptable. The connection between shaft and disc shall be in accordance with the governing standard.

2. The connection between the shaft and the disc shall be mechanically secured by means of solid, smooth sided, stainless steel or monel taper pins or dowel pins. Each taper pin or dowel pin shall extend through or shall wedge against the side of the shaft and shall be mechanically secured in place. The use of set screws, knurled or fluted dowel pins, expansion pins, roll pins, tension pins, spring pins, or other devices instead of the pins specified herein will not be acceptable.

E. Valve Seats

1. Acceptable seating surfaces mating with rubber are AISI Type 304 or 316 stainless steel, monel, or plasma-applied nickel-chrome overlay for all valves; bronze for 20 inch and smaller valves; and alloy cast iron for 20 inch and smaller manually operated valves.

2. Seats shall be located on the valve body. Valve seat configurations which rely on the mating pipe flange to hold the seat in position in the valve body will not be acceptable.

F. Shaft Seals

1. Shaft seals shall be of the chevron type.

G. Thrust Bearings

1. Each valve shall be provided with one or more thrust bearings in accordance with the governing standard. Thrust bearings which are directly exposed to line liquid and which consist of a metal bearing surface in rubbing contact with an opposing metal bearing surface will not be acceptable.

2.4 VALVE ACTUATORS

A. Requirements for valve actuators shall be as specified herein, as indicated in the AWWA Butterfly Valve Schedule, and as specified in the Valve and Gate Actuators section.

B. All 8 inch and larger valves shall have geared actuators.

C. If valves with an AWWA class designation higher than specified are furnished, actuator torque capabilities shall be increased accordingly and shall be acceptable to Engineer.

D. Actuator Sizing

1. The valve manufacturer shall size the actuator in accordance with the governing standard , the operating conditions and requirements indicated in the AWWA Butterfly Valve Schedule, and the valve manufacturer's requirements.

2. Unless otherwise indicated or specified, actuator torque requirements shall be based on a maximum differential pressure across the valve equal to the maximum pressure associated with the valve class and a maximum velocity through the valve of 16 feet per second.

3. Valves with operating stands shall have actuator torques increased by 25 percent. Actuator torques determined by the above requirements shall be increased by any design factors required by paragraph 4.2.8 of ANSI/AWWA C504 for valves 72 inches and smaller, or as specified herein.

2.5 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except finished surfaces, bearing surfaces, and stainless steel components, of valves and accessories shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is

functionally equivalent to the specified coating and is compatible with the specified field painting.

B. Surfaces shall be painted as follows:

Unfinished Surfaces	
Interior Surfaces	Epoxy.
Exterior Surfaces	Universal primer.
Polished or Machined Surfaces	
Flange Faces	Rust-preventive compound.
Other Surfaces	Epoxy.

1. Interior coatings shall comply with ANSI/AWWA C550 and shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils
Universal Primer	3 mils

2.6 ACCESSORIES

A. Requirements for extension stems and stem guides, position indicators, floor boxes, operating stands, torque tubes, valve boxes, and extension bonnets shall be as indicated in the AWWA Butterfly Valve Schedule and as specified in the Valve and Gate Actuators section.

PART 3 - EXECUTION

A. INSTALLATION

1. Valves shall be installed in accordance with the Valve Installation section.

2. Installation Check

a. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Startup Requirements section, and shall revisit the job site as often as necessary until any problems are corrected and the equipment installation and operation are satisfactory in the opinion of Engineer

b. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping and appurtenances; and has been operated under full load conditions and that it has operated satisfactorily.

End of Section

1.010	1.020	1.031	1.040	1.060	1.070	1.080	1.090	2.010
Tag Number	Size	Application	Type of Installation(2)	AWWA Class(3)	Maximum Non-Shock Shutoff Pressure	Maximum Differential Pressure	Maximum Velocity	Type of Manual Actuator(4)
	(in)				(psi)	(psi)	(ft/s)	
42-VBF-001	60	Treated Water	IP	150B-F		60	10	HW
42-VBF-002	60	Treated Water	IP	150B-F		60	10	HW
42-VBF-003	60	Treated Water	IP	150B-F		60	10	HW
42-VBF-301	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-304	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-307	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-303	20	Finished Water	IP	150B-F		110	11	HW
42-VBF-306	20	Finished Water	IP	150B-F		110	11	HW
42-VBF-309	20	Finished Water	IP	150B-F		110	11	HW
42-VBF-314	36	Finished Water	IP	150B-F		110	11	HW
42-VBF-313	16	Finished Water	IP	150B-F		110	11	HW
42-VBF-401	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-404	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-407	24	Treated Water	IP	150B-F		60	11	HW
42-VBF-403	20	Finished Water	IP	150B-F		140	11	HW
42-VBF-406	20	Finished Water	IP	150B-F		140	11	HW
42-VBF-409	20	Finished Water	IP	150B-F		140	11	HW
42-VBF-414	36	Finished Water	IP	150B-F		140	11	HW
42-VBF-413	16	Finished Water	IP	150B-F		140	11	HW

Notes:

(1) Actuators designated "O-C" are for "Open-Close" service. Actuators designated "M" are for "Modulating" service.

(2) Abbreviations for installation types are as follows:

B4	Buried, depth of 4 feet or less
B20	Buried, depth greater than 4 feet but 20 feet or less
Bxx	Buried, depth greater than 20 feet, actual depth of xx feet
SV20	Submerged or vaulted, depth 20 feet or less
SVxx	Submerged or vaulted, depth greater than 20 feet, actual depth of xx feet
IP	In plant

(3) Suffix letters define valve ends as follows:

F	Flanged
MJ	Mechanical joint

(4) Abbreviations for actuator types are as follows:

WN	Wrench Nut
LVR	Lever
CW	ChainWheel
HW	HandWheel

(5) If a value is indicated, the leakage test shall be performed using this pressure value rather than the pressure indicated by the AWWA class.

END OF SCHEDULE

SECTION 15108 - AIR VALVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing combination air valves as required by the Work.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Valves shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of valves.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standard

1. Except as modified or supplemented herein, all valves furnished under this section shall conform to the applicable performance requirements of ANSI/AWWA C512.

E. Identification

1. Air valves shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly drawings, together with detailed specifications and data covering materials used and accessories forming a part of the valves furnished, shall be submitted in accordance with the Submittals Procedures section.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

A. Two inch and smaller combination air valves for clean water applications shall be of the integral type with a valve assembly which functions as both an air and vacuum valve and an air release valve. The valves shall be Apco/Valve and Primer "Single Body Combination Air Valves", Multiplex "Crispin Universal Air Release Valves", ARI “No. D-040”, or Val-Matic "Combination Air Valves".

2.2 MATERIALS

A. Except as modified or supplemented herein, materials of construction shall comply with the governing standard.

Valve Trim	Bronze or austenitic stainless steel or polymer materials. Valve trim for valves in wastewater service shall be austenitic stainless steel.
Float	Austenitic stainless steel, polycarbonate, or foamed polypropylene.
Shop Coatings	
Epoxy (NSF-61 Certified)	PPG Amercoat “Amerlock 400 High Solids Epoxy”, Carboline “Carboguard 891”, Sherwin-Williams "Macropoxy 646NSF" or Tnemec “Series N140 Pota-Pox Plus”.
Epoxy	PPG Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams "Macropoxy 646" or Tnemec “Series N69 Hi-Build Epoxoline II”.
Rust-Preventive Compound	As recommended by manufacturer.

2.3 SHOP PAINTING

A. All interior and exterior ferrous metal surfaces, except stainless steel components, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field coating. Field painting is covered in the Protective Coatings section.

B. Surfaces shall be painted as indicated:

Interior Surfaces of Valves in Clean Water Applications (Raw or Treated Water in Potable Water Facilities)	NSF-61 Certified Epoxy.

Exterior Surfaces of All Other Valves	Universal primer.
Polished or Machined Surfaces	Rust-preventive compound.

C. Interior epoxy coatings for clean water valves shall comply with ANSI/AWWA C550/NSF 61. Interior coatings for all valves shall be free of holidays. The total dry film thickness of shop-applied coatings shall be not less than:

Type of Coating	Minimum Dry Film Thickness
Epoxy	10 mils
Universal Primer	3 mils

2.4 SHUTOFF VALVES

A. A shutoff valve shall be provided in the piping leading to each air valve. Shutoff valves 2 inches and smaller shall be ball valves as specified in the Miscellaneous Ball Valves section. Shutoff valves 3 inches and larger for clean water service shall be butterfly valves as specified in the AWWA Butterfly Valve section. Shutoff valves 3 inches and larger for wastewater service shall be eccentric plug valves as specified in the Eccentric Plug Valve section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Air release and combination air valves shall be installed in accordance with the Valve Installation section.

End of Section

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SECTION 15115 - FLAP GATES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing 4 inch and larger double pivot flap gates and appurtenances as specified herein.

1.2 GENERAL

A. Equipment furnished under this section shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Gates shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of flap gates.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Identification

1. Flap gates shall be tagged in accordance with the Equipment and Valve Identification section.

1.3 SUBMITTALS

A. Drawings and Data.

1. Complete drawings, construction details, and specifications covering the flap gates and appurtenances shall be submitted in accordance with the Submittals Procedures section. Each drawing shall be identified with the applicable flap gate number.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. A flap gate will be provided on the 24” emergency flood drain located in the trench located in the Pump Room to drain water by gravity to an exterior stormwater junction box.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Flap gates shall be designed for the following conditions and requirements.

B. Each gate shall be designed to automatically open whenever the unseating head exceeds the seating head by 0.30 foot or less, and to automatically close whenever the seating head exceeds the unseating head.

2.3 ACCEPTABLE MANUFACTURERS

A. For circular flap gates acceptable manufacturers are Hydro Gate, M&H, and Rodney Hunt.

2.4 MATERIALS

Wall Thimble, Gate Body and Cover	Cast iron.
Hinge Arms	Ductile iron or bronze.
Hinge Pins	Silicon bronze or AISI Type 304 stainless steel.
Hinge Pin Bushings	Bronze or teflon.
Adjusting Bolts and Locknuts	Bronze or AISI Type 304 stainless steel.
Metallic Seats	Bronze or stainless steel.
Resilient Seats	Neoprene or Buna-N.
Assembly Fasteners	Silicon bronze or stainless steel.
Thread Lubricant	Jet-Lube "Nikal", John Crane "Thred Gard Nickel", Never-Seez "Pure Nickel Special", or Permatex "Nickel Anti-Seize".
Epoxy Enamel	PPG-Amercoat “Amercoat 385 Epoxy”, Carboline “Carboguard 890”, Sherwin-Williams “Macropoxy 646” or Tnemec “Series N69 Hi-Build Epoxoline II”.

2.5 CONSTRUCTION

A. Wall Thimbles

1. Wall thimbles shall be furnished by the gate manufacturer. Each wall thimble shall provide a rigid mounting designed to prevent warping of the gate body. The length and configuration of wall thimbles shall be as indicated on the drawings. Each thimble shall be provided with a mounting flange sized, machined, drilled, and tapped to the same template used for the gate body which is to be attached thereto.

B. Body

1. The body of each flap gate shall be of heavy pattern cast construction. All joint surfaces and bearing areas shall be machined. All pivots shall be bushed and provided with suitable fittings to permit periodic lubrication of each pivot pin and bushing. An accurately machined slot or dovetailed groove shall be provided to retain the seat.

C. Cover

1. The gate cover shall be of heavy pattern cast construction, adequately reinforced to withstand the maximum specified seating head without distortion. Unless otherwise specified, each cover shall have an accurately machined slot or dovetailed groove to retain the seat.

2. When resilient seats are specified, the gates shall be furnished with either a metallic cover seat or an accurately machined seating surface affording full contact with the resilient body seat when the gate is fully closed.

D. Seats

1. Seats shall be metallic or resilient. Metallic seats shall fill the finished grooves and shall be pressed or suitably expanded into the grooves in a manner which will ensure that the seats will remain in place and free from distortion during the life of the gate. Seat faces shall be machined to at least a 60 microinch finish. Resilient seats shall fill and be permanently bonded into the groove in the gate body.

E. Hinge Arms

1. Hinge arms shall be of heavy pattern cast construction, with two pivot joints per arm, an adjustable lower pivot with limited rotation, and an adjustable upper hinge post or lug arrangement to permit adjustment of gate opening sensitivity to unseating heads.

F. Shop Painting

1. All iron and steel surfaces, except machined surfaces, which will be fully or partially submerged shall be shop painted with coal tar epoxy or epoxy enamel for gates installed in non-potable water facilities and NSF certified epoxy enamel for gates installed in potable water facilities. The shop coating shall have a dry film thickness of at least 6 mils for epoxy enamel and 15 mils for coal tar epoxy.

2. Refer to the General Equipment Stipulations for other shop painting requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Flap gates and appurtenances shall be installed in accordance with the Valve and Gate Installation section.

End of Section

SECTION 15140 – PIPE SUPPORTS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of pipe hangers, brackets, supports, bracing, anchorage, and the design for the pipe support system for pipes 12 inches and smaller. Pipe supports shall be furnished complete with all necessary inserts, bolts, nuts, rods, washers, and other accessories. This section also covers the spacing of expansion joints in pipes 12 inches in diameter and smaller. Expansion joint products and materials are covered in the respective piping sections.

B. This section covers pipe supports for the following pipe materials:

1. Cast or ductile iron
2. Glass lined cast or ductile iron
3. Stainless Steel
4. Steel (hot water)
5. Steel (other)
6. Copper (hot water)
7. Copper (other)
8. PVC/CPVC Schedule 80 (other)
9. PVC Schedule 40
10. Cast iron soil pipe

1.2 GENERAL

A. Contractor shall provide pipe supports, anchors, flexible couplings, and expansion joints for all piping systems. The Drawings indicate pipe supports, anchors, flexible couplings, and expansion joints for pipes larger than 12 inches in diameter, and in special cases for pipes that are 12 inches and smaller. Contractor shall design anchors, pipe supports, expansion joints, and flexible couplings not already shown on the Drawings, in accordance with the requirements specified herein.

B. Contractor's design shall include pipe supports, bracing, and anchorage adjacent to expansion joints, couplings, valves, in-line devices, equipment, wyes and tees, or changes in direction as required for dismantling piping, removing valves or other in-line devices, disconnecting piping

from equipment, and pipe support, in addition to supports in accordance with the maximum spacing specified herein. The pipe support system design by Contractor shall rigidly support pipe so there is no visible movement or visible sagging between supports. The system shall comply with specified piping code requirements.

C. Contractor shall not delete or relocate the supports, expansion joints, or couplings indicated on the Drawings without written approval of Engineer.

D. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all supports furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

1.3 SUBMITTALS

A. General Drawings and Data.

1. Complete data, catalog information, and drawings covering fabricated pipe supports, fabricated inserts, and stainless steel, galvanized, and copper-plated and plastic-coated pipe supports shall be submitted in accordance with the Submittals Procedures section.

B. Intended Use and Location Schedule.

1. Data shall include a listing of the intended use and general location of each item submitted.

C. Meteorological and Seismic Certification.

1. When a wind and/or seismic design is required, Contractor shall submit confirmation of compliance with the Meteorological and Seismic Design Criteria section.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, all pipe supports shall comply with ANSI/MSS SP-58 and MSS SP-69. Materials of construction for fabricated steel supports are covered in the Structural and Miscellaneous Metals section. All pipe support materials shall be packaged as necessary to ensure delivery in satisfactory condition.

B. Unless otherwise specified or indicated on the Drawings, pipe supports shall be fabricated of manufacturer's standard materials and provided with manufacturer's standard finish.

C. Design loads for inserts, brackets, clamps, and other support items shall not exceed the manufacturer's recommended loads.

D. Pipe supports shall be manufactured for the sizes and types of pipe to which they are applied. Strap hangers will not be acceptable. Threaded rods shall have sufficient threading to permit the maximum adjustment available in the support item. Continuously threaded rod is not acceptable for hanger rods over 12 inches in length.

E. Unless accepted by Engineer, the use of supports which rely on stressed thermoplastic components to support the pipe will not be permitted.

F. Contact between dissimilar metals, including contact between stainless steel and carbon steel, shall be prevented. Portions of pipe supports which come into contact with other metals that are dissimilar shall be rubber or vinyl coated. For compressed air piping upstream of aftercoolers, supports shall be stainless steel.

G. Supports for brass or copper pipe or tubing shall be copper plated or plastic coated.

H. Hot-dip galvanized supports shall be in accordance with ASTM A153 and A385. Galvanized supports shall be provided where specified herein.

I. Pipe support types and application shall comply with Table 1.

2.2 WIND AND SEISMIC LOADS

A. Wind and seismic loads for worst case conditions of either full, partially full, or empty pipes shall be considered in the design. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

PART 3 - EXECUTION

3.1 APPLICATION

A. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section.

B. Anchorage shall be provided to resist thrust due to temperature changes, changes in diameter or direction, or dead-ending. Anchors shall be located as specified to force expansion and contraction movement to occur at expansion joints, loops, or elbows, and as needed to prevent excessive bending stresses and opening of mechanical couplings. Anchorage for temperature changes shall be centered between elbows and mechanical joints used as expansion joints. Anchorage for bellows type expansion joints may be located adjacent to the joint.

C. When expansion joints are required, pipe guides shall be provided adjacent to bellows type expansion joints. Guides will not be required where mechanical couplings are permitted as expansion joints. Guides shall be located on both sides of expansion joints, except where anchors are adjacent to the joint. Unless otherwise indicated on the Drawings, one guide shall be within four pipe diameters from the joint and a second guide within 14 pipe diameters from the first guide. Pipe supports shall allow adequate movement; pipe guides shall not be used for

anchoring pipe against longitudinal forces. Pipe guides shall be provided at locations as recommended by the manufacturer.

D. Pipe supports for insulated cold piping systems shall be sized for the outside diameter of the insulated pipe, and an insulation protection shield shall be installed between the support and the insulation. Rigid insulation inserts shall be installed between the pipe and the insulation shields for piping larger than 2 inches or when needed to prevent crushing of the insulation. Inserts shall be of the same thickness as the adjacent insulation and shall be vapor sealed.

E. Insulated hot piping systems shall be supported by clevises, clamps, support saddles, or rollers. Pipe clamps shall be attached directly to the pipe. Support saddles and rollers shall be sized for the outside diameter of the insulated pipe, and an insulation protection saddle shall be installed at the support.

F. When supports for the FRP piping systems are in contact with less than 180 degrees of the pipe surface or when the width of the support is less than one-third the nominal pipe diameter (4 inches minimum), an FRP or steel saddle, shaped to the outside diameter of the pipe, shall be bonded to at least the bottom 120 degrees of the pipe.

3.2 TYPES OF SUPPORTS

A. The products for pipe supports shall be as indicated in Table 1 for the specified type and size of support. Where stainless steel is specified for pipe supports but is not available from the name suppliers for the model specified in Table 1, Contractor shall provide a heavier duty support that is available in stainless steel.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Hangers		
2-1/2 inch and smaller pipe		
For hot and cold insulated piping		
Clevis	1	B-Line "B3100," Anvil "260" Piping Technology & Products Fig. 83.
Other services		
J-style	5	B-Line "B3690," Anvil "67," Unistrut "J Hanger," or Piping Technology & Products Fig. 67.
Clevis	1	B-Line "B3104," Anvil "260," or Piping Technology & Products Fig. 83.
3 Through 12 inch pipe (Note 3)		

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
For hot insulated piping		
Double bolt	3	B-Line "B3144," Anvil "295," or Piping Technology & Products Fig. 70.
For cold insulated piping		
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
For uninsulated cold piping		
Clamp	4	B-Line "3140," Anvil "212," or Piping Technology & Products Fig. 50.
Clevis	1	B-Line "B3100," Anvil "260," or Piping Technology & Products Fig. 83.
Other services		
Clevis	1	B-Line "B3100" or Anvil "260" for steel pipe; B-Line "B3102," Anvil "590," or Piping Technology & Products Fig. 83 C. L. for cast iron pipe.
Concrete Inserts, Steel		
12 inch and smaller pipe	18	Channel 12 ga , galv, 1-5/8 by 1-3/8 inches , min. 8 inches 200 mm long, anchor lugs on 4 inch centers, at least three lugs, end caps, and filler strip.
Beam Clamps, Malleable Iron or Steel, 12 inch and smaller pipe	21	B-Line "3050" and "3055," Anvil "133" and "134," or Piping Technology & Products Fig. 130 and Fig. 130 (SP).
	28, 29	Anvil "292" or Piping Technology & Products Fig. 140.
	30	B-Line "3054," Anvil "228," or Piping Technology & Products Fig. 140.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Side Beam Bracket	34	B-Line "B3062," Anvil "202," or Piping Technology & Products Fig. 20L.
Wall Supports and Frames, Steel, 12 inch and smaller pipe (Note 2)		
Brackets	32	B-Line "B3066," Anvil "195," or Piping Technology & Products Fig. 76.
	33	B-Line "B3067," Anvil "199," or Piping Technology & Products Fig. 76.
Prefabricated channels	--	12 ga , galv, 1-5/8 inches , with suitable brackets and pipe clamps.
Offset pipe clamp, 1-1/2 inch and smaller pipe	--	Galv, 1-1/4 by 3/16 inch steel, with 3/8 inch bolts.
Offset pipe clamp, 2 to 3-1/2 inch pipe	--	Galv, 1-1/4 by 1/4 inch steel, with 3/8 inch bolts.
Floor Supports, Steel or Cast Iron		
6 inch and smaller pipe	37 (with base)	B-Line "B3090," Anvil "259" or Piping Technology & Products Fig. 48.
8 through 12 inch pipe	38	B-Line "B3093," Anvil "264" or Piping Technology & Products Fig. 46.
Pipe Alignment Guides	--	B-Line "B3281" through "B3287," Anvil "255," or Piping Technology & Products Fig. 6.
Turnbuckles Steel	13	B-Line "B3202," Anvil "230," or Piping Technology & Products Fig. 30.
Hanger Rods, Carbon Steel, Threaded Both Ends, 3/8 inch minimum size	--	B-Line "B3205," Anvil "140," or Piping Technology & Products Fig. 128.
Weldless Eye Nut, steel	17	B-Line "B3200," Anvil "290," or Piping Technology & Products Fig. 40.

TABLE 1 - TYPES OF SUPPORTS

Description and Service	MSS SP 69 Type (Note 1)	Specification
Insulation Protection Saddle	39	B-Line "B3160 Series," Anvil "160 Series," or Piping Technology & Products Fig. 184.
Insulation Protection Shield	40	B-Line "B3151," Anvil "167," or Piping Technology & Products Fig. 183.

Table 1 Notes:

1. MSS SP-69 supports and hangers are illustrated on Figure 1-15140.
2. Pipe clamps or other devices which rely on the application of a clamping force to the supported pipe in order to maintain the clamp position or location in a prefabricated channel or track will not be acceptable for use with nonmetallic pipe or tubing.
3. Alternatively, pipe hangers for 12 inch pipe may be saddle type as indicated on the Drawings.

3.3 SUPPORT SPACINGS

A. Pipe supports and expansion joints shall be spaced in accordance with Tables 2, 3, 4, and 5. The types of pipes to be supported are as specified herein. Table 2 covers spacings for the standard operating conditions specified for each pipe material. Tables 3 and 4 cover PVC and FRP pipe spacings where operating conditions are in excess of the temperature and specific gravity requirements covered in Table 2. Table 5 covers PVC and FRP pipe which carries air or liquids with a specific gravity other than 1.0. Spacing in the tables is the maximum spacing considering gravity loads. Where Contractor's design includes lateral and longitudinal forces due to seismic loads, wind loads, and other forces, the spacing requirement may be less than that indicated in the tables.

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet	Expansion Joint Max Spacing (Note 2) feet	Type of Expansion Joints
Cast iron or Ductile iron	15	80	80	Note 6
Cast iron or Ductile iron, glass-lined	12	80	80	Note 6
Steel, for hot water heating				

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet	Expansion Joint Max Spacing (Note 2) feet	Type of Expansion Joints
1-1/4 inch and smaller	7	30	100	Note 3
1-1/2 to 4 inch	10	30	100	Note 3
Over 4 inch	15	30	100	Note 3
Steel, for other services				
1-1/4 inch and smaller	7	30	100	Note 3
1-1/2 to 4 inch	10	30	100	Note 3
Over 4 inch	15	80	80	Note 6
Stainless steel				
1-1/4 inch and smaller	7	30	100	Note 3
1-1/2 to 4 inch	10	30	100	Note 3
Over 4 inch	15	80	80	Note 3
Copper, for hot water				
1 inch and smaller	5	20	100	Note 3
Over 1 inch	7	20	100	Note 3
Copper, for services other than hot water				
1 inch and smaller	5	--	--	Note 7
Over 1 inch	7	50	100	Note 3
PVC, Schedule 80, for other services at a maximum temperature of 100° F and a maximum specific gravity of 1.0.				
1/8 and 1/4 inch	Continuous Support	20	60	Note 3
1/2 inch	4	20	60	Note 3
3/4 inch	4-1/2	20	60	Note 3
1 and 1-1/4 inch	5	20	60	Note 3
1-1/2 and 2 inch	5-1/2	20	60	Note 3

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet	Expansion Joint Max Spacing (Note 2) feet	Type of Expansion Joints
2-1/2 inch	6	20	60	Note 3
3 inch	7	20	60	Note 3
4 inch	7-1/2	20	60	Note 3
6 inch	8-1/2	20	60	Note 3
8 inch	9-1/2	20	60	Note 3
10 inch	10	20	60	Note 3
12 inch	11	20	60	Note 3
Cast iron soil pipe	10	--	--	Notes 7, 8
PVC, Schedule 40, for services at a maximum temperature of 100° F , and a maximum specific gravity of 1.0.				
1/8 and 1/4 inch	Continuous Support	20	60	Note 3
1/2 inch	3-1/2	20	60	Note 3
3/4 and 1 inch	4	20	60	Note 3
1-1/4 and 1-1/2 inch	4-1/2	20	60	Note 3
2 inch	5	20	60	Note 3
2-1/2 inch	5-1/2	20	60	Note 3
3 inch	6	20	60	Note 3
4 inch	6-1/2	20	60	Note 3
6 inch	7-1/2	20	60	Note 3
8 inch	8	20	60	Note 3
10 inch	8-1/2	20	60	Note 3
12 inch	9-1/2	20	60	Note 3**]**

TABLE 2 – MAXIMUM PIPE SUPPORT SPACING AT STANDARD TEMPERATURES AND SERVICES

Type of Pipe	Pipe Support Max Spacing feet	Max Run Without Expansion Joint, Loop, or Bend (Note 1) feet	Expansion Joint Max Spacing (Note 2) feet	Type of Expansion Joints

Table 2 Notes:

1. Unless otherwise acceptable to Engineer, an expansion joint shall be provided in each straight run of pipe having an overall length between loops or bends exceeding the maximum run specified herein.
2. Unless otherwise acceptable to Engineer, the spacing between expansion joints in any straight pipe run shall not exceed the maximum spacing specified herein.
3. Expansion joint fittings are specified in the respective piping sections.
4. At least two properly padded supports for each pipe section.
5. At least one support for each pipe section.
6. Expansion joints shall be mechanical couplings.
7. No expansion joints are required.
8. Supports for 5 and 10 foot long pipe sections shall be located within 18 inches of each joint. Supports shall be positioned to maintain the piping alignment and to prevent the piping from sagging.
9. References to specific gravity refer to liquid specific gravity and are referenced to water which is assumed to have a specific gravity of 1.0.

B. Temperature Adjustments for PVC Pipe.

1. PVC pipe at a temperature above 100° F shall have maximum support spacing in accordance with the following table. For insulated lines, reduce the support spacing to 70 percent of the listed values.

TABLE 3 – MAXIMUM PIPE SUPPORT SPACING FOR PVC PIPE AT NON-STANDARD TEMPERATURES

feet

Nominal Size	Schedule 40		Schedule 80	
inches	120° F	140° F	120° F	140° F
1/4	Continuous Support		Continuous Support	
1/2	3	2-1/2	3-1/2	3
3/4	3-1/2	3	4	3
1	3-1/2	3	4-1/2	3-1/2
1-1/4	4	3-1/2	4-1/2	4
1-1/2	4	3-1/2	5	4

TABLE 3 – MAXIMUM PIPE SUPPORT SPACING FOR PVC PIPE AT NON-STANDARD TEMPERATURES

feet

Nominal Size	Schedule 40		Schedule 80	
inches	120° F	140° F	120° F	140° F
2	4-1/2	3-1/2	5	4-1/2
2-1/2	4-1/2	4	5-1/2	4-1/2
3	5	4	6	5
4	5-1/2	4-1/2	6-1/2	5-1/2
6	6-1/2	5	8	6-1/2
8	7	5-1/2	8-1.2	7
10	7-1/2	6	9	7-1/2
12	8	6-1/2	10	8-1.2

C. Temperature Adjustments for FRP Pipe

D. Specific Gravity Adjustments for PVC Pipe

1. PVC pipe shall have the maximum spacing indicated in Tables 2 and 3 adjusted in accordance with the following table when the specific gravity of the liquid is greater than 1.0. (Note: Specific gravities listed are liquid specific gravities referenced to water which is assumed to have a specific gravity of 1.0.) Table 4 shall not apply to PVC pipe containing alum solution, caustic soda solution, ferric chloride solution, and hypochlorite solution, as these services are specifically covered in Table 2.

2. Table 4 shall be used for Indicate service and specific gravity.

TABLE 4 – MAXIMUM SUPPORT SPACING CORRECTION FACTORS FOR PVC AND PIPE

Specific Gravity	Correction Factor
1.0	1.00
1.1	0.98
1.2	0.96
1.4	0.93
1.6	0.90
2.0	0.85
2.5	0.80
Air	1.40

3.4 INSTALLATION

A. General

1. All piping shall be supported in a manner which will prevent undue stress on any valve, fitting, or piece of equipment. In addition, pipe supports shall be provided at changes in direction or elevation, and adjacent to flexible couplings. Pipe supports and hangers shall not be installed in equipment access areas.

2. Where horizontal piping is arranged with two or more parallel lines, trapeze hangers may be used in lieu of individual hangers. Trapeze assembly shall consist of structure attachments as previously specified with rod size dependent upon total weight supported. Spacing of assemblies shall be determined by the minimum pipe size included in the group supported. Trapeze horizontal assemblies shall be structural angle or channel section of sufficient size to prevent measurable sag between rods when pipes are full. All lines shall be attached to the horizontal with intermediate pipe guides and U-bolts or one-hole clamps. Pre-engineered support equipment may be used when selected and installed in accordance with the manufacturer's recommendations.

3. Where copper pipe is installed on a support system of dissimilar metal with other pipes, the copper pipe shall be galvanically isolated from the support using Neoprene strips or other material acceptable to Engineer.

4. No piping shall be supported from the pipe above.

5. Horizontal piping hanger support rods shall attach to steel beams with center-loading I-clamps, or welded beam clips. Hanger support rods shall attach to concrete slabs or beams with inserts.

6. Anchorage shall be provided to resist both lateral and longitudinal seismic forces.

B. Inserts

1. Concrete inserts or anchor bolts shall be used to support piping from new cast-in-place concrete. Fastening of supports to existing concrete and masonry shall be in accordance with the Anchorage in Concrete and Masonry section. Reference building structural concrete Drawings for concrete inserts. When not provided as part of the building concrete structure, provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

2. Where concrete slabs form finished ceilings, provide inserts flush with the slab surface.

3. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab. NDE (Non-Destructive Evaluation) shall be used to locate existing reinforcing before drilling.

C. Pipe Hangers and Supports

1. Install hangers to provide a minimum 1/2 inch space between finished covering and adjacent work.

2. A hanger shall be placed within 18 inches of each horizontal elbow, and on both sides of all piping accessories and valves weighing 20 lbs or more.

3. Hangers shall have 1-1/2 inches minimum vertical adjustment.

4. Support horizontal cast iron, ductile iron and no-hub piping systems adjacent to each joint.

5. Support vertical piping at every floor using riser clamps.

6. Support riser piping independently of connected horizontal piping.

7. Hanger and hanger components shall be sized specifically for the pipe size it is to be used on.

3.5 PLACEMENT

A. The maximum spacing for pipe supports and expansion joints shall be as indicated in Tables 2, 3, and 4.

B. Rubber hose and flexible tubing shall be provided with continuous angle or channel support.

C. Unless otherwise indicated on the Drawings or acceptable to Engineer, piping shall be supported approximately 1-1/2 inches out from the face of walls and at least 3 inches below ceilings.

End of Section

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SECTION 15180 - VALVE ACTUATORS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing manual and powered valve actuators and accessories as specified herein.

1.2 GENERAL

A. Equipment provided under this section shall be fabricated and assembled in full conformity with Drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Actuators shall be furnished with all necessary parts and accessories indicated on the Drawings, specified, or otherwise required for a complete, properly operating installation and shall be the latest standard products of a manufacturer regularly engaged in the production of actuators.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, electric motor actuators shall conform to applicable requirements of ANSI/AWWA C542.

2. Except as modified or supplemented herein, actuators for butterfly valves shall conform to the applicable requirements of ANSI/AWWA C504.

3. Except as modified or supplemented herein, manual actuators for ball valves shall conform to the applicable requirements of ANSI/AWWA C507.

E. Power Supply

1. Power supply to electric actuators will be as indicated in the valve schedules.

F. Marking

1. Each actuator shall be marked with the manufacturer's name, model number, and the country of origin. An identifying serial number shall be stamped on a corrosion-resistant plate attached to the actuator.

G. Temporary Number Plates

1. Each actuator shall be factory tagged or marked to identify the actuator and the applicable valve by number or service as indicated in the valve schedule.

1.3 SUBMITTALS

A. Drawings and Data General

1. Complete drawings, details, and specifications covering the actuators and their appurtenances shall be submitted in accordance with the Submittal Procedures section. Submittal drawings shall clearly indicate the country of origin of each actuator and its components.

B. Drawings and Data – Electrical and Wiring Diagrams

1. Submittal drawings shall include separate wiring diagrams for each electrically operated or controlled actuator and the electrical control equipment. Each actuator drawing shall be identified with the respective valve number or name.

C. Testing Certifications and Results.

1. For electric actuators, certified copies of reports covering proof-of-design testing of the actuators as set forth in Section 5 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, together with an affidavit of compliance as indicated in Section 6.3 of ANSI/AWWA C541 or ANSI/AWWA C542 respectively, shall be submitted to Engineer before the actuators are shipped.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN REQUIREMENTS

A. General

1. Actuators and appurtenances shall be designed for the conditions and requirements as indicated in the respective valve sections.

2. Liberal factors of safety shall be used throughout the design, especially in the design of parts subject to intermittent or alternating stresses. In general, working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material.

B. Valve Actuators

1. Each actuator shall be designed to open or close the valve under all operating conditions. Actuators shall be designed for the maximum pressure differential across the valve and maximum velocities through the valve where indicated in the respective valve schedules.

2. Valve actuators shall be provided and adjusted by the valve manufacturer. Actuator mounting arrangements and positions shall facilitate operation and maintenance and shall be determined by the valve manufacturer unless indicated otherwise on the Drawings or directed by Engineer.

3. When valves are to be buried, submerged, or installed in vaults; the actuators and accessories shall be sealed to prevent the entrance of water. The design water depth shall be as indicated in the respective valve schedules but not less than 20 feet.

C. Limit Switches

1. Limit switches shall be provided as indicated on the Drawings or in the valve schedules.

2. For manual or cylinder type actuators, each limit switch shall be heavy duty type, with a cast NEMA Type 4 enclosure, a spring return roller lever, and four isolated contacts (two normally open and two normally closed) rated 10 amperes at 120 to 480 volts ac and 5 amperes at 125 volts dc. The switches shall be Allen Bradley "802T" or Square D "9007 Type C".

3. Limit switches for intelligent electric actuators shall be as indicated in their respective paragraphs.

2.2 MATERIALS

A. Except as modified or supplemented herein, materials used in the manufacture of actuators shall conform to the requirements of the applicable governing standard(s).

2.3 VALVE MANUAL ACTUATORS

A. General

1. Manual actuators of the types listed in the valve specifications or schedules shall be provided by the valve manufacturer.

2. Unless otherwise indicated or specified, each geared manual actuator shall be equipped with an operating handwheel.

3. The direction of rotation of the wheel, wrench nut, or lever to open the valve shall be to the left (counterclockwise). Each valve body or actuator shall have cast thereon the word "Open" and an arrow indicating the direction to open.

4. The housing of traveling-nut type actuators shall be fitted with a removable cover which shall permit inspection and maintenance of the operating mechanism without removing the actuator from the valve. Travel limiting devices shall be provided inside the actuator for the open and closed positions. Travel limiting stop nuts or collars installed on the reach rod of traveling-nut type operating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. The use of stop nuts or adjustable shaft collars which rely on clamping

force or setscrews to prevent rotation of the nut or collar on the reach rod will not be acceptable.

5. Each actuator shall be designed so that shaft seal leakage cannot enter the actuator housing.

6. Valves for throttling service shall be equipped with an infinitely variable locking device or a totally enclosed gear actuator.

7. Actuators shall produce the required torque with a maximum pull of 80 lbs on the lever, handwheel, or chain. Actuator components shall withstand, without damage, a pull of 200 lbs on the handwheel or chainwheel or an input of 300 foot-lbs on the operating nut.

B. Handwheels

1. Handwheel diameters shall be at least 8 inches but not more than 24 inches for 30 inch and smaller valves and not more than 30 inches for 36 inch and larger valves.

C. Wrench Nuts

1. Unless otherwise specified in the valve schedules or on the Drawings, wrench nuts shall be provided on all buried valves and on all valves that are to be operated through floor boxes. Unless otherwise directed by Owner, all wrench nuts shall comply with Section 4.4.13 of ANSI/AWWA C500. At least two operating keys shall be furnished for operation of the wrench nut operated valves.

2.4 ACTUATOR ACCESSORIES

A. Extension Stems

1. Extension stems and stem guides shall be furnished when indicated in the respective valve schedules, indicated on the Drawings, or otherwise required for proper valve operation. Extension stems shall be of solid steel and shall be not smaller in diameter than the stem of the actuator shaft. Extension stems shall be connected to the actuator with a single Lovejoy "Type D" universal joint with grease-filled protective boot. All stem connections shall be pinned.

2. At least two stem guides shall be furnished with each extension stem, except for buried valves. Stem guides shall be of cast iron, bronze bushed, and adjustable in two directions. Stem guide spacing shall not exceed 100 times the stem diameter or 10 feet, whichever is smaller. The top stem guide shall be designed to carry the weight of the extension stem. The extension stem shall be provided with a collar pinned to the stem and bearing against the stem thrust guide.

3. Extension stems for buried valve actuators shall extend to within 6 inches of the ground surface, shall be centered in the valve box using spacers, and shall be equipped with a wrench nut.

B. Valve Boxes

1. Each valve buried to a depth of 4 feet or less shall be provided with a slide type valve box. Valve boxes shall be cast iron, extension sleeve type, suitable for the depth of cover indicated on the Drawings. Only one extension will be allowed with each slide type valve box. Valve boxes shall be at least 5 inches in inside diameter, shall be at least 3/16 inch [4.7 mm] thick, and shall be provided with suitable cast iron bases and covers.

2. Each valve buried deeper than 4 feet shall be provided with a valve box consisting of a cast iron cover and a 6 inch Cast Iron Pipe section. The cover shall be Clay & Bailey "No. 2193". The pipe shaft shall extend from the valve to 5 inches inside the valve box cover.

3. All parts of valve boxes, bases, and covers shall be shop coated with manufacturer's standard coating.

4. Valve boxes which are to be provided with position indicators shall have top sections and covers designed for proper installation of the position indicator and accessories.

2.5 SHOP PAINTING

A. All ferrous metal surfaces, except bearing and finished surfaces and stainless steel components of valve actuators and accessories, shall be shop painted for corrosion protection. The valve manufacturer's standard coating will be acceptable, provided it is functionally equivalent to the specified coating and is compatible with the specified field painting.

B. The following surfaces shall be painted:

Polished or Machined Surfaces	Rust-preventive compound.
Other Surfaces	Epoxy.
Actuators and Accessories	Universal primer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Actuators will be installed on the valves in accordance with the Valve Installation section.

End of Section

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SECTION 15250 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of insulation, jackets, and accessories for the following mechanical systems:

1. piping

2. ductwork

3. equipment

B. Building insulation materials are specified in other sections. Insulation for mechanical equipment which is to be applied at the factory prior to shipment is specified in the individual equipment sections.

C. Electrical heat tracing for piping shall be as specified in the Electrical section.

1.2 GENERAL

A. Materials furnished and installed under this section shall be in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall be responsible for coordinating the installation of insulation with the installation of the items or systems to be insulated. Each item or system shall be tested and accepted by Engineer before installation of the insulation materials.

2. Contractor shall verify that each component of the insulation systems is compatible with all other parts of the system; that all insulation materials are appropriate for the intended applications; and that all necessary devices and accessories have been provided.

3. All insulation of the same class shall be the product of a single manufacturer; however, all the insulation types need not be the products of one manufacturer.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL, NFPA, and ASTM safety requirements.

E. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

F. Surface Burning Characteristics

1. Insulation, jackets, tapes, and adhesives to be used indoors shall have a composite flame spread rating not to exceed 25 and a composite smoke developed rating of 50 when tested by UL 723, NFPA 255, or ASTM E84. All testing shall be done on materials of the same densities and installed thicknesses as the materials being installed. Insulation materials which have been treated with a flame retardant additive to meet the required flame spread and smoke developed ratings are not acceptable.

G. Painting and Identification

1. Field painting and identification shall be as specified in the Protective Coatings section.

2. Piping systems with electrical heat tracing shall have warning labels attach to the outside of the pipe thermal insulation weather barrier to indicate the presence of electric heat tracing. Labels shall be located every 10 feet of pipe, alternating on either side. The labels shall be black on yellow, weatherproof, mylar, with pressure sensitive adhesive and at least 2 inches by 6 inches minimum.

1.3 SUBMITTALS

A. Drawings and Data

1. A complete list of materials and catalog cuts, together with detailed specifications, materials performance data, installation instructions, parts, devices, and accessories furnished, shall be submitted in accordance with the Submittals Procedures section. Information shall include certified test results to show compliance with UL, NFPA, and ASTM safety requirements.

2. Product data for adhesives shall include VOC content.

1.4 QUALITY ASSURANCE

A. Manufacturer Experience

1. A manufacturer shall have furnished material of the type specified which has been in successful operation for not less than the past 5 years.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.2 MATERIALS

A. Insulation, vapor retarders, and field applied jackets shall be installed to cover piping, ductwork, equipment, fittings, and appurtenances as indicated in the Insulation Schedule.

B. Pipe Insulation

1. Type PMF1 Insulation

a. Type PMF1 mineral fiber pipe insulation shall be Johns Manville "Micro-Lok", Knauf "Pipe Insulation" or Owens-Corning.
b. Type PMF1 pipe insulation shall be a one-piece molded glass fiber material with all-purpose jacket. The all-purpose jacket shall be factory-applied, fiberglass reinforced vapor barrier type, with white kraft bonded to aluminum foil and self sealing adhesive lap. The insulation shall be suitable for a temperature range of 0°F to 850°F , shall have a maximum thermal conductivity (k) of 0.24 Btu in/hr ft2 °F at 75°F , and shall conform to ASTM C547.

2. Type PFC1 Insulation

a. Type PFC1 flexible cellular elastomeric pipe insulation shall be Armacell "AP/Armaflex" or K-Flex USA "Insul-Tube" for unslit insulation and Armacell “AP/Armaflex SS” or K-Flex USA “Insul-Lock Seam-Seal” for factory pre-slit insulation. Flexible cellular polyolefin foam insulation shall be IMCOA "Imcolock" or Plastic Technology, Inc. “Innofoam”.
b. Type PFC1 pipe insulation shall be one-piece, molded elastomeric or polyolefin foam insulation suitable for a temperature range of -40°F to 180°F , and shall have a maximum thermal conductivity (k) of 0.28 Btu in/hr ft2 °F at 75°F . The insulation shall be suitable for exposure to weather and direct sunlight or, where not indicated to be jacketed, shall be given two coats of an ultraviolet-resistant finish recommended by the manufacturer. Insulation shall conform to ASTM C534 for elastomeric or ASTM C1427 for polyolefin.

C. Duct Insulation

1. Type DMF2 Insulation

a. Type DMF2 flexible type duct insulation shall be Johns Manville "Microlite", Knauf "Friendly Feel Duct Wrap", or Owens-Corning “SOFTR All-Service Duct Wrap”.
b. Type DMF2 exterior insulation for round ductwork shall be 1 lb per cubic foot density flexible fiberglass duct wrap with factory-applied foil-scrim-kraft facing. Insulation suitable for temperatures of up to 250°F , and shall have a maximum thermal conductivity (k) of 0.27 Btu in/hr ft2 °F at 75°F . The insulation shall conform to ASTM C553.

2.3 ACCESSORIES

A. Aluminum Insulation Jackets

1. Aluminum insulation jackets for insulated piping systems shall be furnished and installed as indicated in the insulation schedule herein and where indicated on the Drawings. Aluminum jackets shall be manufactured from alloys 3003 and 3105 conforming with ASTM B209. The aluminum jacket shall have a nominal thickness of 0.024 in. , with an embossed finish.

2. Fittings in insulated piping systems and equipment where indicated in the insulation schedule shall be provided with aluminum jackets of the same aluminum jacketing material as the piping systems. The jacket shall have a factory-applied moisture retarder of at least 3 mils permanently bonded to the interior surface and extending the full width of the jacket. The retarder shall consist of Polysurlyn or polyethylene film and kraft paper.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. General

1. Contractor shall install all insulation materials as specified herein for the piping systems, ductwork, and equipment that are not factory insulated. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces to be insulated shall be cleaned and dried. All work shall be performed within the temperature ranges recommended by the insulation product manufacturer. Insulation shall be kept clean and dry and shall remain in the factory container until it is installed. Packages or factory containers shall bear the manufacturer's stamp or label with the name of the manufacturer and description of materials.

2. Seams of exposed insulation and jackets shall be in the least visible location.

3. All adhesives used on the interior of the building defined as inside the weatherproofing system shall have a VOC content not greater than 80 g/L.

B. Piping Insulation

1. Type PMF1 Insulation

    a. Pipe insulation, vapor retarders, and field applied jackets shall be installed to cover system piping, fittings, and appurtenances. Insulation shall be full factory unit lengths using a single cut piece to complete the run. Abutting cut pieces or scraps shall not be used. End joints and longitudinal seams shall be tightly butted. Insulation for fittings shall be of the same thickness and conductivity as the adjoining pipe insulation.
    b. Insulated piping conveying fluids at lower than ambient temperatures shall be jacketed with a continuous vapor barrier. The insulation shall be continuous through hangers and penetrations, except at firewall penetrations, and shall be sealed with vapor barrier coating. The vapor barrier coating shall be applied at intervals not exceeding 15 feet for straight runs and not more that 6 inches from fittings. Fibrous insulation laps and butt strips that are not self-sealing shall be secured with adhesive and stapled. Staples and seams shall be coated with vapor barrier material.
    c. On piping 2 inches and larger where the insulation is continuous through the hanger, an insert shall be installed between the support shield and piping. The insert shall be of the same thickness and contour as the adjacent insulation and installed to maintain a continuous vapor barrier through the support. The insert shall be constructed of wood or heavy density insulating material suitable for the system operating temperatures.

2. Type PFC1 Insulation

    a. Pipe insulation shall be installed to cover all pipe, fittings, and appurtenances with all seams and joints sealed by a factory or field applied adhesive. Insulation at fittings and appurtenances shall be carefully formed and fitted. Insulation at elbows shall be mitered using segments of pipe insulation.

C. Duct Insulation

1. Insulation for ducts indicated on the Drawings as wrapped shall be installed as specified herein and indicated on the Drawings. Duct insulation shall be continuous through hangers and penetrations, except firewall penetrations but shall be interrupted at thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their functioning and/or replacement. Insulation jackets shall be continuous across seams, reinforcement, and projections.

2. Insulation on ducts conveying air at temperatures below 60°F shall be installed with a continuous vapor barrier seal. Staples and joints shall be sealed with a vapor barrier coating.

3. Type DMF2 Insulation

    a. Type DMF2 flexible insulation shall be installed with waterproof, fire-retardant adhesive. Insulation jackets shall overlap at least 2 inches and shall be secured under the overlap with adhesive and stapled on 4 inch centers.

D. Aluminum Jacketing

1. Aluminum jacketing for piping systems shall be installed as specified herein and indicated on the Drawings. Jacketing shall be held in place with stainless steel securing bands uniformly spaced at not more than 18 inches to produce tight joints without "bulging". The jacket shall overlap at least 2 inches at longitudinal and circumferential joints. Joints shall be overlapped and sealed with caulk to prevent moisture penetration, and longitudinal joints shall be placed to shed water. Exposed ends of pipe insulation shall be provided with covers constructed of the same material as the jacketing.

2. Elbows shall be jacketed with spirally wrapped aluminum strips or individual mitered segments or gores cut to fit the insulation.

3.2 INSULATION SCHEDULE.

INSULATION SCHEDULE				
		Mechanical Insulation		
Service	Size Inches	Type	Thickness Inches	Notes
PIPING - INDOOR (CONCEALED OR EXPOSED)				
Condensate Drain	All	PMF1	1	(3)
Potable Cold Water	Up to 3 4 & larger	PFC1 PFC1	3/4 1	(3) (3)
Potable Hot Water and Tempered Water	Up to 1-1/4 1-1/2 & larger	PMF1 PMF1	1 1.5	(9) (9)
Refrigerant Suction and Hot Gas Bypass	Up to 1 1 & larger	PFC1 PFC1	1.5 1.5	
Compressed Air Piping Upstream of Aftercoolers	1 1/2	PMF1	1.5	(1) (4)
PIPING - OUTDOOR (EXPOSED)				
Refrigerant Suction and Hot Gas Bypass	Up to 1 1 & larger	PFC1 PFC1	1.5 1.5	(1)
Engine-generator cooling water	All	PFC1	1.5	(1) (4)
DUCTWORK				
Round	Within conditioned space All other indoor locations	DMF2 DMF2	2 3	(6) (5), (6)
EQUIPMENT				
Mechanical Insulation Types:	FC - Flexible Cellular MF - Mineral Fiber MW - Mineral Wool			

INSULATION SCHEDULE				
		Mechanical Insulation		
Service	Size Inches	Type	Thickness Inches	Notes

Notes:

(1) Aluminum jacket.

(2) PVC jackets shall be provided on exposed portions of insulated piping located less than 8 feet above finished floor. On all other portions of the insulated piping system PVC jackets shall be provided only for fittings.

(3) Insulation shall be provided for portions of the piping system which pass through space above finished ceilings or is exposed above equipment, electrical panels, or cabinets.

(4) Insulation shall be provided for exposed portions of the piping system located less than 8 feet above the finished floor or grade.

(5) Insulation shall be provided for outside air plenums and ducts that are located upstream of the heating coil or pass through unheated spaces after the heating coil, unless indicated to be internally lined.

(6) Insulation shall be provided for outside air plenums and ducts, air conditioning supply and return ducts, and dehumidifier reactivation air discharge ducts, unless indicated to be internally lined.

(7) Insulation thickness shall be sufficient to provide a cold face temperature not to exceed 150°F .

(8) The underside of all roof drains shall be insulated to a 1 foot radius from the center of the drain. All roof drain piping within 4 feet of the drain shall be insulated.

(9) Includes 8 feet of the cold water inlet piping to the water heater storage tank.

A. Unless otherwise indicated in the insulation schedule, all mechanical piping, ductwork, equipment, and accessories with an operating temperature in excess of 140°F or below 60°F shall be insulated.

End of Section

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SECTION 15400 - PLUMBING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of materials, appliances, fixtures, equipment, and appurtenances associated with the plumbing systems as specified herein and as indicated on the Drawings. Additional requirements for plumbing systems shall be as indicated in the schedules on the Drawings. Suitable connections shall be provided for each fixture, piece of equipment, and appurtenance.

B. Pipe materials, valves, thermal insulation, and pipe supports which are not an integral part of the fixture or piece of equipment and are not specified herein are covered in other sections.

1.2 GENERAL

A. Materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that each component of the plumbing system is compatible with all other parts of the system; that all piping, fixtures, and appurtenances are appropriate; and that all devices necessary for a properly functioning system have been provided.

2. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

3. Each manufacturer of industrial grade water heaters, shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials provided under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall conform to the requirements of AGA, ASTM, NFPA, and UL safety requirements.

F. Power Supply

1. Unless otherwise specified, power supply to equipment with motors shall be as indicated on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

G. Metal Thickness

1. Metal thicknesses and gages specified herein are minimum requirements. Gages refer to US Standard gage.

H. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications to be submitted for each unit shall include, but shall not be limited to, the following:

Equipment, Piping Accessories, and Appurtenances

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Capacities.

Pressure and temperature ratings.

Overall dimensions.

Piping connection sizes and locations.

Net weight.

Horsepower kW.

Power requirements.

Wiring diagrams.

Plumbing Fixtures

Name of manufacturer.

Type and model.

Construction materials, thicknesses, and finishes.

Water consumption data.

Overall dimensions.

Rough-in dimensions.

Piping connection sizes and locations.

Net weight.

Seismic Design Requirements

Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operations and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

2. Operation and maintenance manuals are required for electronic trap priming panels, water closets, urinals, faucets and flush valves, emergency fixtures, electric water coolers, water heaters, circulating pumps, expansion tanks, and neutralization tanks .

1.4 QUALITY ASSURANCE

A. Welding Qualifications

1. All welding procedures and welding operators shall be qualified by an independent testing laboratory in accordance with the applicable provisions of AWS Standard Qualification Procedures. All procedure and operator qualifications shall be in written form and subject to Engineer's review. Accurate records of operator and procedure qualifications shall be maintained by Contractor and made available to Engineer upon request.

B. Qualification

1. The plumbing system installer shall be licensed as stipulated by the authority having jurisdiction.

C. Manufacturer's Experience

1. Unless the equipment manufacturer is specifically named in this section, the manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past 5 years.

D. Construction

1. Plumbing fixtures shall be constructed in accordance with the following standards:

Enameled Cast Iron	ANSI/ASME A112.19.1M
Vitreous China	ANSI/ASME A112.19.2M
Stainless Steel	ANSI/ASME A112.19.3M
Faucets	ANSI/NSF 61
Emergency/Safety Fixtures	ANSI Z358.1

2. Electric water coolers shall be UL listed and certified in accordance with the Air Conditioning and Refrigeration Institute (ARI) Standard 1010. All materials in contact with water shall comply with the Reduction of Lead in Drinking Water Act. All plumbing fittings and fixtures intended to convey or dispense water for human consumption shall comply with the requirements of NSF/ANSI 61 and NSF/ANSI 372 for lead-free.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for each type and size of plumbing fixture or equipment as required, in the quantities indicated below.

Part	Number Required
Flushometer valve repair kits	1 per 5 fixtures
Water closet seats	1 per 10 fixtures
Faucet washer cartridge and O-ring kits	1 per 5 fixtures
Electric water heater elements	1 per heater
Water heater relief valves	1 per heater

B. Extra materials shall be packaged with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

1. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All plumbing fixtures and equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. All fixtures and equipment shall be designed to meet the performance and design conditions specified herein and indicated on the Drawings.

B. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MANUFACTURE AND FABRICATION

A. Anchor Bolts and Expansion Anchors

1. Anchor bolts, expansion anchors, nuts, and washers shall be as indicated in the Anchorage In Concrete and Masonry section unless otherwise indicated on the Drawings.

B. Surface Preparation

1. All iron and steel surfaces, except motors and speed reducers, shall be shop cleaned by sandblasting or equivalent, in strict conformance with the paint manufacturer's recommendations. All mill scale, rust, and contaminants shall be removed before shop primer is applied.

C. Shop Painting

1. All steel and iron surfaces shall be protected by suitable coatings applied in the shop. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Coatings shall be suitable for the environment where the equipment is

installed. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be shop primed or finished with an oil-resistant enamel or universal type primer suitable for top coating in the field with a universal primer and aliphatic polyurethane system.

2. Surfaces to be coated after installation shall be prepared for painting as recommended by the paint manufacturer for the intended service, and then shop painted with one or more coats of the specified primer.

3. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall conform to the requirements of the Protective Coatings section.

D. Equipment Bases

1. Unless otherwise indicated or specified, all equipment shall be installed on concrete bases at least 6 inches high. Each unit and its drive assembly shall be supported on a single baseplate of neat design. Baseplates shall have pads for anchoring all components. Baseplates will be anchored to the concrete base with suitable anchor bolts.

E. Special Tools and Accessories

1. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

F. Piping Systems

1. Unless otherwise specified herein, piping system materials shall be as specified in other sections.

G. Valves

1. Unless otherwise specified herein, valves indicated to be a part of the plumbing systems shall be as specified in other sections.

2.5 WATER SUPPLY PIPING ACCESSORIES

A. Water Hammer Arresters

1. Water hammer arresters shall be either bellows or piston type. Bellows type arresters shall consist of a stainless steel shell, a factory charged and sealed compression chamber, a stainless steel or elastomer bellows, and a stainless steel threaded adapter. Piston type arresters shall consist of a seamless Type L copper shell, a seamlessly spun and factory charged air chamber, a factory lubricated double or triple O-ring sealed piston, and a threaded copper adapter. Water hammer arresters shall be tested and certified in accordance with American Society of Sanitary Engineering (ASSE) Standard 1010. Arresters shall be rated for a maximum working pressure of 350 psig and a temperature

range of 33° F to 250° F . Water hammer arresters shall be Smith "Hydrotrol," Josam "75000 Series Absorbotron," Wade "Shokstop," or Sioux Chief "Hydra-Rester."

B. Trap Primers

1. Electronic Trap Priming Panel

a. Electronic trap priming panels shall be provided as indicated by the plumbing drawings denoted by a symbol "TPP" and an identifying number. One half-inch copper tubes shall run from the electronic trap priming panel to the traps. Trap primers shall be mounted in accessible locations. Electronic trap priming panels shall consist of a panel, timer, 120 V solenoid, calibrated manifold system and shall be manufactured by Precision Plumbing Products Inc. "PTS Series," Zurn, MIFAB, or equal. Reference the plumbing drawings for the number of priming tubes required per trap priming panel.

C. Thermostatic Mixing Valves

1. Thermostatic mixing valves shall comply with ASSE 1017, shall be bronze or brass body, with stainless steel flow control components, threaded end connections, rotating handle adjustment, lockable setpoint, and hot and cold check stops. Valves shall be suitable for flow ranges and have temperature adjustment ranges as indicated in the schedules. Temperature adjustment range shall be 85° F to 120° F . Accuracy shall be within 3° F of setpoint. Thermostatic mixing valves shall be manufactured by Symmons, Leonard, or Powers.

D. Vacuum Relief Valves

1. Vacuum relief valves shall have bronze or brass bodies rated for 200 psig and shall be provided with male threaded inlet connections. The valves shall open at 1/2 inch water column vacuum and shall have a venting capacity of at least 15 cubic feet per minute. Vacuum relief valves shall be Watts Regulator "Model LFN36," Cash Acme "VR-801," or Apollo Valves "Model VR."

E. Thermometers

1. Thermometers shall be Weksler Instruments "Adjust Angle," Ashcroft "Series EI Everyangle" or Weiss Instruments, Inc. "Vari-angle."

2. Thermometers shall be bimetal type and shall have a dial at least 4-1/2 inch diameter, with black markings on a white background. Pointer travel shall span not less than 200 degrees nor more than 270 degrees. Each thermometer shall have a stainless steel case, bezel, fittings, and stem and shall be hermetically sealed, with external pointer adjustment and an acrylic or shatterproof glass window.

3. Each indicator shall be furnished with an angularly adjustable frame for convenient viewing. Unless otherwise indicated, thermometer range shall be 0 to 200° F .

4. Each thermometer shall be furnished with a stainless steel thermowell for installation in the piping systems. The thermowells shall have 3/4 inch NPT thread mounts, a minimum pressure rating of 250 psig , and a nominal 4 inch insertion length.

F. Strainers

1. Strainers shall be provided where indicated on the Drawings. Strainer screen size shall be 20 mesh unless otherwise indicated. The blowoff from each strainer shall be equipped with a shutoff valve.

2. Strainers located in copper piping systems shall be Y-pattern type with bronze body, threaded ends, and monel or stainless steel screens. Strainers shall be Watts "Series LF777SI," Apollo Valves "Model YB-LF" or Wilkins "Model YBXL."

3. Strainers located in ductile iron piping systems shall be Y-pattern type with iron body, flanged ends, and monel or stainless steel screens. Strainers shall be Hoffman Specialty "Series 400" or Metraflex "Model TF."

G. Hose Faucets

1. Hose faucets shall be constructed with nickel or chrome plated cast brass body, solid brass stem, threaded bonnet, and "T" style handle. Hose faucets shall be provided with a 3/4 inch male pipe thread inlet and a 3/4 inch male hose thread outlet unless otherwise indicated on the Drawings. Hose faucets shall be Prier Brass "Model C-138NP.75," Arrowhead Brass Products, or Zurn.

2. Where indicated on the Drawings, hose faucets shall be equipped with hose connection vacuum breakers. Hose connection vacuum breakers shall be provided with 3/4 inch hose thread ends, brass or bronze bodies, stainless steel stem, rubber seat, and rubber disc. Hose connection vacuum breakers shall be of tamper-resistant design to prevent removal, and shall comply with ASSE Standard 1011 requirements. Hose connection vacuum breakers shall be equipped with manual drain. Hose connection vacuum breakers shall be Febco "Series 731," Watts Regulator Company "Series 8" or Wilkins "Model BFP 8."

H. Wall Hydrants

1. Wall hydrants shall be freezeproof type with bronze body, polished bronze or chrome plated face, integral vacuum breaker, and removable handle key. Wall hydrants shall be provided with 3/4 inch pipe thread inlet and 3/4 inch male hose thread outlet. Wall hydrants shall be ASSE 1019-B approved. Wall hydrants shall be Smith "Model 5619," Zurn "Z1321-C," or Prier "Model C-634."

I. Pressure Gauges

1. Pressure gauges shall be Ashcroft "Duragauge 1279," Weksler, or Weiss Instruments, Inc.

2. Except as modified or supplemented herein, all gauges shall conform to the requirements of ANSI B40.1. Accuracy shall be ANSI Grade A or better. Gauges shall be indicating dial type with C-type phosphor bronze Bourdon tube, stainless steel rotary geared movement, phenolic open-front turret, stainless steel or phenolic ring, case, adjustable pointer, and acrylic or shatterproof glass window.

3. The dial shall be 4-1/2 inch in diameter with black markings on a white background. The units of measurement shall be psi and shall be indicated on the dial face. The pointer shall

span not less than 200 degrees nor more than 270 degrees. The range shall be selected so that the normal operating reading is near the midpoint of the scale.

4. Each gauge shall be provided with a threaded end ball-type shutoff valve as specified in the Ball Valves section.

5. All stem-mounted gauges shall be provided with 1/2 inch NPT connections.

6. Diaphragm Seals

   a. Pipe-mounted diaphragm seals shall be provided where indicated on the Drawings. Diaphragm seals shall be thread-attached type with cleanout ANSI Type 316 stainless steel diaphragm, plated carbon steel upper housing, and stainless steel lower housing. The diaphragm seal shall be of "continuous" design to safely contain the process fluid in the event of gauge failure or removal from the system under pressure. The lower housing shall be provided with a tapped 1/4 inch NPT flushing connection and an MxF stainless steel needle valve. Each gauge isolator and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.
   b. Gauge isolators shall be as manufactured by Ashcroft "Type 101," Weksler, or Weiss Instruments, Inc.

2.6 DRAINAGE AND VENT PIPING ACCESSORIES

A. Cleanouts

1. Cleanouts shall be provided where indicated on the Drawings and required by the referenced codes, and shall be of the required type.

2. Floor cleanouts shall consist of a two piece body, a threaded plug, an adjustable head, and a cover. Cleanouts installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp. Cleanouts installed in partition walls shall be provided with an access cover and frame with a securing screw installed over the cleanout plug. Wall cleanout covers shall be stainless steel. Cleanouts installed in exposed piping shall consist of a ferrule or threaded adapter and a cast brass or bronze plug installed in a T-pattern, 90 degree drainage fitting.

3. Cast iron cleanouts shall be manufactured by Smith, Josam, or Wade.

B. Funnel Receptors

1. Funnel receptors shall consist of cast iron funnels with cast iron dome type bottom strainers. Funnel receptors shall be provided with waterstop flange and threaded or no-hub outlet connections suitable for connection to the waste piping. Funnel receptors connected to chemical resistant waste systems shall be furnished with a factory applied chemical resistant interior coating. Unless otherwise indicated, funnel receptors shall be installed 1 inch above the finished floor.

2. Funnel receptors shall be Smith "Series 3800 Figure SQ-3-1793-DBS," Josam, or Wade.

C. Floor Drains

1. Floor drains shall be of the types specified herein and indicated on the Drawings. Floor drains shall have a two-piece body, a flashing collar, an adjustable head, and a grate. A trap primer connection shall be provided when indicated on the Drawings. Floor drains installed in floors that include a waterproofing membrane shall be provided with a flashing flange and membrane clamp.

2. Cast iron floor drains shall be manufactured by Smith, Josam, or Wade.

D. Downspout Nozzles

1. Downspout nozzles shall be cast brass or bronze, and shall be provided with a threaded inlet and a mounting flange. The mounting flange shall be provided with drilled fastening lugs. Downspout nozzles shall be Smith "Model 1770," Josam, or Wade.

E. Floor Sinks

1. Floor sinks shall consist of a cast iron body with acid resistant interior finish, and a nickel-bronze grate. The grate shall be of the type indicated on the Drawings shall be easily removable for cleaning. Floor sink grates and outlets shall be sized as indicated on the Drawings. Floor sinks shall be manufactured by Smith, Josam, or Wade.

F. Vent Flashings

1. Plumbing vent flashings shall be furnished and installed as indicated on the Drawings.

2.7 PLUMBING FIXTURES AND ACCESSORIES

A. General

1. Plumbing fixtures shall be provided with all required supports, fasteners, supply and drain fittings, gaskets, and escutcheons required for a complete installation.

B. Water Closets

1. Water closets shall be of vitreous china, with an elongated bowl and siphon jet flushing action. The type and water use of water closets shall be as indicated on the Drawings. All water closets shall be provided with anchor bolt caps. Flush valve type water closets shall be provided with top spud connections for flushometer valves. Water closets shall be manufactured by American Standard, Kohler, or Eljer.

2. Seats

a. Water closet seats shall be white, solid plastic, contoured, elongated open front type without cover, with concealed check and stainless steel hinges. The seats shall be manufactured by American Standard, Kohler, Eljer, or Church.

3. Flush Valves

a. Flush valves. Flush valves for top spud type water closets shall be exposed polished chrome plated type, with a chrome plated brass body as per ASSE1037 with corrosion-resistant components with minimum pressure rating of 125 psig, an externally adjustable diaphragm type, an screw driver angle stop, backflow-prevention device, motorized actuator, automatic sensor with manual push button override a renewable valve seat, a tailpiece, a vacuum breaker, a wall flange, a spud nut and flange, automatic 8 hr courtesy flush, recess mounted sensor box, flush connection and coupling for 1 ½" inch top spud escutcheons, hardwired operated power converter, hard-wired AC power kit, sensor box cover, vandal resistance screws, low cycle flush cycle set and a 1 inch NPT water supply connection and The actuator shall be suitable for a 120-volt, 60 Hz, single phase power supply. The actuator with Solenoid and hard-wired electronic sensor shall comply with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application. Flush valves shall be Sloan "Royal 111-ESS", Delany Products, Zurn Industries, LLC

4. Supply Set

a. A supply set consisting of a 1/2 inch NPT brass angle loose key stop valve, a copper supply tube, and an escutcheon plate shall be furnished for each tank type water closet. All supply components shall be polished chrome.

5. Chair Carriers

a. Wall-mounted water closets shall be provided with adjustable chair carriers. The carriers shall be suitable for the chase depth and piping arrangement and shall consist of a heavy-duty cast iron body, complete with a drainage fitting, pylon feet, a drainage nipple, fitting and fixture gaskets, a positioning frame or template, and mounting hardware. Chair carriers shall be manufactured by Smith, Josam, or Wade.

C. Urinals

1. Urinals shall be of the type and water use as indicated on the Drawings. Urinals shall be of vitreous china, wall mounted, with an elongated rim and washout flushing action, and shall be provided with a top spud connection for a flushometer valve. Urinals shall be manufactured by American Standard, Kohler, or Eljer.

2. Flush Valves

a. Flush valves shall be exposed type, of polished chrome plated brass as per ASSE1037/ASME 112.19.2/CSA B125.37 with corrosion-resistant components with minimum pressure rating of 125 psig, with an externally adjustable diaphragm, an angle stop, a renewable valve seat, a tailpiece, backflow-prevention, a vacuum breaker, a wall flange, a spud nut and flange, and a 3/4 inch NPT water supply connections. vandal resistant metal cover with hardwired wall mounted sensor right or left -hand supply installation, hard-wired AC power kit, infrared sensor to have adjustment of 12"-28" and electronic manual override button Flush valves shall supply a maximum of 0.125 gallon per flush. The actuator with

solenoid and hard-wired electronic sensor shall comply with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application. Flush valves shall be Sloan "Royal 186-ESS", Delany Products, Zurn Industries, LLC

3. Supports

a. A fixture support system, including support legs, upper and lower bearing plates, and bearing studs shall be provided for urinals mounted on all walls other than masonry. Urinals mounted on masonry walls shall be provided with suitable anchor bolts. Urinal supports shall be manufactured by Smith, Josam, or Wade.

D. Lavatories

1. Lavatory types, dimensions, and water use shall be as indicated on the Drawings. Lavatories shall be constructed with overflow drains Wall-mounted lavatories shall be drilled for a concealed arm carrier. Faucet drillings shall be 4 inches on center unless otherwise indicated. Lavatories shall be manufactured by American Standard, Kohler, or Eljer.

2. Faucets and Trim

a. Lavatory faucets shall be of polished chrome, 4" trim plate plug adapter power supply, back-check tee, polished chrome finish as per ASSE1037/ASME 112.18.1/CSA B125.1/ NSF/ANSI 61&372 /ANSI A117.1/ with corrosion-resistant components. Faucets shall have a minimum pressure rating of 125 psig, multi-laminars spray, infrared sensor, hardwired-howered, deck-mounted mid body faucet. Each faucet shall be provided with a flow restrictor, a cast brass grid strainer or pop-up drain as indicated on the Drawings, and a 1-1/4 inch cast brass tailpiece. Flow restrictors shall limit water flow as required by the applicable codes and standards. Supply sets consisting of 1/2 inch NPT brass angle loose key stop valves, copper supply tubes, and escutcheon plates shall be furnished for each lavatory faucet. The actuator shall be suitable for a 120-volt, 60 Hz, single phase power supply. The actuator with solenoid and hard-wired electronic sensor shall comply with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application. All supply components shall be polished chrome. Where indicated to be ADA compliant and exposed to human contact, lavatory supplies shall be insulated. Lavatory faucets and supply sets shall be manufactured by American Standard, Kohler, or Eljer.

b. Lavatory traps shall be at least 1-1/4 inch in diameter, cast brass with polished chrome finish, with an escutcheon flange and a cleanout plug. Where indicated to be ADA compliant and if exposed to human contact, lavatory traps shall be offset, insulated type.

c. When insulation is needed, lavatory supplies and traps may be pre-insulated or furnished with an insulation kit for field installation. Insulating material shall be flame retardant closed cell vinyl. The supply insulating kit shall be snap form type or shall be provided with ties. The trap insulation material shall not require the use of ties or mechanical fasteners to be held in place. Pre-insulated traps and supply

insulation kits shall be McGuire Products "ProWrap." Trap and supply insulation kits shall be as manufactured by IPS Corporation-Truebro, Plumberex, or Buckaroos, Inc.

3. Supports

a. Wall-hung lavatories shall be provided with a complete fixture support system, including support legs, bearing plates, concealed arms, and anchor bolts. The support legs shall be mounted within the partition wall. For lavatories mounted on masonry walls, support legs may be omitted. Lavatory supports shall be manufactured by Smith, Josam, or Wade.

E. Janitors Sinks

1. Janitors sink types, dimensions, manufacturers, and models shall be as indicated on the Drawings.

2. Mop sinks shall be floor mounted and constructed of pearl gray terrazzo. Mop sinks shall be provided with an integral 20 gage thick stainless steel threshold cap, a 6 inch drop at threshold, and a shoulder at least 1-1/4 inches wide. A 3 inch cast brass drain and stainless steel strainer, and where indicated, a 20 gage thick stainless steel splash panel shall be provided for each sink. Mop sinks shall be manufactured by Stern-Williams, Fiat, or Florestone Products Company, Inc.

3. Faucets

a. Sink faucets shall be rough plated brass, with lever handles, a threaded spout, a vacuum breaker, a wall brace, and a pail hook. The distance from the wall to the center of the spout outlet shall measure approximately 7-1/2 inches . Sink faucets shall be as manufactured by American Standard, Kohler, or Eljer.

4. Drain Assembly

a. Mop sinks shall be provided with a 3 inch cast brass drain and a stainless steel strainer. Service sinks shall be provided with a 3 inch cast iron P-type trap standard, with a stainless steel strainer, a cleanout plug, and a threaded outlet.

F. Emergency Fixtures

1. Emergency fixtures, including showers, eye/face washes, and combination shower/eye/face wash units shall be furnished and installed as indicated on the Drawings. Emergency fixtures shall be manufactured by Haws, Guardian, or Encon.

2. Corrosion Resistant Combination Units

a. Corrosion resistant combination emergency shower/eye/face wash fixtures shall be pedestal mounted, with 2-1/2 inch schedule 80 PVC stanchion, floor flange, deluge shower, aerated eye/face wash, eye/face wash dust cover, stay-open stainless steel ball valves, interconnecting piping, and universal emergency sign. The shower shall be stainless steel or ABS plastic with stainless steel pull rod actuator. The eye/face wash receptor shall be stainless steel or plastic with push plate actuator.

3. Alarm Systems

a. An audible and visual alarm system shall be provided when indicated on the Drawings. The alarm system shall activate based on water flow when either the emergency shower or eyewash fixture is operated. The alarm system shall provide local, remote, or local and remote alarm indication as indicated on the Drawings. The water flow switch shall be provided with double-pole double-throw contacts rated 5 amperes at 125 volts, suitable for remote alarm annunciation. The audible alarm shall provide an intermittent signal rated at 90 dB at 10 feet. The alarm light shall be amber, flashing type. The alarm system shall be pre-wired and shall be furnished with all necessary junction boxes, conduit, wire, and accessories for a complete installation. The alarm system shall be suitable for a 120 volt power supply.

4. Tempered Water Blending Valves

a. Tempered water blending valves shall be designed specifically for providing tempered water to emergency shower and eyewash fixtures. Each valve shall contain thermostatic elements, integral cold water bypass, and positive hot water shutoff to prevent scalding. Blending valves shall have bronze or brass bodies with threaded inlet and outlet connections and shall be provided with isolation check valves on the hot and cold supplies to the unit. Each unit shall include hot, cold, and blended water temperature gauges and shall be factory set for a blended water temperature of 70° F.

b. Tempered water blending valves serving eyewash fixtures, a single shower, or a single combination unit shall be suitable for a flow range of 3 to 25 gallons per minute and shall be Haws "Model 9201," Guardian "G3700," or Lawler "Model 911E. Tempered water blending valves serving multiple showers or multiple combination units shall be suitable for a flow range of 3 to 60 gallons per minute and shall be Haws "Model 9202," Guardian "G3900" or Lawler "Model 911."

G. Electric Water Coolers

1. Electric water cooler type, capacity, manufacturer, and model shall be as indicated on the Drawings. Water coolers shall be wall mounted, mechanically refrigerated type, and shall deliver 50° F water at the specified rate, based on 80° F inlet water temperature and a room temperature of 90° F . The water coolers shall consist of a heavy gage steel cabinet, an insulated cooling tank, a stainless steel receptor, copper water lines, a water pressure regulating valve, an adjustable thermostat, and a 3-wire power cord with a polarized plug. The refrigeration unit shall consist of a hermetically sealed spring mounted compressor and an air-cooled condenser. Electric water coolers shall be suitable for a 120 volt, 60 Hz, single phase power supply, shall be UL and ARI listed, and shall be manufactured by Elkay, Oasis, or Halsey Taylor.

2.8 PLUMBING EQUIPMENT

A. General

1. Plumbing equipment shall be provided with all supports, fasteners, fittings, and escutcheons required for a complete installation.

B. Water Heaters and Accessories

1. Water heaters shall be furnished and installed where indicated on the Drawings. Heater type, storage capacity, recovery rate, energy input, power supply requirements, manufacturer, and model shall be as indicated on the Drawings.

2. Commercial Grade Electric Storage Water Heaters

a. Electric storage water heaters shall be commercial type, with a glass-lined tank and one or more heating elements. The heater shall be provided with a cold water inlet tube (top inlet), a magnesium anode, polyurethane foam insulation, a drain valve, and adjustable thermostats. Heating elements shall be sheathed immersion type, low or medium watt density, and shall be field replaceable. Heater tanks shall be ASME stamped for a working pressure of at least 125 psig . Each heater shall be equipped with an ASME rated pressure-temperature relief valve of suitable capacity. Heaters shall be UL and NSF listed, and shall meet ASHRAE Standard 90.1 for energy efficiency. The water heaters shall be manufactured by State Industries Inc., A. O. Smith, or Lockinvar.

3. Circulating Pump

a. A circulating pump shall be furnished and installed where indicated on the Drawings. Pump capacity, power requirements, manufacturer, and model shall be as indicated on the Drawings.

b. The circulating pump shall be an in-line unit with a bronze body, bronze fitted, mechanical seals, a stainless steel or ceramic shaft, and at least 1/2 inch NPT connections. The circulating pump shall be controlled by a 7-day time clock provided with the pump. Initial time clock setting shall energize the pump at 6:00 am and de-energize the pump at 6:00 pm each day. The time clock shall be suitable for a 120 volt single phase power supply, and shall have contacts rated for 10 amperes ac. The circulating pump shall be manufactured by Bell & Gossett, Thrush, or Taco.

C. Neutralization Tanks

1. Neutralization tank volume, connection sizes, manufacturer, and model shall be as indicated on the Drawings.

2. Neutralization tanks shall be of heavy-duty construction, rotomolded in one piece from polyethylene resins. Inlet, outlet, and vent fittings molded from the same resins as the tank shall be triple-welded to the tank body at the locations indicated on the Drawings. A full diameter extension constructed of the same material as the tank shall be provided where required to raise the access cover to at or just below the floor level as indicated on the Drawings. When indicated on the Drawings, the tank shall be provided with a minimum 17 inch bolted manway cover. The cover shall be provided with a 6 inch cleanout plug and stainless steel fasteners. The tank shall be filled with hard limestone or marble chunks, 2 to 3 inches in diameter to the level recommended by the manufacturer.

Neutralization tanks shall be manufactured by Orion ,Enfield or Town & Country Plastic, Inc.

D. Hoses

1. Hose type, diameter, manufacturer, and model shall be as indicated on the Drawings.

2. Unless otherwise indicaed, each hose shall be provided with one male swivel type brass hose connector, one female brass hose connector, and one regulating wash-up spray nozzle. Spray nozzles in 1 inch and 1-1/2 inch sizes shall be Potter-Roemer Inc. "Series 2970" with a cast brass body, a rubber bumper, and a female hose thread.

3. Type 2 Hoses

a. Type 2 hoses shall be non-collapsible, suitable for water service and shall be rated for 150 psig working pressure. The hose shall consist of 3/4 inch ID heavy-duty ethylene, propylene diene (EPDM) rubber tubing with synthetic, high tensile textile cord reinforcement and an EPDM cover. Type 2 hoses shall be Gates Rubber Company "Adapta Flex" or Potter-Roemer "Model 2851."

E. Expansion Tanks

1. Expansion tank capacities, connections, manufacturer, and model shall be as indicated on the Drawings.

2. Expansion tanks shall be welded steel diaphragm type, ASME tested and stamped for a working pressure of 125 psig , with a flexible diaphragm and a charging valve. Floor-mounted tanks shall be provided with a suitable mounting base. The tanks shall be suitable for use with potable water and shall be factory pre-charged to the indicated pressure. Expansion tanks shall be manufactured by Amtrol, State Industries Inc., or Watts.

2.9 COLOR

A. Vitreous china, cast iron, enameled steel, and composite plumbing fixtures shall be white unless otherwise indicated. Other plumbing fixtures shall be the manufacturers standard color. Plumbing equipment shall have the manufacturer's standard color and finish unless otherwise indicated in the schedules.

2.10 ELECTRICAL

A. Electrical controls and disconnects shall be furnished and installed under the Electrical section, except where specified herein. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in existing facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will prevent dust or other contaminants from getting on freshly painted surfaces. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

3.3 INSTALLATION

A. Materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Unless otherwise indicated, sleeves shall be provided for all pipe penetrations through concrete and masonry walls. Sleeves and sealing requirements shall be as indicated in the Miscellaneous Piping and Accessories Installation section and as indicated on the Drawings.

C. Not all required reducing fittings and unions are indicated. Additional fittings and unions shall be provided as needed to connect all equipment and appurtenances.

D. Insulating fittings shall be provided to prevent the contact of dissimilar metals in piping systems.

E. When located indoors, fuel gas pressure regulator vents and fuel train vent valves shall be piped to the exterior of the building in accordance with the applicable codes and standards.

F. Piping shall not be routed over or in front of electrical switchboards or panels unless acceptable to Engineer.

G. Water Supply Piping and Accessories

1. Water hammer arresters shall be provided in the hot and cold water supply piping at all quick closing valves, at solenoid valves, and at plumbing fixtures. When not indicated on the Drawings, arresters shall be located and sized by Contractor in accordance with PDI

Standard No. WH201. Contractor shall submit arrester location and sizing plans to Engineer for approval prior to installation. Where possible, water hammer arresters shall be installed in an accessible location.

2. Water supply piping to hose faucets and hose valves shall be secured with a pipe support within 6 inches of the fixture.

3. Scald protection valves shall be installed per manufacturer's recommendation, adjacent to the actuation valve for each emergency shower and the eye/face wash where indicated in the schedules. Drain piping from valves shall be secured to adjacent unit support and routed to nearest funnel receptor and discharge with an air gap.

H. Drainage and Vent Piping and Accessories

1. Unless otherwise indicated or required by code, horizontal sanitary drainage piping 3 inches in diameter or smaller shall be installed at a uniform slope of 1/4 inch per foot ; horizontal sanitary drainage piping larger than 3 inches in diameter shall be installed at a uniform slope of 1/8 inch per foot ; horizontal storm drainage piping shall be installed at a uniform slope of 1/8 inch per foot .

2. All cast iron drainage piping which is buried beneath floors shall be encased in at least 6 inches of concrete. A joint shall be provided in the piping within 12 inches of each end of the encasement. For buildings supported by piers or piles, the concrete encasement shall be reinforced and connected to the floor slab.

3. Drainage fittings shall be installed to convey flow in the piping in the intended direction. To the extent possible, changes in direction shall be made by sweep type fittings. Quarter-bends and sanitary tee fittings shall not be installed for vertical to horizontal or horizontal to horizontal changes of direction.

4. Plumbing vents through roofs shall be located at least 12 inches from a parapet or from the intersection of a cant with the roof deck, and shall be installed with watertight flashings. Plumbing vents shall be located no closer to operable windows or air intakes than is allowed by the applicable code.

5. Vents connecting to horizontal sanitary piping shall connect above the centerline of the piping and shall rise at an angle of not less than 45 degrees from the horizontal to a point at least 6 inches above the flood level rim of the fixture served before offsetting horizontally.

6. Floor drains shall be adjusted to the correct elevation for proper drainage. Heads of fastening screws shall be flush with the grate surface.

7. Cleanouts on drainage piping inside structures shall be located where indicated on the Drawings. Additional cleanouts shall be provided where required by the applicable code or authority having jurisdiction. Cleanouts located in drainage risers shall be located 12 inches above the finished floor.

8. Unless otherwise indicated or required by the applicable code, cleanout size shall equal the line size for 4 inch and smaller drainage piping, and 4 inch in diameter for drains

larger than 4 inch . Proper clearance shall be provided for access to cleanouts. Floor cleanouts shall be installed flush with the finished floor.

9. Floor drains, trench drains, floor sinks, funnel receptors, and bell-up drains indicated to be equipped with traps shall be provided with deep seal "P" traps located as close to the drain as possible.

10. Roof drains shall be set at the proper level for flashing and drainage and shall be securely attached to the roof decks to prevent movement, unless otherwise indicated. Overflow roof drain dams or standpipes shall be set at an elevation 2 inches above the low point of the roof.

I. Plumbing Fixtures and Accessories

1. Plumbing fixtures shall be set level and plumb, and shall be securely attached to the floor or wall. Unless otherwise indicated on the Drawings, each fixture shall be mounted at the height recommended by the manufacturer. Where required to be in compliance with ADA, fixtures shall be mounted at the heights established by the Federal Government.

2. Fixtures shall be sealed to the floor or wall with a sealant as specified in the Joint Sealants section. The color of sealant shall match the color of the fixture.

3. Fixture traps shall be easily removable for servicing and cleaning. Escutcheons shall be placed at all locations where fixture supply or drain piping penetrates walls, floors, or ceilings.

4. Water piping at stop valves, shower heads, and flush valves shall be rigidly secured to blocking. Drop-ear elbows shall be used whenever possible. All water supply piping shall be cleaned and flushed before the plumbing fixtures are installed.

5. Shutoff valves located in the tempered water (TW) supply piping to safety fixtures and shutoff valves in the potable water branch piping to the TW system shall be provided with tags bearing the legend "WARNING: DO NOT CLOSE VALVE WITHOUT AUTHORIZATION." The tags shall have an orange background and black lettering not less than 1/2 inch in height. Other features of the tags shall be as indicated in the Mechanical Identification paragraph.

J. Plumbing Equipment

1. Plumbing equipment shall be installed in accordance with the manufacturer's recommendations. Adequate clearance shall be provided for access to all components which may require adjustment, servicing, or replacement.

2. Water heaters shall be installed in accordance with AGA, NSF, NFPA, and UL requirements. Storage type water heaters shall be cleaned and flushed before being connected to the potable water system. Water heater relief valves shall be piped to the nearest drain or as indicated on the Drawings, and shall terminate the appropriate air gap distance above the drain. Unless otherwise indicated, water heater thermostats shall be set such that the maximum water temperature does not exceed 140° F .

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. An installation check by an authorized representative of the manufacturer of equipment specified herein is not required.

2. An experienced, competent, and authorized representative of the manufacturer for industrial grade water heaters, shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

3. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

4. All costs for these services shall be included in the Contract Price.

B. Startup and Testing

1. Field performance tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 ADJUSTING

A. All devices shall be adjusted for proper flow and quiet operation. Faucet and supply assemblies shall be adjusted or repaired to eliminate leaks. All drains shall be checked for proper operation.

3.6 PROTECTION

A. Plumbing fixtures, equipment and appurtenances shall be protected from damage immediately after installation.

3.7 CLEANING

A. After completion of testing and immediately before the final inspection, plumbing fixtures, equipment, piping, and appurtenances shall be thoroughly cleaned. Cleaning materials and methods shall be as recommended by the manufacturer. All faucet aerators shall be removed, cleaned, and reinserted.

B. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired at no additional cost to Owner.

3.8 DISINFECTION

A. Before the potable water system is placed in operation, it shall be disinfected in accordance with the requirements of the local authority having jurisdiction. In the absence of local requirements, the following disinfection method shall be used:

1. The system shall be purged with clean potable water until all dirt and other substances are flushed from the system.

2. The system shall be filled with a water/chlorine solution containing at least 50 parts per million of available chlorine and allowed to stand for 24 hours; or the system shall be filled with a water/chlorine solution containing at least 200 parts per million of available chlorine and allowed to stand for 3 hours.

3. The system shall be purged with clean potable water until the chlorine is flushed from the system.

4. The procedure shall be repeated if a bacterial examination indicates that contamination remains present in the system.

End of Section

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SECTION 15500 - HEATING, VENTILATING, AND AIR CONDITIONING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of heating, ventilating, and air conditioning (HVAC) equipment, devices, and appurtenances associated with the HVAC systems.

B. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.

2. Where two or more units of the same class of equipment are needed, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.

3. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.

4. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

C. General Equipment Stipulations

1. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL safety requirements.

F. Power Supply

1. Power supply to equipment with motors shall be as indicated in schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise required for a properly operating system.

G. Metal Thickness

1. Metal thickness and gages specified herein are minimum requirements. Gages refer to US Standard gage.

H. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

a. Packaged Air Handling Units

1) Name of manufacturer.

2) Type and model.

3) Construction materials, thickness, and finishes.

4) Capacities.

5) Filter velocities.

6) Overall dimensions and required clearances.

7) Net weight and load distribution.

8) Performance tables with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute, speed or rpm, brake horsepower, and static pressure listed.

9) Multiline wiring diagrams clearly indicating factory installed and field installed wiring with all terminals identified.

10) Electrical requirements including voltage, number of phases, and amperage.

11) Where specified, information on equipment manufacturers' representatives.

b. Fans

1) Name of manufacturer.

2) Type and model.

3) Construction materials, thickness, and finishes.

4) Overall dimensions and required clearances.

5) Net weight and load distribution.

6) Performance curves with the specified operating point clearly identified for each unit, type, and model, with capacity in cubic feet per minute CFM as the abscissa and brake horsepower, static pressure, and efficiency as the ordinate. The fan curves shall include a family of curves for at least 3 different rotative speeds on a single chart.

7) Certified AMCA standard test code sound power output data for the fan outlet and casing when operating at the specified volume flow rate. Sound data shall list dB re 10-12 watts in each octave band, with midrange frequencies starting at 63 Hz and ending at 8,000 Hz.

8) Where specified, information on equipment manufacturers' representatives.

c. Equipment (not specifically listed)

1) Name of manufacturer.

2) Type and model.

3) Construction materials, thickness, and finishes.

4) Manufacturer's performance data.

5) Overall dimensions and required clearances.

6) Net weight and load distribution.

7) Wiring diagrams.

d. Sheet Metal Ductwork

1) Sheet metal duct fabrication drawings indicating dimensions of individual shop and field fabricated sections, top and/or bottom duct elevations, joint locations, and dimensions of duct from walls or column rows.

2) Pressure and seal classifications.

3) Reinforcement types and spacing.

4) Joint and seam types.

5) Hanger and support types, spacing, and attachment methods.

6) Access panel and door construction, sizes, and locations.

7) Duct sealant, adhesive, gasket, and tape information.

8) Product data for adhesives and sealants shall include VOC content.

9) Coatings.

10) Ductwork materials and thicknesses.

11) Product data demonstrating compliance with ASHRAE 62.1

12) Ductwork leakage test report.

e. Temperature Controls

1) Published descriptive data on each item of equipment and accessories, indicating all specific characteristics and options and identified with the designation used herein and on the Drawings.

2) Schematic control diagrams giving specific data on all settings, ranges, actions, adjustments, and normal positions. Although schematic, these diagrams shall, as closely as possible, represent the actual system with all significant equipment and devices identified and located relative to each other. These diagrams shall also show detailed multiline wiring with all terminals accurately identified. The wiring diagrams shall show the internal connections of the temperature control panels and all field wiring to equipment remote from the control panels, including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation. Wiring diagrams shall be detailed to the degree necessary for field construction and shall include all related wiring.

3) Sequence of operation for each system corresponding to the control schematics.

4) Space thermostat schedule indicating the types of covers and means of adjustment for each space.

5) Conduit and wire types.

6) Where specified, information on equipment manufacturers' representatives.

f. Seismic Design Requirements

1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1.4 QUALITY ASSURANCE

A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

B. Each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve to the left of the peak pressure/efficiency point.

C.

D.

E.

F. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

G. Elevation

1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2.3 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

A. Packaged Air Handling Units

1. Packaged air handling units, denoted by the symbol "AHU" and an identifying number, shall be furnished and installed where indicated on the Drawings. Each unit shall be designed for indoor vertical or horizontal installation as indicated on the Drawings consisting of cabinet, coil(s), filter, drain pan, fan, and motor. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1. The air handling unit manufacturer and model shall be Trane Model TWE or approved equal.

2. Extra Materials

Extra Materials	Quantity
Sets of matched belts per unit	1
Sets of air filters per unit	2

3. Performance and Design Requirements

a. The units shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Each unit shall be designed for direct expansion cooling suitable for use with the specified refrigerant. The unit shall be suitable for the power supply and shall have the capacities indicated on the Drawings.

4. Cabinet

   a. The unit shall be constructed of zinc-coated steel properly reinforced and braced for maximum rigidity. The unit shall be given a factory-applied coat of rust-inhibitive primer and shall be provided with the manufacturer's standard enamel finish. Interior surfaces of the unit shall have 1 inch thick, 1 lb density, insulation foil faced or coated on the air side. Removable panels shall be provided to permit easy inspection and maintenance.

5. Coil Section

   a. The coil shall be multirow of seamless copper tubing mechanically bonded to heavy-duty aluminum fins. The coil shall be factory pressure and leak tested to at least 300 psig or greater as needed for the system operating pressures. The coil shall be provided with expansion device or valve and filter-dryer. The coil section shall have fully insulated, sloped drain pan extending under the coil section and arranged to capture and collect any condensate including carryover that may be produced when the unit is operating within the specified operating conditions. The drain pan construction shall comply with the requirements of ASHRAE 62.1.

6. Heating Section

   a. Where indicated on the Drawings, the units shall be provided with electric heating coils. Electric coils shall be completely factory assembled and wired integral within the unit. Coils shall be heavy-duty nickel chromium elements with an automatic reset device to de-energize all staging contactors on high temperature. The heating coils shall be electrically subdivided within the unit into balanced, individually fused stages as required by the National Electrical Code.

7. Fans and Motors

   a. The indoor supply fan shall be a double inlet, forward-curved, multiblade, centrifugal type statically and dynamically balanced by the unit manufacturer. The fan shall be direct or belt driven as indicated on the Drawings. Direct drive fans motors shall be multispeed with integral thermal-overload protection. Where belt driven fans are used, adjustable mounts and adjustable motor pulleys shall be provided.

   b. Static pressure values indicated on the Drawings are external to the complete unit. Internal coil(s), filters and fan housing losses are not included. A filter allowance of 0.15 inch water column shall be used for 1 inch pleated filter losses and 0.35 inch water column shall be used for 2 inch pleated filter losses.

8. Filters

a. Filters shall be mounted integral within the unit and shall be 2 inches thick unless otherwise indicated on the Drawings. Filters shall conform to the requirements in the Air Filtration Equipment paragraph.

9. Controls

a. A thermostat for operation of the unit shall be furnished and installed as indicated on the Drawings. The thermostat shall be as needed to perform the sequence of operation as indicated on the Drawings. Thermostats shall be programmable wall mounted type and shall conform to the requirements of the Thermostats paragraph.

B. Heaters

1. Heaters of the types, sizes, and capacities specified herein shall be furnished and installed where indicated on the Drawings. All heaters shall be complete with controls and accessories required for satisfactory operation. Heaters shall be UL listed unless otherwise indicated.

2. Electric Unit Heaters

a. Electric unit heaters, denoted by the symbol "EUH" and an identifying number, shall have the capacity indicated in the schedules on the Drawings.

1) Electric Unit Heaters (heavy-duty). Electric unit heaters located in unclassified areas shall be Chromalox "LUH," or Brasch. Each heater shall include a fan and motor assembly, a built-in contactor, safety disconnect switch, and a control transformer for 120 volt control, and shall be suitable for use with the power supply indicated in the heater schedule on the Drawings. Heater elements shall be steel plate, fin type, with elements brazed to common fins for maximum strength and heat transfer. Each unit heater fan motor shall be provided with automatic reset thermal overload protection. Where shown on the Drawings to be wall hung, a wall mounting bracket shall be provided.

3. Wall Heaters

a. Wall heaters, denoted by the symbol "WH" and an identifying number, shall be manufactured by Indeeco "WAI," or Brasch "BWH."

b. Wall heaters shall be architectural, downflow type; designed for mounting as indicated on the Drawings; and shall include an electric heating element, a thermal limit switch, a fan and motor assembly, and a built-in thermostat. The heaters shall be suitable for use with the specified power supply and shall have the capacity indicated in the schedules on the Drawings.

C. Fans

1. Fans shall be rated in accordance with AMCA standards, shall be licensed to bear the AMCA Certified Rating Label unless otherwise indicated in the Fan Schedule on the Drawings, and shall be UL listed. Surfaces in contact with the airstream shall comply with the requirements of ASHRAE 62.1.

2. Each fan shall be complete with an electric motor, factory mounted safety disconnect switch with wiring to the motor, drive, and accessories required for satisfactory operation. Belt-driven fans shall be complete with a V-belt drive designed for 50 percent overload capacity, sheaves, adjustable base or rails for belt tightening, and a belt guard. Adjustable pitch sheaves shall be furnished for fans with less than 10 horsepower motors and fixed sheaves for 10 horsepower and larger motors. Adjustable sheaves shall be selected so that the fan speed at the specified conditions is at the mid-position of the sheave range. Sheaves shall be replaced with sheaves of the proper size after the air system balancing if necessary, to provide the required fan speed for the specified airflow.

3. Fan drive motors shall be as specified in the Electrical paragraph, unless otherwise indicated. Fans shall be suitable for use with the power supply indicated on the Drawings.

4. The external static pressure values indicated in the schedules on the Drawings are external to the complete unit. Internal fan housing and when furnished, backdraft damper and filter losses are not included. An allowance of 0.35 inch water column shall be used for pleated filter losses.

5. A solid state variable speed controller shall be provided for each direct-driven fan motor less than 1/2 hp to balance the fan airflows to the specified rates. The speed controller shall have a capacity range of approximately 50 through 100 percent of the design airflow rate specified. The speed controller shall be mounted on or in the fan housing unless otherwise indicated.

6. Where indicated in the schedules on the Drawings, fans shall be given a special coating resistant to the corrosive atmosphere indicated.

7. Extra Materials

Extra Materials	Quantity
Sets of matched belts per fan	1
Sets of air filters per fan	2

8. Cabinet Fans

   a. Cabinet fans, denoted by the fan type "CF" in the HVAC schedule, shall be Greenheck "Model SP-A/CSP-A," PennBarry, or Loren Cook. Cabinet fans shall have forward-curved, squirrel-cage type wheels. The fans shall be statically and dynamically balanced. Motors shall be open dripproof, with permanently lubricated ball bearings and internal thermal overload protection, and shall be suitable for use with the power supply indicated in the schedules on the Drawings. An internal motor disconnect shall be provided. Fan housings shall be fabricated of heavy gage galvanized steel with welded seams and shall be acoustically lined. Fans shall be installed in the configuration indicated on the Drawings.
   A removable access panel or exhaust grille shall be provided on the bottom of each fan and a factory installed backdraft damper shall be provided on the fan discharge. Vibration isolator units and wall caps shall be provided for each fan as indicated in the schedules on the Drawings.

9. Propeller Fans

   a. Propeller fans, denoted by the fan type "PF"in the HVAC schedule, shall be Greenheck "Model AER" for direct drive and "Model SB/SBC" for belt drive, or PennBarry, or Loren Cook.
   b. Propeller fans shall consist of a panel frame, wire guard, motor, fan blades, and a disconnect switch. Fan blades shall be constructed of aluminum. Propeller fans shall be statically and dynamically balanced to ensure quiet, vibration-free operation, and be suitable for mounting as indicated.
   c. When indicated in the schedules on the Drawings, a wall mounting kit shall be provided. The wall mounting kit shall consist of a wall collar, motor wire guard, backdraft damper, and weather hood with birdscreen.

10. Wall Fans

   a. Wall fans, denoted by the fan type "WF" in the HVAC schedule, shall be Greenheck "Model CUE," PennBarry "Fumex," or Loren Cook "ACW."
   b. Wall fans shall be suitable for sidewall installation; shall be direct driven, centrifugal type, with aluminum wheels and housing, and a wheel guard located on the discharge side; and shall be statically and dynamically balanced at the factory. The fan motors shall be of adequate size to prevent overloading when operating at the specified capacity and shall be suitable for use with the power supply indicated in the schedules on the Drawings. Each fan shall be complete with 1/2 inch mesh aluminum bird screen over all openings, and, where indicated in the schedules on the Drawings, a backdraft damper.
   c. Motors and drives shall be mounted outside the airstream. The wheel shaft shall be of ground and polished steel, mounted in heavy-duty, relubricatable or permanently sealed bearings with a minimum L_{50} service life of at least 200,000 hours at the equipment's maximum cataloged operating conditions.
   d. A safety disconnect switch shall be mounted in the hood. Where a factory installed integral disconnect switch is not available as a standard option, a disconnect for field installation shall be provided.

D. Dampers

1. Control Dampers

a. Control dampers shall be denoted by the symbol "CD" and an identifying number. Dampers with an area larger than 25 square feet or with any blade dimension exceeding 48 inches shall be built in sections. All dampers shall be carefully inspected before and after installation, and any damper having poorly fitted blades, insufficient framed rigidity, or excessive clearance or backlash in moving parts will be rejected and shall be replaced with an acceptable unit. The leakage rate shall not exceed 4 cubic feet per minute per ft^2 when tested at 1 in wc for all sizes 24 inches wide and above.

b. Two-position dampers shall have parallel operating blades. Modulating dampers shall have opposed operating blades.

c. Damper blades shall be installed on a steel shaft operating in synthetic bearings suitable for industrial service. Dampers shall be close-fitting and shall be designed to offer minimum resistance to the airflow when in the fully open position. Damper blade linkage shall be concealed in the frame.

d. Control dampers shall be given a special coating identical to the coating applied to the connected ductwork and equipment.

1) Duct Mounted Control Dampers. Control dampers mounted in ductwork and equipment curbs shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-50." The damper frames shall be constructed of 5 inch Type 6063 T5 extruded aluminum. Damper blades shall be constructed of 6 inch wide airfoil-shaped extruded aluminum.

2) Wall Mounted Control Dampers. Control dampers mounted in walls behind louvers shall be Arrow United Industries "Type AFD-20" or Ruskin "CD-40." Control damper frames shall be constructed of 4 by 1 inch 6063 T5 extruded aluminum. Damper blades shall be constructed of 4 inch wide airfoil-shaped extruded aluminum.

3) Round Control Dampers. Round control dampers shall be Arrow United Industries "Type 70, 75, or 80." The damper frames and blades shall be constructed of 16 gage galvanized steel.

2. Volume Control Dampers

a. Volume control dampers shall be denoted by the symbol "VCD."

b. Galvanized volume control dampers in round ductwork shall be Arrow United Industries "Type 200 VCRD," or Ruskin "Model MDRS25." Volume control dampers in rectangular ductwork shall be Arrow United Industries "Type 1770," or Ruskin "Model MD35." Rectangular volume control dampers shall be fabricated of 16 gage thickness galvanized steel, with a nominal 4 or 5 inch by 1 inch channel frame, and opposed operating blades. Round dampers shall be fabricated of galvanized steel, with a nominal 7 inch long, 22 gage thickness frame, and a minimum 20 gage thickness circular blade.

c. The dampers shall be provided with adjustment quadrants and locking devices so arranged that the position of the damper will be indicated and the damper will not move when locked.

E. Damper Operators

1. The damper operators shall be direct coupled or foot-mounted type. Each operator shall be complete with all necessary crank arms, ball joint connectors, push rods, linkages, and mounting brackets.

2. Each operator shall have sufficient torque to operate the connected control damper based on at least 130 percent of control damper area. Each damper operator shall have at least a 50 inch-pound normal running torque. Where the required damper torque exceeds the damper operator running torque rating, multiple operators or operators with a greater running torque shall be furnished to produce the torque required to operate the damper. Control dampers shall fail to the closed position unless otherwise indicated on the Drawings.

3. Two-position direct coupled electric damper operators shall be Belimo "NFBUP-S" or "AFBUP-S," Honeywell "MS4100 Series," or Johnson Controls. Foot-mounted type electric damper operators shall be Honeywell "Model M4185," or Johnson Controls "Model M100."

4. Damper operators shall be spring return and shall have one internal spdt auxiliary switch rated 5 amperes at 120 volts ac or the power supply available from the temperature control system furnished. Damper operators shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply. Auxiliary transformers, where required, shall be factory wired to the damper operator and installed in a NEMA enclosure with a rating equal to or better than the damper operator.

   a. Direct coupled two position electric damper operators shall be housed in a galvanized steel or aluminum case. Operators shall use a "V" shaped bolt and cradle design to eliminate slippage on the damper shaft. Single bolt or set screw type designs are not acceptable for round shafts. The operators shall be suitable for direct mounting to shafts up to 1 inch and shall be complete with mounting brackets and damper position indicator.
   b. Foot-mounted type two-position electric damper operators shall be housed in a die-cast aluminum case with a mounting flange. Motor and gear train components shall be immersed in oil. Damper operators shall have a 3/8 inch square, double-ended drive shaft.

F. Air Outlet and Inlet Devices

1. Air outlet and inlet devices shall be manufactured by Price, Tuttle & Bailey, or Titus. Air outlet and inlet devices shall be furnished and installed where indicated on the Drawings.

2. Where air outlet and inlet devices are installed in ductwork given a special coating, an identical coating shall be applied to the air outlet and inlet devices.

3. Ceiling Diffusers

a. Diffusers shall be square or rectangular, constructed of the materials indicated in the schedules on the Drawings. Diffusers shall have a key-operated, opposed-blade damper mounted in the neck where indicated in the schedules on the Drawings. Size, location, and direction of airflow shall be as indicated on the Drawings.

4. Registers and Grilles

a. Registers and grilles shall be constructed of aluminum or steel as indicated in the schedules on the Drawings. The front blades of adjustable blade models shall be parallel to the short dimension unless otherwise indicated, and the front blades of fixed blade models shall be horizontal unless otherwise indicated. All registers shall be furnished with key-operated opposed blade dampers. The dampers shall be constructed of the same material as the attached grille.

G. Flexible Connections

1. Flexible connections located indoors shall be Ventfabrics "Ventglas." Flexible connections installed outdoors or exposed to sunlight or weather shall be Ventfabrics "Ventlon."

2. Ductwork connections to the air handling equipment, and where indicated on the Drawings, shall be made using fabric connectors with sheet metal collars. The fabric shall be fire resistant, waterproof, mildew-resistant, and airtight. At least 3 inches of fabric shall be exposed. Flexible connections shall be in accordance with the requirements of UL and NFPA.

3. Fabric for flexible connections protected from sunlight and the weather shall be suitable for a temperature range of -20° to 180° F and shall weigh at least 27 ounces per square yard.

4. Fabric for flexible connections exposed to sunlight or the weather shall be suitable for a temperature range of -10° to 250° F and shall weigh at least 24 ounces per square yard.

H. Air Filtration Equipment

1. Pleated Air Filters

a. Pleated air filters shall be American Air Filter "AM-AIR 300X" or Farr "30/30." Filters shall be disposable type, high-loft blend of cotton and synthetic fiber pleated media. The media shall be rated as Class 1 or Class 2 in accordance with UL 900. A metal support grid shall be bonded to the media. The filter frame shall be constructed of rigid, high-strength, moisture-resistant beverage board. The pleated media pack shall be bonded to the inside of the frame. All filters shall have a minimum efficiency reporting value (MERV) based on the ASHRAE 52.2 guidelines of at least MERV 6.

2.5

a. Two inch pleated air filters shall have at least 12 pleats per linear foot and at least 4.2 square feet of media per square foot of filter area. Two inch filters shall have a maximum initial resistance of 0.13 inch water column at 300 feet per minute .

B. Sheet Metal Ductwork

1. Ductwork, accessories, bracing, and supports shall be constructed of galvanized steel. Ductwork, turning vanes, and other accessories shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards unless otherwise indicated. Accessories, bracing, and supports shall be constructed of similar materials as the ductwork.

2. Galvanized ductwork located in air conditioned spaces shall be constructed of G-60 or better lockforming quality in accordance with ASTM A653. All other galvanized ductwork shall be constructed of G-90 or better galvanized steel. All welds on galvanized metal shall be cleaned and coated with a zinc-rich paint.

3. Sheet metal fan boxes shall be fabricated with 12 gage thickness galvanized sheet metal skin and structural steel framing of sufficient strength to support the fan box and the fan mounted on the box. Drawings of the fan boxes shall be submitted in accordance with the Submittals Procedures section.

4. Sealants shall be suitable for the duct service and shall maintain leakage integrity at pressures in excess of the ductwork pressure classification.

5. Where indicated on the Drawings, ductwork and accessories shall be given a special coating resistant to the corrosive atmosphere indicated. Where no special coating for ductwork is indicated, the coating shall be as specified in the Protective Coatings and Architectural Painting sections.

C. Duct Insulation

1. Interior duct liner shall be Knauf “Sonic XP Duct Liner,” CertainTeed “ToughGard R,” or Johns Manville “Linacoustic RC.”

2. Interior duct liner shall be 1-1/2 pound per cubic foot density, spray coated duct liner with an “R” value of at least 4.2 ft2 hr F/BTU per inch thickness at 75° F. The insulation shall be suitable for temperatures up to 250° F and shall have at least a 0.55 NRC per 1 inch thickness. The insulation shall conform to ASTM C1071. The insulation surface shall be resistant to microbial growth in accordance with UL 181, ASTM C1338, or comparable test method and shall be cleanable in accordance with NAIMA recommended practices.

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C. Flexible Duct and Takeoffs

1. Flexible duct shall be Thermaflex "Type G-KM" or Flexmaster "Type 8." Takeoffs shall be Buckley Air Products "Air-Tite Bellmouth BM-D."

2. Flexible duct shall be a galvanized or vinyl-coated spring steel helix, bonded to a polymer liner, and wrapped with glass fiber insulation suitable for use in heating and cooling systems. The insulation shall provide an "R" value of at least 4.2 ft2·hr F/BTU. The outer jacket shall be a vapor barrier of fire retardant polyolefin or polyethylene material. The flexible duct shall be listed under UL 181 as Class 1 flexible air duct and shall comply with the latest edition of NFPA 90A.

3. Takeoffs for the flexible duct shall be bellmouth type manufactured of the same material as the associate ductwork with a neoprene gasket and predrilled holes. Each takeoff shall be equipped with a balance damper constructed of 26 gage thickness galvanized steel. Scoops or other obstructions in the main duct will not be acceptable.

D. Access Doors

1. Access doors shall be fabricated in accordance with the latest SMACNA HVAC Duct Construction Standards. Access doors shall be double skin insulated type for insulated ductwork and single skin type for noninsulated ductwork. Insulated doors shall be insulated with the same thickness insulation as the duct in which it is installed. Duct-mounted access doors and panels shall be fabricated of the same material as the ductwork, with sealing gaskets and quick-fastening locking devices. Where access doors are insulated, a sheet metal cover shall be installed over the insulation.

E. Temperature Controls

1. The temperature control components and systems shall be manufactured by Honeywell; Johnson Controls; or Siemens Building Technologies, Landis Division. Where manufacturers are not specified, materials and equipment furnished shall meet the performance and design requirements indicated.

2. Performance and Design Requirements

a. Contractor shall coordinate with the Work to make certain that the field wiring associated with the work of this section is completed in accordance with the requirements of the heating, ventilating, and air conditioning equipment furnished and their interconnection. Where cable and conduit is not indicated on the Drawings but is needed for a complete and functional control system in accordance with the sequence of operation it shall be provided as specified herein. The control wiring shall be installed so that all HVAC equipment will function as described in the HVAC sequence of operation.

b. Conduit and control wiring for all control circuits needed between all field mounted HVAC controlling and indicating devices, such as, but not limited to, damper actuators, thermostats, temperature control panels, pressure differential switches, control switches, motor starters, and the HVAC equipment, shall be

furnished and installed as specified in the Electrical Wiring paragraph. Cable and conduit for all HVAC power circuits shall be as specified in the Electrical section.

3. Tolerances

   a. Unless otherwise indicated, the controls shall maintain space temperatures within ±2° F, and the relative humidity within ±5 percent of the setpoint.

4. Thermostats

   a. Where indicated on the Drawings, thermostats shall be constructed of materials resistant to or shall be protected from the corrosive atmosphere indicated. Thermostats specified in the individual equipment paragraphs shall be provided with the respective equipment.

      1) Two Position Wall Mounted Thermostats

         a) Two position wall mounted thermostats shall be Honeywell "T631A Airswitch," Penn Controls "A19BAC-1," or Siemens Building Technologies.

         b) Two position wall mounted thermostats shall be line voltage type. The thermostats shall have a range of approximately 35° F to 100° F with a nonadjustable differential of 3.5° F. The thermostats shall have a spdt switch rated for 1 horsepower.

      2) Programmable Wall Mounted Thermostats

         a) Programmable, wall mounted thermostats shall be Honeywell "Model T7300," Penn Controls, or Siemens Building Technologies.

         b) Programmable wall mounted thermostats shall be single or multistage as required by the controlled equipment, solid state programmable electronic type configurable for use with a conventional or heat pump system. The thermostats shall have a setpoint range of approximately 45° F to 95° F with the following features:

            - 7 day programming with 2 occupied/unoccupied periods per day.
            - Automatic heat/cool changeover.
            - Battery backup.
            - Setback controls to automatically restart and temporarily operate system during setback periods.
            - Digital display.
            - Temporary override of setpoints.

- 2 configurable LED's.
- Where an economizer is used, the programmable thermostat shall be suitable for interfacing with the economizer control package.

5. Smoke Detectors

   a. Smoke detectors shall be as specified in the Fire Detection and Alarm System section.
   b. Smoke detectors, denoted by the symbol "SMD" and an identifying number, shall be System Sensor "D4120," Secutron "MRD-DH100ACDCP," or Totaline "P270-2000P."
   c. Detectors shall be designed to detect combustion gases, fire, and smoke in air conditioning and ventilating duct systems in compliance with the NFPA 90A and shall contain a detector and air sampling chamber which serves as a reference point to help stabilize the detector against the effects of changes in temperature, humidity, and pressure.
   d. Smoke detectors shall be duct mounted photoelectric type and shall be completely self-contained, including integral power supply, supervisory and control circuitry and isolated alarm contacts. The detector shall provide a single-pole, single-throw supervisory alarm contact and a single-pole, double-throw supervisory trouble contact rated 2 amperes at 30 volts dc. The detector shall also provide double-pole, double-throw auxiliary alarm contacts rated 10 amperes at 120 volts ac. A local tamper trouble signal shall be emitted by the detector in the event the cover is removed or missing. A remote key-operated test station with alarm light and power supply status light shall also be furnished and installed where indicated on the Drawings. Detectors shall be suitable for operation on a 120 volt, 60 Hz, single phase power supply or the power supply available from the temperature control system furnished.
   e. Detectors shall be provided with sampling tubes extending the width of the air duct.

6. Temperature Sensor

   a. Space temperature sensors shall use a precision type accurate to ±.5 DegF over a temperature range of 40 DegF to 90 DegF. The assembly shall be installed within a ventilated off white enclosure suitable for wall mounting. The output shall be compatible with the controller it serves. Where manual overrides are indicated, the sensor shall include push button override capability, thermometer or temperature indication, sliding warmer/cooler mechanism for adjusting the temperature setpoint, and latching cover.

7. Temperature Controller

    a. Temperature controllers shall be provided where indicated on the drawings. Controllers shall be provided by the controls contractor.
    b. The controller shall work directly in tandem with the room temperature sensor receiving signals from the temperature sensor and energizing the exhaust fans as needed.
    c. Refer to the sequence of operations in the HVAC drawings for the Pump Room equipment control.

8. Pressure Differential Airflow Switches

    a. Pressure differential airflow switches, denoted by the symbol "PDS" and an identifying number, shall be furnished and installed as indicated on the Drawings and the sequence of operation. Each pressure switch operating range shall be selected so that the setpoint is between 25 and 75 percent of the scale range. Switches used for proving airflow shall be selected with the lowest operating range such that the switch activates at 50 percent of the system airflow. Differential switches shall be UL listed.

    b. Pressure differential airflow switches shall be Dwyer Instruments, Inc. "Series 1800." Pressure differential switches for airflow service shall be diaphragm operated by differential air pressure between duct and atmosphere or across a filter. The switch shall be spdt, shall be rated 10 amperes at 120 volts ac and for a temperature range of 0° F to 125° F, and shall be provided with corrosion resistant mounting brackets. Unless otherwise indicated on the Drawings, initial setpoints of pressure differential switches located across filters shall be 0.75 inch water column to alarm high filter pressure loss and 0.1 inch water column when mounted in air systems to alarm ventilation failure.

9. Accessory Components

    a. All additional control components, including, but not limited to, electric relays, temperature sensors and transmitters, humidity sensors and transmitters, controllers, and position switches, shall be furnished where necessary to ensure a complete, properly operating installation. All components shall be products of the temperature control manufacturer. Accessory components not mounted inside the temperature control panels shall be furnished with equipment enclosures. Relays shall be provided with 120 volt coils and at least 10 ampere contacts.

10. Electrical Wiring

    a. Detailed wiring diagrams shall be submitted in accordance with the Submittals Procedures section. The wiring diagrams shall show the internal connections of the control panels and all field wiring to equipment remote from the control panels including wiring to Owner-furnished equipment. The wiring diagrams shall be complete, showing all connections necessary to place the temperature control systems in operation.
    b. Control wiring shall be in accordance with the National Electric Code (NEC). Cable shall be multi-conductor, at least 18 AWG size, specifically designed for industrial systems and UL listed for indoor/outdoor installations.

c. Conduit for all HVAC control circuits in indoor locations shall be furnished and installed under this section. Conduit type shall be as specified in the Electrical Section.

2.7 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with integral disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.8 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.9 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.10 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

2.11 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient course for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

B. Where penetrations through existing concrete slabs are made, the Contractor shall locate and avoid damage to all rebar, embedded conduit, etc. when making new openings.

3.2 PREPARATION

A. Field Measurement

1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

B. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Architectural Painting and Protective Coatings sections.

3.3 INSTALLATION

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. The space beneath baseplates shall be grouted as specified in the Grouting section.

C. Packaged Air Handling Units

1. Units shall be installed level and with vibration isolators types where indicated on the Drawings. Flexible connections shall not be in tension when the fans are operating. Ductwork and piping installed adjacent to each unit shall not interfere with unit servicing or panel removal.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

D. Heaters

1. The bottom elevation of unit heaters shall be 8 feet above finished floor unless otherwise indicated.

2. The bottom elevation of wall heaters shall be 16 inches above finished floor unless otherwise indicated.

E. Fans

1. Where indicated on the Drawings, flexible connections shall be installed between fan inlet and outlet sheet metal connections. Flexible connections shall not be in tension when the fans are operating. Where fan inlets and outlets are exposed, safety screens shall be installed over the opening. Scroll drains for equipment installed indoors shall be piped to the nearest floor drain.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

F. Damper Operators

1. Damper operators shall be installed on a mounting bracket rigidly attached to the damper frame or duct. Where the bracket attaches to the duct, suitable stiffeners shall be installed on the duct to prevent noticeable deflection of the duct when the damper operates. Damper operators may be installed inside or outside the duct but consideration shall be given to the environment and duct dimensions in which the operators are installed. Where the damper installation inside the duct may or actually prevents the design airflow from being achieved, the damper operator shall be installed outside the duct. Damper operators shall be readily accessible and access doors shall be provided when the operator is installed inside the duct.

2. The damper operator shall be installed to prevent entry of moisture from contacting internal parts. Conduit shall enter the operator from below or horizontally and incorporate a drip leg to prevent water from following the conduit into the operator interior.

3. The number of operators furnished for each damper shall provide the torque necessary to operate the damper. Unless otherwise indicated, control dampers shall fail to the closed position.

G. Air Outlet and Inlet Devices

1. Air outlet and inlet devices shall be installed level and plumb and in accordance with the manufacturer's written instructions. Diffusers with balance dampers installed in the flexible duct takeoffs shall not have an opposed blade damper mounted in the throat of the diffuser. For devices installed in lay-in ceilings panels, the units shall be located in the center of the panel. Ceiling mounted air devices or services weighing 20 pounds or more shall be supported directly from the structure.

H. Sheet Metal Ductwork

1. Ductwork, turning vanes, and other accessories shall be installed and supported in accordance with the latest SMACNA Duct Construction Standards unless otherwise indicated. The locations, arrangement, and sizes of ductwork shall be as indicated on the Drawings. The duct sizes indicated are clear dimensions inside the duct or duct lining. Sheet metal sizes are larger for ductwork with interior linings.

2. Ductwork shall be fabricated, reinforced, supported, and sealed for the operating pressures indicated in the schedules for the connected equipment. All ductwork shall have a pressure classification of at least 1 inch.

3. Sheet metal ductwork shall be sealed according to the classifications described in the SMACNA HVAC Duct Construction Standards in accordance with the following:

	Duct Type			
	Supply		Exhaust	Return
Duct Location	≤ 2 inches wc	> 2 inches wc		
Outdoors	A	A	A	A
Unconditioned Areas	B	A	B	B
Conditioned Spaces				
(concealed ductwork)	C	B	B	C
(exposed ductwork)	A	A	B	B

Sealing Levels

A - All transverse joints, longitudinal seams, and duct wall penetrations

B - All transverse joints and longitudinal seams

C - Transverse joints only

4. All joints, seams, connections, and penetrations in ductwork located outdoors shall be sealed watertight and weatherproof. Transverse joints shall be flanged and shall be provided with a continuous gasket and flange cap.

5. Ductwork shall be supported as required by SMACNA. Where ductwork is connected to equipment, it shall be independently supported with no weight bearing on the equipment and in such a manner that the equipment maybe removed for service without temporary support of the ductwork. Ductwork shall be supported within 24 inches of each elbow and within 48 inches of each branch intersection. Strap or wire hangers shall not be used where the hanger length exceeds 5 feet.

6. Ductwork shall be constructed and installed in accordance with the Drawings. When acceptable to Owner, modifications in the size and location of ductwork may be made where required to avoid interference with the building structure, piping systems, or electrical work. The installation shall be coordinated with other phases of work to establish space and clearance requirements. Unless otherwise indicated by a bottom of duct elevation, all ductwork shall be routed as high as possible, with a minimum height of 8 feet above the finished floor. Ductwork installed above suspended ceilings shall be installed with at least 8 inch lighting allowance between the ceiling and the bottom of the ductwork.

7. Turning vanes shall be installed in all elbows with 45 degree or greater angles. Vanes shall be double thickness or a minimum 4.5 inch radius type for vanes 30 inches and longer, where installed in ducts with velocity greater than 2000 fpm, or where installed in ducts with a pressure classification greater than 2 inches wc. Where 4.5 inch or double thickness type turning vanes are required, each vane shall be welded to the vane runner.

I. Duct Insulation

1. Insulation materials shall be installed in accordance with the manufacturer's written instructions and recommendations. Surfaces which are to be insulated shall be cleaned and dried. Insulation shall be kept clean and dry and shall not be removed from the factory container until it is installed. Packages or factory containers shall have the manufacturer's stamp or label bearing the name of the manufacturer and description of the contents.

2. Insulation shall be terminated at items mounted in ductwork such as thermometers, controls, damper linkages, flexible connections, access doors, etc., to avoid interference with their function and/or replacement.

3. The duct liner in the corners of the duct sections shall be folded and compressed or shall be cut and fit to ensure overlapping, butted edges. Top and bottom pieces shall overlap the side pieces. Longitudinal seams shall be made only at corners unless duct dimensions and standard liner product dimensions make seams necessary at other locations.

4. The duct liner shall be held to the duct by a coat of waterproof, fire-retardant adhesive applied over the entire duct surface. Where duct dimensions exceed 8 inches on any side, mechanical fasteners shall be used in addition to the adhesive. All exposed edges of the duct liner shall be tightly butted and coated with adhesive.

5. The following ducts shall be insulated with interior duct liner unless indicated on the Drawings to be wrapped or otherwise indicated:

Location	Ductwork	Insulation Thickness
Interior within conditioned space (heated or cooled)	a. Cooling supply and return	1 inch
	b. Heating and cooling supply and return	1 inch
Note: Exhaust systems shall not be internally lined.		

K. Flexible Duct and Takeoffs

1. The length of the flexible ductwork shall not exceed 8 feet. All support saddles for flexible duct shall be a minimum of 6 inches wide.

L. Access Doors

1. Airtight access doors shall be provided for inspection of all dampers, operators, filters, smoke detectors, duct-mounted coils, and at other locations indicated on the Drawings. The access doors shall be of a size suitable for the duct dimensions and at least 8 inches square for hand access, 18 inches for shoulder access, or as indicated on the Drawings. Each access door shall be installed to open against the pressure in the duct.

M. Temperature Controls

1. Automatic temperature controls shall be furnished and installed as indicated on the Drawings and as specified herein.

2. Contractor shall be responsible for determining that all equipment supplied is suitable for installation in the space indicated on the Drawings. Control equipment shall be installed with adequate space for operating and maintenance access.

3. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

4. Thermostats

   a. Wall-mounted thermostats shall be mounted above the finished floors as indicated in the Electrical section. Insulating spacers shall be provided for thermostats mounted on exterior building walls. The spacers shall be installed between the thermostat and its mounting surface, so that the thermostat will not be affected by surface temperatures.
   b. Wall-mounted thermostats in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

5. Temperature Sensor

   a. Temperature sensor shall be mounted above the finished floors as indicated in the Electrical Section.

6. Temperature Controller

   a. Wall-mounted temperature controller shall be mounted above the finished floors as indicated in the Electrical section.
   b. Wall-mounted temperature controllers in non air-conditioned areas shall be furnished and installed with a cast aluminum or wire guard.

3.4 FIELD QUALITY CONTROL

A. Startup and Testing

1. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

3.5 CLEANING

A. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15650 - REFRIGERATION SYSTEMS

PART 1 - GENERAL

1.1 SCOPE

1. This section covers the furnishing and installation of refrigerant piping and accessories, condensing units, heat pumps, ductless split systems, and appurtenances associated with the heating, ventilating, and air conditioning (HVAC) systems.

2. Piping, pipe supports, valves, and accessories which are not an integral part of the equipment or are not specified herein are covered in other sections.

1.2 GENERAL

1. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

2. Coordination

   a. Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, ductwork, materials, fans, pumps, and motor sizes are appropriate; and that all devices necessary for a properly functioning system have been provided.
   b. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
   c. Where individual equipment paragraphs specify the requirement for local service, each manufacturer shall have a local service center, or with written consent of Engineer, shall be able to provide service from other locations within 24 hours. The service center shall be equipped and staffed to service the system and shall maintain a local parts supply. Information on equipment manufacturers' representatives shall be included with the submittals.
   d. Where several manufacturers' names have been listed in this section as possible suppliers, only the products of the first manufacturer listed have been checked for size, functions, and features.

3. General Equipment Stipulations

   a. The General Equipment Stipulations shall apply to all equipment and materials furnished under this section. If requirements in this specification differ from those in the General Equipment Stipulations, the requirements specified herein shall take precedence.

B. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

C. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with UL safety requirements.

3. The refrigerant systems shall be constructed in accordance with ASHRAE Standard 15. Refrigeration system equipment shall have a minimum efficiency of not less than specified in the latest edition of ASHRAE 90.1**,** ARKANSAS ENERGY CODE, unless otherwise indicated on the Drawings.

4. Capacity ratings for condensing units and heat pumps with capacities less than 135,000 BTUH shall be in accordance with AHRI Standard 210/240. For condensing units, heat pumps, packaged air conditioning units and packaged heat pumps with capacities over 135,000 BTUH the capacity ratings shall be in accordance with AHRI Standard 340/360.

D. Power Supply

1. Power supply to equipment with motors shall be as indicated in the schedules on the Drawings. Power supply for controls shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system.

E. Metal Thickness

1. Metal thickness and gauges specified herein are minimum requirements. Gauges refer to US Standard gauge.

F. Mechanical Identification

1. Mechanical identification shall conform to the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly and installation drawings, and wiring and schematic diagrams, together with detailed specifications and data covering materials, parts, devices, and accessories forming a part of the equipment furnished, shall be submitted in accordance with the Submittals Procedures section. Device tag numbers indicated on the Drawings shall be referenced on the wiring and schematic diagrams where applicable. The data and specifications for each unit shall include, but shall not be limited to, the following:

Refrigerant Piping

Schematic arrangement showing equipment, coils, piping sizes, valves, and accessories.

A refrigerant piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction.

Air Cooled Condensing Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Locations and sizes of field connections.

Certified performance data and ratings.

Capacity and saturated suction temperature at specified conditions.

Equipment efficiency ratings.

Refrigerant type and charge.

Overall dimensions and required clearances.

Wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

Ductless Split System Condensing Units

Name of manufacturer.

Type and model.

Construction materials, thickness, and finishes.

Location and sizes of field connections.

Certified performance data and ratings.

Capacity at specified conditions.

Refrigerant type and charge.

Overall dimensions and required clearances.

Multiline wiring diagrams with field and factory wiring clearly identified and electrical requirements.

Net weight and load distribution.

Where specified, information on equipment manufacturers' representatives.

B. Operation and Maintenance Data and Manuals

1. Adequate operation and maintenance information shall be supplied as required in the Submittals Procedures section. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

2. In addition to the requirements of the Submittals Procedures section, the operation and maintenance manuals shall include a listing of all filter locations, types, sizes, and quantities associated with each piece of equipment.

1.4 QUALITY ASSURANCE

A. Quality assurance shall comply with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

1.6 EXTRA MATERIALS

A. Extra materials shall be furnished for the equipment as specified in the individual equipment paragraphs.

B. Extra materials shall be packaged in accordance with the Product Delivery Requirements section, with labels indicating the contents of each package. Each label shall indicate manufacturer's name, equipment name, equipment designation, part nomenclature, part number, address of nearest distributor, and current list price. Extra materials shall be delivered to Owner as directed.

C. Extra materials subject to deterioration such as ferrous metal items and electrical components shall be properly protected by lubricants or desiccants and encapsulated in hermetically sealed plastic wrapping.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be designed and selected to meet the specified conditions.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment and coil capacities shall be as indicated on the schedules. Where equipment is provided with special coatings, unit capacities shall be corrected to account for any efficiency losses from the selected special coating.

B. For equipment including fans, each fan's operating selection point on the fan curves shall be selected to the right of the peak pressure/efficiency point and below the lowest point along the fan curve, to the left of the peak pressure/efficiency point.

C. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values of the first manufacturer listed. Contractor shall review the contract Drawings, the manufacturer's layout drawings, and installation requirements and shall make any modifications required for proper installation subject to acceptance by Engineer. At least 3 feet of clear access space shall be provided on all sides of the unit unless otherwise indicated.

D. Elevation

1. Equipment shall be designed to operate at the elevation indicated in the Meteorological and Seismic Design Criteria section.

2.3 ACCEPTABLE MANUFACTURERS

1. Acceptable manufacturers shall be as listed in the respective product description paragraphs.

2.4 MATERIALS

A. Refrigerant Piping and Accessories

1. Refrigerant piping shall conform to the Copper Tubing and Accessories section. Piping shall be supported as specified in the Pipe Supports section. Refrigerant filter dryers, expansion valves, solenoid valves, combination sight glass and moisture indicators, charging valves, relief valves, and other accessories shall be furnished and installed as needed for proper operation of the system.

2.5 EQUIPMENT

A. Condensing Units

1. Condensing units, denoted by the symbol "CU" and an identifying number shall be furnished and installed where indicated on the Drawings. Each unit shall consist of compressor(s), condenser coil, condenser fan(s) and motor(s), starters, and all controls necessary for proper operation. Condensing units and heat pumps shall be manufactured by Trane, Carrier, McQuay, or York.

2. Performance and Design Requirements

   a. Each unit shall be completely factory assembled and tested, piped, internally wired, and shipped in one piece. Each unit shall be fully charged with R-410A and compressor oil. Condensing units and heat pumps shall be selected to satisfy the cooling and cooling/heating requirements of the air handling unit being served. A 2° F suction temperature difference for piping losses shall be allowed between the condensing unit or heat pump and the air handling unit when in the cooling mode.
   b. Condensing units and heat pumps shall be capable of satisfactory cooling operation at the maximum and minimum outdoor ambient air temperatures indicated on the Drawings. When units are indicated to operate in the cooling mode at a lower temperature than the factory standard as indicated in the schedules on the Drawings, a low ambient kit shall be installed. The low ambient kit shall be designed for ambient temperature of 0° F consisting of a solid state controller to vary the speed of the outdoor fan motor in response to refrigerant condensing temperature. Heat pumps shall be capable of operating satisfactorily at an ambient air temperature of 0° F in the heating mode.
   c. The condensing units and heat pumps shall be designed to operate on the power supply as indicated on the Drawings.
   d. Where indicated in the schedules on the Drawings, all copper and other unit surfaces subject to corrosion from the atmosphere indicated shall be given a special coating.

3. Casing

    a. The unit casing shall be of weatherproof design, constructed of heavy gauge galvanized or zinc-coated steel, and reinforced and braced for maximum rigidity. All bracing and reinforcing members shall be integral to each unit. The casing shall be given a factory-applied coat of rust-inhibitive universal primer, followed by the manufacturer's standard baked enamel finish. Fasteners shall be stainless steel or coated for corrosion protection. Each unit shall have removable panels or access doors for access to all components and connections. Drainage holes shall be located in the base section for moisture removal. The unit shall be supported above the mounting surface with base rails or feet.

4. Outdoor Coils

    a. Outdoor coils shall be of the air-cooled, finned tube type with liquid accumulator and integral subcoolers. The coils shall be constructed of 3/8 inch OD seamless copper tubing with aluminum fins securely bonded to the surface. Coils shall be factory leak and pressure tested at 425 psig and then completely dehydrated and sealed with a holding charge of nitrogen or refrigerant. The coils shall be protected from hail damage by louvered metal grilles or on units 5 tons or less, corrosion resistant wire maybe used.

5. Fans and Motors

    a. Outdoor fans shall be vertical discharge, direct-driven propeller type, and shall be statically and dynamically balanced. Fan guards shall be located on the discharge of each fan. Fan motors shall be totally enclosed suitable for outdoor installation and shall have permanently lubricated ball bearings and built-in overload protection.

6. Compressors

    a. Compressors shall be of the reciprocating hermetic, semi-hermetic, or scroll type mounted on vibration isolators. The compressor motor shall have temperature and current sensitive overload protection devices. Where the compressors are located outside the cabinet, grilles shall be installed over the openings to protect the compressor area. Each condensing unit/heat pump shall have a minimum number of capacity reduction steps as indicated in the schedules on the Drawings.
    b. Reciprocating hermetic compressors shall be suction gas cooled with internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, and automatic reset timer to prevent the compressor from rapid cycling.

c. Reciprocating semi-hermetic compressors shall be suction gas cooled, internal pressure relief for high pressure protection, high and low pressure cutout switches, temperature actuated crankcase heater, oil level sight glass, and automatic reset timer to prevent the compressor from rapid cycling. Capacity reduction shall be provided by automatic suction valve unloaders. Each compressor shall start unloaded.
d. Scroll compressors shall be suction gas cooled with high and low pressure cutout switches and automatic reset timer to prevent the compressor from rapid cycling. The compressor shall have radial and axial compliant scroll plates to allow the compressor to handle liquid slugging without damage to the compressor.

7. Refrigerant Circuit and Accessories

a. Each refrigerant circuit shall be equipped with filter-dryer and multiuse liquid and gas line valves. The multiuse valves shall be constructed of brass with service pressure gauge ports. For condensing units and heat pumps larger than 20 tons, factory mounted suction and discharge pressure gauges shall be provided. All factory installed gauges, switches, and other devices connected to the refrigerant circuit shall have isolation valves.
b. Heat pumps shall be provided with reversing valve, flow control check valve, and solid state defrost control system. The defrost system shall be a time and temperature initiated system that activates in response to a temperature sensing element mounted at the outdoor coil.
c. A hot gas bypass kit, including but not limited to a solenoid valve and hot gas bypass valve shall be provided for each condensing unit larger than 5 tons where indicated on the schedules on the Drawings. For condensing units larger than 20 tons, the kits shall be factory installed. For condensing units smaller than 20 tons, the kit maybe field installed.

8. Controls

a. Condensing units and heat pumps shall be completely factory wired for a single point power supply connection and unit mounted disconnect switch. All wiring shall be installed in accordance with the National Electrical Code.
b. Condensing units and heat pumps 5 tons or less shall be provided with factory wired control panel containing magnetic contactors, relays, and control power transformer. Units larger than 5 tons shall be provided with a factory wired control panel containing full voltage magnetic starters for compressor and outdoor fan motors and internal control power transformer.
c. Units with multiple compressors shall have a built-in time delay to prevent both compressors from starting simultaneously. The control system shall prevent the operation of the auxiliary heat when the heating load can be met by the heat pump alone.
d. All internal panel wiring shall be neatly run in gutters or bundles to terminal strips for connection of external wiring. All wires and terminal strips shall be numbered or color coded in accordance with the wiring diagram. All internal and external controls, gauges, lights, and switches shall be identified with nameplates. A complete wiring diagram showing the compressor and fan starting circuits and the control circuit shall be furnished.

e. Terminal blocks shall be factory wired to provide terminal points for permissive start for each stage of cooling or cooling and heating from a remotely located control panel or thermostat, supply voltage terminal points for remotely located refrigerant solenoid valves, and terminal points to energize remote condensing unit and heat pump indicating lights.
f. A normally open dry contact that closes on any alarm condition except low refrigerant suction pressure, shall be furnished.

B. Ductless Split Systems

1. Ductless split systems shall be furnished and installed where indicated on the Drawings. Each unit shall include an indoor ceiling suspended fan coil section and an outdoor remote condensing unit/heat pump. Each unit shall be fully charged with R-410A and compressor oil. A programmable thermostat shall be provided for control of each system.

2. Ductless split systems shall be as manufactured by Trane/Mitsubishi, Carrier , Friedrich, or equal.

3. The manufacturer of the equipment provided shall have a local service center.

4. Fan Coil

a. Each fan coil unit , denoted by the symbol "FC" and an identifying number, shall be of the ductless, indoor, under-ceiling mounted, direct expansion type. Each fan coil unit shall consist of a fan, evaporator coil, air filter, return grille, supply louver, mounting hamess, and drain pan.
b. Fans shall be centrifugal type designed for quiet operation. Evaporator coils shall be copper tube with aluminum fins and galvanized steel tube sheets. The fins shall be bonded to the tubes by mechanical expansion. Air filters shall be of the cleanable type. Each unit shall be provided with access doors for easy removal of the filters. Each fan coil shall be provided with a mounting system and supports.
c. The fan coil fan shall be suitable for the power supply indicated on the Drawings.

5. Condensing Unit

a. Each condensing unit/heat pump, denoted by the symbol "CU" for air conditioning or "HP" for heat pumps and an identifying number, shall be factory assembled suitable for outdoor installation.
b. Each condensing unit shall have a galvanized steel cabinet that shall be bonderized and coated with a baked-enamel finish. The housing shall have removable panels, weep holes, and mounting holes. Compressors shall be high-efficiency, hermetically sealed reciprocating or scroll type with overload protection. Condenser coils shall consist of louvered aluminum fins mechanically bonded to copper tubing. Each unit shall be provided with resilient compressor vibration isolators to minimize noise. Each fan shall have a TEFC motor.

6. Accessories

a. Each unit shall be provided with an electric programmable thermostat capable of controlling all unit functions. The thermostat shall be automatic changeover type with integral sub-base.
b. Where indicated on the Drawings, an internal condensate pump shall be provided to remove condensate from the drain pan.
c. All copper surfaces shall be protected against corrosion by a shop applied special coating.
d. Each unit shall be provided with a low ambient control kit to allow operation when outdoor temperatures are between 0° and 60° F. External service valves and electrical knockouts shall be provided.

2.6 ELECTRICAL

A. Electric motors and motor controls shall conform to the Basic Mechanical Building Systems Materials and Methods section. Motor starters and controls shall be furnished and installed under the Electrical section, except for equipment specified or furnished with prewired integral starters. Disconnects for equipment shall be furnished and installed under the Electrical section, except where specified with disconnects. All electrical controls shall have enclosures suitable for the environment and NEMA rating as indicated on the electrical Drawings. Equipment installed outdoors shall have NEMA Type 4 enclosures.

2.7 DRIVE UNITS

A. Electric motors, V-belt drives, and safety guards shall be in accordance with the requirements of the Basic Mechanical Building Systems Materials and Methods section.

2.8 MANUFACTURE AND FABRICATION

A. Manufacture and fabrication shall comply with the requirements of the Basic Mechanical Systems Materials and Methods section.

2.9 SHOP TESTING

A. The equipment furnished under this section shall be tested at the factory according to the standard practice of the manufacturer. Ratings shall be based on tests made in accordance with applicable AMCA, ASHRAE, AHRI, NBS, NFPA, and UL Standards.

B.

2.10 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that the resonance at normal operating speeds is avoided. In any case, the maximum measured root-mean-square (rms) value

as measured at any point on the equipment shall not exceed those listed in the latest ASHRAE Applications Handbook.

B. At any operating speed, the ratio of rotative speed to the critical speed of a unit or components thereof shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSPECTION

A. Equipment installed in facilities with limited access shall be suitable for being installed through available openings. Contractor shall field verify existing opening dimensions and other provisions for installation prior to submittal of bids.

3.2 PREPARATION

A. Field Measurement

1. Contractor shall be responsible for verifying all field dimensions, and for verifying location of all equipment relative to any existing equipment or structures.

B. Surface Preparation

1. All surfaces to be field painted shall be dry and free of dirt, dust, sand, grit, mud, oil, grease, rust, loose mill scale, or other objectionable substances, and shall meet the recommendations of the paint manufacturer for surface preparation. Cleaning and painting operations shall be performed in a manner which will protect freshly painted surfaces from dust or other contaminants. Oil and grease shall be completely removed by use of solvents or detergents before mechanical cleaning is started. The gloss of previously painted surfaces shall be dulled if necessary for proper adhesion of top coats.

2. Surface finish damaged during installation shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings section.

3.3 INSTALLATION

A. Equipment and materials furnished under this section shall be installed in proper operating condition in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. The space beneath the baseplate shall be grouted as specified in the Grouting section.

C. Valves

1. Valves shall be installed with their stems horizontal or vertical and above the valve body and with the applicable requirements of the valve sections.

D. Refrigerant Piping and Accessories

1. The refrigerant piping shall be sized and arranged in accordance with the manufacturer's recommendations. Pipe routing and isolation shall be selected to minimize vibration and transmission of sound to the conditioned space. The refrigerant piping system shall be provided with the necessary traps and risers for uniform return of oil to the compressor. The suction gas line shall be sized to produce a minimum load gas velocity of 1,000 feet per minute in vertical risers with upward gas flow and 500 feet per minute in horizontal piping. The full load pressure drop should not exceed 3 psi or 2° Fchange in saturated refrigerant temperature. The maximum gas velocity shall not exceed 4,000 feet per minute. The liquid lines shall be sized to limit the pressure loss to the equivalent of 2° F of temperature change and a maximum liquid line velocity of 360 feet per minute. A piping schematic indicating refrigerant piping sizes and corresponding velocities, accessories, accessory pressure losses, and piping pitch and direction shall be submitted in accordance with the Submittals section.

E. Condensing Units

1. The condensing units shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the manufacturer's recommended clearances. The units shall be firmly anchored where indicated on the Drawings.

2. After the refrigerant system has been tested, the system shall be fully charged with refrigerant and compressor oil.

3. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

F. Ductless Split Systems

1. Ductless split systems shall be installed in accordance with the manufacturer's installation instructions. Each unit shall be leveled and installed to maintain the recommended clearances.

2. The installation shall be checked by the manufacturer in accordance with the Installation Check paragraph.

3.4 FIELD QUALITY CONTROL

A. Installation Check

1. Where an installation check by the manufacturer is specified in the equipment installation paragraphs above, an experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the

equipment is placed in operation in accordance with the Startup Requirements section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

B. Startup and Testing

1. After the equipment and systems have been installed, adjusted, and balanced, tests shall be conducted to demonstrate that each system is functioning as specified and to the satisfaction of Engineer. Tests shall be as indicated in the Startup Requirements section.

2. If inspection or tests indicate defects, the defective work or material shall be replaced, and inspection and tests repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable

C. Operator Instruction and Training

1. After completion of the field testing, operator instruction and training on equipment and system operation shall be provided. The training should provide a complete overview of all equipment, testing, adjusting, operation, and maintenance procedures. The training shall take the form of classroom instruction and shall cover:

   a. Documentation in the final Operation and Maintenance Manuals.
   b. Use the Operation and Maintenance Manuals.
   c. Equipment and system startup and shutdown.
   d. System operation procedures for all modes of operation.
   e. Procedures for dealing with abnormal conditions and emergency situations for which there is a specified system response.

2. The training shall take the form of classroom sessions at the project site conducted by the equipment manufacturer representatives who are knowledgeable and familiar with the project. Hands-on instruction and training will be conducted so that actual operation and maintenance of the equipment and systems can be performed by Owner upon completion of the training. The length of the operator instruction and training shall be as required.

3. At least two weeks prior to the proposed date for the operator instruction and training session, Contractor shall notify Engineer and shall submit an outline for the proposed operator instruction and training session. The proposed outline shall be approved before any training is conducted.

3.5 CLEANING

A. At the completion of the testing, all equipment, pipes, ductwork, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

End of Section

SECTION 15990 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the cleaning, testing, adjusting, and balancing of the air system(s) associated with the heating, ventilating, and air conditioning (HVAC),.

1.2 GENERAL

A. Equipment and systems shall be cleaned, tested, adjusted, and balanced in full conformity with the drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by Engineer.

B. Coordination

1. Contractor shall verify that all components and devices necessary for a properly functioning system have been provided. Prior to cleaning, testing, adjusting, and balancing, Contractor shall verify that each system has been installed properly and is operating as specified. Equipment bearings shall be lubricated in accordance with the manufacturer's recommendations.

2. Air systems shall be complete and operating, with dampers, filters, ductwork, air outlet and inlet devices, duct mounted equipment, and control components.

C. Governing Standards

1. Except as modified or supplemented herein, all work covered by this section shall be performed in accordance with all applicable municipal codes and ordinances, laws, and regulations. In case of a conflict between this section and any state law or local ordinance, the latter shall govern.

2. All work shall comply with the latest edition of AABC, NEBB, or SMACNA standard manuals for testing, adjusting, and balancing of air systems.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete apparatus report sheets for all air systems shall be accurately and completely filled out in accordance with the Standard's manual. The testing and balancing results shall be submitted on the TAB report forms of the applicable standard. Copies of the final test readings and report sheets shall be submitted in accordance with the Submittals Procedures section. A description of the standard procedures used during testing, adjusting, and balancing shall be included in the submittal. The submittal shall include a reduced set of drawings, with the air outlet devices, air inlet devices, and equipment identified to correspond with the report sheets. Test dates shall be recorded on the individual TAB report forms indicating when the actual testing was performed.

2. The apparatus report sheets shall include the following information:

a. Title Page:
   1) Company name
   2) Company address
   3) Company telephone number
   4) Project name
   5) Project location
   6) Project Engineer
   7) Project Contractor
   8) Project altitude
   9) Date

b. Instrument List:
   1) Instrument
   2) Manufacturer
   3) Model
   4) Serial number
   5) Range
   6) Calibration date

c. Air Moving Equipment:
   1) Unit number
   2) Location
   3) Manufacturer
   4) Model and serial number
   5) Airflow, design and actual
   6) Total static pressure (total external), design and actual
   7) Static pressure, inlet and discharge
   8) Total pressure
   9) Fan RPM, design and actual

d. Electric Motors:
   1) Manufacturer
   2) Motor type and frame
   3) HP/BHP
   4) Phase, voltage, amperage, nameplate, actual, no load
   5) RPM
   6) Service factor
   7) Starter size, rating, heater elements

e. V-Belt Drive:
   1) Required driven RPM
   2) Driven sheave make, diameter, and RPM
   3) Belt make, size, and quantity
   4) Motor sheave make, diameter, and RPM
   5) Center to center distance, maximum, minimum, and actual

f. Return Air/Outside Air Data:
   1) Unit number
   2) System airflow, design and actual
   3) Return airflow, design and actual
   4) Outside airflow, design and actual
   5) Return air temperature
   6) Outside air temperature
   7) Mixed air temperature, design and actual
   8) Outside/retum air ratio, design and actual

g. Coil Data:
   1) Unit number
   2) Location
   3) Service
   4) Manufacturer
   5) Fin spacing and rows
   6) Face area
   7) Airflow, design and actual
   8) Air velocity, design and actual
   9) Entering air DB temperature, design and actual
   10) Entering air WB temperature, design and actual
   11) Leaving air DB temperature, design and actual
   12) Leaving air WB temperature, design and actual
   13) Water flow, design and actual
   14) Water pressure drop, design and actual
   15) Entering water temperature, design and actual
   16) Leaving water temperature, design and actual
   17) Air pressure drop, design and actual

h. Duct Traverse:
   1) System zone/branch
   2) Duct size
   3) Area
   4) Velocity, design and actual
   5) Airflow, design and actual
   6) Duct static pressure
   7) Air temperature
   8) Air correction factor

i. Outlet and Inlet Devices:
   1) Air outlet and inlet device number
   2) Room number/location
   3) Air outlet and inlet device type
   4) Air outlet and inlet device size
   5) Area factor
   6) Velocity, design, preliminary, and final
   7) Air flow, design, preliminary, and final
   8) Percent of design airflow

j. Sound Level Report:
   1) Location
   2) Octave bands - equipment off
   3) Octave bands - equipment on

k. Air Cooled Condenser:
   1) Unit number
   2) Location
   3) Manufacturer and model
   4) Refrigerant type and capacity
   5) Entering DB air temperature, design and actual
   6) Leaving DB air temperature, design and actual
   7) Number of compressors
   8) Suction pressure and temperature
   9) Condensing pressure and temperature

1.4 QUALITY ASSURANCE

A. Contractor shall provide the services of a licensed independent contractor, certified by AABC, NEBB, or TABB and with proven experience on at least three similar projects, to perform operational testing, adjusting, and balancing of the air systems. The work shall be performed in accordance with the latest edition of the procedural standards as published by the National Organization associated with the testing, adjusting, and balancing contractor.

1.5 MAINTENANCE

A. Contractor shall provide the services of a company specializing in water analysis and chemical treatment with at least 3 years of documented experience.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. All equipment shall be adjusted or balanced to meet the specified conditions and to operate at the elevation indicated in the equipment sections.

2.2 CONSTRUCTION

A. Painting

1. Surface finish damaged during cleaning, testing, adjusting, and balancing of equipment shall be repaired to the satisfaction of Engineer. Field painting shall be as specified in the Protective Coatings sections.

PART 3 - EXECUTION

3.1 INSPECTION

A. Before testing and balancing the air system, doors and windows surrounding the area served by the system shall be closed. Fans shall be checked for correct rotation and rotative speed. Dampers shall be open and access doors and panels shall be closed during the testing and balancing period.

B. A resistance shall be placed at all filter locations to simulate dirty filter conditions. The filter resistance shall be as follows:

Filter Type	Simulated Loss
2 inch pleated	0.35 inch water column

C. Before starting the hydronic system testing and balancing, all valves and control components shall be opened or set to direct flow through the heat transfer element. The pumps shall be checked for correct rotation and rotative speed.

3.2 STARTUP REQUIREMENTS

A. System equipment shall be subject to preliminary field tests as indicated in Startup Requirements section.

B.

C.

3.3 FIELD PERFORMANCE TESTING

A. Field performance tests shall be conducted for each system to demonstrate each is functioning as specified and to the satisfaction of Engineer. All tests shall be conducted in a manner acceptable to Engineer and shall be repeated as many times as necessary to secure Engineer's acceptance of each system. If inspection or tests indicate defects, the defective item or material shall be replaced, and the inspection and tests shall be repeated. All repairs to piping shall be made with new materials. Caulking of threaded joints or holes will not be acceptable.

B. Air filters which are subject to a pressure loss exceeding the dirty filter values shall be removed and replaced. The spare air filters furnished with equipment shall not be used as the replacement filters. Dirty filter values shall be as follows:

Filter Type	Dirty Filter Conditions
2 inch pleated	1 inch water column

C. Refrigerant Piping

1. The refrigerant piping system shall be tested in accordance with ANSI/ASME B31.5.

2. After testing of the refrigerant piping system is completed, the system shall be charged with the proper refrigerant and placed in operation.

3. The completed refrigerant system shall be guaranteed to be sufficiently free from leaks for 1 year from the date of acceptance. The loss of refrigerant shall not exceed 5 percent over that period.

3.4 CLEANING

A. At the completion of the testing, all parts of the installation shall be thoroughly cleaned. All equipment, ductwork, pipes, valves, and fittings shall be cleaned of grease, debris, metal cuttings, and sludge. Any stoppage, discoloration, or other damage to parts of the building, its finish, or furnishings shall be repaired by Contractor at no additional cost to Owner.

3.5 ADJUSTING & BALANCING

A. The air system shall be adjusted and balanced.

B. All instrumentation shall be calibrated in accordance with the governing standard manual and shall be checked for accuracy before testing, adjusting, and balancing the systems. The accuracy of the instrumentation shall be not less than specified by the testing, adjusting, and balancing standard manual or the instrument manufacturer.

C. All data, including system deficiencies encountered and corrective measures taken, shall be recorded. If a system cannot be adjusted to meet the design requirements, Contractor shall notify Engineer in writing as soon as practicable.

D. Following final acceptance of the certified balancing reports, the testing and balancing contractor shall permanently mark the settings of all adjustment devices, including valves and dampers, and shall lock the memory stops.

E. All ceiling tiles, belt guards, panels, and doors removed during testing, adjusting, and balancing shall be reinstalled.

F. Air Systems

1. Air systems shall be adjusted to the design airflows indicated on the Drawings. Airflows shall be adjusted to maintain a net positive (supply airflow greater than exhaust airflow) or negative (exhaust airflow greater than supply airflow) pressure as indicated on the Drawings. Dampers located behind air outlet and inlet devices shall be used to adjust the airflow only to the extent that the adjustments do not create objectionable air movement or noise. Fans shall not be adjusted above the maximum safe speed as determined by the fan manufacturer.

2. Dampers with operators shall be checked for tight shutoff when in the closed position. Shutoff dampers shall not be used for balancing.

End of Section

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SECTION 16050 - ELECTRICAL

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the furnishing and installation of all equipment and materials needed for the electrical requirements of this Contract. It also covers conduit, wiring, and terminations for electrical equipment installed under Electrical Equipment Installation section.

B. This section covers the installation and interconnection of electrical equipment furnished under other sections, except electrical items designated to be installed under those sections.

C. This section covers installation of equipment furnished by Owner.

1.2 GENERAL

A. Electrical apparatus on all equipment shall be installed complete and placed in readiness for proper operation.

B. Electrical materials furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment provided under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Coordination

1. Electrical work shall conform to the construction schedule and the progress of other trades.

F. Anchor Bolts and Expansion Anchors

1. All anchor bolts, nuts, washers, and expansion anchors shall comply with Anchorage in Concrete and Masonry section, except smaller than 3/4 inch will be permitted to match NEMA standard size bolt holes on motors and electrical equipment.

G. Drawings

1. Supplementing this section, the Drawings indicate locations of equipment and enclosures and provide one-line and schematic diagrams regarding the connection and interaction with other equipment.

1.3 CODES AND PERMITS

A. All work shall be performed and materials shall be furnished in accordance with the NEC - National Electrical Code, the NESC - National Electrical Safety Code, and the following standards where applicable:

AEIC	The Association of Edison Illuminating Companies
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
Fed Spec	Federal Specification
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
NEIS	National Electrical Installation Standards
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
UL	Underwriters' Laboratories

B. Equipment covered by this section shall be listed by UL, or by a nationally recognized third party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. If no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to be used.

1.4 SEISMIC DESIGN REQUIREMENT.

A. Seismic Design Requirements

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.5 IDENTIFICATION.

A. Conduit

1. Conduits in manholes, handholes, building entrance pull boxes, junction boxes, and equipment shall be provided with identification tags. Identification tags shall be 19 gage stainless steel, with 1/2 inch stamped letters and numbers as indicated on the Drawings. Identification tags shall be attached to conduits with nylon tie wraps and shall be positioned to be readily visible.

B. Conductors

1. All conductors in power, control, and instrumentation circuits shall be identified and color coded as described herein.

2. Conductor Identification Number

a. Except for lighting and receptacle circuits, each individual conductor in power, control, and instrumentation circuits shall be provided with wire identification markers at the point of termination.
b. The wire markers shall be of the heat-shrinkable tube type, with custom typed identification numbers.
c. The wire numbers shall be as indicated on the equipment manufacturer's drawings.
d. The wire markers shall be positioned to be readily visible for inspection.

3. Conductor Color Coding

a. Power conductors shall be color coded as indicated below. For conductors 6 AWG and smaller, the color coding shall be the insulation finish color. For sizes larger than 6 AWG, the color coding may be by marking tape. The equipment grounding conductor shall be green or green with one or more yellow stripes if the conductor is insulated.
b. The following color coding system shall be used:

1) 120/240V single-phase — black, red, and white

2) 120/208V, three-phase — black, red, blue, and white

3) 120/240V, three-phase — black, orange, blue, and white

4) 277/480V, three-phase — brown, orange, yellow, and gray

5) 2400/4160V, three-phase — black, red, blue, and white

6) 7200/12470V, three-phase — black, red, blue, and white

c. Where 120/240 and 120/208 volt systems share the same conduit or enclosure, the neutral for either the 120/240 volt system or the 208 volt system shall be white with a permanent identifiable violet stripe.
d. Control and instrumentation circuit conductors shall be color coded as indicated in the Cable Data Figures at the end of this section.

C. Motor Starters

1. Motor starters shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the motor starters.

D. Control Stations

1. Control stations shall be provided with nameplates identifying the related equipment. Pilot controls and indicating lights shall have engraved or etched legends ("start", "stop", etc.) as indicated on the Drawings. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the control stations.

E. Circuit Breakers

1. Circuit breakers shall be provided with nameplates identifying related equipment. Nameplates shall be laminated black-over-white plastic, with 1/8 inch engraved letters, and shall be securely fastened to the circuit breakers.

F. Disconnect Switches

1. All switches shall have front cover-mounted permanent nameplates that include switch type, manufacturer's name and catalog number, and horsepower rating. An additional nameplate, engraved or etched, laminated black-over-white plastic, with 1/8 inch letters, shall be provided to identify the associated equipment. Both nameplates shall be securely fastened to the enclosure.

G. Arc Flash Hazard Labels

1. Lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter socket enclosures, and other electrical equipment likely to be worked on energized shall be provided with permanent labels warning the risk of arc flash and shock hazard. Labels shall be designed in accordance with ANSI Z535.4 and shall include the following:

   WARNING

   Arc Flash and Shock Hazard

   Appropriate personal protection equipment (PPE) required. SEE NFPA 70E. Equipment must be accessed by qualified personnel only.

   Turn off all power sources prior to working on or inside equipment.

2. Additional information shall be provided on the labels where specified in the Arc Flash Hazard Analysis section of this section.

1.6 SUBMITTALS

A. Drawings and Data – General

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the work performed by the Contractor, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

    a. Drawings and data.
    b. Operating manuals.
    c. Samples.
    d. Test reports
    e. Studies

B. Submittal Details & Identification

1. Information covering all materials and equipment shall be submitted for review in accordance with the Submittal Procedures section. Each sheet of descriptive literature submitted shall be clearly marked to identify the material or equipment as follows:

    a. Lamp fixture descriptive sheets shall show the fixture schedule letter, number, or symbol for which the sheet applies.
    b. Equipment and materials descriptive literature and drawings shall show the specification paragraph for which the equipment applies.
    c. Sheets or drawings covering more than the item being considered shall have all inapplicable information crossed out.
    d. A suitable notation shall identify equipment and materials descriptive literature not readily cross-referenced with the Drawings or Specifications.
    e. Schematics and connection diagrams for all electrical equipment shall be submitted for review. A manufacturer's standard connection diagram or schematic showing more than one scheme of connection will not be accepted, unless it is clearly marked to show the intended connections.
    f. Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer’s descriptive bulletins and product sheets.

C. Engineering and Testing Firm

1. Contractor shall submit the name and qualifications of the Engineering and Testing Services firm proposed to perform the protective device study and the on-site testing.

D. Cable and Conduit Submittal

1. Within 90 days after the Notice to Proceed, Contractor shall furnish a submittal for all types of cable and conduit to be provided. The submittal shall include the cable manufacturer and type, and sufficient data to indicate that the cable and conduit meet the specified requirements.

E. Cable Samples

1. In addition to the complete specifications and descriptive literature, a sample of the largest size of each type of cable shall be submitted for review before installation. Each sample shall include legible and complete surface printing of the cable identification.

F. Seismic Design Requirements

1. Submitted confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.7 PROTECTION AND STORAGE

A. During construction, the insulation on all electrical equipment shall be protected against absorption of moisture, and metallic components shall be protected against corrosion by strip heaters, lamps, or other suitable means. This protection shall be provided immediately upon receipt of the equipment and shall be maintained continuously.

PART 2 - PRODUCTS

2.1 POWER SERVICE ENTRANCE

A. Contractor shall consult the local electric utility regarding their service installation requirements, and shall furnish the service equipment in compliance with these requirements.

B. Power service equipment to be furnished by Contractor shall include, but is not limited to, meter board, meter socket, meter test cabinet, disconnecting means , grounding materials, riser conduits, and other service entrance fittings required by the utility and for compliance with local codes and regulations.

C. Contractor shall also provide trenching and backfill, conduits, service cables, concrete for duct banks, transformer pads, and other underground service entrance fittings required by the utility for underground service installation.

D. A weatherhead shall be provided on each service riser conduit.

2.2 CABLE

A. All cables of each type (such as lighting cable or 600 volt power cable) shall be from the same manufacturer.

B. All types of cable shall conform to the Cable Data Figures at the end of this section and as described herein.

C. Lighting Cable

1. Lighting cable (Figure 1- 16050 THHN-THWN) shall be provided only in lighting and receptacle circuits operating at 277 volts or less. Lighting and receptacle circuits, 8 AWG or larger, shall be as specified for 600 volt (Figure 2- 16050 XHHW-2) power cable.

D. 600 Volt Power Cable

1. Cable in power, control, indication, and alarm circuits operating at 600 volts or less, except where lighting, multiconductor control, and instrument cables are required, shall be 600 volt (Figure 2- 16050 XHHW-2) power cable.

E. Instrument Cable

1. Cable for electronic circuits to instrumentation, metering, and other signaling and control equipment shall be two- or three-conductor instrument cable twisted for magnetic noise rejection and protected from electrostatic noise by a total coverage shield. Types of instrument cables shall be (Figure 4- 16050 single pair) , (Figure 5- 16050 single triad) .

F. Medium Voltage Power Cable

1. Cable for circuits rated higher than 600 volts but not above 5,000 volts, and for wet or dry locations in conduit and open air, shall be (Figure 9- 16050 8 kV EPR) power cable.

2.3 RACEWAY

A. Conduit and cable tray shall be as described in the following paragraphs:

B. Rigid Steel Conduit

1. Rigid steel conduit shall be heavy wall, hot-dip galvanized, shall conform to NEMA C80.1, and shall be manufactured in accordance with UL 6.

C. Liquidtight Flexible Metal Conduit

1. Liquidtight flexible metal conduit shall be hot-dip galvanized steel, shall be covered with a moistureproof polyvinyl chloride jacket, and shall be UL labeled.

D. Rigid Nonmetallic (PVC) Conduit

1. PVC conduit shall be heavy wall, Schedule 40, UL labeled for aboveground and underground uses, and shall conform to NEMA TC-2 and UL 651.

E. PVC-Coated Rigid Steel Conduit

1. The conduit shall be rigid steel. Before the PVC coating is applied, the hot-dip galvanized surfaces shall be coated with a primer to obtain a bond between the steel substrate and the coating. The PVC coating shall be bonded to the primed outer surface

of the conduit. The bond on conduit and fittings shall be stronger than the tensile strength of the PVC coating. The thickness of the PVC coating shall be at least 40 mils.

2. A chemically cured two-part urethane coating, at a nominal 2 mil thickness, shall be applied to the interior of all conduit and fittings. The coating shall be sufficiently flexible to permit field bending the conduit without cracking or flaking of the coating.

3. Every female conduit opening shall have a PVC sleeve extending one conduit diameter or 2 inches, whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit before coating. The wall thickness of the sleeve shall be at least 40 mils.

4. All fittings, condulets, mounting hardware, and accessories shall be PVC-coated. All hollow conduit fittings shall be coated with the interior urethane coating described above. The screw heads on condulets shall be encapsulated by the manufacturer with a corrosion-resistant material.

5. PVC coated rigid steel conduit shall be manufactured by Calbond, Ocal, or Robroy Industries.

F. Electrical Metallic Tubing (EMT)

1. EMT shall be hot-dip galvanized, shall conform to NEMA C80.3, and shall be manufactured in accordance with UL 797.

2.4 WIRING DEVICES, BOXES, AND FITTINGS

A. Concealed conduit systems shall have flush-mounted switches and convenience outlets. Exposed conduit systems shall have surface-mounted switches and convenience outlets.

B. Conduit Boxes and Fittings

1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be manufactured by Crouse-Hinds, Appleton, or O Z Gedney. In applications utilizing aluminum conduit systems, aluminum boxes and fittings manufactured by Crouse-Hinds, Appleton, or O Z Gedney shall be installed.

2. Rigid PVC device boxes and fittings shall be manufactured by Carlon or Cantex.

3. Sheet steel device boxes shall be manufactured by Appleton, Raco, or Steel City.

4. PVC coated device boxes shall be manufactured by Calbond, Ocal, or Robroy Industries.

5. Hub arrangements on threaded fittings shall be the most appropriate for the conduit arrangement to avoid unnecessary bends and fittings.

C. Device Plates.

1. Galvanized or cadmium-plated device plates shall be used on surface mounted outlet boxes where weatherproof plates are not required.

2. Device plates on flush mounted outlet boxes where weatherproof plates are not required shall be AISI Type 302 stainless steel, Eaton "93000 series", Hubbell "S series", or Leviton "840nn-40 series"; nylon or polycarbonate, Eaton "5000 series", Hubbell "Pn series", or Leviton "807nn-I series".

3. Device plate mounting hardware shall be countersunk and finished to match the plate.

4. Device plates for switches outdoors or indicated as weatherproof shall have provisions for padlocking switches "On" and "Off", and shall be Appleton "FSK-1VS", Crouse-Hinds "DS185" or O Z Gedney "FS-1-WSCA".

~~5.~~ Device plates for receptacles indicated as weatherproof shall be Appleton "FSK-WRD", Crouse-Hinds "WLRD1", or O Z Gedney "FS-1-WDCA.

6. Flush-mounted, weatherproof plates shall be provided with adapter plates, Appleton "FSK-SBA" or Crouse-Hinds "FS031".

7. Device plates for ground fault interrupter receptacles indicated to be weatherproof shall be Appleton "FSK-WGFI", Eaton "S966", or O Z Gedney "FS-1-GFCA".

8. Receptacle covers outdoors or otherwise indicated to be weatherproof while in-use shall be die cast aluminum and shall include a padlock eye. Covers for standard convenience outlets shall be Hubbell “WP8M” or Thomas and Betts Red Dot “CKMUV”. Covers for ground fault interrupter receptacles shall be Hubbell “WP26M” or Thomas and Betts Red Dot “CKMUV”.

9. Engraved device plates, where required, shall be manufactured by Leviton, or equal.

10. Device plates on PVC conduit fittings shall be Carlon "E98 Series" or Cantex "513300 Series".

D. Wall Switches

1. Switches on ac lighting panel load circuits through 277 volts shall be 20 amperes, 120/277 volts, Eaton "AH1221V" through "AH1224V", Hubbell "HBL 1221I" through "HBL 1224I", or Leviton "1221-2I" through "1224-2I".

2. Switches for pulse control of lighting contactors shall be 20 amperes, 120/277 volts, momentary, double-throw, center "Off", Eaton "1995V", Hubbell "1557I" or Leviton "1257-I".

3. Switches on ac lighting panel load circuits through 277 volts in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be 20 ampere, 120/277 volts. Hazardous area switches shall be factory sealed tumbler switches, Appleton “EDS” or Killark “FXS”.

E. Receptacles

1. Standard convenience outlets shall be duplex, three-wire, grounding, 20 amperes, 125 volts, Eaton "AH5362V", Hubbell "5362I" or Leviton "5362-I" for 120 volt circuits,

and 250 volts, Eaton "AH5462CV", Hubbell "5462I" or Leviton "5462-I" for 240 volt circuits.

2. Ground fault circuit interrupter receptacles shall be duplex, 20 amperes, 125 volts, Eaton "SGFH20", Hubbell "GFRST20I" or Leviton "G5362-I".

3. Ground fault circuit interrupter receptacles in damp or wet locations shall be duplex, 20 amperes, 125 volts, Hubbell "GFWRST20I" or Leviton "G5362-WTI".

4. 600 volt welding receptacles shall be 30 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE3034-100", Crouse-Hinds "AR348" plus "ARRC33" and "AR30" or Leviton " 430MI5W". One matching plug, Appleton "ACP3034BC", Crouse-Hinds "APJ3485" or Leviton "430P5W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

5. 240 volt welding receptacles shall be 60 amperes, 3 phase, with grounding conductors connected through a fourth pole, Appleton "ADRE6034-150", Crouse-Hinds "AREA6425" or Leviton "460MI9W". One matching plug, Appleton "ACP6034BC", Crouse-Hinds "APJ6485" or Leviton "460P9W" with appropriate woven grip and plug cap, shall be furnished for the cable size directed by Owner.

6. Receptacles in Class I, Division 1 and Division 2, Group D hazardous areas indicated on the Drawings shall be three-wire, grounding, 20 amperes, 125 volts. Hazardous area receptacles shall be factory sealed, with an integral switch that is only activated when an approved matching plug is fully inserted and rotated into the engaged position. Hazardous area receptacles shall be Appleton “ENR”, Crouse-Hinds “ENR”, or Killark “UGR”.

2.5 JUNCTION BOXES, PULL BOXES, AND WIRING GUTTERS

A. Indoor boxes (larger than switch, receptacle, or fixture type) and gutters shall be constructed of sheet steel, shall be galvanized after fabrication, and shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

B. Indoor boxes and gutters in corrosive areas indicated on the Drawings and outdoor boxes and gutters shall be NEMA Type 4X, ABS or stainless steel and shall be rigidly supported by PVC-coated or stainless steel framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

C. Bolt-on junction box covers 3 feet square or larger, or heavier than 25 lbs, shall have rigid handles. Covers larger than 3 by 4 feet shall be split.

D. Where indicated on the Drawings, junction and pull boxes with a removable side opposite the underground conduits shall be provided over building ends of underground conduit banks. Boxes shall be sized in accordance with the National Electrical Code, including space for full size continuations of all underground conduits not originally continued. Conduit arrangement shall leave maximum space for future conduits.

2.6 LIGHTING FIXTURES

A. Lighting fixtures shall be furnished as described in the fixture schedule and as indicated on the Drawings. Lighting fixtures shall be furnished complete with lamps. Pendant fixtures shall have swivel type box covers and threaded conduit pendants unless otherwise specified. Lighting fixtures shall be provided with disconnects in accordance with NEC requirements.

B. Electronic Drivers

1. Electronic drivers furnished with LED type lighting fixtures shall be certified as meeting requirements of ANSI C82.77 with a THD level of not more than 20 percent.

2.7 LIGHTING PANELS

A. Each lighting panel shall be a dead-front, 120/240 volt, single phase or 120/208 volt, three phase panelboard with circuit breakers, in accordance with the Drawings and the following:

B. Cabinet

1. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a hinged trim (cover). Breaker operating handles shall be accessible through a latched, lockable, door. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

C. Circuit Breakers

1. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip. Breakers shall have interrupting ratings not less than 22,000 amperes. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed. Breakers and provisions for future breakers shall be provided in the quantities, number of poles, and ampere ratings indicated on the Drawings.

2. Where indicated on the Drawings, circuit breakers shall include arc-fault circuit interrupter (AFCI) and/or ground fault circuit interrupter (GFCI) protection functions. Where GFCI breakers dedicated to protect heat tracing circuits, GFCI breakers shall be configured for equipment protection with a ground fault trip threshold of 30 mA. Otherwise, GFCI breakers shall be configured for personnel protection with a ground fault trip threshold of 5 mA.

D. Buses

1. The panel shall have main and neutral buses insulated from the cabinet, and a ground bus. Buses shall be copper, with ampere ratings and main lugs or breaker as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, a removable bond to the neutral bus, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.8 POWER PANELS

A. Unless otherwise specified, each power panel, with a neutral, shall be dead-front, 3 phase panelboard with circuit breakers, in accordance with the Drawings and the following:

1. Cabinet

a. The panel shall have a flush-mounted or surface-mounted enclosure with a NEMA designation appropriate for the location where it will be installed. The enclosure shall have a door with latch and lock. At the completion of the Contract, a neatly printed or typed directory listing the panel and circuit identities shall be mounted inside the door.

2. Circuit Breakers

a. Circuit breakers shall be thermal-magnetic, bolt-in, individually front replaceable, and shall indicate "On", "Off", and "Tripped". Breakers indicated as multiple-pole shall be common trip type. Breakers for 480 volts shall be rated 600 volts, with interrupting ratings not less than 65,000 amperes at 480 volts. Handle clips to prevent casual operation of breakers shall be provided for 10 percent (at least two) of the breakers and applied to the circuits directed.

3. Buses

a. The panel shall have 3 phase buses and a ground bus. Buses shall be copper, with ampere and voltage ratings and main lugs or breakers as indicated. The ground bus shall be similar to a neutral bus and shall have a good ground connection to the cabinet, clamp type lugs for the ground cable in each supply conduit, and connections for a ground cable in each load conduit.

2.9 SURGE PROTECTIVE DEVICES

A. Scope

1. Surge protective devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.

2. Each SPD shall be furnished and installed for the electrical equipment indicated on the Drawings or as specified herein. All new lighting and power panels shall be furnished with an integral SPD.

3. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

4. Power panels shall have SPD’s rated for a medium exposure levels.

B.

C. Standards

1. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

   a. ANSI/IEEE C62.41 and C62.45;
   b. ANSI/IEEE C62.1 and C62.11;
   c. IEEE C62.62;
   d. National Electrical Manufacturers Association (NEMA LS1 Guidelines);
   e. National Fire Protection Association (NFPA 20, 70, 75, and 780);
   f. Underwriters Laboratories UL 1449 and 1283

2. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

D. Environmental Requirements

1. Operating Temperature: 0°F to +140°F.

2. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

E. Electrical Requirements

1. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.

2. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.

3. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.

4. Protection Modes. Four-wire configured systems shall provide, Line-to-Neutral (L-N), Line-to-Ground (L-G), and Neutral-to-Ground (N-G), and Line-to-Line (L-L) protection. Three-wire configured systems shall provide, Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.

5. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

6. UL 1449 Voltage Protection Rating (VPR). The maximum VPR per mode for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
120/208 3-phase	800 V	800 V	800 V	1200 V
480 V 3W		1200 V		2000 V

7. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.

8. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

9. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200 kA symmetrical fault current with 600 volts ac applied.

   At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.

   The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

10. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit. When furnished integral to the panelboard, the status indicators shall be viewable when the panelboard door is opened.

F. Installation

1. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

G. Miscellaneous

1. Disconnect Switch. Each SPD shall be furnished with an integral disconnect switch. The unit shall be UL 1449 listed as such, and the UL 1449 Voltage Protection Ratings shall be provided. The disconnect switch shall be fused and capable of withstanding, without failure, the published maximum surge current magnitude without failure or damage to the switch.

H. Acceptable Manufacturers

1. Integral SPD's shall be manufactured by Eaton, General Electric, or Schneider-Electric. External SPD's shall be manufactured by Eaton, General Electric, Siemens Energy & Automation, Schneider-Electric, or Current Technology. The products of other manufacturers will not be acceptable.

2.10 CONTROL STATIONS

A. Control stations shall be provided as indicated on the one-line diagrams or schematics or as required by the equipment furnished. Pilot devices shall be 30.5 mm heavy-duty, oiltight construction, and shall perform the functions indicated. Pilot lights shall be full voltage type with LED lamps. Indoor control stations shall have NEMA Type 13 enclosures. Control stations outdoors or indicated to be weatherproof shall have NEMA Type 4X stainless steel enclosures with protective caps on the control devices. Control stations in NEC Class I, Division 1 and Division 2, Group D hazardous areas shall have NEMA Type 7 enclosures, or be factory sealed type, Appleton “Contender Series” or Killark “Seal-X Series”.

B. Emergency Break-Glass Switch

1. Each break-glass switch for HVAC emergency shutoff shall be furnished with a NEMA enclosure as specified herein with hammer, hammer clip, and chain. Each switch shall be Eaton "10250TGS" or Schneider-Electric "Type 9001K15" with one normally open and one normally closed contact block, or equal. Five spare glass disks shall be furnished for each switch. When the glass disk is broken with the hammer, the button will return to a normal extended position.

2.11 DISCONNECT SWITCHES

A. Unless otherwise specified, each disconnect switch shall be 3 pole, nonfusible, 600 volts, with a continuous current rating as indicated on the Drawings.

B. Where indicated on the Drawings, fused switches shall be furnished complete with fuses. Fuse sizing shall be as indicated on the Drawings, as required by the results of the protective device study, or as recommended by the respective protected equipment manufacturer.

C. Switches located indoors shall have NEMA type enclosure designations as required by the locations where they will be installed. Switches located outdoors shall have NEMA Type 4X enclosures. Switches in chlorine rooms, or in other areas where contact with caustic substances may occur, shall have NEMA Type 4X enclosures of molded reinforced polyester.

D. Switches shall have high conductivity copper, visible blades; nonteasible, positive, quick-make, quick-break mechanisms; and switch assembly plus operating handle as an integral part of the enclosure base. Each switch shall have a handle whose position is easily recognizable and which can be locked in the "Off" position with three padlocks. The "On" and "Off" positions shall be clearly marked.

E. All switches shall be UL listed and horsepower rated, and shall meet the latest edition of NEMA KS1. Switches shall have defeatable door interlocks that prevent the door from being opened while the operating handle is in the "On" position.

2.12 LIGHTING AND AUXILIARY POWER TRANSFORMERS

A. Separately mounted transformers shall be provided in the phases, kVA, and voltages indicated on the Drawings. Transformers shall be self-air-cooled, dry type, wall- or floor-mounted, and enclosed for wiring in conduit. Transformers installed outdoors shall be weatherproof.

Transformers shall have at least four full capacity voltage taps, two above and two below rated voltage. Transformers shall meet DOE 10 CFR 431 guidelines for energy efficiency.

2.13 LIGHTING CONTACTORS

A. Remote control lighting contactors shall be provided as indicated on the Drawings. Contactors shall have positive locking features and shall be mechanically held in both positions. Main contacts shall be double-break, continuous-duty rated 20 amperes, 600 volts ac, for all types of loads. Terminals shall accept 18 through 10 AWG conductors. Contactors shall operate in any position and may be manually operated for testing and maintenance. Contactors shall be ASCO 918. Contactor control panels shall be UL 508A listed. The short circuit current rating shall meet or exceed the available short circuit current indicated on the bus feeding the contactor.

2.14 PHOTOELECTRIC CONTROLS

A. Photoelectric controls shall be weatherproof, swivel adjustable, with built-in time delay to prevent accidental turnoff by momentary brightness. The photocell shall be rated 1800 VA, 120 volts ac, and shall be field adjustable from 1 ft/c turn-on to 15 ft/c turn-off.

2.15 RELAY ENCLOSURES

A. Relay enclosures shall be furnished as indicated on the Drawings. The enclosure shall have a NEMA designation appropriate for the location where it will be installed. Pilot devices shall be heavy duty, oiltight construction. Relays and timers shall have 120 volt, 60 Hz coils rated for continuous duty in 40 C ambient and 10 ampere, 120 volt ac contacts. Intrinsically safe relays shall be installed within the enclosures in accordance with NEC requirements and shall be Gems "Safe-Pak", B/W "Series 53", or equal.

2.16 ALARM HORN AND BEACON

A. The alarm horns and beacons shall be provided and located as indicated on the Drawings. The beacon shall be 120 VAC, strobe light with clear lens and acrylic dome, Edwards "Model No. 94C-N5" or Federal Signal "Model 371DST". The alarm horn shall be 120 VAC, weatherproof horn, Edwards "Model No. 876-N5" or Federal Signal "Model 350WB". In Class 1, Division 1 and Division 2, group D hazardous areas as indicated on the Drawings the beacon shall be 120 VAC, strobe light with clear lens and acrylic dome, Edwards “Model 116EXMSTC-N5“ or Federal Signal “Model 27XST”. In Class 1, Division 1 and Division 2, group D hazardous areas as indicated on the Drawings the alarm horn shall be 120 VAC, weatherproof horn, Edwards “Model 878EX-N5” or Federal Signal “Model 31X.

2.17 DOOR ENTRY SWITCHES

A. Door entry switches shall be provided as indicated on the Drawings and as specified herein. Switches shall be heavy-duty industrial, adjustable, magnetic wide gap type. Switch and magnet housings located in NEC Class I, Division 1 and 2, Group D hazardous areas shall be die-cast aluminum, explosionproof, Sentrol "2800T Series", Simplex "Model 2760-9077", or

equal. Switch and magnet housings located in other areas shall be Honeywell "968XTP", or equal.

2.18 UNINTERRUPTIBLE POWER SYSTEM (UPS).

A. The uninterruptible power system shall be designed for industrial applications. The UPS shall consist of a maintenance bypass switch, the UPS cabinet, and battery cabinet(s). The UPS shall be rated for 240 or 208 volt, single-phase ac input and 120/240 volt ac single-phase output. Input voltage range shall be +15%/-20%. Input power factor shall be 0.98. Output voltage regulation shall be +/- 3% of input voltage. Overload capacity shall be 150% surge and 110% for 10 minutes on inverter. UPS shall meet the testing standards of ANSI C62.41 and C62.45. UPS shall be rated for 60 Hz input and output voltage. The UPS shall be rated for minimum of 10 kVA capacity or as shown on the drawings.

B. The External Maintenance Bypass switch shall include an AC line disconnect to disconnect incoming power to the UPS and a Bypass switch which transfers the load between AC Line power, UPS power, and OFF. The bypass switch shall be make before break type. Wiring between bypass switch, UPS, and battery cabinet(s) shall be manufacture supplied.

C. DC Batteries shall be sealed lead acid, maintenance free, type enclosed in a battery cabinet with an enclosed disconnecting means. Batteries shall be rated for a minimum of 90 minutes runtime at the load shown on the panel schedules on the drawings.

D. The UPS shall be capable of Ethernet/IP protocol communication. The UPS shall have a dry output contact for alarm.

E. UPS shall be Eaton 9155 10kVA (64 Battery) or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING, AND COMMISSIONING

A. All material, equipment, and components specified herein shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

3.2 ARC FLASH HAZARD ANALYSIS

A. Contractor shall commission an Arc Flash Hazard Analysis in accordance with OSHA 29 CFR Part 1910, NEC, NFPA 70E, and IEEE 1584 and shall submit an Arc Flash Hazard Analysis report as specified herein. The scope of the analysis shall include arc flash labeling for each piece of electrical equipment including lighting panels, power panels, power centers, switchgear, switchboards, motor control centers, motor control line ups, transfer switches, industrial control panels, adjustable frequency drives, fused switches, meter sockets, medium-voltage transformers, and other electrical equipment likely to be worked on energized

B. The scope of the analysis shall include all electrical equipment within the facility distribution system, beginning with the electric utility meter socket or service entrance equipment.

C. The analysis shall calculate the incident energy value and arc flash boundary at defined working distances for all AC, three-phase, 208 volt through 15kV, electrical equipment in accordance with the IEEE 1584 calculation method.

D. AC single-phase equipment, rated 208 volt and above, shall be calculated using single-phase fault current values applied to the three-phase equations in accordance with IEEE 1584.

E. AC single-phase equipment, rated below 208 volt, with a maximum available fault current of 25 kA and a maximum fault clearing time of 2 cycles, shall be analyzed and labelled using the Arc-Flash PPE Categories for Alternating Current Systems, Table 130.7(C)(15)(a), in NFPA 70E (2018).

F. DC system and equipment shall be analyzed and labelled using the Arc-Flash PPE Categories for Direct Current Systems, Table 130.7(C)(15)(b), in NFPA 70E (2018).

G. The Arc Flash Hazard Analysis shall be performed in association with, or as a continuation of, the short circuit study and protective device study. Protective-device settings shall be selected to provide the necessary equipment protection and device coordination required while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

H. The analysis shall be performed for multiple electrical system modes of operation in order to calculate the worst-case incident energy at each piece of equipment. At a minimum, the system shall be analyzed for the minimum and maximum available fault current and X/R ratios from the electric utility supplying service or for the separately derived power system. The Contractor shall be responsible for obtaining the available fault current values from the local electric utility. The analysis shall not assume bolted fault current values.

I. For equipment with an integral main overcurrent protective device that is not adequately isolated from the bus, the upstream protective device shall be used as the fault clearing device in the analysis. Where arc reduction maintenance mode switches are installed on protective devices, the arc reduction shall only apply for downstream equipment that is adequately isolated from the protective device. Adequately isolated equipment shall be confirmed by the equipment manufacturer and shall be submitted to Engineer for review.

J. The Contractor shall be responsible for collecting all field data for a complete analysis. Assumptions should only be made after every effort has been made to obtain the needed information. All assumptions used in the analysis shall be documented in the report for review by Engineer.

K. The results shall include, but shall not be limited to, a tabulated spreadsheet of the following items for each piece of equipment included in the analysis:

1. Equipment name.

2. Three-phase bolted fault current.

3. Arcing fault current.

4. Arcing fault current through the protective device.

5. Protective device clearing the fault.

6. Protective device opening time.

7. Bus gap.

8. Worst-case incident energy and corresponding working distance. Equipment with arc reduction maintenance mode switches shall include the calculated incident energy level with and without the switch enabled.

9. Arc flash protection boundary.

L. An Engineering and Testing Services firm acceptable to Engineer shall conduct the Arc Flash Hazard Analysis.

M. Arc Flash Analysis Software

1. The Arc Flash Hazard Analysis shall be performed using the latest version of ETAP electrical power system analysis software, without exception. After the final version of the study and analysis are completed and accepted, Contractor shall provide a copy of the electronic computer model files to Owner.

N. Arc Flash Hazard Report.

1. Contractor shall be responsible for submitting complete and accurate arc flash analysis information in the Arc Flash Hazard Report. The report shall be submitted to Engineer for review before the final report is prepared.

2. The report shall include the following information at a minimum:

a. Executive summary.
b. Description of scope and study methodology.
c. Documentation of the modes of operation evaluated in the analysis including applicable input data such as utility fault current values.
d. Discussion of results and any recommendations.
e. Tabulated results spreadsheet.
f. List of assumptions.
g. One-line diagram(s) from the computer model software showing equipment names and other applicable information.
h. Documentation of software study parameters and configuration settings.
i. Recommended arc flash Personal Protective Equipment (PPE) selection in accordance with NFPA 70E.

3. A bound hardcopy and digital PDF of the final Arc Flash Hazard Analysis report shall be submitted in accordance with the Submittal Procedures section.

4. The final report shall be signed and sealed by a registered Professional Engineer.

O. Arc Flash Labeling

1. After approval of the Arc Flash Hazard Report, Contractor shall furnish and install arc flash labels on the applicable electrical equipment. The label template shall be subject to review and acceptance by Engineer. The arc flash labels shall comply with ANSI Z535.4 and NFPA 70E requirements. Labels shall include, at a minimum, the nominal system voltage, the arc flash boundary distance, worst-case incident energy and the corresponding working distance, date of the analysis, and equipment name.

2. Switchgear, motor control centers, and other multi-section equipment shall be provided with a duplicate label for each vertical section.

3. Equipment with arc reduction maintenance mode switches shall include a dual label with the worst-case calculated incident energy level with and without the switch enabled. The label shall clearly identify the associated maintenance mode switch that shall be enabled in order for the lower incident energy level to apply.

3.3 PROTECTIVE DEVICE STUDY

A. Contractor shall commission a short circuit study and protective device study of relays, fuses, circuit breakers, and all other protective devices and shall submit a coordination and protective device settings report as specified herein. The study shall be in compliance with IEEE 242 and include the entire distribution system, including any and all existing power distribution components which will impact the results of the protective device study, starting with the smallest – 480 volt, 3 phase, 60 Hz – circuit protective device on the load end, to the nearest protective device on the power company's line side. Where existing electrical distribution system components are part of the study, the Contractor shall field verify and report the respective ratings and settings of each device as found as a prerequisite to the study analysis being performed. Protective device settings shall be selected to provide selective coordination to the maximum extent possible for equipment protection and device coordination while balancing the goal to reduce the calculated incident energy to the greatest extent possible.

B. Contractor shall be responsible for and shall ensure that all relays, protective devices and circuit breakers shown on the Drawings and Specifications are sized and set according to the study results.

C. The study shall include, but shall not be limited to, the following:

1. Color-coded printouts of coordination curves prepared with calculation software.

2. A tabulation of all protective relay and circuit breaker trip settings and recommended sizes and types of medium-voltage fuses.

3. Motor starting profiles for all 50 horsepower and larger motors.

4. Transformer damage curves and protection, evaluated in accordance with IEEE C57.109.

5. Generator damage curves and protection, evaluated in accordance with manufacturers recommendations.

6. Coordination curve(s) from the power company, if available.

7. Calculated short-circuit values at all nodes in the distribution system included within the scope of the protective device study.

8. Protective device settings shall include, but not limited to, motor and pump RTD settings, motor starts per hour, bus and transformer differential settings, synch-check settings, under and over-voltage settings, under and over-frequency settings, low-voltage breaker and MCC starter overload settings, and all protective functions shown on the Drawings and Specifications

9. Adjustable frequency drive settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

10. Reduced voltage starter settings evaluated in accordance with the manufacturers recommendations and driven equipment requirements

D. An Engineering and Testing Services firm acceptable to Engineer shall conduct the protective device study.

E. Contractor shall be responsible for obtaining the following:

1. The coordination curves for relays, fuses, and circuit breakers.

2. Transformer damage curves.

3. Motor and pump data.

4. Generator data

5. Other applicable information for all new and existing electrical equipment.

F. Contractor shall coordinate with the power company to obtain the required protective device curves and shall be responsible for all the field work associated with obtaining the necessary data on existing relays, circuit breakers, fuses, and transformers to be included in the protective device study.

G. The available 3 phase, symmetrical fault current at the point of service shall be obtained from the Power Company.

H. The protective device report shall be bound in a standard 8-1/2 by 11 inch three-ring binder and shall be submitted in accordance with the Submittal Procedures section. Final selection of all protective device settings or sizes shall be subject to review and acceptance by Engineer.

3.4 POWER AND SERVICE ENTRANCE INSTALLATION

A. Contractor shall consult the local electric utility regarding their service installation requirements, and shall install the service equipment in compliance with these requirements. Contractor shall install all power service equipment components except for components installed by the utility as directed in the utility service installation requirements.

B. Contact information for the electric utility is as follows:

Name of electric utility	Carroll Electric Cooperative
Electric utility contact person and telephone number	Jeff Smalley 870-423-2161

C. Contractor shall coordinate details and timing of service entrance installations with the utility. Contractor shall complete and submit service applications to the electric utility as necessary.

3.5 CABLE INSTALLATION

A. General

1. Except as otherwise specified or indicated on the Drawings, cable shall be installed according to the following procedures, taking care to protect the cable and to avoid kinking the conductors, cutting or puncturing the jacket, contamination by oil or grease, or any other damage. Circuits to supply electric power and control to equipment and devices, communication and signal circuits as indicated on the one-line diagrams shall be installed continuous and may not be spliced unless approved by the Engineer.

2. Stranded conductor cable shall be terminated by lugs or pressure type connectors. Wrapping stranded cables around screw type terminals is not acceptable.

3. Stranded conductor cable shall be spliced by crimp type connectors. Twist-on wire connectors may only be used for splicing solid cable and for terminations at lighting fixtures.

4. Splices may be made only at readily accessible locations.

5. Cable terminations and splices shall be made as recommended by the cable manufacturer for the particular cable and service conditions.

6. All 5,000 volt rated cable and above shielded cable stress cone terminations shall be IEEE Class 1 molded rubber type. Shielded cable splices shall be tape or molded rubber type as required. Shielded cable splices and stress cone terminations shall be made by qualified splicers. Materials shall be by 3M Company, Plymouth/Bishop, or Raychem Electric Power Products.

7. Cable shall not be pulled tight against bushings nor pressed heavily against enclosures.

8. Cable-pulling lubricant shall be compatible with all cable jackets; shall not contain wax, grease, or silicone; and shall be Polywater "Type J".

9. Cables operating at more than 2000 volts shall be fireproofed in all cable vaults, manholes, and handholes. Fireproofing shall be applied with a half-lapped layer of 3M "Scotch 77 Arc-Proofing Tape", anchored at each end with a double wrap of 3M "Scotch 69 Glass Cloth Tape" or with equivalent tape by Anixter or Plymouth/Bishop.

10. Where necessary to prevent heavy loading on cable connections, in vertical risers, the cable shall be supported by Kellems, or equal, woven grips.

11. Spare cable ends shall be taped, coiled, and identified.

12. Cables shall not be bent to a radius less than the minimum recommended by the manufacturer. For cables rated higher than 600 volts, the minimum radius shall be 8 diameters for nonshielded cable and 12 diameters for shielded cable.

13. All cables in one conduit, over 1 foot long, or with any bends, shall be pulled in or out simultaneously.

14. Circuits to supply electric power and control to equipment and devices are indicated on the one-line diagrams. Conductors in designated numbers and sizes shall be installed in conduit of designated size. Circuits shall not be combined to reduce conduit requirements unless acceptable to Engineer.

15. Instrument cable shields and drain wires shall be continuous over the entire length of the circuit and grounded at one end only. In general, the field end of the shield shall be ungrounded. At the ungrounded termination of the circuit, the shield and drain wire shall be insulated by taping to prevent grounding.

16. Cables operating at more than 2,000 volts which terminate at medium-voltage padmounted equipment bushings shall include a metal oxide varistor surge protective elbow terminator conforming to IEEE Standard 386. Elbows shall provide a weatherproof, dead-front, hot-stick operable separable connection. Surge protector rating shall be as recommended by the terminator supplier.

B. Medium-Voltage Cable Insulation Test

1. New conductors with insulation rated 5,000 volts and higher shall be given a field dc insulation test.

2. The ampacity rating of direct current testing equipment shall be at least 2,500 microamperes.

3. Final test voltages and the duration of the test shall be as indicated on the Cable Data Sheets attached to this section. Cable insulation testing shall be recorded on the Cable Test Data Form attached to this section, Figure 16- 16050.

4. Test procedures shall conform to ICEA S-93-639 (NEMA WC 74), 5-46 kV Shielded Power Cable For Use In The Transmission & Distribution of Electric Energy, and the applicable qualification testing standards of AEIC CS-8.

5. The tests shall be performed by qualified and experienced personnel specializing in electrical cable testing. Triplicate copies of test data for each cable shall be submitted to Engineer.

6. Existing shielded conductors with insulation rated 5,000 volts and higher shall be given a very low frequency ac tangent delta test.

7. Each phase of the circuit shall be tested for the entire cable system including all terminations, cable, and joints within the circuit. Where existing conductors are spliced

to a new conductor, the existing conductor shall be tested before splicing and after splicing.

8. Duration of the test at each voltage shall be a minimum of 3 minutes. Tangent delta testing shall be recorded and submitted to the Engineer for review. The results shall include at a minimum the VLF-TD time stability measured by standard deviation at U_0, differential VLF-TD between 0.5 U_0 and 1.5 U_0, and mean VLF-TD at U_0.

9. Test procedures shall conform to IEEE 400.2, Guide for Field Testing of Shielded Power Cable Systems Using Very low Frequency (VLF) (less than 1 Hz).

10. The tests shall be performed by qualified and experienced personnel specializing in electrical cable testing. Triplicate copies of test data for each cable shall be submitted to Engineer.

3.6 RACEWAY INSTALLATION

A. Contractor shall be responsible for routing all raceway. This shall include all conduits indicated on the one-lines, riser diagrams, and home-runs shown on the plan Drawings. Conduits shall be routed as defined in these Specifications. Where conduit routing is shown on plans, it shall be considered a general guideline and shall be field verified to avoid interferences.

B. Except as otherwise specified or indicated on the Drawings, conduit installation and identification shall be completed according to the following procedures.

C. Installation of Interior and Exposed Exterior Conduit

1. This section covers the installation of conduit inside structures, above and below grade, and in exposed outdoor locations. In general, conduit inside structures shall be concealed. Large conduit and conduit stubs may be exposed unless otherwise specified or indicated on the Drawings. No conduit shall be exposed in water chambers unless so indicated on the Drawings.

2. All conduit within the Pump room and Medium-Voltage Electrical rooms shall be routed in or below slab unless to turn out and terminate at final destination or otherwise noted on the conduit routing plans.

3. Unless otherwise indicated on the Drawings, Contractor shall be responsible for routing the conduit to meet the following installation requirements:

   a. Conduit installed in all exposed indoor locations, except corrosive areas indicated on the Drawings, and in floor slabs, walls, and ceilings of hazardous (classified) locations, shall be rigid steel. Exposed conduit shall be rigidly supported by hot-dip galvanized hardware and framing materials, including nuts and bolts.

   b. Conduit installed in floor slabs and walls in non-hazardous locations shall be rigid Schedule 40 PVC.

   c. Conduit installed in all exposed outdoor locations shall be PVC-coated rigid

steel, rigidly supported by PVC-coated framing materials. Mounting hardware, which includes nuts, bolts, and anchors, shall be stainless steel. All damaged coatings shall be repaired according to the manufacturer's instructions.

d. Final connections to dry type transformers, to motors without flexible cords, and to other equipment with rotating or moving parts shall be liquidtight flexible metal conduit with watertight connectors installed without sharp bends and in the minimum lengths required for the application, but not longer than 6 feet unless otherwise acceptable to Engineer.

e. Terminations and connections of rigid steel and intermediate metal conduit shall be taper threaded. Conduits shall be reamed free of burrs and shall be terminated with conduit bushings.

f. Exposed conduit shall be installed either parallel or perpendicular to structural members and surfaces.

g. Two or more conduits in the same general routing shall be parallel, with symmetrical bends.

h. Conduits shall be at least 6 inches from high temperature piping, ducts, and flues.

i. Conduit installed in corrosive chemical feed and storage areas as indicated by Area Type on the Drawings shall be rigid Schedule 80 PVC. Exposed conduit in corrosive areas shall be supported by FRP framing materials with stainless steel hardware, including nuts and bolts.

j. Rigid Schedule 40 and 80 PVC conduit shall have supports and provisions for expansion as required by NEC Article 352.

k. Metallic conduit connections to sheet metal enclosures shall be securely fastened by locknuts inside and outside.

l. Rigid Schedule 40 and 80 PVC conduit shall be secured to sheet metal device boxes using a male terminal adapter with a locknut inside or by using a box adapter inserted through the knockout and cemented into a coupling.

m. Conduits in walls or slabs, which have reinforcement in both faces, shall be installed between the reinforcing steel. In slabs with only a single layer of reinforcing steel, conduits shall be placed under the reinforcement. Conduits larger than 1/3 of the slab thickness shall be concrete encased under the slab.

n. Conduits that cross structural joints where structural movement is allowed shall be fitted with concretetight and watertight expansion/deflection couplings, suitable for use with metallic conduits and rigid Schedule 40 or 80 PVC conduits. The couplings shall be Appleton Type DF, Crouse-Hinds Type XD, or O-Z Type DX.

o. Conduit shall be clear of structural openings and indicated future openings.

p. Conduits through roofs or metal walls shall be flashed and sealed watertight.

q. Conduit installed through any openings cut into non-fire rated concrete or masonry structure elements shall be neatly grouted. Conduit penetrations of fire rated structure elements shall be sealed in a manner that maintains the fire rating as indicated on the Architectural Drawings.

r. Conduits shall be capped during construction to prevent entrance of dirt, trash, and water.

s. Exposed conduit stubs for future use shall be terminated with galvanized pipe caps.

t. Concealed conduit for future use shall be terminated in equipment or fitted with couplings plugged flush with structural surfaces.

u. Where the Drawings indicate future duplication of equipment wired hereunder, concealed portions of conduits for future equipment shall be provided.

v. Horizontal conduit shall be installed to allow at least 7 feet of headroom, except along structures, piping, and equipment or in other areas where headroom cannot be maintained.

w. Conduit shall not be routed across the surface of a floor, roof, or walkway unless approved by Engineer.

x. PVC-coated rigid steel conduit shall be threaded and installed as recommended by the conduit manufacturer's installation procedure using appropriate tools.

y. All conduits that enter enclosures shall be terminated with acceptable fittings that will not affect the NEMA rating of the enclosure.

z. Conduit which turns out of concrete slabs or walls, shall be connected to a 90 degree elbow of PVC-coated rigid steel conduit before it emerges. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from slabs or walls and the coupling shall extend 2 inches from the wall.

aa. Conduit for Heliax type foam dielectric coaxial cable shall be installed as follows:

Heliax Size inches	Minimum Conduit Size inches	Minimum Conduit Bend Radius inches
1/2	1-1/2	10
7/8	2	18

1-1/4	4	22
1-5/8	4	28

ab. Power conductors to and from adjustable frequency drives shall be installed in steel conduit where conduit is not routed within floor slabs. Power conductors to and from adjustable frequency drives shall be installed in PVC-coated rigid steel conduit where conduit is routed within floor slabs.

ac. Electrical Metallic Tubing shall only be installed within administrative spaces such as restrooms, control room, storage, laboratory, halls and office/conference room.

D. Underground Conduit Installation

1. All excavation, backfilling, and concrete work shall conform to the respective sections of these Specifications. Underground conduit shall conform to the following requirements:

a. All underground conduits shall be concrete encased unless indicated otherwise on the Drawings. Concrete encasement within 15 feet of building entrances, under and within 5 feet of roadways, and within 10 feet of indicated future excavations shall be reinforced as detailed on the Drawings.

b. Concrete encased conduit shall be schedule 40 PVC. Conduits shall have PVC-coated rigid steel coupling embedded a minimum of 3 inches when emerging from walls and the coupling shall extend 2 inches from the wall, with exception to conduits carrying isolated phase conductors. All PVC joints shall be solvent welded in accordance with the recommendations of the manufacturer.

c. Conduits which contain conductors for isolated phase circuits as indicated on the Drawings shall be rigid schedule 40 PVC. Conduit elbows and conduit turning out of earth or emerging from walls shall be schedule 80 PVC heavy wall fiberglass. No coupling or transition containing ferrous metal shall be used. The conduits shall be installed in close proximity of each other within the duct bank. No ferrous metal such as steel reinforcement shall be routed in between the conduits at any location throughout the entire circuit length.

d. Concrete encasement on exposed outdoor conduit risers shall continue to 6 inches above grade, with top crowned and edges chamfered.

e. Conduit and concrete encasement installed underground for future extension shall be terminated flush at the bulkhead with a coupling and a screw plug. The termination of the duct bank shall be reinforced with bars 100 diameters long that shall be terminated 2 inches from the bulkhead. Matching splice bars shall be 50 bar diameters long. Each longitudinal bar shall be provided with a Lenton "Form Saver" coupler and plate or a Dayton "Superior DBR" coupler at the bulkhead. The coupler shall be threaded to accept a dowel of like diameter in the future. Threads shall be protected with screw-in plastic caps. A 1-3/4 by 3/4 inch deep horizontal shear key shall be formed in the concrete encasement above and below the embedded conduits. After concrete placement, conduit and bar connector ends shall be cleaned and coated with two coats of thixotropic coal tar.

f. Underground conduits indicated not to be concrete encased shall be rigid Schedule 40 PVC.

g. Underground conduit bend radius shall be at least 2 feet at vertical risers and at least 3 feet elsewhere.
h. Underground conduits and conduit banks shall have at least 2 feet of earth cover, except where indicated otherwise.
i. Underground conduit banks through building walls shall be cast in place, or concreted into boxouts, with water stops on all sides of the boxout. Water stops are specified in the Cast-In-Place Concrete section.
j. Underground nonmetallic conduits, except conduits carrying isolated phase conductors, which turn out of concrete or earth in outdoor locations, shall be connected to 90 degree elbows of PVC-coated rigid steel conduit before they emerge.
k. Conduits not encased in concrete and passing through walls, which have one side in contact with earth, shall be sealed watertight with special rubber-gasketed sleeve and joint assemblies or with sleeves and modular rubber sealing elements.
l. Underground conduits shall be sloped to drain from buildings to manholes.
m. Each 5 kV or higher voltage cable, each 250 kcmil or larger cable, and each conduit group of smaller cables shall be supported from manhole walls by Kindorf "D-990" or Unistrut "P-3259" inserts, with Kindorf "F-721-24" or Unistrut "P-2544" brackets and Unistrut "P1753" or "P1754" fiberglass reinforced polyester cable saddles.
n. Telephone cables shall not be installed in raceways, conduits, boxes, manholes, or handholes containing other types of circuits.
o. Intercommunication and instrument cables shall be separated the maximum possible distance from all power wiring in pull-boxes, manholes, and handholes.

E. Sealing of Conduits

1. After cable has been installed and connected, conduit ends shall be sealed by forcing nonhardening sealing compound into the conduits to a depth at least equal to the conduit diameter. This method shall be used for sealing all conduits at handholes, manholes, and building entrance junction boxes, and for 1 inch and larger conduit connections to equipment.

2. Conduits entering chlorine feed and storage rooms shall be sealed in a junction box or conduit body adjacent to the point of entrance.

3. Conduits entering hazardous (classified) areas and submersible or explosion proof enclosures shall have Appleton "Type ESU" or Crouse-Hinds "EYS" sealing fittings with sealing compound.

F. Reuse of Existing Conduits

1. Existing conduits shall not be reused.

3.7 WIRING DEVICES, BOXES, AND FITTINGS INSTALLATION

A. Metallic and nonmetallic conduit boxes and fittings shall be installed in the locations as shown on Contract Drawings or mentioned below:

B. Conduit Boxes and Fittings

1. Galvanized or cadmium plated, threaded, malleable iron boxes and fittings shall be installed in concrete walls, ceilings, and floors; in the outdoor faces of masonry walls; and in all locations where weatherproof device covers are required. These boxes and fittings shall also be installed in exposed rigid steel and intermediate metal conduit systems.

2. Galvanized or cadmium plated sheet steel boxes shall be installed in the indoor faces of masonry walls, in interior partition walls, and in joist supported ceilings.

3. Rigid PVC device boxes shall be installed in exposed nonmetallic conduit systems.

4. PVC coated boxes and fittings shall be installed in PVC coated conduit systems.

5. Telephone conduit shall be provided with separate junction boxes and pull fittings.

C. Device Plates

1. Oversized plates shall be installed where standard-sized plates do not fully cover the wall opening.

D. Wall Switches

1. Wall switches shall be mounted 3'-6" above floor or grade.

2. After circuits are energized, all wall switches shall be tested for proper operation.

E. Receptacles

1. Convenience outlets shall be 18 inches above the floor unless otherwise required.

2. Convenience outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.

3. Welding receptacles shall be surface-mounted 4 feet above the floor.

4. After circuits are energized, each receptacle shall be tested for correct polarity and each GFCI receptacle shall be tested for proper operation.

5. Conduit and wire for convenience outlet installation is not shown on the Drawings and shall be sized, furnished, and installed by Contractor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for convenience outlet installation.

F. Special Outlets

1. Wall thermostats shall be 4'-6" above the floor unless otherwise required. Thermostats on exterior walls shall be suitably insulated from wall temperature.

2. Telephone outlets shall be 18 inches above the floor unless otherwise required. Telephone outlets outdoors and in garages; in basements, shops, storerooms, and rooms where equipment may be hosed down; shall be 4 feet above floor or grade.

3. Clock outlets shall be located 7 feet above the floor.

4. Horns and strobe lights for audio/visual alarms shall be mounted a minimum of 8 feet above finished floor and shall be positioned to provide maximum penetration of the surrounding area.

3.8 EQUIPMENT INSTALLATION

A. Except as otherwise specified or indicated on the Drawings, the following procedures shall be used in performing electrical work.

B. Setting of Equipment

1. All equipment, boxes, and gutters shall be installed level and plumb. Boxes, equipment enclosures, metal raceways, and similar items mounted on water- or earth-bearing walls shall be separated from the wall by at least 1/4 inch thick corrosion-resistant spacers. Where boxes, enclosures, and raceways are installed at locations where walls are not suitable or available for mounting, concrete equipment pads, framing material, and associated hardware shall be provided.

C. Sealing of Equipment

1. All outdoor substation, switchgear, motor control center, and similar equipment shall be permanently sealed at the base, and all openings into equipment shall be screened or sealed with concrete grout to keep out rodents and insects the size of wasps and mud daubers. Small cracks and openings shall be sealed from inside with silicone sealant, Dow-Corning "795" or General Electric "SCS1200".

3.9 GROUNDING

A. General

1. The electrical system and equipment shall be grounded in compliance with the National Electrical Code and the following requirements:

   a. All ground conductors shall be at least 12 AWG soft drawn copper cable or bar, bare or green-insulated in accordance with the National Electrical Code.

   b. Ground cable splices and joints, ground rod connections, and equipment bonding connections shall meet the requirements of IEEE 837, and shall be exothermic weld connections or irreversible high-compression connections, Cadweld "Exothermic" or Burndy "Hyground". Mechanical connectors will not be acceptable. Cable connections to bus bars shall be made with high-compression two-hole lugs.

   c. Ground cable through exterior building walls shall enter within 3 feet below finished grade and shall be provided with a water stop. Unless otherwise indicated, installation of the water stop shall include filling the space between the strands with solder and soldering a 12 inch copper disc over the cable. The copper disc shall be installed on the exterior of the wall and shall be a minimum thickness of 12 gauge and have a diameter that is a minimum of 2 inch larger than the diameter of the core hole that the ground cable passes through. The copper disc shall be soldered to the ground cable and caulk shall be applied around the outside edge of the copper disc where it adjoins the exterior wall. Caulk rated for submerged application shall comply with the Joint Sealants section.

   d. Ground cable near the base of a structure shall be installed in earth and as far from the structure as the excavation permits, but not closer than 24 inches . The tops of ground rods and ground cable interconnecting ground rods shall be buried a minimum of 30 inches below grade, or below the frost line, whichever is deeper.

   e. All powered equipment, including lighting fixtures and receptacles, shall be grounded by a copper ground conductor in addition to the conduit connection.

   f. Ground connections to equipment and ground buses shall be made with copper or high conductivity copper alloy ground lugs or clamps. Connections to enclosures not provided with ground buses or ground terminals shall be made with irreversible high-compression type lugs inserted under permanent assembly bolts or under new bolts drilled and inserted through enclosures, other than explosion proof enclosures, or by grounding locknuts or bushings. Ground cable connections to anchor bolts; against gaskets, paint, or varnish; or on bolts holding removable access covers will not be acceptable.

   g. The grounding system shall be bonded to the station piping by connecting to the first flange inside the building, on either a suction or discharge pipe, with a copper bar or strap. The flange shall be drilled and tapped to provide a bolted connection.

h. Ground conductors shall be routed as directly as possible, avoiding unnecessary bends. Ground conductor installations for equipment ground connections to the grounding system shall have turns with minimum bend radii of 12 inches .

i. Ground rods not described elsewhere shall be a minimum of 3/4 inch in diameter by 10 feet long, with a copper jacket bonded to a steel core.

j. Test wells and covers for non-traffic areas shall be molded high density polyethylene. Test wells for traffic areas shall be precast concrete construction rated for traffic duty with concrete or cast iron covers.

B. Grounding System Resistance

1. The grounding system design depicted on the Contract Drawings is the minimum design required for each building or structure. Each system shall comply with the maximum resistance of 5 ohms to ground. Contractor shall confirm the system grounding resistance with the results of the testing specified herein. Systems exceeding the maximum resistance specified shall be supplemented with additional grounding provisions and retested until the maximum specified resistance is achieved.

C. Grounding System Testing

1. The grounding system of each new building or structure and each existing building or structure indicated below, shall be tested to determine the resistance to earth. Testing shall be performed by an independent electrical or grounding system testing organization. Testing shall be completed after not less than three full days without precipitation and without any other moistening or chemical treatment of the soil.

2. New Grounding Systems

a. Grounding systems of each new building or structure shall be tested for resistance to earth utilizing the three-point fall of potential test as defined by IEEE 81. Testing shall be completed prior to installation of the electrical distribution equipment to ensure the grounding system is isolated from the utility grounding system and the systems of other structures. The current source probe for the test shall be placed in soil at a distance of 5 to 10 times the distance of the widest measurement across the grounding system ring or grid to ensure adequate measurements outside of the grounding system's sphere of influence. Test probe measurements shall be taken at a distance of one foot from the grounding system reference connection and at each 10 percent increment from the grounding system reference connection to the current source probe location. Test results shall be documented on a graphical plot with resistance in ohms on the vertical axis and distance in feet on the horizontal axis. The results shall clearly indicate a system resistance plateau which confirms a valid test procedure.

3. Grounding System Test Report

a. A report certified by the testing organization shall be prepared and submitted in accordance with the Submittal Procedures section. The final report shall include complete testing results for each building or structure, graphical representation of

the test point results for the three-point fall of potential method, and complete observations of all site weather conditions and other environmental conditions that may affect the test results. Final acceptance of the results reported shall be subject to the review and approval of Engineer.

3.10 LIGHTING FIXTURE INSTALLATION

A. The Drawings indicate the general locations and arrangements of the lighting fixtures. Fixtures in rows shall be aligned both vertically and horizontally unless otherwise specified. Fixtures shall be clear of pipes, mechanical equipment, structural openings, indicated future equipment and structural openings, and other obstructions.

B. Conduit and wire for lighting fixture installation is not shown on the Drawings and shall be sized, furnished and installed by Contractor. Circuits to emergency lighting units, exit signs, and fixtures indicated to be night lights shall not be switched. Circuits to lighting fixtures indicated to have emergency battery packs shall include an additional un-switched hot conductor. Conductors shall be minimum 12 AWG and conduit shall be minimum 3/4 inch for lighting fixture installation.

3.11 MODIFICATIONS TO EXISTING EQUIPMENT

A. Modifications to existing equipment shall be completed as specified herein and indicated on the Drawings. All existing facilities shall be kept in service during construction. Temporary power or relocation of existing power and control wiring, equipment, and devices shall be provided as required during construction. Coordination and timing of outages shall be as specified in other sections of these Specifications. Electrical power interruptions will only be allowed where agreed upon in advance with Owner, and scheduling at times of low demand may be required.

B. Demolition

1. Unless otherwise specified or indicated on the Drawings, all cable and all exposed conduit for power and control signals of equipment indicated to be removed shall be demolished. Conduit supports and electrical equipment mounting hardware shall be removed, and holes or damage remaining shall be grouted or sealed flush. Conduit partially concealed shall be removed where exposed, and plugged with expanding grout flush with the floor or wall. Repairs shall be refinished to match the existing surrounding surfaces. Demolished equipment shall be discarded or salvaged as indicated on the Drawings and as specified in other sections of these Specifications.

End of Section

STANDARD SPECIFICATIONS

REFERENCE: UL 83, ICEA S-95-658 (NEMA WC70).

CONDUCTOR: Solid, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, UL 83, Type THHN and THWN, ICEA S-95-658.

SHIELD: None.

JACKET: Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 83.

FACTORY TESTS: Cable shall meet the requirements of UL 83 for Type THHN and THWN.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	µm	in.	mm
12	4.0	1	0.015	380	0.17	4.32
10	6.0	1	0.020	510	0.20	5.08

*The average thickness shall be not less than that indicated above. The minimum thickness shall not be less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, THWN or THHN, conductor size, and 600 volt.

600 Volt, Single Conductor Lighting Cable (600-1-PVC-THHN-THWN)

BLACK & VEATCH	Cable Data	**Figure 1**- 16050

STANDARD SPECIFICATIONS

REFERENCE: ICEA S-95-658 (NEMA WC 70).

CONDUCTOR: Concentric-lay, uncoated copper; strand Class B. Wet/dry maximum operating temperature 90°C.

INSULATION: Cross-linked thermosetting polyethylene, ICEA S-95-658, Paragraph 3.6.

SHIELD: None.

JACKET: None.

FACTORY TESTS: Cable shall meet the requirements of ICEA S-95-658.

Cable Details

Size		Number of Strands	Conductor Insulation Thickness*		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
14	2.5	7	0.030	760	0.17	4.32
12	4.0	7	0.030	760	0.19	4.83
10	6.0	7	0.030	760	0.21	5.33
8	10.0	7	0.045	1140	0.27	6.86
6	16.0	7	0.045	1140	0.31	7.87
4	25.0	7	0.045	1140	0.36	9.14
2	35.0	7	0.045	1140	0.42	10.67
1	40.0	19	0.055	1400	0.48	12.19
1/0	50.0	19	0.055	1400	0.52	13.21
2/0	70.0	19	0.055	1400	0.57	14.48
4/0	95.0	19	0.055	1400	0.68	17.27
250	120.0	37	0.065	1650	0.75	19.05
350	185.0	37	0.065	1650	0.85	21.59
500	300.0	37	0.065	1650	0.98	24.89
750	400.0	61	0.080	2030	1.22	31.00
1,000	500.0	61	0.080	2030	1.37	34.80

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 90 percent of the values indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, XLP, XHHW-2, conductor size, and voltage class.

600 Volt, Single Conductor Lighting/Power Cable (600-1-XLP-NONE-XHHW-2)

BLACK & VEATCH	Cable Data	Figure 2- 16050

STANDARD SPECIFICATIONS

REFERENCE: UL 66, UL 1277.

CONDUCTOR: 16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.

INSULATION: Polyvinyl chloride, not less than 15 mils (380 μm) average thickness; 13 mils (330 μm) minimum thickness, UL 66, Type TFN.

LAY: Twisted pair with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.

SHIELD: Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.

JACKET: Conductor: Nylon, 4 mils (100 μm) minimum thickness, UL 66.

Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.

CONDUCTOR IDENTIFICATION: One conductor black, one conductor white.

FACTORY TESTS: Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		**Maximum Outside Diameter**	
	in.	**μm**	**in.**	**mm**
Single Pair	0.045	1140	0.34	8.64

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single pair, and voltage class.

600 Volt, Single Pair, Shielded Instrument Cable (600-SINGLE-PAIR-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 4-** 16050

STANDARD SPECIFICATIONS

REFERENCE:	UL 66, UL 1277.
CONDUCTOR:	16 AWG (1.5 mm^2), 7-strand, concentric-lay, uncoated copper. Maximum operating temperature 90°C dry, 75°C wet.
INSULATION:	Polyvinyl chloride, not less than 15 mils (380 µm) average thickness; 13 mils (330 µm) minimum thickness, UL 66, Type TFN.
LAY:	Twisted triad with 1-1/2 inch to 3 inch (38.10 mm - 63.5 mm) lay.
SHIELD:	Cable assembly, combination aluminum-polyester tape and 7-strand, 20 AWG (0.5 mm^2) minimum size, tinned copper drain wire, shield applied to achieve 100 percent cover over insulated conductors.
JACKET:	Conductor: Nylon, 4 mils (100 µm) minimum thickness, UL 66. Cable assembly: Black, flame-retardant polyvinyl chloride, UL 1277, applied over tape-wrapped cable core.
CONDUCTOR IDENTIFICATION:	One conductor black, one conductor white, one conductor red.
FACTORY TESTS:	Insulated conductors shall meet the requirements of UL 66 for Type TFN. Assembly jacket shall meet the requirements of UL 1277. Cable shall meet the vertical-tray flame test requirements of UL 1277.

Cable Details

	Assembly Jacket Thickness*		Maximum Outside Diameter	
	in.	**µm**	**in.**	**mm**
Single Triad	0.045	1140	0.35	8.87

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the value indicated above.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, Type TC, Type TFN, conductor size, single triad, and voltage class.

600 Volt, Single Triad, Shielded Instrument Cable (600-SINGLE-TRIAD-SH-INSTR)

BLACK & VEATCH	**Cable Data**	**Figure 5-** 16050

STANDARD SPECIFICATIONS

REFERENCE:	ICEA S-93-639 (NEMA WC 74), AEIC CS-8, ICEA P-45-482.
CONDUCTOR:	Concentric-lay, uncoated or coated copper, strand Class B. Normal maximum operating temperature 90°C.
CONDUCTOR SHIELD:	Extruded semiconducting thermosetting material, ICEA S-93-639, Section 3.
INSULATION:	Ethylene-propylene rubber, ICEA S-93-639, Section 4, not less than 115 mils (2920 μm) average thickness; 103.5 mils (2630 μm) minimum thickness.
INSULATION SHIELD:	Extruded semiconducting thermosetting material, and nonembedded coated copper tape or coated copper wires, ICEA S-93-639, Section 5. Extruded material shall be tested in accordance with ICEA S-93-639 and AEIC CS-8. Shield area shall be not less than that of one helically applied 5 mil (130 μm) copper tape with a 10 percent overlap when calculated according to Formula 3 in ICEA P-45-482.
JACKET:	Black polyvinyl chloride, ICEA S-93-639, Paragraph 7.1.9.
FACTORY TEST:	Cable shall meet the requirements of ICEA S-93-639 and AEIC No. CS-8.

Cable Details

Size		Number of Strands	*Jacket Thickness		Maximum Outside Diameter	
AWG or kcmil	mm^2		in.	μm	in.	mm
6	16	7	0.060	1520	0.74	18.8
4	25	7	0.060	1520	0.78	19.81
2	35	7	0.060	1520	0.84	21.34
1	40	19	0.060	1520	0.88	22.35
1/0	50	19	0.060	1520	0.92	23.37
2/0	70	19	0.080	2030	1.01	25.65
4/0	95	19	0.080	2030	1.12	28.45
250	120	37	0.080	2030	1.18	29.97
350	185	37	0.080	2030	1.29	32.77
500	300	37	0.080	2030	1.45	36.88
750	400	61	0.080	2030	1.65	41.91
1000	500	61	0.080	2030	1.81	45.97

*The average thickness shall be not less than that indicated above. The minimum thickness shall be not less than 80 percent of the values indicated above.

The conductor shield, insulation, and insulation shield shall be applied in a triple extrusion process with all three components being cured at the same time.

The color of the insulation shall be in contrast to the color of the semiconducting paint. The semiconducting paint shall be readily removable for terminating.

A durable marking shall be provided on the surface of the cable at intervals not exceeding 24 inches (600 mm). Marking shall include manufacturer's name, insulating material, conductor size, and voltage class.

Voltage Test After Installation: DC Test Voltage - 36 kV
Duration of Test - 15 Minutes

8000 Volt, Single Conductor Power Cable
100 Percent Insulation Level (8000-1-EPR-PVC-SH)

BLACK & VEATCH	Cable Data	**Figure 9-** 16050

Project and Location _____ Project No. _____

Circuit Designation _____ Date _____

DC TEST DATA

Time in Minutes After 100% Test Voltage Is Applied	Current, µA		
	Phase A	Phase B	Phase C
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
kV dc after 1 min Decay			

DC Test Voltage _____

Cable Installation: New ____ Used ___ Years____

Cable: Size _____ Length: _____

Oper. kV _____ Grounded _____ Ungrounded_____

Rated Cable Voltage _____

Insulation Wall _____
(Type & Thickness)

Conductor Jacket Wall _____
Type & Thickness)

Shield _____
(Type)

Cable Manufacturer _____

Temperature _____ Humidity_____

Type of Termination _____

Type of Splice & Location_____
_____

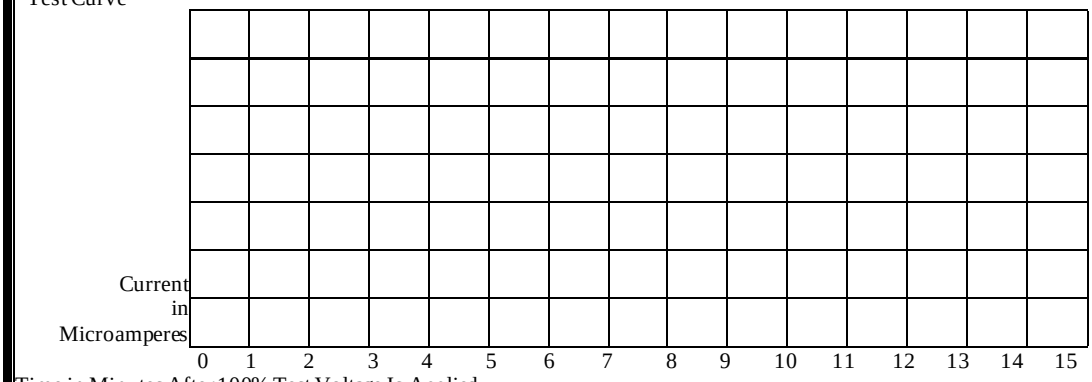
Remarks_____

100 Microamperes (µA) = 0.1 Milliampere

APPLICATION OF TEST VOLTAGE

The initially applied direct-current voltage shall be not greater than 3.0 times the rated alternating-current voltage. The rate of increase from the initially applied voltage to the specified test voltage shall be not over 100 percent in 10 seconds nor less than 100 percent in 60 seconds. The duration of the direct-current voltage test shall be 15 minutes for shielded cables and 5 minutes for nonshielded cables.

Test Curve



NOTES:
1. Plot results of tests on all three phases on this graph.
2. Assign and indicate values for each division on the microamperes scale as required for the circuit being tested.

Cable Test Data Form

BLACK & VEATCH	**Cable Data**	**Figure 16-** 16050

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SECTION 16100 - ELECTRICAL EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the installation of electrical equipment.

1.2 GENERAL

A. Equipment specified to be installed under this section shall be erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. The electrical equipment identified as being provided by others will be furnished complete for installation by Contractor. Technical specifications under which the equipment will be purchased are available.

C. Coordination

1. When manufacturer's field services are provided by the equipment manufacturer, Contractor shall coordinate the services with the equipment manufacturer. Contractor shall give Engineer written notice at least 14 days prior to the need for manufacturer's field services furnished by others.

2. Submittals for equipment furnished under the original procurement contract will be furnished to Contractor upon completion of review by Engineer. Contractor shall review equipment submittals and coordinate with the requirements of the Work and the Contract Documents. Contractor accepts sole responsibility for determining and verifying all quantities, dimensions, and field construction criteria.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Delivery

1. When sills are required for electrical equipment, they shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed.

B. Storage

1. Upon delivery, all equipment and materials shall immediately be stored and protected by Contractor in accordance with Product Storage and Handling Requirements section, and in accordance with manufacturer's written instructions, until installed in the Work. Equipment shall be protected by Contractor against damage and exposure from the elements. At no time shall the equipment be stored on earth or grass surfaces or come

into contact with earth or grass. Contractor shall keep the equipment clean and dry at all times. Openings shall be plugged or capped (or otherwise sealed by packaging) during temporary storage.

C. Handling

1. Electrical equipment shall be moved by lifting, jacking, or skidding on rollers as described in the manufacturer's instructions. Special lifting hamess or apparatus shall be used when required. Lifting and jacking points shall be used when identified on the equipment. Contractor shall have required unloading equipment on site to perform unloading work on the date of equipment delivery.

PART 2 - PRODUCTS

Not used.

PART 3 - EXECUTION

3.1 INSTALLATION, TESTING, AND COMMISSIONING

A. All installation work shall be in accordance with manufacturer's written instructions.

B. All material, equipment, and components specified to be installed according to this section shall be installed, tested, and commissioned for operation in compliance with NECA 1000 – NEIS Specification System. Where required in NECA 1000, testing and commissioning procedures shall be followed prior to energizing equipment.

C. Electrical equipment cubicles and vertical sections shall be installed plumb and level. Drawout equipment carriages, circuit breakers, and other removable components shall operate free and easy without binding or distortion.

D. Unless otherwise indicated or specified, all indoor floor-mounted electrical equipment and control cabinets shall be installed on concrete equipment pads four inches in height.

E. Indoor metalclad switchgear shall be bolted to steel floor channels which are installed level and flush with the top of the concrete floor or equipment pad.

F. Outdoor metalclad switchgear and interrupter gear with integral floor channels or beams shall be secured to concrete pads with anchor bolts and clips.

G. Motor control centers with integral floor sills shall be secured to concrete floors or equipment pads with anchor bolts.

H. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

I. Cleaning

1. All deposits of oil, grease, mud, dirt or debris shall be cleaned from the electrical equipment following installation and field wiring. A detergent water based solution, or other liquid cleaners not harmful to material or equipment finishes, shall be used as recommended by the manufacturer.

End of Section

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SECTION 16155 - MEDIUM-VOLTAGE ADJUSTABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers medium-voltage adjustable frequency drive equipment for the driven equipment listed in the schedule at the end of this section.

Driven equipment Specification number.	11110
Unit designations.	42-AFD-301, 42-AFD, 302, 42-AFD-303, 42-AFD-401, 42-AFD-402, 42-AFD-403

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. Equipment provided under this section shall be fabricated as specified in this section and as shown on the schematics and one line diagrams on the Drawings.

C. Unless otherwise indicated on the Drawings, one adjustable frequency drive, complete with all required control components, shall be furnished for each motor.

D. Drives shall be manufactured and assembled in their entirety at the manufacturer's factory. Systems fabricated or assembled in whole or in part by parties other than the drive manufacturer will not be acceptable.

E. Coordination

1. The design of the adjustable frequency drive shall be coordinated with the driven equipment. Contractor shall be responsible for coordinating the collection of data and the design effort to limit harmonics to the levels specified.

2. The manufacturer of the driven equipment shall be responsible for furnishing the adjustable frequency drive.

F. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

G. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

H. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

I. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.

J. Governing Standards

1. Adjustable frequency drives shall be designed, constructed, and tested in accordance with the applicable standards of NEMA, NSI, UL, and IEEE, and shall be designed for installation in accordance with the NEC.

2. The equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be conducted at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

K. Nameplates

1. Nameplates with the description and designation of each control or indicating device shall be provided. Unless specified otherwise, each drive enclosure shall be provided with a nameplate bearing the unit designation as indicated above. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch high letters for the drive designation and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the enclosure shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

1.3 DESCRIPTION

A. The drive shall produce an adjustable ac voltage/frequency output and shall be equipped with an output voltage regulator to maintain correct output V/Hz despite incoming voltage variations.

1.4 SUBMITTALS

A. Drawings and Data

1. Complete drawings, details, and specifications shall be furnished in accordance with Submittals Procedures section.

B. Shop Drawing Submittals

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the drive shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

    a. Name of manufacturer.
    b. Types and model numbers.
    c. Rated drive input kVA and output kVA
    d. Percent efficiency at 100 percent speed, 90 percent speed, and 80 percent speed.
    e. Drive cooling water requirements, gpm, if applicable.
    f. Maximum Btu heat release data and verification of the drive cooling requirements.
    g. Total weight and lifting instructions, height, mounting, and floor space required for drive. Total dimensions on isolation transformer, power factor correction equipment, dc link reactor, etc.
    h. Panel interior view and front and side exterior view details showing maximum overall dimensions of transformer, power factor correction equipment, and drive assembly.
    i. Schematics, including all interlocks.
    j. Wiring diagrams, including all internal and external devices and terminal blocks.
    k. Locations and sizes of electrical connections, ground terminations, and shielded wires.
    l. List of diagnostic indicators.
    m. List of fault and failure conditions, which the drive can recognize and indicate for simultaneous occurrence.
    n. List of standard features and options.
    o. List of spare parts to be furnished.
    p. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
    q. Harmonic calculations by the drive manufacturer at the points of analysis. Detailed drawings and information showing how protection is applied to comply with harmonic limits.
    r. Submit a detailed harmonic testing plan. The test plan should include instruments to be used, verification of testing locations for voltage and current harmonic metering, verification of maximum allowable voltage and current distortion, and drive load and speed test parameters.

C. Operation and Maintenance Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures sections. The operation and maintenance manuals shall include the following information for each size and type of drive being furnished.

   a. Manufacturer's operation and maintenance manual for each size of adjustable frequency drive.
   b. Manufacturer's standard manuals for each size and type of transformer, reactor, filter etc.
   c. Schematics, wiring diagrams, and panel drawings in conformance with construction record.
   d. Model numbers and up-to-date cost data for spare parts.
   e. Troubleshooting procedures, with a cross-reference between symptoms and corrective recommendations.
   f. Connection data to permit removal and installation of recommended smallest field-replaceable parts.
   g. Information on testing of power supplies and printed circuit boards and an explanation of the drive diagnostics.

1.5 SPARE PARTS

A. The drive manufacturer shall provide spare parts for each type and size of drive supplied. The spare parts shall include at least one complete set of all plug-in components for each size and type of drive, and shall include at least the following:

   1. Three of each type of power and control fuse

   2. 10% of each type of power module (SCR, GTO, IGBT, IGCT, power diode, etc.) used in the converter/rectifier or inverter

   3. Two of each type of DC link capacitor

   4. One of each type floating capacitor

   5. Two of each type of input and output filter capacitor

   6. Five of each type of panel lamp

   7. One of each printed circuit board

   8. One replacement cooling fan

B. Spare parts shall be suitably packaged in accordance with the General Equipment Stipulations, with labels indicating the contents of each package, and shall be delivered to OWNER.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Drives shall be modular, multi-level series cell type as manufactured by Siemens/Robicon; pulse width modulated, multi-level type as manufactured by Schneider Electric, Eaton, Toshiba or ABB; or active front end-type as manufactured by Rockwell Automation/Allen-Bradley or TMEIC. Siemens/Robicon, Toshiba, and ABB shall be equipped with front ends that are not less than 18-pulse type. Schneider Electric and Eaton shall be equipped with front ends that are not less than 24-pulse type. The products of other manufacturers will not be acceptable.

B. All adjustable frequency drives shall be a product of the same manufacturer. Contractor shall be responsible for selecting the single drive manufacturer of all drives.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Performance

1. The adjustable frequency drive controller shall be of sufficient capacity and shall produce a quality output waveform for stepless motor control from 10 to 100 percent of base speed. The adjustable frequency drive shall be suitable for variable torque (VT) loads. The adjustable frequency drive shall be suitable for operation at an elevation below 3300 ft, and shall meet the following ratings and parameters:

Input voltage and frequency	4.16 kV, (+10 percent, -5 percent); 3 phase; 60 Hz, (±2 percent); imbalance, 2 percent maximum.
Minimum drive efficiency	98 percent at 100 percent speed, 97.5 percent at 90 percent speed, and 97 percent at 80 percent speed.
Minimum Transformer efficiency at operating speed	98 percent through operating range of 80 to 100 percent.
Power Factor	0.95 or higher throughout operating range.
Ambient temperature	0 to 40ºC.
Relative humidity	0 to 95 percent non-condensing.
Drive service factor	1.0.
Overcurrent capability	110 percent for 1 minute for variable torque; 150 percent for 1 minute for constant torque.

Volts/Hz ratio	Voltage varies as the square of frequency over the entire range of the unit for variable torque drives, linear over the entire range of the unit for constant torque drives; except under voltage boost condition.
Acceleration/deceleration time	Adjustable over a range that meets the requirements of the driven equipment.
Output speed regulation	0.5 percent.
Output frequency stability	0.1 percent of nominal.

B. Adjustments

1. The following drive adjustments shall be provided:

    a. Maximum speed.
    b. Minimum speed.
    c. Linear acceleration time.
    d. Linear deceleration time.
    e. Volts/Hz ratio; linear, squared, and automatic settings.
    f. Voltage boost.
    g. Process follower gain, offset, and bias.
    h. Torque limit.
    i. Critical frequency avoidance with adjustable bandwidth.

C. Fault Protection

1. The design of the power circuit shall include provisions for protection against fault conditions as follows:

2. Input Protection

    a. Adjustable overvoltage and undervoltage protection. Undervoltage protection shall be provided with automatic restart, which shall ride through a momentary dip as specified herein and through a five cycle loss of power.
    b. Phase loss and reverse phase trip with manual restart.
    c. For active front end drives, the drive shall be equipped with an integral input contactor that opens when the drive is not running and closes when a drive run signal is initiated.

3. Internal Protection.

    a. Distribution class surge suppression and power device snubbers.
    b. Instantaneous overcurrent.
    c. Static overspeed (overfrequency) protection.
    d. DC bus overvoltage trip.
    e. Individual transistor overtemperature and overcurrent protection.
    f. Control logic circuit malfunction indication.

4. Output Protection.

   a. Inverse-time motor overload protection adjustable from 10 percent to 100 percent.
   b. Overvoltage protection.
   c. Overfrequency protection.
   d. Short circuit protection (three phase, phase to phase, and ground fault protection).
   e. Protection against opening or shorting of motor leads.
   f. Static overspeed protection.
   g. Stall protection on overload with inverse time overcurrent trip, adjustable current limit from 10 percent to 120 percent.

D. Harmonic Distortion Abatement

1. The electrical system shall be provided with the necessary equipment to protect the drive and the power system ahead of the drive from harmonic distortion, as described below. The harmonic distortion abatement analysis shall be based on the information on the Contract Drawings and on the following:

Short circuit current at utility interface	Obtain from Utility
Total maximum running amperes of all equipment powered from the utility connection	711 amps at each Utility connection

2. The drive shall operate satisfactorily when connected to a bus supplying other solid-state power conversion equipment which may be causing up to 10 percent total harmonic voltage distortion and commutation notches up to 36,500 volt-microseconds.

3. Harmonic distortion abatement equipment shall be provided to bring the facility and its electrical system into compliance with IEEE 519, 1992 at the points of analysis defined below and indicated on the Contract Drawings. The supplier shall review the existing facility loads and shall take note of the equipment listed above. All distortion reports and/or testing shall include the existing facility loads. The maximum total harmonic distortion (THD and TDD) allowed at the points of analysis shall include harmonics from the existing equipment and the harmonics from equipment provided under this section.

4. Current Distortion Limits

   a. Maximum allowable total and individual harmonic current distortion limits for each odd harmonic shall not exceed limits set forth in IEEE 519, 1992. The utility connection shall be the primary point of analysis (point of common coupling) for current distortion. The short circuit current at the utility interface and the total maximum running amperes of all equipment powered from the utility connection is indicated above.

5. Voltage Distortion Limits

2.3 Individual or simultaneous operation of the drives shall result in a maximum total harmonic voltage distortion of 5 percent on the bus feeding the drives. Individual or simultaneous

operation of the drives shall not add more than 10 percent total harmonic voltage distortion to the bus feeding the drives while operating from a standby generator. The point(s) of analysis for harmonic voltage distortion testing shall be the nearest electrical bus on the supply side of each drive. The three phase fault current at the bus feeding the drives is as obtained from the Utility. CONSTRUCTION

A. Construction requirements shall be as follows and as specified below:

Unit designations	42-AFD-301, 42-AFD-302, 42-AFD-303, 42-AFD-401, 42-AFD-402, 42-AFD-403
Cable entry	Bottom
Cable exit	Bottom
Enclosure type	NEMA Type 1
Maximum drive dimensions	120 inches Wide 60 inches Deep 110 inches High

B. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

C. Fabrication and Assembly

1. The adjustable frequency drive system shall be shop assembled in a single enclosure using interchangeable plug-in printed circuit boards and power conversion components wherever possible. Shop assembly shall be performed by the drive manufacturer; systems fabricated or assembled in whole or in part by parties other than the drive manufacturer will not be acceptable. Changes to the drive manufacturer's product by a distributor or system integrator are not allowed.

2. The adjustable frequency drive system shall be designed to fit in the space indicated on the Drawings.

3. Isolation transformers, power factor correction equipment, and dc link reactors, where required, shall be mounted within the drive lineup.

D. Wiring

1. Internal cabinet wiring shall be neatly installed in wireways or with wire ties where wireways are not practical. If wire ties are used, the wire bundles shall be held at the back panel with a screw-mounted mounting base. Bases with a self-sticking back are not acceptable.

2. Sufficient space shall be furnished for terminating medium-voltage power cables with stress cones.

3. Terminal blocks shall be nonbrittle, interlocking, track-mounted type, complete with a marking strip, covers, and pressure connectors. Screw terminals will not be acceptable. A terminal shall be provided for each conductor of external circuits, plus one ground for each shielded cable. In freestanding panels, 8 inches of clearance shall be provided between terminals and the panel base for conduit and wiring space. Not less than 25 percent spare terminals shall be provided. Terminals shall be labeled to agree with the identification on the submittal drawings. Each control loop or system shall be individually fused, clearly labeled, and located for ease of maintenance.

4. All grounding wires shall be attached to the sheet metal enclosure with a ring tongue terminal. The surface of the sheet metal shall be prepared to ensure good conductivity and corrosion protection.

5. Wires shall not be kinked or spliced and shall be color coded or marked on both ends. The markings or color coding shall agree with the submittal drawings.

6. With the exception of electronic circuits, all interconnecting control wiring and control wiring to terminals for external connection shall be stranded copper, insulated for at least 600 volts, with a moisture-resistant and flame-retardant covering rated for at least 90°C.

E. Enclosures

1. The drive shall consist of factory mounted and wired components within a dead front, grounded enclosure. The complete drive package, including accessories, shall fit into the space indicated on the Drawings.

2. Freestanding panels shall include provisions for anchoring to the supporting structure. Suitable lifting facilities shall be provided for handling and shipment.

3. Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match the identification on the manufacturer's wiring diagrams.

F. Cooling Fans

1. The AFD enclosure cooling fans shall only run when the drive is operational or during the drive’s cooldown period.

G. Printed Circuit Boards

1. All plug-in type boards shall be mechanically held at the circuit board connector. Compression fit only at the connector will not be acceptable.

H. Shop Painting

1. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop cleaned in accordance with the coating manufacturer's recommendations, and finished with the drive manufacturer's standard coating. Finish color shall be the manufacturer's standard color. Dry film thickness of the finish coat shall be at least 4 mils. Field painting, other than touchup, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished for field touchup of damaged coatings.

2.4 ACCESSORIES

A. Warning Nameplate

1. A warning nameplate shall be mounted on the drive to warn the operator to trip the circuit breaker before performing any maintenance.

B. Input Isolation Transformers

1. The input isolation transformer utilized to supply power to the variable speed drive shall meet the following minimum performance and construction requirements. The AFD manufacturer shall determine the manufacturer of the transformer.

2. The AFD is to be supplied with an isolation transformer providing common mode voltage protection of the motor. Phase shifting isolation transformers are required for Siemens/Robicon, ABB, Schneider Electric, Eaton and Toshiba drives. Phase shifting is not required for the Rockwell Automation/Allen-Bradley or TMEIC drive. AFD systems utilizing input three phase AC line reactors which require motors equipped with special higher voltage rated insulation systems are not acceptable and will not be allowed as an alternate bid.

3. The transformer shall have sufficient power capacity to provide the continuous full load capacity of the AFD without overheating.

4. The input transformer shall be an indoor dry type and shall be an integral part of the drive line-up.

5. The transformer shall be a rectifier grade isolation transformer designed with the appropriate K-rating for the type of drive. The transformer shall form a coordinated part with the drive and shall be suitable for converter application.

6. The input transformer impedance shall be selected to limit available fault current to a value that is safe for the line converter components.

7. The transformer shall be designed, manufactured, and tested according to the latest version of applicable ANSI Standards.

8. The transformer primary shall be provided with four 2.5% full capacity taps, two above and two below the nominal voltage. The transformer shall be equipped with standard protection features and shall include a padlockable, no-load tap changer.

9. The transformer voltage and winding configuration shall be 4.16 kV primary delta and 4.16 kV secondary wye.

C. Medium Voltage Contactors

1. Contactors shall be vacuum type, with enclosures that match the drive enclosure rating. The contactor voltage rating shall be 5 kV.

2.5 CONTROLS

A. Features

1. The adjustable frequency drive shall include the following features in addition to those indicated on the Drawings:

a. A door mounted membrane keypad with integral two or three-line, 24 character minimum LCD display that is capable of controlling the drive and setting drive parameters. The keypad module shall be programmed with factory set drive parameters in nonvolatile EEPROM or FLASH memory and shall be resettable in the field through the keypad. The keypad module shall contain a self-test software program that can be activated to verify proper keypad operation.
b. Control switches and pilot lights shall be provided as indicated on the schematic diagrams. Manual-automatic and start-stop controls included as features of the drive keypad shall be password protected or disabled to prevent override of control switches and safety interlocks shown on the schematic diagrams.
c. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.
d. Microprocessor-based regulator. Nonvolatile memory modules shall have a useful life of at least 20 years without requiring battery or module replacement.
e. Manual speed adjustment.
f. Indication of power "On", drive "Run", and drive "Fault". Indication of these parameters shall be provided by pilot lights that utilize 6 volt LED lamps with built-in transformers. Lamps shall be easily replaceable from the front of the indicating light.
g. Elapsed time meter.
h. Speed indication calibrated in percent rpm.
i. Control circuits of not more than 115 volts supplied by internal control power transformers. Control power transformers shall have additional capacity by external devices indicated on the Drawings. Control power transformers shall be equipped with two primary leads fused, one secondary lead fused, and one secondary lead grounded.
j. Automatic controller shutdown on overcurrent, overvoltage, undervoltage, motor overtemperature and other drive fault conditions. Controller shutdown shall be manually reset type. Incoming terminals shall accept wiring from a motor protection relay located in the drive enclosure.
k. Diagnostic indicators that pinpoint failure and fault conditions. Indicators shall be manually reset to restore operation after abnormal shutdown.
l. Accept a remote 4-20ma speed control signal, rated 0 to 100 percent speed.
m. Process control output for remote 4-20 mA speed indication, rated 0 to 100 percent speed.
n. Spare interlock contacts rated 5 amperes at 120 volts ac, wired separately to the unit terminal board. One NO and one NC isolated spare interlock shall be

furnished with each drive. Additional interlock contacts shall be provided as indicated on the Drawings.

o. Drive fault, in remote, E-stop and run status contacts for remote indication, rated 5 amperes at 120 volts ac.

p. Speed droop feature that reduces the speed of the drive on transient overloads. The drive shall return to set speed after the transient is removed. If the acceleration or deceleration rates are too rapid for the moment of inertia of the load, the drive shall automatically compensate to prevent drive trip.

q. Individual adjustable speed profile settings for start, stop, entry, slope, and minimum and maximum speed points.

r. Coast, controlled ramp, or dc injection selectable modes of stopping.

s. PID setpoint control selection.

B. Diagnostics

1. Diagnostic indicators on the face of the drive shall display the type of fault responsible for drive shutdown, warning, or failure. If two or more faults occur simultaneously, the diagnostic segment shall record or indicate each condition. The drive shall be capable of storing 15 events with a time and date stamp for each event.

C. Motor Protection Relay

1. A three phase modular electronic relay to protect motors against overloads (51/49), acceleration time, RTD overtemperature (49), negative sequence current (46), adjustable current unbalance (46), phase loss (46), multiple starts (48), short circuit (50), ground fault (50G/51G), hot motor compensation, undercurrent minimum load (37), phase reversal (46), adjustable lockout on thermal trip, and mechanical jam shall be incorporated into a single field-programmable package. The following alarm features shall also be included: motor overload, stator RTD alarm, ground fault alarm, undercurrent alarm, unbalance alarm, thrust and guide bearing RTD alarm, broken RTD alarm, and self-test alarm. Other features shall include alphanumeric display, actual motor values display, status indication, analog output load amperes, analog output motor thermal capacity, and analog output stator temperature. Relays that require add-on modules for RTD detection and alarming shall have them provided as a part of this package.

2. Relays shall be manufactured by Schweitzer Engineering Laboratories, General Electric, Eaton, or an Engineer approved equivalent.

D. Noise Level

1. Noise level of the drive equipment shall not exceed 85 dB as measured by an appropriate calibrated instrument. The required sound level limit shall be met at a minimum of four locations, each not more than 3 feet above the floor and not more than 10 feet from the equipment. This requirement shall also apply to all filters, reactors, and transformers supplied with the drive.

2.6 TESTING

A. All power switching components shall be pre-run under anticipated operating temperature and load conditions.

B. Factory Testing

1. After the drive system has been assembled at the manufacturer's facility, it shall be tested for at least 4 hours before it is shipped.

2. The complete drive system, including all peripherals, shall be factory tested under simulated operating conditions, including normal operating sequences and fault conditions. Contact closure inputs and simulated driven-outputs shall be connected to the system input/output modules.

3. A test report summary indicating satisfactory final test results shall be submitted to Engineer before shipment of the equipment.

C. Secondary Factory Testing

1. The drive units shall be assembled with the driven equipment for shop testing as specified in the driven equipment sections. The drive manufacturer shall provide the services of a qualified representative to work with the equipment manufacturer at the equipment manufacturer's facility. The representative shall advise and assist in assembling and testing the equipment and drive unit packages.

2. Personnel conducting the tests shall be competent, authorized representatives of the equipment and drive manufacturers who are familiar with operation of the equipment furnished and who have satisfactory experience in conducting similar tests. Qualified personnel shall perform the tests, record the data, make the required calculations, and prepare a report on the results. Five copies of the report shall be submitted in accordance with the Submittals Procedures section. The information collected shall be used as a basis for determining acceptability of the manufacturer's test results. In case of conflict, interpretations and calculations made by Engineer will govern.

3. Testing shall be conducted in a manner acceptable to Engineer. At least 2 weeks before the proposed testing date, Contractor shall notify Engineer of the testing date and shall submit a report from the equipment manufacturer detailing the proposed performance testing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

B. Installation Supervision. Installation supervision by the manufacturer is not required.

3.3 FIELD TESTING

A. Field Acceptance Testing

1. After installation of the system at the site of the work and checkout by the drive manufacturer, a field acceptance test shall be conducted jointly by the drive manufacturer and the manufacturer of the driven equipment.

2. The field acceptance test shall consist of repeating the factory acceptance testing procedure and an additional 5 days of similar testing, during which the system shall run continuously without loss of basic functions. Functional tests shall demonstrate satisfactory operation of all interlocks, alarms, and normal operating sequences. The drive manufacturer shall use suitable test equipment to identify and correct malfunctions. Failure of redundant equipment will not be considered as downtime, provided that automatic failover occurs as specified herein and, that in the opinion of Engineer, the failure was not caused by deficiency in design or installation. Repeated failure of any component shall be cause for the acceptance test to be terminated and restarted.

3.4 TRAINING OF OWNER'S PERSONNEL

A. Employees of OWNER, shall be trained in the proper operation, troubleshooting, and maintenance of the equipment. Training shall be conducted by a qualified representative, and shall consist of combined classroom and hands-on instruction. Training shall be conducted at a place and time mutually agreeable to OWNER and the drive manufacturer.

B. All costs for these services shall be included in the Contract Price.

End of Section

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SECTION 16220 - COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

A. This section covers single and three-phase, small (fractional) and medium (integral) horsepower, alternating current motors rated 500 horsepower and less (NEMA MG1).

B. Motors shall be designated and coordinated with the driven equipment and shall be located as indicated on the Drawings.

1.2 GENERAL

A. Motors furnished under driven equipment Specification sections shall be fabricated and assembled in full conformity with Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.

B. Where applicable, individual motor data sheets have been developed which specify additional requirements for specific motors.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all motors, unless otherwise specified. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Motors furnished under this section shall be designed, constructed, and tested in accordance with the latest version of NEMA MG 1, NEMA MG 10, and IEEE 112, Test Method B.

F. Nameplates

1. All motor nameplate data shall conform to NEMA MG 1 requirements.

1.3 SUBMITTALS

A. Drawings and Data - General

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

B. Drawings and Data – Each Motor

1. Name of manufacturer.

2. Type and model.

3. Type of bearing and method of lubrication.

4. Rated size of motor, hp , and service factor.

5. Temperature rise and insulation rating.

6. Full load rotative speed.

7. Net weight.

8. Efficiency at full, 3/4, and 1/2 load.

9. Full load current.

10. Locked rotor current.

11. Space heater wattage, where applicable.

12. Motor temperature switch data, where applicable.

13. Motor Shaft Grounding Ring data, where applicable.

14. RTD data, where applicable.

C. Seismic Design Requirement Certifications

1. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 OPERATION AND MAINTENANCE DATA AND MANUALS

A. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

B. Operation and maintenance manuals shall include the following:

1. Assembly, installation, alignment, adjustment, and checking instructions.

2. Lubrication and maintenance instructions.

3. Guide to troubleshooting.

4. Parts lists and predicted life of parts subject to wear.

5. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

6. Test data and performance curves, where applicable.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS

A. Service conditions for motors shall be as specified in the driven equipment Specification sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. Where site elevation and ambient temperature is not specified in the driven equipment Specification sections, the motors shall be designed for the following.

Site elevation	Below 3,300 ft
Ambient temperature	50 °C

B. Unless specified otherwise, all motors shall be designed for full voltage starting and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

C. Motors utilizing a reduced-voltage, autotransformer starter shall be capable of reduced-voltage starting at a 65 percent tap setting.

D. Motors utilizing a reduced voltage solid state starter shall be capable of starting at 50% of the specified voltage.

E. When powered from an adjustable frequency drive (AFD), motors shall be inverter duty and specifically selected for service with an adjustable frequency type speed controller and shall be derated as required to compensate for harmonic heating effects and reduced self-cooling capability at low speed operation. Each motor shall not exceed a Class B temperature rise when operating in the installed condition at load with power received from the adjustable frequency drive. All motors driven by AFDs shall be supplied with full phase insulation on the end turns and shall meet the requirements of NEMA MG 1, Part 31. In addition to the requirements of NEMA MG 1, Part 31, motors shall be designed to be continually pulsed at the motor terminals with a voltage of 1600 volts ac.

F. The number of starts per hour for motors shall be rated for the load cycling requirements of NEMA MG 10.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless otherwise specified in the attached motor data sheet(s), design and construction of each general-purpose motor shall be as specified herein. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

Motor voltage.	460, 3 phase for ½ horsepower and larger, 120, single phase for smaller than ½ horsepower
Frequency.	60 Hz
Speed.	Constant speed
Service factor.	1.0 , except for AFD driven motors which shall be 1.15
Insulation class and temperature rise above 50° C design ambient (by resistance method.	Class F with 80° C rise at 1.0 SF
Enclosure.	Totally enclosed fan cooled
Main conduit box sized to include.	Main motor leads and space heater leads where space heaters are specified

B. Nameplate Horsepower

1. Motor nameplate horsepower shall be equal to or greater than the maximum load imposed by the driven equipment.

C. Enclosures

1. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, and the fan covers of totally enclosed fan cooled motors shall meet NEMA MG 1 requirements for a fully guarded machine.

2. Totally Enclosed Motors

a. Totally enclosed motors shall be furnished with drain holes and rotating shaft seals. Frames, bearing brackets, external terminal housings, and fan covers for fan cooled motors shall be cast iron. External cooling fans for fan cooled motors shall be fabricated of brass, bronze, aluminum alloy containing not more than 0.2 percent copper, malleable iron, or plastic. All plastic fans shall be fabricated of a reinforced thermosetting plastic and shall be UL approved.

D. Main Conduit Boxes

1. The main conduit box shall be in accordance with NEMA MG 1. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line Drawings.

2. The main conduit box shall be oversized at least one size larger than NEMA standard. The main conduit box shall be sized for all indicated accessory leads.

3. Motors furnished in NEMA 320 frame series and larger shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

E. Leads

1. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their terminals shall be permanently marked in accordance with the requirements of NEMA MG 1, Part 2. Each lead marking shall be visible after taping of the terminals.

2. All motors rated 100 horsepower and larger, and all vertical motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

3. Leads for dual-voltage rated or for multispeed motors shall be easily connected or reconnected in the main conduit box for the operating voltage or for the specified speeds. Permanent instructions for making these connections shall be furnished inside the main conduit box or on the motor frame or nameplate.

F. Terminals

1. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.

G. Grounding Connections

1. All motors shall be furnished with a ground connection.

H. Bearings

1. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.

2. Motor bearings shall be antifriction type with L_{10} life rating of 40,000 hours in accordance with ABMA Standards.

3. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.

4. Insulated Bearings

a. Motors over 100 horsepower controlled by an adjustable frequency drive shall be furnished with one insulated bearing. The insulated bearing shall be installed on the non-drive end of the motor.

I. Rotors

1. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec or less.

J. Shafts

1. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

K. Torque Characteristics

1. Motors rated 200 horsepower and less shall have torques and locked-rotor current in accordance with NEMA MG 1, Part 12.

L. Motor Space Heaters

1. Unless otherwise specified in the attached motor data sheet(s), motors 1 horsepower and larger shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

M. Temperature Sensing Devices

1. Each motor controlled by an adjustable frequency drive shall be furnished with at least one automatic reset winding temperature switch per phase. Temperature switch contacts shall be normally closed and rated 5 amps at 120 volts ac. The contacts shall be wired in series with the end leads brought out to the motor terminal box.

2. An auxiliary conduit box shall be provided for termination of temperature switch wiring.

N. Motor Shaft Grounding Ring

1. Each motor controlled by an adjustable frequency drive shall be furnished with a maintenance free, conductive micro fiber, shaft grounding ring with circumferential micro fibers to discharge electrical shaft currents within the motor. Motor shaft grounding ring shall be installed on the drive end on the motor shaft. Shaft grounding ring shall be installed by the motor's manufacturer in accordance with grounding ring manufacturer's recommendations.

O. Assembly

1. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

P. Efficiency

1. Unless otherwise specified in the attached motor data sheet(s), motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or

greater than values indicated in the following table. Efficiency shall be determined in accordance with IEEE 112, Test Method B.

2. Vertical motors shall have efficiency values equal to or greater than those indicated in the following table minus 0.50.

Motor		Nominal Efficiency Values				Nominal Efficiency Values			
kW	hp	Open Drip Enclosure				TEFC Enclosure			
		3600 rpm	1800 rpm	1200 rpm	900 rpm	3600 rpm	1800 rpm	1200 rpm	900 rpm
0.7	1	84.0	85.5	82.5	75.0	77.0	85.5	82.5	75.5
1.1	1.5	84.0	86.5	86.5	78.0	84.0	86.5	87.5	80.0
1.5	2	85.5	86.5	87.5	86.5	85.5	86.5	88.5	85.5
2.2	3	85.5	89.5	88.5	89.5	87.0	89.5	89.5	86.5
3.7	5	86.5	89.5	89.5	89.5	88.5	89.5	89.5	85.5
5.6	7.5	88.5	91.0	90.2	88.5	90.0	91.7	91.0	86.5
7.5	10	89.5	91.7	91.7	91.0	91.0	91.7	91.0	91.0
11.2	15	90.2	93.0	91.7	91.0	91.0	92.4	92.0	91.0
14.9	20	91.7	93.0	92.4	92.0	92.0	93.0	92.0	91.0
18.7	25	92.4	93.6	93.0	92.0	92.0	93.6	93.0	91.0
22.4	30	93.0	94.1	93.6	93.0	92.4	93.6	93.0	93.0
29.8	40	93.0	94.1	94.1	93.0	92.4	94.1	94.1	93.0
37.3	50	93.0	94.5	94.1	93.0	93.0	94.5	94.1	93.0
44.8	60	93.6	95.0	94.5	94.0	93.6	95.0	94.5	93.0
56	75	94.0	95.0	95.0	94.0	93.6	95.4	95.0	94.0
74.6	100	94.5	95.4	95.0	95.0	94.1	95.4	95.0	94.0
93.2	125	95.0	95.4	95.0	95.0	95.0	95.4	95.0	94.0
112	150	95.0	95.8	95.4	95.0	95.0	95.8	95.8	94.0
149	200	95.4	95.8	95.4	95.0	95.4	96.2	95.8	94.1
186	250	95.0	95.8	95.4	95.0	95.8	96.2	95.8	94.5
224	300	95.4	95.8	95.4		95.8	96.2	95.8	
261	350	95.4	95.8	95.4		95.8	96.2	95.8	
298	400	95.8	95.8	95.8		95.8	96.2	95.8	
336	450	95.8	96.2	96.2		95.8	96.2	95.8	
373	500	95.8	96.2	96.2		95.8	96.2	95.8	

2.3 ACCESSORIES.

A. Special Tools and Accessories

1. Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2.4 ANCHORS

A. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2.5 BALANCE

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required by NEMA MG 1. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Each motor shall be installed in accordance with the Equipment Installation section.

End of Section

SECTION 16221 - MEDIUM-VOLTAGE INDUCTION MOTORS

PART 1 - GENERAL

1.1 SCOPE.

A. This section covers medium voltage horizontal induction motors for use with the horizontal split case centrifugal pumps as specified in section 11110.

B. Motors shall be designated and coordinated with the driven equipment and shall be located as indicated in this Specification and as shown on the drawings.

C. Tag numbers for the driven equipment as specified in section 11110 are 42-PSC-301, 42-PSC-302, 42-PSC-303, 42-PSC-401, 42-PSC-402 and 42-PSC-403.

D. Number of motors required is 6.

1.2 GENERAL.

A. Motors furnished under Driven Equipment Specification sections shall be fabricated, and assembled in full conformity with drawings, specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by the Engineer.

1.3 General Equipment Requirements.

A. The General Equipment Requirements shall apply to all motors specified under Driven Equipment Specification sections.

1.4 Abbreviations.

A. Reference to standards and organizations shall be indicated by the following abbreviated letter designations:

AFBMA	Antifriction Bearing Manufacturers Association
ANSI	American National Standards Institute
IEEE	Institute of Electrical and Electronics Engineers
NEC	National Electrical Code
NEMA	National Electrical Manufacturers Association
UL	Underwriters' Laboratories

1.5 Nameplates.

A. Motors shall be provided with a motor rating nameplate and a nameplate engraved with bearing and lubrication data.

1.6 SUBMITTALS.

A. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor shall be submitted in accordance with the Submittals Procedures section. The drawings and data shall include, but shall not be limited to, the following:

1. Motors
2. Name of manufacturer
3. Type and model
4. Type of bearing and method of lubrication
5. Rated size of motor, hp, and service factor
6. Temperature rise and insulation rating
7. Full load rotative speed
8. Net weight
9. Efficiency at full, 3/4, and 1/2 load
10. Full load current

11. Locked rotor current

12. Space heater wattage, where applicable

13. Motor temperature switch data, where applicable

14. RTD data, where applicable

1.7 OPERATION AND MAINTENANCE DATA AND MANUALS.

A. Adequate operation and maintenance information shall be supplied. Operation and maintenance manuals shall be submitted in accordance with the Submittals Procedures section.

B. Operation and maintenance manuals shall include the following:

1. Assembly, installation, alignment, adjustment, and checking instructions.

2. Lubrication and maintenance instructions.

3. Guide to troubleshooting.

4. Parts lists and predicted life of parts subject to wear.

5. Outline, cross-section, and assembly drawings; engineering data; and wiring diagrams.

6. Test data and performance curves, where applicable.

1.8 ACCEPTABLE MANUFACTURERS.

A. Motors shall be manufactured by US Motors (Emerson Electric) without exception.

PART 2 - PRODUCTS

2.1 SERVICE CONDITIONS.

A. Service conditions for motors shall be as specified in the driven equipment specification sections. Motors shall be designed for special conditions such as area classification, altitude, frequent starting, intermittent overload, high inertia, mounting configuration, or service environment. Where site elevation and ambient temperature is not specified in the driven equipment specification sections, the motors shall be designed for the following.

Site elevation	Below 3,300 ft
Ambient temperature	50 °C

B. All motors shall be designed for operation via an Adjustable Frequency Drive and to operate from an electrical system that may have a maximum of 5 percent voltage distortion according to IEEE 519.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS.

A. Design and construction of each general-purpose motor shall be as specified herein and as required. Motor voltage, frequency, speed, service factor, and insulation class shall be as follows.

B.

Motor voltage.	4000V, 3 phase
Frequency.	60 Hz
Speed.	Adjustable Frequency Drive
Service factor.	1.15
Insulation class and temperature rise above 50° C design ambient (by resistance method.	Class F with 80° C rise at 1.0 SF
Enclosure.	WP-I
Main conduit box sized to include.	Main motor leads
Auxiliary conduit box sized to include.	RTDs and motor space heater leads

2.3 Nameplate Horsepower.

A. Motor nameplate horsepower shall be equal to or greater than the maximum load imposed by the driven equipment.

2.4 Enclosures.

A. All motors shall be self-ventilated. All self-ventilated open type motors, including those with dripproof, splashproof, and weather protected enclosures, shall meet NEMA requirements for a fully guarded machine.

2.5 Main Conduit Boxes.

A. The main conduit boxes shall be diagonally split for easy access to the motor leads, and designed for rotation in 90-degree increments. A gasket shall be furnished between the halves of the box. Conduit openings in the main conduit box shall match the size and quantity of conduits indicated on the one line drawings.

B. The main conduit box shall be oversized at least one size larger than NEMA standard. The main conduit box shall be sized for all indicated accessory leads.

C. As required, each motor shall have auxiliary terminal boxes with terminal leads grouped in boxes for all external connections. Terminal boxes shall be oversized and shall have terminals and conduit hubs sized for the cables and conduit indicated on the drawings.

D. Motors shall have conduit boxes designed and constructed to permit motor removal after installation without disconnecting raceways.

2.6 Leads.

A. Motor power leads shall be wired into the main conduit box. Unless otherwise specified, space heater leads shall be wired into the main conduit box. All motor leads and their terminals shall be permanently marked. Each lead marking shall be visible after taping of the terminals.

B. All motors shall have the direction of rotation marked by an arrow mounted visibly on the stator frame near the terminal housing, or on the nameplate, and the leads marked for phase sequence T1, T2, T3, to correspond to the direction of rotation and supply voltage sequence.

2.7 Terminals.

A. Cable type leads shall be provided with Burndy Type YA or acceptable equal compression type connectors.

2.8 Grounding Connections.

A. All motors shall be furnished with a ground connection in the cable termination box and grounding pad on motor frame.

2.9 Bearings.

A. All bearings shall be self-lubricating, shall have provisions for relubrication, and shall be designed to operate in any position or at any angle.

B. Motor bearings shall be antifriction type with L_{10} life rating of 100,000 hours in accordance with AFBMA Standards.

C. Provide SKF bearings without exception. Provide insulated bearings for adjustable frequency application of this motor to prevent circulation of shaft currents.

D. All bearing mountings shall be designed to prevent the entrance of lubricant into the motor enclosure or dirt into the bearings, and shall be fitted with pipes, drain plugs, and fittings arranged for safe, easy relubrication from the outside of the motor while the motor is in service, as necessary.

2.10 Rotors.

A. All induction motors shall have squirrel-cage rotors adequately sized to avoid overheating during acceleration of the motor and driven equipment. Rotors shall be dynamically balanced to 0.08 in./sec or less.

2.11 Shafts.

A. Shafts shall be furnished with corrosion resistant treatment or shall be of a corrosion resistant material.

2.12 Torque Characteristics. Not used.

2.13 Motor Space Heaters.

A. Motors shall be provided with a space heater element sized to prevent condensation on the core and windings. The space heaters shall be isolated or so located as to prevent heat damage to adjacent painted surfaces and shall be suitable for 120 volt, 60 Hz, single phase power supply.

2.14 Temperature Sensing Devices.

A. Each motor shall be furnished with resistive temperature devices (RTDs) placed to sense temperature in the motor windings and bearings. All RTDs shall be 100 ohm, platinum type. Each motor shall be equipped with a pair of RTDs in each phase winding and one or two RTDs in the thrust and guide bearings as required. Bearing RTDs complete with detector head and holder assemblies shall be furnished in accordance with the applicable requirements of ANSI MC96.1 and IEEE 119. All RTDs shall be connected with a twisted shielded triad to the motor auxiliary conduit box.

B. An auxiliary conduit box shall be provided for termination of RTD's.

2.15 Shaft Current Mitigation.

A. Provide a ring type ground brush designed for the mitigation of shaft currents induced by the adjustable frequency drive operation. Grounding brush shall be mounted internal to the motor enclosure and shall be installed prior to delivery on site.

2.16 Assembly.

A. All motors shall be completely assembled with the driven equipment, lubricated, and ready for operation.

2.17 Efficiency.

A. As required, motors shall be premium efficiency type and shall have a NEMA nominal efficiency nameplate value equal to or greater than 94.5 percent at full load and 100 percent speed.

2.18 Power factor.

A. Motors shall have a power factor value equal to or greater than 0.85 at full load and 100 percent speed.

2.19 ACCESSORIES.

A. Special Tools and Accessories.

1. Motors requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Each motor shall be provided with lifting eyebolts or lugs and appropriate fittings for adding bearing lubricant. Grease lubricated units shall be provided with a means of venting the casing. Oil lubricated units shall be provided with constant level oilers or with sight glasses arranged to indicate operating and static oil levels.

2.20 ANCHORS.

A. Contractor shall furnish suitable anchors for each item of equipment as required for driven equipment.

2.21 SHOP PAINTING.

A. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for coating. Electric motors shall be shop primed or finished with an oil-resistant enamel or universal type primer, suitable for top coating in the field with a universal primer and epoxy system.

2.22 BALANCE.

A. All rotating parts shall be accurately machined and shall be in as nearly perfect rotational balance as practicable. Excessive vibration shall be sufficient cause for rejection of the equipment. The mass of the unit and its distribution shall be such that resonance at normal operating speeds is avoided. In any case, the unfiltered vibration displacement (peak-to-peak), as measured at any point on the machine, shall not exceed the limits as required. At any operating speed, the ratio of rotative speed to the critical speed of a unit or its components shall be less than 0.8 or more than 1.3.

PART 3 - EXECUTION

3.1 INSTALLATION.

A. Each motor shall be installed in accordance with the Electrical Equipment Installation section.

END OF SECTION

SECTION 16345 MEDIUM-VOLTAGE VACUUM INTERRUPTER SWITCHGEAR

PART 1 - GENERAL

1.1 SCOPE

A. This section covers medium-voltage metal-clad switchgear that shall be furnished as specified herein and as indicated on the Drawings.

B. Switchgear shall meet the specified design conditions and features.

C. The Switchgear supplier shall ensure coordination between the switchgears and the Engine Generator Master and Local Control Panels supplied by the Engine Generator Supplier in section 11910. Switchgear 43-SWGR-1 shall be provided by the Engine-Generator Supplier.

D. Switchgear shall be designated and located as follows:

Tag number(s)	43-SWGR-1	42-SWGR-1	42-SWGR-2
Switchgear lineup designation(s)	4160V Switchgear	4160V Switchgear	4160V Switchgear
Location of switchgear lineup(s)	Electrical Building	Pump Station MV Electrical Room 1	Pump Station MV Electrical Room 2
Service Entrance Rated	No	No	No

E. Switchgear 43-SWGR-1 shall include a utility main circuit breaker, an engine-generator main circuit breaker isolating the generator bus from electric utility feed, two engine-generator circuit breakers, and a spare circuit breaker for future Tie configuration. The switchgear shall include all necessary ac and dc power supplies, ac and dc instrumentation, relaying, voltage regulator equipment, generator control equipment, indicating lights, selector switches and other accessories required for a complete and functional system.

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

2. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

C. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

D. Workmanship and Materials

1. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.

E. Governing Standards

1. All equipment to be furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

IEEE C37.04, C37.06, C37.11, C37.20.2, C37.09, and C57.13

NEMA C37.55, and SG-4.

2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

3. Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of Contractor. In the event no third-party testing laboratory provides the required listing, an independent test shall be performed at Contractor's expense. Before the test is conducted, Contractor shall submit a copy of the testing procedure to Engineer.

F. Nameplates

1. A master nameplate shall be attached to the switchgear giving switchgear designation, voltage and ampere rating, short circuit rating, manufacturer's name, general order number and item number.

2. Each circuit breaker and instrument on the front of the switchgear shall have a suitable nameplate. Each incoming line section shall be furnished with a nameplate to indicate the power source or substation from which it is fed. The nameplates for the distribution circuit breakers shall indicate the equipment fed through the breaker. Nameplates shall be black and white laminated phenolic material or suitable size, and shall be engraved with 3/4 inch high letters for section and circuit breaker identity and 1/8 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

3. Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

G. System Characteristics

1. All incoming and outgoing power cables shall enter and exit the switchgear from the bottom. Control wiring shall enter the switchgear and/or generator control sections from the bottom. Provisions shall be included in the switchgear to allow for top entry of any future power and control wiring.

2. The switchgear will be connected to a power system with characteristics as specified below.

Voltage rating	4.16 kV
Frequency	60 Hz
Type	Three phase
Grounding	Solid

H. Rating

1. The metal-clad switchgear assembly shall be rated as below.

Maximum design voltage	4.76 kV
Basic impulse level	60 kV
Rated Short Circuit Current	40 kA, rms
Bus rating	1200 A
Rated breaker interrupting time	3 cycle (0.05 seconds)

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the switchgear, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

    a. Master drawing index.
    b. Front view elevation.
    c. Floor plan.
    d. Top view.
    e. Conduit entry/exit locations.
    f. Weight.
    g. Bill of materials.
    h. Single line diagram.
    i. Three line diagram
    j. Schematic diagram.
    k. Nameplate schedules.
    l. Assembly ratings including short circuit rating, voltage, continuous current, and basic impulse level.
    m. Major component ratings including voltage, continuous current, interrupting rating.
    n. Cable terminal sizes.
    o. Descriptive bulletins.
    p. Product data sheets.
    q. Confirmation of compliance with the requirements of the Meteorological and Seismic Criteria section

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Switchgear shall be equipped to be handled by a crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

1.5 SPARE PARTS

A. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed. Spare parts shall be provided as follows:

Spare Parts	Quantity

Fuses	100% replacement set
Indicating lamps	100% replacement set
Color caps	100% replacement set

1.6 PROTECTIVE DEVICE STUDY

A. A protective device study of the power distribution system will be conducted as specified in the Electrical section. The equipment manufacturer shall provide the following information to Engineer with the initial equipment drawing submittal:

1. Protective relay coordination curves for each solid-state trip device.

2. Time current curves for each circuit breaker.

B. Data for all devices with adjustable settings shall be submitted, with all literature necessary to determine the appropriate settings. This shall include, but shall not be limited to, Operation Manuals for each type of adjustable trip device.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The switchgear shall be manufactured by Eaton, ABB, Schneider-Electric, or Siemens without exception.

2.2 CONSTRUCTION

A. All equipment furnished under this section shall be designed and constructed in accordance with the following requirements. The switchgear shall be the product of a manufacturer of both the stationary and draw out elements of a complete power circuit breaker assembly.

B. Sills and Anchors

1. Contractor shall furnish sills for all switchgear that requires sills to be embedded in the floor for leveling and alignment. The sills shall be drilled and tapped as necessary for the installation. All equipment requiring anchor bolts shall be provided with the anchor materials, complete with bolts, nuts, and washers. Sills and anchor materials shall be shipped ahead of the scheduled equipment delivery to permit installation before concrete is placed. Equipment submittal drawings shall show sill and anchor bolt locations.

C. Enclosure

1. The type of switchgear enclosure shall be NEMA Type 1 . The enclosure shall contain circuit breakers and all necessary accessory components. The integrated switchgear

assembly shall withstand the effects of closing, carrying, and interrupting currents up to the assigned short circuit rating. End sections shall include provisions for main, ground and neutral bus extensions and installation of future vertical sections.

2. Rear doors of each switchgear section with power cable termination or bus connections shall be equipped with an infrared inspection system for thermographic inspection of the power cable terminations or bus connections with the door closed. The system shall be positioned such that all the power cable terminations or bus connections are visible through the lens. The system shall consist of an infrared lens of 2-inch (50mm) diameter minimum and mounting hardware. The system shall be Fluke CLKTO, or approved equal.

3. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

D. Vertical Sections

1. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted together to form a rigid metal-clad switchgear assembly. Each vertical section shall accommodate breakers stacked two high and auxiliaries four high. Metal side sheets shall serve as grounded barriers between adjacent structures. Solid removable metal barriers shall isolate the primary major sections of each circuit. Two rear covers shall be furnished for each vertical section for circuit isolation and ease of handling.

E. Space Heaters

1. Each switchgear compartment shall be equipped with a space heater of adequate capacity to prevent moisture condensation within the switchgear. The heaters shall be thermally insulated and located at a safe distance from painted surfaces. Each space heater shall be rated for double the applied voltage. The heaters shall be controlled by an adjustable thermostat set to cut out when the temperature rises to 90°F and to cut in when the temperature falls below 85°F. Each space heater shall be equipped with a disconnect switch.

2. Space heater wiring with branch circuit protection shall be factory installed, with terminals provided for connection of an external power supply. The Contractor shall provide the necessary 120 VAC, 60 Hz, single phase power feed to the space heaters during the construction phase. Upon installation of the switchgear sections into their final conditioned space, the space heaters shall no longer be required to be in service.

F. Circuit Breakers

1. The circuit breakers shall be three-pole, single-throw, and shall be furnished complete with all equipment on a draw out carriage. The breakers shall be operated by a stored energy mechanism consisting of a heavy-duty spring, charged normally by a universal electric motor, and, in an emergency, by a manual handle. The circuit breaker control voltage shall be 48 volt dc and shall be derived from a DC power system specified in this section.

2. Each circuit breaker shall contain three vacuum interrupters, separately mounted in a self-contained, self-aligning housing which can be removed as a complete unit. The vacuum interrupter pole unit shall be mounted on glass polyester supports. Each vacuum interrupter shall be provided with a contact wear gap indicator which requires no tools to indicate available contact life, and is easily visible when the breaker is withdrawn on the extension rails. For ease of inspection and maintenance, the breaker front panel shall be removable when the breaker is withdrawn.

3. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from the housing, and to discharge the stored energy mechanism upon insertion or removal from the housing. The breaker shall be secured positively in the housing between, and including, the operating and test positions.

4. All removable breaker units of the same type and ampere capacity shall be wired alike and shall be electrically and mechanically interchangeable.

G. Main Bus

1. The main bus shall consist of rigidly supported, tin-plated copper bars of suitable design and cross-sectional area to satisfactorily carry the rated current without exceeding the specified temperature rise.

2. The bus shall have insulation, bus joint covers, and supports that is nontracing, nonflammable, and nonhygroscopic. Bus supports shall be glass polyester. The bus shall be capable of withstanding the magnetic forces imposed by short-circuit currents equal to the close and latch rating of the largest circuit breakers.

3. The bus insulation shall be of molded epoxy material over the entire length and shall be designed for the voltage service of 4.76 kV. The bus insulation shall be able to withstand the ANSI standard 60 Hz full wave and impulse (1-1/2 x 40 microseconds) test voltages of 19 and 60 kV. The molded epoxy insulation shall have a high resistance conducting surface in contact with the bus to eliminate corona damage to the bus insulation.

4. The current-carrying capacity shall be based on actual service conditions, including skin and proximity effect, insulation, steel enclosure, and an ambient temperature of 40°C. The bus shall be derated in accordance with IEEE C37.20.2 for ambient temperatures higher than 40°C. The bus shall be supplied in unit lengths that will permit the reassembly of the units in the field.

5. All joints shall have tin-to-tin contact surfaces and minimum contact resistance. Joints shall be equipped with removable insulating fittings at least equal to the bus bar insulation.

6. To prevent undesirable or destructive mechanical strains in the bus supports and connections, provisions shall be made for bus expansion through an ambient temperature range of -30 to +50°C. Expansion joints shall be supplied as necessary.

H. Ground Bus

1. An uninsulated ground bus of tin-plated high conductivity copper, with momentary and short time ratings at least equal to those of the largest circuit breaker, shall be furnished through the entire length of the switchgear. All switchgear equipment requiring grounding shall be connected to this ground bus. A clamp type connector shall be provided on each end of the ground bus for external connection of a 4/0 awg stranded copper grounding cable to the grounding system. A clamp type connector shall also be provided in each vertical section for connection of stranded copper grounding cable run with incoming and outgoing phase wires , as indicated on the Drawings.

I. Neutral Bus. Not Used.

J. Auxiliary Contacts

1. Each breaker shall be furnished with a sufficient number of auxiliary contacts and auxiliary switch contacts to provide all necessary interlocks for proper operation of the equipment. Not less than two spare NO and two spare NC auxiliary contacts (52AUX) shall be furnished on each breaker. Additionally, mechanism operated cell (52MOC) switches mounted in the stationary switchgear housing shall be provided with not less than two spare NO and two spare NC contacts. The 52MOC switches shall operate when the breaker is in the connected and test position unless indicated otherwise on the Drawings or Specifications. Truck operated (52TOC) switches mounted in the stationary switchgear housing shall also be provided with not less than two spare NO and two spare NC contacts. The 52TOC switches shall change state when the breaker is moved from connected to test or disconnected position. All auxiliary contacts and auxiliary switch contacts, including spare contacts, shall be wired to terminal blocks for use with control circuits.

K. Bus Connections

1. All current-carrying connections to the main buses shall be insulated copper of suitable capacity and shall conform to the requirements of the main bus insofar as bracing and temperature limits are concerned. Stationary contacts for the circuit breaker connections shall be suitable for the particular service.

2. Connections to the bus shall be made with suitable bus clamps or bolts with lock washers, and the copper bars shall be tin-plated at current-carrying connections. Molded removable covers or similar devices shall be used at connections to the bus.

3. Connections from the current transformers shall permit the transformers to be easily replaced.

4. Insulated cable connections shall be furnished for the potential transformers and control power transformers.

5. All materials required for insulation of field connections and their associated bus and terminals shall be provided.

L. Current Transformers

1. Ring type or toroidal current transformers of IEEE standard relay accuracy shall be furnished as indicated herein, as indicated on the Drawings, and as verified by the coordination study. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. The standard arrangement of two current transformers on the bus side and two on the line side of the breaker units shall be front accessible to permit adding or changing the current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all current transformers.

M. Potential and Control Power Transformers

1. Potential and control power transformers shall be supplied in the quantities and of the ratings specified herein or indicated on the Drawings. Potential or control power transformers up to 15 kVA single phase shall be mounted in a drawer or a tilt-out carriage in an auxiliary compartment. Opening the drawer shall ground the primary fuses of the transformer and permit easy inspection, testing, and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

2. The instrument potential transformer rating shall be coordinated with the instruments, relays, meters, and devices specified. The transformers shall have a mechanical rating equal to the momentary rating of the circuit breakers and shall have metering and relaying accuracies conforming to ANSI standards. The primary fuses furnished with the transformers shall be current-limiting type and shall be rated approximately 1/2 ampere. The fuses shall clear a faulted transformer in approximately 1/2 cycle (on 60 Hz basis), but shall not blow on magnetizing inrush current nor protect a transformer with a shorted secondary. Secondary fuses shall be provided for protection of potential transformers.

3. A mechanical interlock shall be provided for control power transformers, to require the secondary breaker to open before the drawer can be withdrawn.

N. Control Devices

1. Control switches shall be 600 volt, 20 ampere, multistage rotary type with black handles. Each switch shall have a fixed pistol grip handle with an engraved black plastic escutcheon plate. All circuit breaker control switches mounted on the front instrument panels shall be equipped with red, white, and green indicating lights.

2. White lights shall indicate breaker trip and shall be wired in series with a breaker auxiliary normally closed contact and control switch slip contacts, so the light will not be energized when the breaker is operated by the control switch.

3. Each electrically operated breaker shall be provided with a two-pole control power disconnecting and protective device in the closing circuit and another in the tripping

circuit. The disconnecting and protective device shall be either a molded-case circuit breaker or an enclosed fuse pullout.

4. Additional control devices shall consist of auxiliary relays and switches, control wiring and operating mechanism required for the particular breaker, an operation counter, a manually operated trip bar or lever, and provisions for manual closing.

5. Auxiliary control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.

O. Relays

The manufacturer shall furnish and install protective relays in the metal-clad switchgear in the quantities, types, and ratings indicated on the Drawings and specified herein.

Switchgear protective relays shall be of the draw out type in a semiflush mounting case, with test switches and devices incorporated in the relay unit. Relays shall have hand reset indicators. Exposed metal surfaces of relays shall have a dull black finish. Relays shall be wired so that the tripping current of the circuit breaker trip coil will be interrupted by means other than relay contacts.

Relays shall be furnished with test plugs that will allow testing of the relay without removing system wiring. Relays shall be furnished with extender boards that will permit troubleshooting of the PC boards outside the relay cradle. Power supply to relays shall be 48 volt dc. Voltage and current input to relays shall be 120 volt and or 0 to 5 amps from potential and or current transformers as indicated on the drawings. Relays shall be individual and multifunction type.

1. Relays shall have low burden, solid-state, microprocessor based circuitry and shall meet or exceed ANSI/IEEE standards. All settings shall be stored in non-volatile memory. Relays shall be manufactured by Schweitzer Engineering Laboratories, General Electric or Eaton, without exception.

2. Solid State Metering and Protection Unit

   a. Microprocessor based metering and protection units shall be capable of monitoring and displaying values of phase amperes, phase voltage, watts, vars, power factor, frequency, watt-hours, watt demand, and total harmonic distortion waveforms when metering is indicated on the Drawings. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of Ethernet/IP communication for remote monitoring.
   b. The digital power meters shall be manufactured by Schweitzer Engineering Laboratories, General Electric or Eaton, without exception.
   c. The protection functions shall include voltage phase loss, current phase loss, phase voltage unbalance, phase voltage reversal, overvoltage, undervoltage, and time delay for overvoltage, undervoltage, and phase unbalance. When required and as

indicated on the Drawings, the unit shall be capable of Ethernet/IP communication for remote monitoring. The metering and protection unit shall also be capable of digital communication over Ethernet to the engine-generator master control panel. If Ethernet/IP protocol is not supported then Modbus TCP/IP shall be used and the necessary communication module shall be provided in the engine-generator master control panel specified in section 11910.

d. Sufficient lengths of communication cable shall be provided for connection of metering units within the medium-voltage switchgear and as indicated on the Drawings.

3. Overcurrent Relays

a. Microprocessor based multiphase and ground, instantaneous and time overcurrent relay (devices 50/51 and 50N/51N) shall have programmable trip parameters (time curve, time dial, timed pickup and instantaneous) accessible from the front of the unit. Push buttons and a digital display shall be provided for manual programming. The relay shall have eight groups of time overcurrent curves selectable from the relay memory. Fault records for at least four faults shall be stored in memory for use in troubleshooting and system analysis. Timed overcurrent pickup range for the relay shall be 25 to 250 percent of CT secondary amperes adjustable in steps of 1 percent. Instantaneous current pickup range shall be 1 to 18 times phase pickup adjustable in steps of 0.1. Time dial range shall have at least 32 selections for each curve.

b. Overcurrent relays shall also include microprocessor based metering as a single device and shall be capable of monitoring and displaying values of phase amperes, phase voltage, harmonics, watts, VAs, VARs, power factor, frequency, watt-hours, and watt demand.

c. The units shall be operational from a 48 VDC control power source.

d. A lockout relay (device 86), shall be wired to trip the associated breaker.

e. Feeder protection relays (FPR and MPR) shall be SEL-751, Multilin-850 or EDR-3000, without exception.

f. Generator protection relays (GPR) shall be SEL-700G, Multilin-889 or EGR-5000, without exception.

4. Bus Differential Relays

a. When required, microprocessor based differential relays (device 87) shall provide a zone of protection which shall overlap the tie breaker and include all breakers normally served by the associated incoming feeder breaker.

b. A lockout relay (device 86), shall be wired to trip all breakers associated with the zone.

c. Bus differential protection relays shall be SEL-587Z, Multilin-B30 or EBR-3000, without exception.

P. Ethernet Switches

1. The Switchgear System Supplier shall provide Ethernet switch that meets the requirements of Network Systems section 13590.

Q. Switchgear Arrangement

1. The assembly shall consist of sections arranged as indicated on the Drawings and as specified herein.

R. Incoming Line Sections

1. When incoming line sections are required, each section shall consist of a basic incoming line unit, which houses the equipment and devices as indicated on the Drawings; installed and completely wired.

S. Bus Tie Breaker Sections

1. When bus tie sections are required, each section shall consist of a bus sectionalizing unit, which houses the equipment and devices as indicated on the Drawings; installed and completely wired.

T. Feeder Breaker Sections

1. When feeder breaker sections are required, each section shall consist of a basic feeder unit, which houses the equipment and devices as indicated on the Drawings; installed and completely wired.

U. Auxiliary Power Section

1. Control power shall be fed from a separately located 48 VDC battery system as described herein and as indicated on the Drawings.

2. Each circuit breaker within the medium-voltage switchgear shall be electrically operated at 48 VDC from the separately located 48 VDC battery system. Circuit breaker operating mechanism shall be electrically charged, stored energy type. Charging motor shall include a limit switch feature and an anti pump relay. Make provisions for manual charging of the mechanism and for slow closing of the contacts for inspection and adjustment.

V. Potential Transformers Sections

1. The potential transformer section shall consist of a sheet steel enclosed stationary cubicle, which houses the following:

1 Set of draw out potential transformers as indicated on the Drawings.

1 Hinged door, on the draw out side of the switchgear, serving as an instrument and control panel containing a voltmeter to indicate line-to-line voltage and a voltmeter transfer switch when indicated on the Drawings.

W. Ground-Test Device. Not used.

X. Wiring

1. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and at least 25 percent spare terminal points. Switchgear secondary wire

shall be 14 AWG, Type SIS, rated 600 volts, 90°C, and furnished with wire markers at each termination. Wires shall terminate on terminal blocks, with marker strips numbered to agree with detailed connection diagrams.

2. Compression type lugs, of the size indicated on the Drawings, shall be furnished for all incoming line and feeder cables. The design and arrangement of each section shall provide sufficient space for terminating power cables with IEEE Class 1 stress cones. The design shall take into account space for minimum bending radii of the cables to be terminated.

2.3 ACCESSORIES.

A. Special Tools and Accessories

1. Special tools, instruments, and accessories required for proper maintenance; and special devices for lifting or handling shall be furnished. The following accessories shall be supplied with the metal-clad switchgear.

1	Set of special wrenches or tools required for installation, operation, or maintenance of the equipment.
1	Test cabinet with test jumper for testing breakers out of the housing, for mounting on the wall, and wired for a power source separate from the switchgear control bus.
1	Breaker lifting device and transfer truck for moving the circuit breaker into and out of the breaker housing.
1	Set of extension rails.
1	Maintenance closing lever for closing the circuit breakers.
1	Manual operating lever for moving the breaker element into and out of the operating position.
1	Set of test plugs suitable for testing the relays.
1	Electric remote racking device. Racking motor shall operate on 120VAC voltage and shall be furnished with a minimum 25-foot grounded power cord and plug assembly and remote operation control station with 25-foot control cord. Unit shall be capable of racking breakers with all cubicle doors closed.

2.4 SHOP PAINTING

A. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop coated with the manufacturer's standard coating. Finish color shall be ANSI 61 for indoor equipment and ANSI 61 or 70 for outdoor equipment. Field painting, other than touchup painting, will not

be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup painting of damaged coatings.

B. The underside of equipment installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is considered to be the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting.

2.5 SHOP TESTS

A. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and other standard tests for the particular class of equipment, as defined by industry standards.

2.6 DC BATTERY SYSTEM

A. Contractor shall furnish and install dual normal and backup battery systems as indicated on the Drawings and specified herein, to operate breaker mechanisms, protective relays and other auxiliary loads within the switchgear lineups that utilize 48 VDC control power. One system shall be supplied in the Electrical Building and one system shall be supplied in the Pump Station as indicated on the Contract Drawings.

B. The dual normal and backup battery systems in both buildings shall be capable of operating 100% of the 5 kV circuit breakers simultaneously. One-minute discharge rate down to final 1.75 volt/cell shall be equal to trip current drawn by 100% of breakers tripping simultaneously. The battery systems shall be sized to operate each of the 5 kV breakers simultaneously. Minimum battery system ratings shall be as required by the switchgear manufacturer plus 25% spare capacity. Submit battery system sizing calculations in the shop drawings.

C. Batteries shall be valve regulated lead acid, gel-type, cabled to produce a 48 VDC output. Batteries shall be manufactured by EnerSys, Hawker Battery or ENGINEER approved equal.

D. Medium-voltage switchgear controls, utilizing 48 VDC power, shall be circuited as indicated on the Drawings.

E. Provide a modular cabinet enclosure to house the batteries. Battery cabinet enclosure shall be NEMA 12, fan ventilated with roof panel provisions for external ducting. Hydrogen and temperature monitoring shall be provided within the enclosure with provisions for remote alarm monitoring. Battery rack configuration is not acceptable.

F. Furnish a current limiting battery charger to automatically recharge the batteries. The charger shall float at 2.17 volts per cell and equalize at 2.33 volts per cell. Include input and output overload protection, silicon diode full wave rectifiers, voltage surge suppressors, and direct current ammeter. Charger output shall not be less than 20 amperes. Charger shall be smart type provided with MODBUS TCP/IP communication.

G. The battery system including batteries, battery cabinets, cabling, battery chargers, manual transfer switches, and other required equipment shall be provided by the Contractor for a

complete functioning system. Cabling between battery cabinets and transfer switches shall be welding type for flexibility.

H. A separately enclosed circuit breaker shall be supplied to disconnect the battery from the load and the charger during testing and maintenance of the battery. The circuit breaker shall be rated to carry the full-load current and the maximum short-circuit current provided by the battery. The circuit breaker shall be equipped with an auxiliary switch to indicate the open or close status of the circuit breaker. The switch shall be rated 120V and mounted in a NEMA 12 enclosure.

I. Direct Current Manual Transfer Switches.

1. Non-service entrance rated, manual transfer switches shall be furnished with ampere rating as shown on the Drawings. Transfer switches shall be wall mounted. The switches shall be manually controlled and mechanically operated load transfer switches with the voltage, continuous current capacity and withstand rating as indicated and as appropriate for the conditions of the installation.

2. Transfer switches mounted indoors shall have an enclosure rated NEMA 12. NEMA 12 enclosures shall be painted with the manufacturer's standard light gray ANSI 61 paint.

3. Provide transfer switches with withstand rating of 25,000 A rms symmetrical current minimum. Transfer switches shall be make-after-break as required by the system installation.

4. Manufacturers shall be ABB, Square D, Eaton or Engineer approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation will be in accordance with the Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.3 TRAINING

A. The manufacturer’s representative shall provide training of Owner’s personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

SECTION 16480 - 600 VOLT CLASS MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE

A. This section covers motor control center (MCC) equipment which shall be furnished and installed as specified herein and as indicated on the Drawings. Motor control centers shall meet the following requirements, and the design conditions and features specified herein.

B. Motor control centers shall be designated and shall be located as follows:

Tag number(s)	42-MCC-1
Motor control center designation(s)	480V Pump Station MCC
Location of motor control center(s)	Pump Station Low-Voltage Electrical Room

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless Engineer notes exceptions.

B. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. The supplier shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

E. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with applicable governing standards. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except when required by tests.

F. Governing Standards

1. All equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

   a. NEMA ICS 18
   b. UL 845.

2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

3. Equipment covered by this section shall be listed by UL or a nationally recognized third-party testing laboratory. All costs associated with obtaining the listing shall be the responsibility of the Contractor. In the event, no third-party testing laboratory provides the required listing; an independent test shall be performed at the Contractor's expense. Before testing, the Contractor shall submit a copy of the testing procedure that will be used in evaluating the equipment.

G. Nameplates

1. Nameplates with unit description and designation of each control or indicating device shall be provided on all hinged doors. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/8 inch high letters for compartment identity and 3/16 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the units shall be identified with permanent nameplates or painted legends to match the identification on the manufacturer's wiring diagram.

H. System Characteristics

1. This equipment will be connected to a power system with characteristics as specified below.

Voltage	480 V
Frequency	60 Hz

Type	Three phase

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the motor control center shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

a. Motor Control Center

1) Elevation, plans, and weight.

2) Unit wiring diagrams showing devices, connections, and terminal designations.

3) Interconnection diagrams.

4) Control schematic diagrams.

5) Circuit breaker time-current characteristic curves.

6) Surge protective device submittals shall include drawings (including unit dimensions, weights, component and connection locations, mounting provisions, and wiring diagrams), equipment manuals that detail the installation, operation and maintenance instructions for the specified unit(s), and manufacturer's descriptive bulletins and product sheets.

b. Seismic Design Requirements

1) Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

B. Operation and Maintenance Data and Manuals

1. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.4 SPARE PARTS

A. Spare parts shall be suitably packaged, as specified herein, with labels indicating the contents of each package. Spare parts shall be delivered to Owner as directed. Spare parts shall be provided as follows:

Spare Parts	Quantity
Fuses	100% replacement set
Indicating lamps	100% replacement set

1.5 PROTECTIVE DEVICE STUDY

A. A protective device settings study of the power distribution system will be conducted in accordance with the Electrical section. The initial equipment drawing submittal shall include the circuit breaker coordination curves for the main breaker(s), the tie breaker, the largest circuit breaker utilized in a combination starter and the smallest circuit breaker provided as a part of the motor control center assembly.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

B. Motor control centers shall be equipped to be handled by a crane. Where cranes are not available, control centers shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The equipment shall be manufactured by Allen-Bradley, Eaton, ABB, Schneider-Electric, or Siemens without exception.

2.2 CONSTRUCTION

A. Each control center shall conform to the arrangement, one-line diagram, schematics, and requirements indicated on the Drawings or specified herein. End sections shall include provisions for main, ground and neutral bus extensions and installation of future vertical sections.

B. Motor control center wiring shall be NEMA Class IIS and NEMA Type B. Construction shall be as specified below.

Tag number(s)	42-MCC-1
Bus bracing, circuit breaker and combination motor starter rating	65,000 A
Horizontal bus rating	1200 A
Service entrance rated	No
Cable entry	Top and bottom
Enclosure type	NEMA Type 1 gasketed
Main SPD exposure level	High

C. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

D. Vertical Sections

1. The control center shall consist of standardized, freestanding structures bolted together to form a single dead-front panel assembly containing combination motor control units; feeder units; transformers; lighting panels; and metering, relaying, and interlocking, and miscellaneous control devices, as indicated on the Drawings. A removable lifting angle shall be mounted on the top of each shipping group. Removable front and rear bottom channel sills shall extend the full width of the motor control center.

2. Each vertical section shall be 90 inches high and not less than 20 inches wide. Sections shall be 20 inches deep. Each 20 inch wide standard section shall have all necessary hardware and busing for modular plug-in units to be added and moved around. All unused space shall be covered by hinged blank doors and equipped to accept future units. Removable rear plates shall be sectionalized so that it is unnecessary to handle any plate larger than the section width or one-half the section height.

3. A metal barrier extending the full height and depth of the section shall be provided to isolate each section from the next section.

E. Compartmented Units

1. Each vertical section shall be constructed of modular components of various sizes. The modular components shall be designed to accommodate not more than six Size 1 or Size 2 full voltage combination motor starters per vertical section.

2. Removable circuit breaker and motor starter units shall be provided with a mechanical interlock to prevent insertion or withdrawal when in the "on" position.

3. Individual motor starter units, feeder breaker units, transformers, lighting panels, and control device compartments shall be isolated from each other by barriers of metal or a suitable insulating material.

4. Each vertical section shall have a vertical-wiring trough for power and control wiring, and wiring troughs on top and bottom, which are continuous through the entire control center. Wire ties shall be provided in the vertical wireways unless the wireways are separated from the plug-in units by a permanent wall.

F. Wiring Labels and Terminal Blocks

1. All internal wires shall be labeled at each termination. Terminals shall also be identified with labels showing the terminal block and terminal number.

2. All starter units shall be provided with unit control terminal blocks. Terminal blocks shall be pull-apart type rated 20 amperes. All current carrying parts shall be tin-plated. The removable portion of the terminal blocks shall be used for factory installed wiring.

G. Busing

1. The horizontal main bus and the vertical bus extensions shall be tin-plated copper mounted on supports formed of materials having high dielectric strength, low moisture absorbency, and high impact strength. The main bus shall extend the full length of the motor control center and shall have provisions for splicing additional sections onto either end. Both horizontal and vertical busing shall be braced against forces resulting from fault current.

2. The vertical bus connecting an incoming power feeder cable shall have the same ampere rating as the main horizontal bus. Each vertical bus extension shall be rated for the total connected load of the vertical section.

3. A tin-plated copper ground bus rated 300 amperes shall extend through the entire control center and shall be located where it will not interfere with pulling of external cable. Grounding connections shall be accessible from the front. The ground bus shall be provided with six 0.38 inch holes for each vertical section to accept ground lugs for any loads requiring a ground conductor. A solderless connector shall be provided on the ground bus in each end section for an external ground cable, sized from 1/0 AWG to 250 kcmil.

4. Each vertical section shall have a vertical ground bus. The plug-in units shall engage the ground bus prior to engagement of the power stabs and shall disengage only after the power stabs are disconnected.

H. Isolation of Buses

1. The main bus shall be isolated from the horizontal wiring trough. The entire vertical bus assembly shall be enclosed within grounded steel or glass filled polyester barriers. The barriers shall have openings for power stabs of plug-in units. Shutters shall be provided to close the openings when units are removed.

I. Combination Magnetic Starters

1. As indicated on the Drawings, control center starters shall be breaker combination, magnetic, reduced voltage, or across-the-line type as follows:

   a. Starters shall be 3 phase, 60 Hz contactors with overloads, a 120 volts ac coil, a dry type control transformer, and a molded-case circuit breaker. Control transformers shall be mounted with the removable starters and shall have capacity for all simultaneous loads. Control transformers shall have both primary leads fused, one secondary lead fused, and one secondary lead grounded.
   b. Contactors shall be NEMA rated and have an 8 hour current rating in accordance with the latest NEMA standards. Contactors of reversing or multispeed starters shall be mechanically and electrically interlocked.
   c. One NO and one NC spare interlock contacts, whether on the starter or a relay, shall be wired separately to the unit terminal board.
   d. Heaterless overload protection shall be provided by three current sensors monitored by a microprocessor. The overload device shall also include phase loss and unbalance protection, trip class selection, Class II ground fault protection, and manual reset.
   e. An external manual breaker operating handle with provisions for up to three padlocks shall be provided on each starter. The access door shall be interlocked with the circuit breaker so that the door cannot be opened, except by an interlock override, while the breaker is closed.
   f. Contractor shall match control transformers, overloads, and minimum sizes of starters to equipment furnished, which may differ from the estimated values indicated on the Drawings. Overload relay elements shall be sized to reflect reduced motor current caused by load-side power factor correction capacitors.
   g. Unless otherwise specified, spare starters shall have breakers and overloads sized for the largest rated motor and 100 watts extra transformer capacity.

J. Contactors

1. Contactors for control of bus voltage loads other than motors shall be the same as contactors for combination magnetic starters, except overloads will not be required. Mechanically held contactors shall have 120 volts ac coils with disconnecting contacts. Other contactors shall have 120 volt, continuous duty coils and contacts where indicated on the Drawings.

K. Relays and Timers

1. Auxiliary relays and timers shall have 120 volt, 60 Hz coils for continuous duty in 40°C ambient, and 10 ampere, 120 volts ac contacts. Auxiliary relays shall be NEMA rated.

L. Control Switches and Pilot Lights

1. Control switches and pilot lights shall be 30.5 mm heavy-duty, oiltight construction. Pilot lights shall be full voltage type with LED lamps.

M. Circuit Breakers

1. Control center disconnects shall be three pole, single-throw, 600 volt, molded-case air circuit breakers. Circuit breakers of combination starters shall be magnetic motor circuit protector type. Feeder circuit breakers shall be thermal-magnetic type and shall be manually operated, with quick-make, quick-break, trip-free toggle mechanism. Bimetallic thermal elements shall withstand sustained overloads and short-circuit currents without injury and without affecting calibration. Thermal elements shall trip the breaker at 125 percent of trip rating. The instantaneous elements of 225 ampere frame and larger breakers shall be adjustable and shall be set at 800 percent of trip rating.

2. Main circuit breakers and feeder circuit breakers 225 amperes and larger shall be furnished with a solid-state trip unit complete with built-in current transformers. The ampere rating of the trip unit shall be as indicated on the Drawings. The trip unit shall have adjustable settings for continuous amperes, and short-time pickup. The trip unit shall be provided with additional short delay trip time adjustment for better system coordination. Where indicated on the Drawings, main circuit breakers shall be provided with instantaneous pickup and integral ground fault protection with shunt trip devices.

N. Surge Protective Devices

1. Scope

a. Surge Protective Devices (SPD) shall be provided as specified herein and as indicated on the Drawings. Each unit shall be designed for parallel connection to the facility's wiring system and shall utilize non-linear voltage-dependent metal oxide varistors (MOV) in parallel.
b. SPD’s shall be furnished and installed for the electrical equipment indicated on the Drawings and designated in this section and as specified herein. SPD’s shall be installed integral to each MCC and MCC panelboard.

2. Standards

a. The specified unit shall be designed, manufactured, tested and installed in compliance with the following standards:

1) ANSI/IEEE C62.41 and C62.45;

2) ANSI/IEEE C62.1 and C62.11;

3) NEMA LS1;

4) NFPA 20, 70, 75, and 78;

5) UL 1449 and 1283

b. The unit shall be UL 1449 Listed as a Type 2 Surge Protective Device and UL 1283 Listed as an Electromagnetic Interference (EMI) Filter.

3. Environmental Requirements.

a. Operating Temperature: 0°F to +140°F.
b. Relative Humidity: Reliable operation with 5 percent to 95 percent non-condensing.

4. Electrical Requirements

a. Unit Operating Voltage. The nominal unit operating voltage and configuration shall be as indicated on the Drawings.
b. Maximum Continuous Operating Voltage (MCOV). The SPD shall be designed to withstand a MCOV of not less than 115 percent of nominal RMS voltage.
c. Operating Frequency. Operating frequency range shall be 47 to 63 Hertz.
d. Protection Modes. Four-wire configured systems shall provide Line-to-Neutral (L-N), Line-to-Ground (L-G), Line-to-Line (L-L), and Neutral-to-Ground (N-G) protection. Three-wire configured systems shall provide Line-to-Line (L-L) protection and Line-to-Ground (L-G) protection.
e. Rated Single Pulse Surge Current Capacity. The rated single pulse surge current capacity, in amps, for each mode of protection of the unit shall be as required and shall be no less than listed in the following table. Lighting panels shall be rated for the low exposure level capacity unless otherwise noted.

	L-N	L-G	N-G	L-L
High Exposure Level	120 kA	120 kA	120 kA	120 kA
Medium-High Exposure Level	100 kA	100 kA	100 kA	100 kA
Medium Exposure Level	80 kA	80 kA	80 kA	80 kA
Low Exposure Level	60 kA	60 kA	40 kA	60 kA

f. UL 1449 Voltage Protection Rating (VPR). The maximum VPR for the device (inclusive of disconnect) shall be as required and shall not exceed the following:

Voltage	L-N	L-G	N-G	L-L
480 V 3W		1200 V		2000 V

g. Noise Attenuation. The unit shall be capable of a minimum -30 dB attenuation at 100kHz when tested per the 50 ohm insertion loss method as defined by MIL-STD-220C.
h. Nominal Discharge Current. Each SPD shall have a nominal discharge current rating of 20 kA.

i. Overcurrent Protection. At high and medium-high exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 200kA symmetrical fault current with 600 volts ac applied.
At medium and low exposure levels, the SPD shall incorporate internal fusing capable of interrupting, at minimum, up to 65kA symmetrical fault current with 600 volts ac applied.
The device shall be capable of allowing passage of the rated maximum surge current for every mode without fuse operation.

j. Unit Status Indicators. The unit shall include long-life, externally visible phase indicators that monitor the on-line status of the unit.

5. Warranty

a. The manufacturer shall provide a minimum Five Year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

6. Installation

a. Each SPD shall be installed according to the manufacturer's recommendations. If possible for the integral units, provide direct bus connections.

O. Incoming Line Metering Compartment

1. The incoming line section(s) shall be provided with a microprocessor-based, digital power meter. Current transformers and potential transformers shall be provided for input of current and voltage signals to the metering package. Phase currents, phase voltages, watts, vars, power factor, frequency, watt-hours, watt demand , and total harmonic distortion waveforms shall be available for display. Metering units shall also include a display with touch screen monitor on the front of the equipment. The following alarm features shall be provided: undervoltage, power factor leading or lagging, kVAR limit, voltage sequence reversal, under frequency, and overcurrent. The metering package shall be capable of Ethernet/IP communication for remote monitoring. The digital power meters shall be Allen-Bradley "Power Monitor 5000", Eaton "Power Xpert Meter 1200", GE "EPM9450", Schneider-Electric "PowerLogic Model CM4000T", or Siemens "9410 Series".

2. Sufficient lengths of communication cable shall be provided for connection of metering units within the motor control center and as indicated on the Drawings.

3. The metering package shall be compatible with the metering system software and metering system network as specified in the Electrical section. Contractor shall furnish and install applications software for origination and display of all metering unit data and microprocessor-based trip-unit data in accordance with the Electrical section.

P. Miscellaneous

1. Other items indicated on the Drawings shall conform to the applicable provisions of NEMA ICS 2 and UL 845.

Q. Shop Painting

1. All iron and steel surfaces, except stainless steel and machined surfaces, shall be plated or shop painted with the manufacturer's standard coating. Finish color for both indoor and outdoor equipment shall be ANSI 61. Field painting, other than touchup painting, will not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2. The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

2.3 SHOP TESTS

A. The complete control center shall be tested at the factory. All circuits, including power and control, shall be given dielectric tests in accordance with NEMA ICS 2-322.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning section, and shall revisit the job site as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract price.

B. Installation Supervision

1. Installation supervision by the manufacturer is not required.

3.3 TRAINING

A. The manufacturer’s representative shall provide training of Owner’s personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

SECTION 16491 - AUTOMATIC TRANSFER SWITCH

PART 1 - GENERAL

1.1 SCOPE

A. This section covers both indoor and outdoor automatic transfer switches, , which shall be furnished, and tested as specified and as indicated on the Drawings.

B. Automatic transfer switch equipment shall meet the design conditions and features.

C. Automatic transfer switch equipment shall be designated and located as follows:

Tag number(s).	43-ATS-1
Transfer switch designation(s).	Automatic Transfer Switch
Location of transfer switch(es).	Electrical Building

1.2 GENERAL

A. Equipment furnished and installed under this section shall be fabricated, assembled, erected , and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of the equipment manufacturer, unless exceptions are noted by Engineer.

B. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If stipulations in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

C. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

D. Dimensional Restrictions

1. Layout dimensions will vary between manufacturers and the layout area indicated on the Drawings is based on typical values. Contractor shall review the Contract Drawings, the manufacturer's layout drawings and installation requirements, and make any modifications required for proper installation subject to acceptance by Engineer.

E. Workmanship and Materials

1. Equipment supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

F. Governing Standards

1. The equipment furnished under this section shall be designed, constructed, and tested in accordance with the following standards:

   a. UL 1008;
   b. NFPA 110;

2. The equipment shall also conform to all the applicable standards of ANSI, IEEE, NEMA, UL, and NFPA 70.

3. The automatic transfer switch shall be UL listed for use in standby power systems in accordance with Article 702, Optional Standby Systems, of the National Electrical Code.

G. Nameplates

1. Nameplates with designation of each control or indicating device shall be mounted on the switch enclosure. Nameplates shall be black and white laminated phenolic material of suitable size, and shall be engraved with 3/4 inch high letters for section identity and 1/8 inch letters for other information. The engraving shall extend through the black exterior lamination to the white center.

2. Each control device and each control wire terminal block connection inside the units shall be identified with a permanent nameplate or painted legend to match the identification on the manufacturer's wiring diagram.

H. System Characteristics

1. The equipment will be connected to a power system with characteristics as specified below:

Voltage, phase	480, 3-phase V
Frequency	60 Hz
Number of conductors	3-wire

1.3 SUBMITTALS

A. Drawings and Data

1. Complete assembly, foundation, and installation drawings, together with complete engineering data covering the materials used, parts, devices, and accessories forming a part of the transfer switch, shall be submitted in accordance with the Submittal Procedures section. The drawings and data shall include, but shall not be limited to, the following:

2. Drawings showing front and side views, plan, and weight.

3. Rating and specifications.

4. Circuit breaker time-current characteristic curves, if applicable.

5. Single-line, control schematic, and wiring connection diagrams.

6. Operation and maintenance and manuals including a list of spare parts.

7. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 OPERATION AND MAINTENANCE MANUALS

A. Operation and maintenance manuals shall be submitted in accordance with the Submittal Procedures section. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Shipping shall be in accordance with the Product Delivery Requirements section. Handling and Storage shall be in accordance with the Product Storage and Handling Requirements section.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The automatic transfer switch shall be a product of a manufacturer who has supplied such equipment for at least 5 years.

B. The automatic transfer switch shall be manufactured by Automatic Switch Co. (ASCO), GE Zenith Controls, Eaton, or Russelectric Inc., without exception.

2.2 CONSTRUCTION FEATURES

A. Enclosure

1. The enclosure for the transfer switch shall be as follows:

Type of mounting	Freestanding
Enclosure rating	Indoor NEMA Type 1

2. Adequate bracing shall be provided for seismic forces. The bracing shall be designed to meet the requirements of the Meteorological and Seismic Design Criteria section.

B. Rating

1. Automatic transfer switches shall be rated for continuous duty in both normal and emergency positions. The switches shall have the number of poles as specified below, and shall be double-throw. Ampere ratings, and 3-cycle closing and withstand ratings shall be as specified below.

Number of poles	3-pole
Ampere rating and 3-cycle closing and withstand rating	As indicated on the Drawings

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Equipment Description

1. The automatic transfer switches shall transfer electric loads from the normal source of electric power to an emergency source of power as indicated on the Drawings. The transfer switches shall automatically transfer the electrical load circuits upon an interruption or a decrease in the voltage of the normal source of power and shall transfer the loads back to the normal source when it becomes available. The transfer switches shall be furnished without integral overcurrent protection. The switches shall be electrically operated but mechanically held in both the normal and emergency positions. The operating mechanism shall be momentarily energized from the source to which the load is being transferred. All main and arcing contacts and control elements shall be removable from the front of the switches without removing the switch from the enclosure and without removing the power cables. The automatic transfer switches shall be so designed that the load circuits cannot be connected to more than one source of power at a time. The automatic transfer switches shall be magnetic contactor type.

2. Automatic Transfer Switch

   a. The automatic transfer switch shall be an electrically operated double throw switch. Main contacts shall be silver composition. Main and arcing contacts shall be visible without major disassembly to facilitate inspection and maintenance. A manual handle shall be provided for maintenance.
   b. Switches composed of molded case breakers, contactors, or similar components not specifically designed for automatic transfer switch applications will not be acceptable.

B. Control System

1. The control system shall consist of all control devices necessary to operate the switch as described. The system shall incorporate a microprocessor control module connected to the power transfer components by a wire harness and keyed disconnect plugs. The control module shall be completely enclosed with a protective cover and shall be mounted separately from the transfer switch unit for safety and ease of maintenance. Sensing and control logic shall be provided on plug-in circuit boards. All interface relays shall be identical and shall be control grade, plug-in type, with dust covers.

2. All control components shall meet or exceed the voltage withstand capability in accordance with IEEE C37.90.1 and NEMA ICS 1.

3. Performance

a. The automatic transfer switch shall be designed to function in accordance with the following requirements:
   1) The voltage of each phase of the normal source shall be monitored and the pickup voltage shall be adjustable from 85 percent to 100 percent of nominal, and the dropout voltage shall be adjustable from 75 percent to 98 percent of the pickup value. The transfer to emergency will be initiated upon reduction of the normal source to 85 percent of the normal voltage, and retransfer to normal shall occur when the normal source restores to 90 percent of the normal voltage.
   2) A time delay to override momentary normal source outages to delay all transfer switch and engine starting signals shall be provided. The time delay shall be field adjustable from 0.5 to 6 seconds and shall be factory set at 1 second.
   3) A time delay to retransfer to the normal source shall be provided. The time delay shall be automatically bypassed if the emergency source fails and the normal source is available. The time delay shall be field adjustable from 0 to 30 minutes and shall be factory set at 10 minutes.
   4) An in-phase monitor shall be provided to control transfer so motor load inrush currents do not exceed normal starting currents. The monitor shall compare the phase relationship and frequency difference between the normal and emergency sources and shall permit transfer only at acceptable values of voltage, phase relationship, and frequency differential.
   5) An unloaded running time delay for engine-generator cool-down shall be provided. The time delay shall be field adjustable from 0 to 60 minutes and shall be factory set at 5 minutes.

4. Indication

   a. The automatic transfer switch shall include indication features in accordance with the following requirements:
      1) A detailed step-by-step operating instruction plate shall be provided on the front of the switch.
      2) Indicating lights or microprocessor control display indication shall be provided for, but shall not be limited to, the following:
         a) Normal source available.
         b) Emergency source available.
         c) Automatic transfer switch inhibit.
         d) Automatic transfer switch in normal position.
         e) Automatic transfer switch in emergency position.
      3) One auxiliary contact shall be provided that is closed when the automatic transfer switch is connected to the normal source and one contact that is closed when the automatic transfer switch is connected to the emergency source.
      4) A contact, which will close when the normal source fails, shall be provided to initiate engine starting. The contact shall be rated 10 amperes, 32 VDC and shall be gold plated for low voltage service.

C. Shop Painting

1. All iron and steel surfaces, except machined surfaces and stainless steel, shall be shop painted with the manufacturer's standard coating. Finish color shall be ANSI 61. Field painting, other than touchup painting, shall not be required. A sufficient quantity of additional coating material and thinner shall be furnished to permit field touchup of damaged coatings.

2. The underside of equipment to be installed in exposed outdoor locations shall be thoroughly cleaned and coated with an automotive type undercoating material. The coating shall be thick enough to withstand normal handling during shipping and installation. The underside is defined as the surfaces in contact with the floor or pad and other surfaces not readily accessible for field painting. The coating may be factory or field applied.

D. Shop Tests

1. After the equipment has been completely assembled, it shall be shop tested for general operating condition, circuit continuity, high potential, and for compliance with the governing standards. Certified test results shall be submitted to Engineer before the equipment is shipped.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The transfer switch will be installed in accordance with Electrical Equipment Installation section.

3.2 FIELD QUALITY CONTROL

A. Installation Check

1. An experienced, competent, and authorized representative of the manufacturer shall visit the site of the Work and inspect, check, adjust if necessary, and approve the equipment installation. The representative shall be present when the equipment is placed in operation in accordance with Commissioning section, and shall revisit the jobsite as often as necessary until all trouble is corrected and the equipment installation and operation are satisfactory in the opinion of Engineer.

2. The manufacturer's representative shall furnish a written report certifying that the equipment has been properly installed and lubricated; is in accurate alignment; is free from any undue stress imposed by connecting piping or anchor bolts; and has been operated under full load conditions and that it operated satisfactorily.

3. All costs for these services shall be included in the Contract Price.

3.3 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

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SECTION 16670 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 SCOPE

A. This section covers furnishing the design of lightning protection systems and the furnishing and installation of lightning protection equipment for the following structures:

1. Pump Station

2. Electrical Building

B. Lightning protection systems shall be furnished, installed, and tested as specified. Lightning protection equipment shall meet the requirements specified herein.

C. Lightning protection systems shall consist of, but not be limited to, air terminals; main, bonding, and down conductors; ground terminals; and all required connectors and fittings required to complete the system.

D. The lightning protection system shall include the bonding of all roof-mounted mechanical equipment, roof drains, roof mounted ladders, chimneys, antennas, and other roof mounted metal objects.

1.2 GENERAL

A. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor and obtain all inspections to complete the work as specified, and in compliance with all codes, standards, and regulations.

B. Contractor shall provide coordination with other contractors and supervision of installation as needed during construction.

C. The design of the system shall include determination of the overall lightning hazard for the geographic location of the project and for the structures, the selection of Class I and/or Class II materials, the need of corrosion protection for the copper and/or aluminum components used, and consideration of other pertinent factors. The design shall produce a zone of protection from lightning to prevent personal injury, structural damage, and equipment downtime.

D. Equipment furnished and installed under this section shall be fabricated, assembled, erected, and placed in proper operating condition in full conformity with the Drawings, Specifications, engineering data, instructions, and recommendations of UL unless exceptions are noted by Engineer.

E. The system shall be installed by an installer who has UL listing and subscribes to the UL Follow-Up Service.

F. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

G. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

H. Governing Standards

1. All system components furnished under this section shall be designed in accordance with ANSI/UL 96 - Lightning Protection Components. All lightning protection systems furnished under this section shall be designed, constructed, and tested in accordance with UL 96A – Installation Requirements for Lightning Protection Systems and ANSI/NFPA 780 – Standard for the Installation of Lightning Protection Systems.

2. Lightning protection systems shall be bonded to grounding electrode systems in accordance with the National Electrical Code.

I. Workmanship and Materials

1. Contractor shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.

2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and thicknesses so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, unless required by tests.

1.3 SUBMITTALS

A. Drawings and Data

1. Complete certification of design calculations; assembly, and installation drawings; together with complete engineering data covering the materials used and the parts, devices, and accessories forming the system, shall be submitted in accordance with the Submittals Procedures section.

B. Meteorological and Seismic Design Criteria Compliance

1. Submit confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.

1.4 QUALITY ASSURANCE

A. The lightning protection system shall be inspected and tested after installation by conducting continuity and ground resistance tests as well as a visual inspection. Inspection results and test data shall be submitted in accordance with the Submittals Procedures section. Upon completion of the installation, Contractor shall apply for and deliver the UL Master Label Certificate of Inspection for each structure/building.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. The system components shall be manufactured by a company that has been specializing in the design and manufacture of UL listed lightning protection equipment for at least 5 years.

2.2 MATERIALS

A. All manufactured and fabricated components shall conform to NFPA 780 Class I or Class II as needed for the structures on which they will be installed. The system components shall be fabricated from the following metals:

Conductors	Copper.
Air Terminals	Copper or bronze.
Grounding Electrodes	Copper clad steel.
Fasteners	Copper or bronze.
Bimetallic Fasteners	Bronze and aluminum.

B. Aluminum conductors and air terminals shall be mounted on aluminum surfaces only.

C. All materials furnished for the lightning protection system shall bear the inspection label of UL.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The lightning protection system shall be installed in a neat and inconspicuous manner so all components will blend in with the appearance of the building. All conductors shall be concealed or semi-concealed during construction using methods recommended in NFPA 780 and UL 96A.

B. Air terminals shall have base supports designed for the surface on which they are used and shall be securely anchored. All exposed metal eave troughs, roof vents, guy wires, antennas, and air handling equipment shall be bonded to the lightning protection system in such a way that two paths to ground are provided.

C. The lightning protection system shall be bonded to structure/building electrical ground rings wherever they are available.

End of Section

SECTION 16721 - FIRE DETECTION AND ALARM SYSTEM

PART 1 - GENERAL

1.1 SCOPE

A. This section covers the design and the furnishing and installation of a fire detection and alarm system. All associated equipment, devices, and controls necessary for proper operation shall be included.

B. The design of the system shall consist of, but shall not be limited to, a determination of the applicable fire and safety codes; an analysis of the various plant ambient temperatures, noise levels and environments (wet, dusty, oily, corrosive, hazardous, etc.); the number and type of detectors, alarm indicators, and manual stations required; and the proper wiring and mounting configurations.

C. Peripheral components as specified shall be located as indicated on the Drawings and provided in sufficient number and located as needed to meet all applicable codes.

D. Pump Station and Electrical Building (42-FACP-100): A panel shall be furnished in the Pump station as located in the Drawings and shall monitor both the pump station spaces and the electrical building space. The panel shall perform area detection and duct smoke detection for all applicable areas, including:

1. Pump Station: Laboratory (105), Storage (106), Low Voltage Electrical Room (109), Pump Room (111), Med Volt Electrical Room 1 (113), Med Volt Electrical Room 2 (114)

2. Electrical Building: Electrical Room (101)

E. The system shall alarm to the plant control system as well as various audio and visual alarms as required by building codes.

1.2 GENERAL

A. Contractor shall furnish all installation drawings, tools, equipment, materials, and supplies and shall perform all labor to complete the work as specified, and in compliance with the codes, standards, and regulations listed below.

B. Contractor’s Qualifications

1. The system design, equipment, installation, and installation supervision furnished under this section shall be provided by a single manufacturer or supplier who has been engaged in the business of supplying fire alarm systems of this type for at least 5 years.

C. General Equipment Stipulations

1. The General Equipment Stipulations section shall apply to all equipment furnished under this section. If requirements in this section differ from those in the General Equipment Stipulations section, the requirements specified herein shall take precedence.

D. Seismic Design Requirements

1. Seismic design requirements for products specified herein shall be as indicated in the Meteorological and Seismic Design Criteria section.

E. Governing Standards

1. Arkansas State Fire Marshal's Regulations for Safety to Life from Fire and Emergencies in Buildings and Structures, and General Fire Protection.

2. National Fire Protection Association, NFPA 45, 71, 72, 90A, and 101.

3. Local City Fire Department Regulations

4. National Electrical Code, Article 760.

F. All fire alarm equipment and materials, devices, and assemblies shall be listed and/or labeled by Underwriters' Laboratories, Factory Mutual, or another accepted testing laboratory for the intended purpose where acceptable to the authority having jurisdiction. The equipment shall not be altered, installed, or modified in any way that would void the label or listing.

G. All control equipment shall have transient voltage protection devices in compliance with UL 864.

H. The system controls shall be UL listed for Power Limited Applications according to NEC 760. All circuits shall be marked in accordance with NEC 760.10.

I. Nameplates

1. Major components of equipment shall be identified with a permanently affixed nameplate bearing the manufacturer's name and address, and type or style and catalog number of the item.

J. Tags

1. Keys and locks shall be furnished with tags bearing stamped identification numbers. Cable and conduit runs, wiring circuits, and all spare parts supplied to maintain the system shall be furnished with hard phenolic or stainless steel tags.

K. Power Requirements

1. Power supply to the fire alarm control panel (FACP) will be 120 volts, 60 Hz, single phase.

2. The alarm system shall include an automatically recharged backup power supply with sufficient battery capacity to operate the entire system in the normal supervisory mode

for 24 hours and then sound all alarms for 5 minutes. In the event of power failure, the system shall automatically transfer to the standby batteries.

3. All external circuits requiring system-operating power shall be suitable for 24 volt dc service and shall be individually fused at the control panel.

L. Spare Parts

1. Spare parts as specified below shall be supplied with the fire detection and alarm system. Spare parts shall be suitably packaged for shipment.

Spare Parts	Quantity
Smoke detectors and heat detectors	One of each type used
Manual pulls stations	One of each type used
Audiovisual alarms	One of each type used

1.3 SUBMITTALS

A. Drawings and Data

1. Complete electrical wiring diagrams; assembly and installation drawings; detailed specifications; and data covering the materials used and the parts, devices, and other accessories forming a part of the equipment furnished shall be submitted in accordance with the Submittal Procedures section.

B. Agency Review Package

1. In addition to the submittals to Engineer, Contractor shall submit complete plans and information to the local fire department for review. Contractor shall provide signed and sealed plans by a registered engineer in the state of where required by local or state requirements. The equipment submittals shall include the following:

   a. A complete description of all system components, including certification of listing by the required testing laboratory.
   b. Complete sequence of operation for all functions of the system.
   c. Complete system wiring diagram for all components and interfaces to equipment supplied under other sections.
   d. Location drawings for all controls, alarm actuating devices, and audiovisual alarm signaling devices.
   e. A listing of the manufacturer's representatives responsible for installation and service.
   f. Confirmation of compliance with the requirements of the Meteorological and Seismic Design Criteria section.
   g. Operation and maintenance manuals.

1.4 SYSTEM DESCRIPTION

A. The fire alarm system shall be operated and monitored by a fire alarm control panel (FACP), located as indicated on the Drawings. The system shall automatically initiate fire alarm signals whenever any manual or automatic fire detection device is placed in an alarm mode. The system shall transmit a signal to the municipal alarm connection, HVAC systems, the plant control system, and other plant systems as indicated in the activation sequence herein. The FACP shall annunciate and sound local alarms for detection device alarm conditions, system trouble, or circuit failure. Alarm signals shall be consistent throughout the building or site. The operation of any alarm initiating device shall cause audible and visual alarms to sound and to be displayed throughout the building by applicable codes. A key-accessible reset function shall reset the alarm system after alarm initiating conditions have been cleared.

B. The system functions shall include area detection, manual stations, duct smoke detection, as applicable .

C. The system shall automatically activate smoke detected audiovisual annunciation equipment whenever an area smoke detector or duct smoke detector is in alarm mode. The system shall identify the device and the location. For duct smoke detection, the system shall simultaneously provide an isolated alarm contact indication to the temperature control system to deactivate the HVAC systems as indicated in the HVAC sequence of operations on the Drawings.

D. Fire Alarm System

1. Initiating device, notification device, and signaling line circuits shall be NFPA 72, 3-4, Class A. The system shall monitor incoming power and standby power. In addition to the FACP, the system shall include heat detectors, smoke detectors, audiovisual alarm units, end-of-line devices, manual pull stations wiring connections to devices, outlet boxes, junction boxes, and all other necessary equipment for a complete operating system.

2. System trouble, including grounded or open supervised circuit, power failure, system battery low voltage, or system failure, shall cause the system to enter a trouble mode and display visual and audible alarms. The visual alarm shall be displayed until the initiating trouble has been cleared.

E. Activation Sequence

1. The alarm sequence initiated by the activation of any manual station, automatic detection device, duct smoke detector, shall be as follows:

    a. Selected audible alarm indicating devices shall sound a march time code until silenced by the alarm silence switch at the FACP.
    b. Selected visual alarm indicating devices shall display a continuous strobe pattern until the system is reset.
    c. A supervised signal shall notify the local fire department or the central processing unit.
    d. For duct smoke detection, the system shall simultaneously provide an isolated alarm contact indication to the temperature control system to deactivate the HVAC systems as indicated in the HVAC sequence of operations on the Drawings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All panels and peripheral devices shall be the standard products of a single manufacturer, and the manufacturer's name shall be displayed on each component. The system shall be manufactured by Bosch Security Systems; Gamewell-FCI; Notifier; Siemens Building Technologies; or Simplex Grinnell.

2.2 REMOTE SENSORS

A. Fire Alarm Pull Stations

1. Addressable pull stations shall communicate the station's status (alarm, normal) over two wires that also supply power to the pull station. The address shall be set on each station. The stations shall be manufactured from high-impact red Lexan. Lettering shall be raised and painted white. When activated, the stations shall mechanically latch and remain latched until they are manually reset using a key common to all locks.

2. The location "address" of the pull stations shall be capable of field programming from the FACP over the signaling line circuit.

B. Smoke Detectors

1. Analog addressable smoke detectors shall be of the photoelectric type and shall communicate actual smoke chamber values to the system control panel. The sensors shall be solid-state, containing no radioactive material, and shall be capable of detecting up to seven sensitivity levels between 0.5 and 3.7 percent.

2. The sensors shall be plug-in units mounted on a twist-lock base. Smoke detector bases shall be common with the heat detector bases and shall be compatible with other addressable detectors and addressable manual stations on the same circuit. The detectors shall be suitable for both ceiling and wall mounting and shall have a 30-mesh insect screen. Detector bases shall contain a light emitting diode that will flash each time it is scanned by the control panel. When the sensor detects smoke or fails, the diode shall illuminate to indicate the abnormal condition. When required, detector bases shall be provided with a relay driver output that may be controlled either automatically or manually from the control panel.

3. Each detector shall contain a magnetically actuated test switch for alarm testing at the sensor location.

4. Smoke detectors for installation in ducts shall be as specified above and shall be provided with auxiliary DPDT relays, remote LED alarm indicators, and key-operated test stations.

C. Heat Detectors

1. Addressable heat detectors shall be ambient compensated combination rate-of-rise and fixed temperature types. The fixed temperature operation of the sensor shall be selectable

for either 117 or 135° F. Rate-of-rise operation shall be selectable for either 15 or 20° F per minute and shall be self-restorable.

2. The thermal type sensor shall be a plug-in unit that mounts on a twist-lock base. Bases shall be as described for smoke detectors.

D. Audiovisual Alarm Units

1. Alarm units shall consist of a horn and a Xenon flashtube installed in a surface or semi-flush wall- or ceiling-mounted enclosure. The horn shall have polarized connections with separate leads for in/out wiring for each leg of the associated signal circuit. Sound level shall be 90 dB at 10 feet.

2. The visual unit shall operate on 24 volts dc and shall have a white translucent pyramidal lens with the word "FIRE" imprinted in red lettering. The flash rate shall be 1 to 1.5 times per second.

E. Auxiliary Relays

1. Auxiliary relays shall be supplied where required. The relays shall be of high quality and shall be fitted with dusttight plastic covers. The contacts shall be at least 1/8 inch in diameter, of gold-plated silver cadmium oxide, rated for 5 amperes at 115 volts ac.

F. Addressable Input Modules

1. Each external dry contact input from sprinkler system flow switches and other required auxiliary inputs shall be equipped with addressable input modules designed to provide circuit monitoring and point identification of dry contact inputs.

2.3 PANELS

A. Fire Alarm Control Panel

1. The control panel shall be an analog/addressable type fire alarm control panel. The panel enclosure shall be constructed from steel, in compliance with UL 864, with front access door, and shall be surface wall-mounted.

2. The control panel shall be of modular construction, with solid-state, microprocessor-based electronics, and shall display only the primary controls and functions essential to operation during a fire alarm condition. Keyboards or keypads shall not be required to operate the system during fire alarm conditions. A local audible device shall sound during alarm, trouble, or supervisory conditions. The sound that identifies each condition shall be readily distinguishable without having to view the panel. The audible device shall also sound during each key press to indicate that the key has been pressed. The panel shall be fully field programmable from the keypad and capable of downloadable programming from a Windows-based application program. The panel shall include self-programming logic capable of automatically programming new addressable field initiating devices.

3. The following primary controls shall be visible through a front access panel:

a. Eighty-character liquid crystal display, backlit.
b. Red system alarm LED.
c. Yellow supervisory service LED.
d. Yellow trouble LED.
e. Green “power on” LED.
f. Alarm acknowledge key.
g. Supervisory acknowledge key.
h. Trouble acknowledge key.
i. Alarm system key.
j. System reset key.
k. Manual evacuation (drill).

4. The control panel shall include the following functions:

a. Setting of time and date.
b. LED testing.
c. Listing of alarm, trouble, and abnormal conditions.
d. Separate enabling and disabling of each monitor point.
e. Separate activation and deactivation of each control point.
f. Changing operator access levels.
g. Walk-test enable.
h. Running diagnostic functions.
i. Displaying software revision level.
j. Displaying historical logs.
k. Displaying card status.
l. Point listing.

5. The following lists from the points list menu shall be available for maintenance purposes:

a. All points by address.
b. Monitor points.
c. Auxiliary controls.
d. Feedback points.
e. Pseudo points.
f. LED/switch status.

6. Scrolling through menu options or lists shall proceed in a self-directing manner, guided by prompting messages. The controls for the points list menu shall be located behind an access door.

7. The control panel shall contain a back lighted 2 line by 40 character liquid crystal display. To conserve standby battery power in the event of an ac power failure, the display shall be lit only during keypad activity.

8. The display shall consist of both upper case and lower case letters. Lower case letters shall be used for soft key titles and for prompting the user. Upper case letters shall be used for system status information. A cursor shall be visible when information is being entered.

9. All wiring shall be brought to terminal strips for field connections.

10. Front Panel Operation and Capabilities

    a. Under normal conditions, the front panel shall display a "SYSTEM IS NORMAL" message and the current time and date.
    b. Should an abnormal condition be detected, the appropriate alarm, supervisory, or trouble LED shall flash. The audible signal shall pulse for alarm conditions and sound steady for trouble or supervisory conditions.
    c. The LCD shall display the following information pertaining to the abnormal condition:

        1) Location label (40 characters available).

        2) Type of alarm device - smoke detector, pull station, and water flow sensor.

        3) Point status - alarm, trouble.

    d. Buttons shall be provided to acknowledge alarm conditions and to silence audible alarms in compliance with NFPA 72.

11. Alarm Silencing

    a. When the "ALARM SILENCE" button is pressed, all alarm signals shall cease. Alarm signals shall not be silenced during "alarm silence inhibit" mode.

12. System Reset

    a. Using the "SYSTEM RESET" button shall restore the system to its normal state after an alarm condition has been remedied.
    b. The LCD display shall step the user through the resetting procedure with simple printed messages.

13. Device Status

    a. Complete status of all addressable field devices shall be available through use of the operator keypad and front panel display.

14. History Logging

    a. The system shall be capable of logging and storing 500 alarm, trouble, and operation events in a history log. These events shall be stored in a battery-protected random access memory. Each recorded event shall include the time and date of the occurrence.

15. Silent Walk Test with History Logging

    a. The system shall be capable of being tested by one person. While in testing mode, the alarm activation of an initiating device circuit shall be silently logged as an alarm condition in the historical data file. After logging the alarm, the panel shall automatically reset.

b. The momentary disconnection of an initiating or indicating device circuit shall be silently logged in the historical data file as a trouble condition. After logging the trouble condition, the panel shall automatically reset.
c. Should the walk test feature be on for an inappropriate length of time, it shall automatically revert to the normal mode.
d. The control panel shall be capable of supporting up to eight separate testing groups, one of which may be in a testing mode while the other (non-testing) groups may be active and operating as normally programmed. After testing is completed, testing data may be retrieved from the system in chronological order to ensure device/circuit activation.
e. Should an alarm condition occur from an active point that is not in walk test mode; it shall initiate the normal alarm sequence.

16. LED Supervision

a. All LEDs shall be supervised for burnout or disarrangement. Should a problem occur, the LCD shall display the location numbers of the module and the LED to facilitate location of the affected LED.

17. System Trouble Reminder

a. In the event of a trouble condition within the system, with the audible signal silenced, the trouble signal shall resound at 24 hour intervals as a reminder that the fire alarm system is not 100 percent operational. Both the time interval and the trouble reminder signal shall be programmable to adapt to the application.

18. Operator Access Levels

a. Operator access to system functions shall be limited by a key switch and multiple levels of password protection.
b. The following functions shall be protected:

1) Alarm Silence.

2) System Reset.

3) Set Time/Date.

4) Manual Control.

5) On/Off/Auto Control.

6) Disable/Enable.

7) Clear Historical Alarm Log.

8) Clear Historical Trouble Log.

9) Walk Test.

10) Change Alarm Verification.

c. Acknowledge keys shall also require privileged access to acknowledge points. If the operator presses an acknowledge key with insufficient access, an error message will be displayed. The points shall scroll with acknowledge key presses to view the points on the list, but the points will not be acknowledged in the database.

19. Wiring

a. Intermodule wiring for common system functions shall be installed in a supervised cable bus. Disarrangement of the bus shall cause a distinctive "Cable Supervisory" LED to be illuminated in addition to activating the common trouble indicators.
b. Detector and signal circuits and wiring may be nonpower-limited type and shall comply with the applicable articles of the NEC.

B. Enclosures

1. A cabinet of sufficient size shall be provided to accommodate all equipment required. The door of the cabinet shall be equipped with locks and a continuous hinge, providing protection from tampering, yet allowing full view of the various lights and controls. Indoor enclosures shall be of a NEMA type suitable for the area designation. Outdoor NEMA Type 4X enclosures shall be stainless steel.

2.4 CABLE AND RACEWAYS

A. Cable

1. Cable used in the fire alarm system shall be multi-conductor cable, at least 18 AWG size, specifically designed for industrial fire alarm systems and UL listed for indoor/outdoor installations. All cable required for the system shall be furnished by the Contractor.

B. Raceways

1. All cable shall be installed in conduit furnished under this section. All conduit shall conform to the applicable paragraphs of the Electrical section.

PART 3 - EXECUTION

3.1 GENERAL

A. All work shall be installed as indicated on the Drawings, and in accordance with the manufacturer's diagrams and recommendations, except where otherwise indicated.

B. All junction boxes furnished hereunder shall be painted red and permanently labeled "FIRE ALARM." A consistent wiring color code shall be maintained throughout the installation.

C. Installation of equipment and devices that connect to equipment furnished under other sections, or furnished by the Owner, shall be closely coordinated with the suppliers of the equipment and with Owner.

D. After completion of the installation, Contractor shall clean the inside and the outside of the fire alarm equipment and shall remove all dirt and debris from the site.

E. Cable

1. Cable shall be installed as described in the cable installation paragraphs in the Electrical section. The system conductors shall be installed in conduits or junction boxes separate from conductors of other systems. Conduit fill shall meet applicable NEC requirements.

F. Raceways

1. Conduit shall be installed as described in the conduit installation paragraphs in the Electrical section.

G. Testing

1. Contractor shall notify Engineer at least 30 days before the performance and acceptance tests are to be conducted. The tests shall be performed in the presence of Owner,. The Contractor shall furnish all instruments and personnel required for the tests. A complete test report and letter of completion shall be submitted to Engineer. The tests shall be performed by, or under the supervision of, a qualified representative of the fire alarm system manufacturer and shall include the following:

    a. Verify that the system is free of grounds or open circuits. The FACP shall indicate when a ground or an open circuit exists.
    b. Verify that all alarm signal devices, stations, transmitters, automatic detectors, and supervisory devices are functioning as specified.
    c. Test each fire alarm device and circuit. Individually activate each manual initiating station and verify correct alarm operation and control panel response. Individually test each automatic initiating device and verify correct alarm operation, control panel response, and remote equipment operation.
    d. Test battery backup systems for specified capacity.
    e. Repeat test to verify correction of any defect found in the initial testing.

3.2 TRAINING

A. The manufacturer's representative shall provide training of Owner's personnel as described in the Demonstration and Training specification. All costs for training services shall be included in the Contract Price.

End of Section

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APPENDIX A

SOIL AND FOUNDATION INVESTIGATION
BWD WESTERN CORRIDOR PUMP STATION
SPRINGDALE, ARKANSAS

Report

To

Beaver Water District

Lowell, AR

September 2021

Grubbs, Hoskyn, Barton & Wyatt, INC.
CONSULTING ENGINEERS

P.O. Box 1248
Springdale, Arkansas 72765
341 West County Line Road 72764
(479) 756-5999
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September 17, 2021
Job No. 21-064

Beaver Water District
301 North Primrose Road
Lowell, Arkansas 72745

Attn: Mr. Bill Hagenburger, P.E.
Chief Operating Officer

SOIL and FOUNDATION INVESTIGATION
PROPOSED BWD WESTERN CORRIDOR PUMP STATION
SPRINGDALE, ARKANSAS

INTRODUCTION

This report presents the results of the soil and foundation investigation performed for the proposed pump station to be located on West Miller Road in Springdale, Arkansas. These services were authorized by Mr. Bill Hagenburger on May 13, 2021, and have been performed in general accordance with our proposal dated May 12, 2021 (GHBW Proposal #SP21-031).

We understand the project consists of a single-story building with approximate plan dimensions of 200 ft by 140 ft and a generator building with approximate plan dimensions of 35 ft by 65 ft. Foundation loads are expected to be light. Finish floor of the buildings is planned at El 1260. Site grading in the main building pad area is expected to include 5 to 6 ft of cut at the south end and 7 to 9 ft of fill at the north end. Site grading in the generator building is estimated to include 5 to 10 ft of fill. Permanent open cut and fill slopes are generally planned with a 3-horizontal to 1-vertical (3H:1V) or flatter slope configuration. Some site retaining walls are also expected. The project also includes paved parking and drives. Site grading in the main access drive is expected to be minor. However, significant fill is expected in the northern portion of the drive leading to the generator building.

The purposes of this study were to explore subsurface conditions in the project area and to develop recommendations to guide design and construction of foundation systems, floor slabs and pavements as well as to provide site grading and construction criteria. The

results of the field and laboratory studies are discussed in the following report sections. Conclusions and recommendations are provided in subsequent report sections.

SUBSURFACE EXPLORATION

Subsurface conditions at the site were investigated by drilling a total of seven (7) sample borings – five (5) borings (B-1 through B-5) in the proposed building areas to 25-ft depth, and two (2) sample borings (B-6 and B-7) in the proposed access drive area to 10-ft depth. The number and location of the borings were selected by Black & Veatch. The borings were staked by Olsson. The site vicinity is shown on Plate 1. Boring locations are shown on the Plan of Borings, Plate 2. Logs of the borings, presenting descriptions of the subsurface strata encountered and results of field and laboratory tests, are included as Plates 3 through 9. Approximate ground surface elevation at each boring location, as inferred from the available topographic information, is also shown on the logs. A key to the terms and symbols used on the boring logs is presented as Plate 10.

The borings were drilled with a track-mounted CME 55 drilling rig using dry-auger drilling procedures. Samples were obtained at approximate 2-ft intervals to a depth of 10 ft and at 5-ft intervals thereafter. Samples were typically obtained using a 2-inch-diameter split-barrel sampler driven into the strata by the blows of a 140-lb automatic hammer dropped 30 inches, in accordance with Standard Penetration Test (SPT) procedures. The number of blows required to drive the standard split-barrel sampler the final 12 inches of an 18-inch total drive, or portion thereof, is defined as the Standard Penetration Number (N). Recorded N-values are shown on the boring logs in the "Blows Per Ft" column.

All samples were removed from samplers in the field. Samples were then visually classified by the geotechnical technician or field engineer and placed in appropriate containers to prevent moisture loss and/or disturbance during transfer to our laboratory for further examination.

As noted, the borings were advanced using dry-auger procedures to facilitate evaluation of shallow groundwater conditions. Observations regarding groundwater are

noted in the lower-right portion of the logs and are discussed in subsequent sections of this report.

LABORATORY TESTING

To evaluate pertinent physical properties and engineering characteristics of the foundation and subgrade soils, laboratory tests consisting of *in-situ* water content determinations and soil classification tests were performed on selected representative samples. To develop a water content profile for each boring, fifty (50) water content determinations were performed. Results of these tests are plotted on the logs in accordance with the scale and symbol shown in the legend located in the upper-right corner of the log forms.

To verify field classification and to evaluate soil plasticity, six (6) liquid and plastic limit determinations (Atterberg limits) and six (6) sieve analyses were performed on selected representative samples. The Atterberg limits are plotted on the boring logs as small pluses connected with a dashed line using the water content scale. The percentage of soil passing the No. 200 Sieve is noted in the "- No. 200 %" column on the log form.

SITE and SUBSURFACE CONDITIONS

Site Conditions

The project site is located at 7931 West Miller Road in Springdale. The site is an open land with some trees and tall brush. Terrain at the site gently slopes to the north and east. Total vertical relief across the site is approximately 25 ft. A natural shallow draw runs from the southwest corner of the site towards northeast where an existing pond is present just to the northeast of the generator building. Surface drainage conditions at the site are considered good.

Seismic Conditions

According to the Arkansas Building Authority (2005), the Washington County site is located in Seismic Zone 1, i.e. the "Area of lowest anticipated seismic damage". Based on the subsurface conditions encountered in the borings and the local geology, a Seismic Site Class D

(stiff soil profile) is considered applicable for the site in accordance with the criteria of IBC 2012. The liquefaction potential of the cohesive soils encountered within the exploration depths of the borings is considered negligible.

Site Geology

As described and mapped by the United States Geological Survey and shown on the Geologic Map of Arkansas[1], the project site is underlain by units of the Boone Formation and the residual cherty clay overburden soil blends. Typically, the limestone/cherty limestone units of the Boone decompose (weather) to somewhat erratic blends of chert fragments and clay/silty clay. The residual soil mantle may extend to significant depths on higher terrain and may contain hard chert seams and/or layers.

The Boone formation consists of gray, fine- to coarse-grained fossiliferous limestone interbedded with chert. Some sections may be predominantly limestone or chert. The cherts are dark in color in the lower part of the sequence and light in the upper part. The quantity of chert varies considerable both vertically and horizontally. The Boone formation is well known for dissolutional features, such as sinkholes, caves, and enlarged fissures. The thickness of the Boone Formation is typically 300 to 350 ft in northern Arkansas.

Subsurface Conditions

Based on the results of the borings, the subsurface conditions in the project area may be generalized into three (3) primary strata as follows:

Stratum I: On-site Fill: As encountered only at the east end of the access drive (see Boring 7), the surficial soils consist of possible on-site fill to about 5.5 ft depth. The fill consists of firm to stiff red and reddish tan silty clay with chert fragments (Unified Soil Classification CL). The Stratum I silty clay fill exhibits low to moderate shear strength and moderate to high compressibility. The on-site fill should be expected to be variable. Lateral extent of the fill is not known.

Stratum II: The natural surficial soils at the site generally consist of soft to firm brown and tan silty clay to clayey silt with surface organics (Unified Soil Classification CL to CL-ML) to about 1- to 2-ft depth. The Stratum II silty clay to clayey silt exhibits low plasticity, low shear strength and high compressibility. These soils are also considered moisture-sensitive and

[1] Geologic Map of Arkansas, Arkansas Geologic Commission and United States Geological Survey, 1993

expected to lose significant strength upon saturation and/or disturbance.

Stratum III: The above strata are underlain by stiff to very stiff red, reddish tan and tan sandy clay with numerous chert fragments (Unified Soil Classification CL and GC) to completion depth of the borings. This stratum consists of residual material resulting from weathering of the Boone formation. Numerous highly to completely weathered chert seams and layers are present within this stratum.

The sandy clay with chert fragments exhibits moderate to moderately high shear strength, generally moderate plasticity and low compressibility. Shrink/swell potential of the Stratum III sandy clay with chert fragments is generally considered to be low due to the amount of chert fragments and sand present. However, discontinuous high-plasticity clay (CH) layers are present within this stratum (see Boring 3). Such high-plasticity clay intervals may be present elsewhere at the site. The clay exhibits high plasticity and some shrink/swell potential.

Groundwater

Boreholes were left open to monitor groundwater conditions at the site. Groundwater was not encountered at any of the borings. It should be noted that significant vertical relief exists across the site. Consequently, potential exists for encountering downgradient seepage from the higher terrain towards the lower. Potential exists for encountering localized seepage in the open cut faces where a relatively deep cuts are planned at the south end of the site. Groundwater conditions will also vary depending upon site conditions, precipitation levels and infiltration rates.

ANALYSES and RECOMMENDATIONS

Foundations

Foundations for the lightly-loaded buildings must satisfy two (2) basic and independent design criteria. First, the maximum bearing pressure transmitted to the supporting strata must not exceed the allowable bearing pressure based on an allowable factor of safety with respect to bearing stratum shear strength. Second, foundation movements resulting from consolidation, shrinkage, or swelling of the supporting strata should be within tolerable limits for the structure. Construction factors such as installation of foundation units, fill placement, excavation procedures, and surface and groundwater conditions must also be considered.

Foundation loads are expected to be light. Finish floor of the buildings is planned at El 1260.0. Site grading in the main building pad area will include significant cut on the order of 5 to 6 ft at the south end and fill on the order of 7 to 9 ft at the north end. Similarly, site grading in the generator building area is expected to include fill ranging from 5 to 10 ft. Considering these factors and the results of the borings, a shallow foundation system consisting of continuous and individual footings is considered suitable to support the anticipated light structural loads. Foundations may be founded in compacted engineered or in natural stiff to very stiff sandy clay with chert fragments (Stratum III). Recommendations for shallow foundations are presented in the following report sections.

Shallow Footings

Structural loads may appropriately be supported on continuous or individual footings founded in engineered fill or very stiff red, reddish tan and tan sandy clay with chert fragments (Stratum III). Exterior footings should be founded at a minimum depth of 2 ft below lowest final adjacent grades. Interior footings may be founded at shallower depth. The depth at which interior footings may be founded will be dependant upon structural requirements, but should not be less than 1 ft below lowest final adjacent grade. Footings founded as recommended may be designed on the basis of maximum net allowable soil bearing pressures of 2,000 and 2,500 lbs per sq ft for continuous and individual footings, respectively.

Considering the results of the borings and the anticipated site grading, footings for the generator building will be founded in engineered fill. However, footings for the main building will likely be founded in a combination of natural Stratum III soils and engineered fill. The Stratum III includes localized high-plasticity clay seams and layers. The high-plasticity clay exhibits moderate shrink/swell potential; consequently, the footings should not be directly founded on the high-plasticity clay. If encountered, the clay should be undercut. Localized undercut on the order of 1 to 2 ft may be required. Mass footing undercut is generally not anticipated. Unsuitable soils if encountered at plan footing bearing elevation should be undercut as directed by the Geotechnical Engineer. The footing undercut may be backfilled to plan bearing elevation with either compacted engineered fill or lean concrete. Footing undercuts backfilled with engineered fill should extend laterally to a width determined by a 1-

horizontal to 1-vertical projection from the footing edge to the required undercut depth. Footing undercuts backfilled with lean concrete may be cut neat to plan footing dimensions.

Uplift resistance of footings will be provided by the weight of the structures and the foundation units. Resistance to lateral forces will be provided by the sliding resistance at the footing bottom. Resistance to sliding may be evaluated using an ultimate friction factor (tan δ) value of 0.40 for concrete on compacted select fill or stiff to very stiff natural sandy clay with chert fragments (Stratum III). An appropriate factor of safety must be included in analysis of sliding.

The recommended bearing values are based on a minimum factor of safety of greater than 2.5 with respect to the anticipated shear strength of the engineered fill and the measured shear strength of the natural soils. Post-construction total settlement is estimated to be about 1 inch with the differential settlement to be half of the total settlement. Considering a relatively deep fill required for site grading, varying fill thicknesses across the building areas and a combination of natural soils and engineered fill supporting the footings at the main building, it is very critical that approved engineered fill is appropriately placed in thin lifts and compacted as further described in the Site Grading section of the report in order to minimize potential for differential settlement. Consideration may be given to providing construction joints in the building in order to minimize adverse effects of potential differential settlements.

Continuous and individual footings should have a minimum width of 18 inches and 24 inches, respectively. The perimeter footings should be founded at a minimum depth of 2 ft below lowest adjacent final grade for frost protection.

Floor Slabs

Slab-on-grade construction is considered appropriate for floor slabs. As indicated, high-plasticity clay (CH) may be locally present in the cut areas of the main building. If clay is encountered at the slab subgrade, it should be undercut and replaced with approved engineered fill. Localized undercut of 1 to 2 ft may be warranted.

A design modulus of subgrade reaction (k) value of 175 pci is considered appropriate. We recommend that the floor slabs be supported on a 4- to 6-in.-thick clean crushed stone or gravel layer placed on a properly prepared subgrade. The granular layer should be densified

prior to placing the floor slab. Impervious sheeting should be placed between the slab and granular course to act as a vapor barrier.

Below-grade Walls and Retaining Walls

We understand that some site retaining walls will likely be required to transition grades. A below-grade reinforced concrete trench is also planned. The below grade walls and retaining walls may be supported on shallow foundations as recommended in the Foundations section of this report.

At-rest lateral earth pressure conditions are expected to act on below-grade walls that will be fixed at the top, restricting rotation about the wall base. Unrestrained retaining walls are expected to mobilize active earth pressures. Equivalent fluid pressure (EFP) values for wall design have been developed for both at-rest and active earth pressures. Lateral earth pressures will vary with soil backfill type, degree of backfill compaction, and drainage conditions. It is expected that wall backfill will consist of either free-draining crushed stone or engineered fill.

To maintain backfill drainage, the zone extending at least 1.5-ft behind walls should be backfilled with clean, free-draining crushed stone or gravel. Wall pressures may be further reduced by backfilling a zone extending from the back of the wall footing to the ground surface on a 1-horizontal to 1-vertical configuration with clean, crushed stone. All clean stone backfill should be separated from clayey backfill soils with a suitable filter fabric. To allow drainage of perched water from wall backfill, a perimeter foundation drain consisting of a continuous, perforated PVC pipe wrapped in geotextile fabric should be provided within the granular course behind the walls. Water should be discharged from the backfill by gravity to a positive discharge or to a sump pit.

The clean crushed stone backfill should be placed in 12-inch thick loose lifts and densified with a vibratory plate using a minimum of three passes. Low-plasticity clayey backfill should be placed in 8-inch loose lifts compacted to a minimum of 98 percent of the Standard Proctor (ASTM D-698) dry density at a water content within 3 percent of optimum value. The top 12 to 18 inches of backfill should consist of low-permeability clayey soils. This top layer should preclude significant infiltration of surface water into the wall backfill. This is particularly

important where clean stone is used as wall backfill. Compaction within 5 ft of walls should be achieved with hand compaction equipment. Overcompaction of backfill can result in damage to walls.

A summary of recommended equivalent fluid pressures is tabulated below for walls backfilled with free-draining, clean, crushed stone or engineered fill.

Table 1: Equivalent Fluid Pressures for Below-Grade and Retaining Wall Design

Earth Pressure Condition	Equivalent Fluid Pressure, lbs per sq ft per ft depth (clean crushed stone backfill)	Equivalent Fluid Pressure, lbs per sq ft per ft depth (imported/on-site low-plasticity clayey backfill)
Active, drained	35	50
Active, undrained	80	90
At-rest (restrained), drained	50	70
At-rest (restrained), undrained	85	100

Lateral earth pressures must also include the influence of surcharge loads. We recommend a lateral earth pressure coefficient of 0.4 be used to evaluate surcharge loads in the active case. For the at-rest (restrained) case, a lateral earth pressure coefficient of 0.75 should be applied to surcharge loads.

Pavements

Parking and Drives

Paved parking and drives are planned for the facility. Specific traffic information is not available for the project. We anticipate traffic on the parking lots will primarily consist of light automobile traffic. Heavier traffic including infrequent delivery and dumpster service is anticipated in addition to automobile traffic for the drives.

Site grading in the main access drive from West Miller Road is expected to be minor. Significant cut and fill are expected in the pavement areas around the buildings. Pavements should not be supported on natural Stratum II silty clay to clayey silt with surface organics. Stratum II soils are expected to be completely stripped from the site during site grading. Variable on-site fill (Stratum I) was encountered locally at the east of the main access drive. The Stratum I variable fill should be appropriately undercut and replaced with engineered fill

as recommended by the Geotechnical Engineer at the time of construction. Localized undercut of about 5 ft may be warranted. Lateral extent of the on-site fill is not known.

In the wake of the above discussion, pavement subgrade is expected to consist of engineered fill or natural Stratum III stiff to very stiff red, reddish tan and tan sandy clay with numerous chert fragments. These soils are expected to offer good pavement subgrade support properties and characteristics in conjunction with positive drainage. Undercut and backfill beneath the new pavements should be performed in accordance with the Site Grading section of this report.

Recommended alternatives for pavement sections are summarized in Table 1. The pavement sections included in Table 1 are based on subsurface conditions revealed by the borings, anticipated site grading and traffic conditions and our experience with projects of similar size and scope. Additional analysis is recommended if further traffic information becomes available.

Table 2: Recommended Pavement Sections

Pavement Type	Pavement Component	AHTD* Specification Section	Thickness (inches)
Flexible Pavement: Parking areas (Light Duty)			
	Asphalt Concrete Hot Mix Surface Course, ½ inch, N_{max}=115	407	3
	AHTD Class 7 Aggregate Base Course	303	6
Flexible Pavement: Drives (Heavy Duty)			
	Asphalt Concrete Hot Mix Surface Course, ½ inch, N_{max}=115	407	3
	AHTD Class 7 Aggregate Base Course	303	10
Rigid Pavement: Parking areas (Light Duty)			
	Portland Cement Concrete f'_c=4000 psi @ 28 days	501	5
	AHTD Class 7 Aggregate Base Course	303	4
Rigid Pavement: Drives (Heavy Duty)			
	Portland Cement Concrete f'_c=4000 psi @ 28 days	501	6
	AHTD Class 7 Aggregate Base Course	303	6

* Arkansas Highway and Transportation Department, Standard Specifications for Highway Construction, 2014

All aggregate base should be compacted to a minimum of 95 percent of the Modified Proctor (ASTM D-1557) maximum dry density at a water content near the optimum value. It is recommended that pavement in trash dumpster areas be a minimum 6-in.-thick Portland cement concrete underlain by at least 6 inches of compacted aggregate base. The concrete

area should be large enough to incorporate both the dumpster and the wheels of a service truck.

It should be recognized that some periodic maintenance of pavements will be required. As a minimum, this should include periodic sealing of all joints and cracks to prevent surface water infiltration. Maximum joint spacing for concrete pavements is typically on the order of 10 to 12 ft, but should be based on specific design. The importance of positive site drainage for satisfactory pavement performance cannot be overstated.

Drainage Considerations

Shallow groundwater was not encountered at the site. Perched groundwater could be encountered within the surface soils. Considerable topographic relief exists across the site. Consequently, downgradient flow from uphill landscape features and adjacent areas is possible. Seepage may also be encountered in the fractured chert layers where excavation is relatively deep. Where seepage is encountered during site grading, we recommend the seepage be directed via French or blanket drains to positive discharge at daylight or to storm drainage lines.

Rock Excavation

Based on the results of the borings and the anticipated site grading requirements, mass cuts in the overburden soils can generally be performed with conventional medium- to heavy-duty excavation equipment. However, Stratum III sandy clay with chert fragments includes occasional hard fractured chert intervals with depth. A relatively deep cut is expected at the south end of the site. Resistant chert units may be encountered in the excavations potentially requiring rock excavation techniques. Depending upon the location and depth of cut required for utility installation, there is potential for encountering hard chert beds in utility trench excavations that could require rock excavation techniques. Rock excavation methods such as hoeram or jackhammer are possible where hard chert beds are encountered. Potential for rock excavation is higher in narrow trench excavations. We recommend that Contract Documents include a unit price for removal and disposal of materials and obstructions that cannot be excavated with conventional heavy-duty excavating equipment. The conventional heavy-duty excavating equipment may be defined as a Caterpillar D-8 bulldozer with a single

tooth ripper, a Caterpillar 330 track excavator equipped with a 30-inch bucket and rock teeth, or equipment of similar power and capability. Rock excavation volumes should be determined based on in-place measurements via cross sectioning.

Site Grading

We recommend that a pre-site grading meeting be held to review site and subgrade conditions at the time of construction. This meeting should include the Engineer, Geotechnical Engineer, General Contractor, Site Grading Contractor and Owner. At that time, specific site grading procedures, such as temporary drainage, type of equipment to be used and potential for undercut should be reviewed.

Site preparation should begin with grubbing trees and stripping the moisture sensitive Stratum II silty clay to clayey silt with surface organics. The Stratum II soils should be completely stripped from the site. Required depth of stripping for complete removal of Stratum II soils is expected to range from 1 to 2 ft with an average of about 1.75 ft. Tree stumps should be completely undercut and backfilled with engineered fill.

Following stripping, and cutting as dictated by site grading requirements, and prior to fill placement, the subgrade should be proof-rolled with a loaded tandem-wheel dump truck or similar equipment. Proof-rolling should be observed by the Geotechnical Engineer. All soft or loose soils encountered in the building and pavement areas should be processed and recompacted or excavated and replaced with select fill, whichever is appropriate. In the cut areas, potential exists for locally encountering high-plasticity clay intervals within the Stratum III sandy clay with chert fragments. Building floor slab or pavements should not be directly supported on the high-plasticity clay. The high-plasticity clay, if encountered, should be undercut as directed by the Geotechnical Engineer. On-site variable fill (Stratum I) was encountered at the east end of the main access drive (see Boring 7). Lateral extent of the on-site fill is not known. The on-site variable fill should be undercut as directed by the Geotechnical Engineer. Required localized undercut of fill may be on the order of 5 ft.

Stratum I on-site variable fill and Stratum II silty clay to clayey silt with organics stripped/undercut from the site are not considered suitable for use as engineered fill. Stratum III sandy clay with numerous chert fragments is generally considered suitable. However, some

potential limitations and challenges in using this material should be noted. Considerable moisture adjustment (drying or wetting) may be required to bring these soils near optimum. These soils are also not expected to be as uniform and homogeneous as the soils from standard borrow pits in the area. The fractured chert layers may come out in large sizes. This may require segregating the oversize particles and/or more compaction effort may be warranted to break down the hard chert. Discontinuous high-plasticity clay intervals may be encountered within Stratum III. If high-plasticity clay is encountered, it should be segregated and discarded from use as engineered fill. In the wake of the above discussion, we recommend that some test pits be performed in the cut areas during the early stages of construction in order to obtain bulk samples and further evaluate the on-site Stratum III soils for use as select fill for the project. Laboratory testing on the bulk samples will likely include classification and Proctor tests.

Imported borrow for fill or backfill should be an approved low-plasticity sandy clay (CL), clayey sand (SC), gravelly clay (CL), silt gravel (GM) or clay gravel (GC) having a liquid limit less than 40. The suitability of locally available "hillside" silt/clay gravel (GC or GM) having a liquid limit greater than 40 should be evaluated by the Geotechnical Engineer on a case by case basis.

Considering the relatively deep fill proposed in the building area, proper control, monitoring and testing of fill is critical to minimize potential for post-construction settlement of the buildings. Fill and backfill should be placed in continuous, essentially horizontal lifts with a nominal loose thickness not exceeding 8 inches. Each lift of fill should be compacted to at least 100 percent of the Standard Proctor (ASTM D-698) maximum dry density in the building pad area and 95 percent of the Standard Proctor (ASTM D-698) maximum dry density in the pavement areas at a water content within 3 percent of the optimum value. Fill placed on slopes should be tied into the slope by appropriately benching and placing horizontal lifts. All cut and fill slopes should have a 3-horizontal to 1-vertical or flatter configuration, unless specifically analyzed.

CONSTRUCTION CONSIDERATIONS

Positive surface drainage should be established and maintained throughout construction operations. Water should not be allowed to pond in the building or pavement areas. If ponding occurs and the foundation or subgrade soils become soft or otherwise disturbed, unsuitable soils should be excavated and wasted.

Density and water content of all earthwork should be maintained until foundations and pavements are completed. Footing excavations should be clean and dry at the time of concrete placement. Concrete and steel should be placed in footings expeditiously to limit changes in conditions. Footing depths should be extended as required to bear on a suitable bearing stratum. All footing excavations should be observed by the Geotechnical Engineer to verify suitable bearing and construction.

The Owner or a designated representative thereof should monitor site preparation, grading work, foundation installation and pavement construction. Subsurface conditions significantly at variance with those encountered in the borings should be brought to the attention of the Geotechnical Engineer. Grubbs, Hoskyn, Barton & Wyatt, Inc. should be retained to review final design plans to insure the intent of this report was properly implemented. The conclusions and recommendations of this report should then be reviewed in light of the new information. Additionally, Grubbs, Hoskyn, Barton & Wyatt, Inc. should be retained to provide testing and observation during excavation, grading, and construction phases of the project based upon our familiarity with the project, the subsurface conditions, and the intent of the recommendations and design.

* * * * *

The following plates are attached and complete this report:

Plate 1	Site Vicinity
Plate 2	Plan of Borings
Plates 3 through 9	Logs of Borings
Plate 10	Key to Terms and Symbols

* * * * *

We appreciate the opportunity to be of service to you during this phase of the project. Should you have any questions regarding this report, or if we may be of additional assistance during subsequent phases of design or construction, please call on us.

Respectfully submitted,

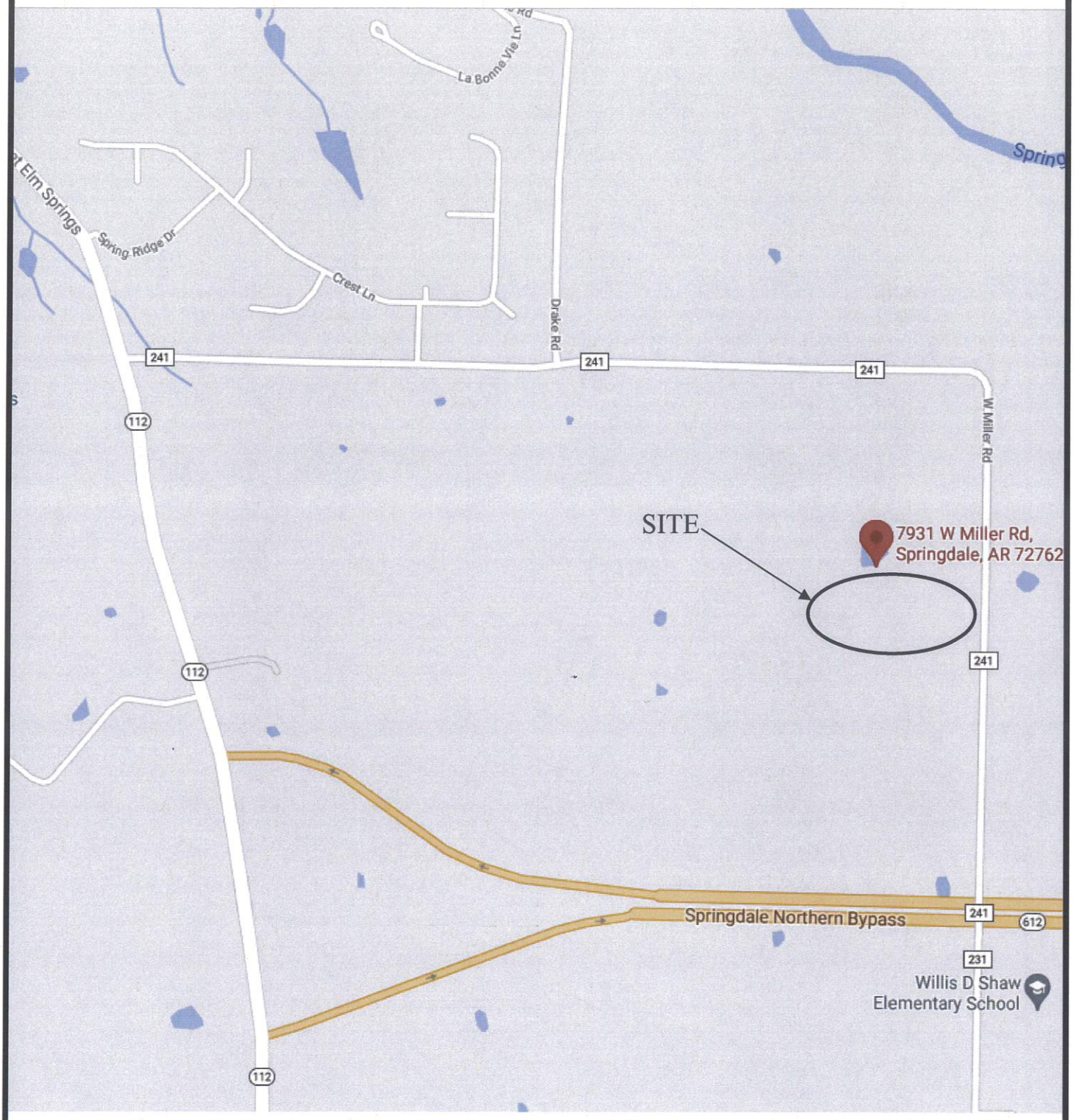
GRUBBS, HOSKYN,
BARTON & WYATT, INC.

Subra T. Bhat, Ph.D., P.E.
Vice President/Manager of Springdale Office

STB:

Copies Submitted: Beaver Water District
Attn: Mr. Bill Hagenburger, P.E. (email)
Attn: Mr. Darryl Fendly, P.E.

Black & Veatch
Attn: Mr. Matt Richart (email)
Attn: Mr. Tim Malcolm, P.E. (email)



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SITE VICINITY
BWD WESTERN CORRIDOR PUMP STATION
SPRINGDALE, ARKANSAS

Job No.: 21-064

Plate 1

48" DISCHARGE TO BENTONVILLE

STORMWATER DETENTION POND

33505
1240.19
SBR/BORE POINT 5
SOIL BORING

24" STORM DRAIN INV EL 1245.00

PROPOSED 10' WIDE NATURAL GAS LINE EASEMENT

PROPOSED 60' WIDE ROGERS EASEMENT

ABANDON EXISTING WELL

B-1
GENERATOR BUILDING

STORMWATER JUNCTION BOX WITH AREA INLET (TOP EL 1256.50)

24" STORM DRAIN INV EL 1248.50

33513
1255.33
SBR/BORE POINT 7
SOIL BORING

FUTURE GENERATOR BUILDING

PROPOSED 9'x18' PARKING STALL (TYP)

4" NATURAL GAS

PROPOSED 20' WIDE ACCESS ROAD

MAJOR COLLECTOR ROAD IMPROVEMENT IN ACCORDANCE WITH SPRINGDALE STREET MASTER PLAN

B-3

24" EMERGENCY TRENCH FLOOD DRAIN WITH DUCKBILL CHECK VALVE (INV EL 1249.50)

B-5

B-6

B-7

STORMWATER AREA INLET (TOP EL 1255.00

PUMP STATION (FLOOR EL 1260)

24" STORM DRAIN INV EL 1252.00

B-2

B-4

DEMO EXISTING FOUNDATION

6" WATER SERVICE

36127
1248.77
B-48/1248.765

60" PLUG FOR FUTURE 60" TIE IN

FUTURE 60" SUCTION FROM WTP

60" SUCTION FROM WTP

33512
1256.50
SBR/BORE POINT 9
SOIL BORING

48" DISCHARGE TO SPRINGDALE

EXISTING ACCESS ROAD

0 60 ft 120 ft

N W E S

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

PLAN OF BORINGS
BWD WESTERN CORRIDOR PUMP STATION
SPRINGDALE, ARKANSAS

Scale: 1" = 60 ft	Job No.: 21-064	Plate 2

21-064

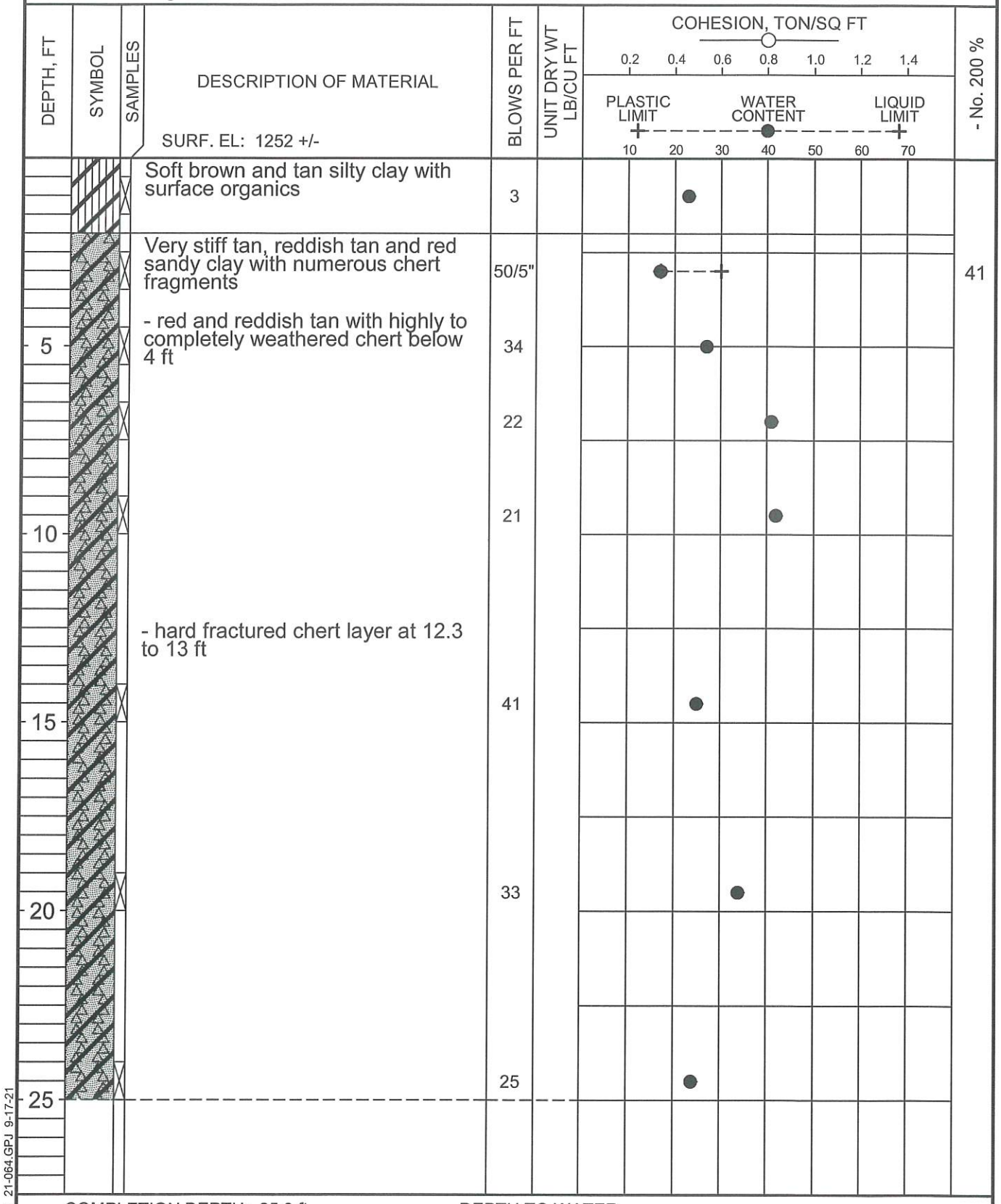
Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 1

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2



COMPLETION DEPTH: 25.0 ft
DATE: 6-1-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 3

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 2

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 1263 +/-				
			Soft dark brown and tan silty clay with surface organics				
			Very stiff red and reddish tan sandy clay with numerous chert fragments and highly to completely weathered chert seams and layers	8			
				47			55
5				32			
				29			
			- with more highly weathered chert seams and layers below 9 ft	26			
10							
				17			
15							
				20			
20							
				22			
25							

COMPLETION DEPTH: 25.0 ft
DATE: 6-1-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 4

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 3

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 1255 +/-				
			Firm dark brown and tan silty clay with surface organics	6			
			Stiff red sandy clay with highly to completely weathered chert seams and layers	11			60
5			- with some clay seams and layers to 3.5 ft - very stiff below 4 ft	13			
			- with occasional clay seams and layers below 6 ft	17			
10				32			
				17			
15							
20				10			
				12			
25							

COMPLETION DEPTH: 25.0 ft
DATE: 6-1-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 5

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 4

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2

SURF. EL: 1265 +/-

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT / WATER CONTENT / LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
0			Firm dark brown silty clay with surface organics				
			Stiff red and reddish tan sandy clay with numerous chert fragments and highly to completely weathered chert seams and layers	8			
				11			
5				25			32
				25			
				13			
10							
				21			
15							
				22			
20							
				16			
25							

COMPLETION DEPTH: 25.0 ft
DATE: 6-2-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 6

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
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LOG OF BORING NO. 5

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT
			SURF. EL: 1259 +/-		
			Soft brown and tan silty clay with surface organics	5	
			Very stiff red sandy clay with numerous chert fragments and highly to completely weatherd chert seams and layers	33	
5				55	
				21	
				29	
10					
				34	
15					
				50/6"	
20			- hard fractured chert layer at 19.5 to 20 ft		
				15	
25					

COHESION, TON/SQ FT
0.2 0.4 0.6 0.8 1.0 1.2 1.4

PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT
10 20 30 40 50 60 70

- No. 200 %

COMPLETION DEPTH: 25.0 ft
DATE: 6-1-21

DEPTH TO WATER
IN BORING: Dry after 3 days
DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 7

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 6

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 1255 +/-				
			Soft brown clayey silt with surface organics	5			
			Stiff to very stiff red and reddish tan sandy clay with numerous chert fragments and with chert seams and layers	11			55
5				35			
				31			
				20			
10							
15							
20							
25							

COMPLETION DEPTH: 10.0 ft
DATE: 6-2-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 8

21-064

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

LOG OF BORING NO. 7

BWD Western Corridor Pump Station
Springdale, Arkansas

TYPE: Auger

LOCATION: See Plate 2

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WT LB/CU FT	COHESION, TON/SQ FT (0.2 0.4 0.6 0.8 1.0 1.2 1.4) / PLASTIC LIMIT — WATER CONTENT — LIQUID LIMIT (10 20 30 40 50 60 70)	- No. 200 %
			SURF. EL: 1240 +/-				
			Soft dark brown clayey silt with surface organics (FILL)	4			
			Stiff red and reddish brown silty clay with chert fragments (possible FILL)	10			
5			- firm below 4 ft	9			69
			Very stiff reddish tan and tan silty clay with some chert fragments	14			
10				14			
15							
20							
25							

COMPLETION DEPTH: 10.0 ft
DATE: 6-2-21

DEPTH TO WATER
IN BORING: Dry after 3 days

DATE: 6/4/2021

06-185-1 21-064.GPJ 9-17-21

PLATE 9

Grubbs, Hoskyn, Barton & Wyatt, Inc.
Consulting Engineers

SYMBOLS AND TERMS USED ON BORING LOGS

SOIL TYPES

(SHOWN IN SYMBOLS COLUMN)

Gravel Sand Silt Clay

Predominant type shown heavy

SAMPLER TYPES

(SHOWN ON SAMPLES COLUMN)

Shelby Tube | Rock Core | Split Spoon | No Recovery | Cutting

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on No. 200 sieve): Includes (I) Clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

DESCRIPTIVE TERM	N-VALUE	RELATIVE DENSITY
VERY LOOSE	0-4	0-15%
LOOSE	4-10	15-35%
MEDIUM DENSE	10-30	35-65%
DENSE	30-50	65-85%
VERY DENSE	50 and above	85-100%

FINE GRAINED SOILS (major portion passing No. 200 sieve): Includes (1) Inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TON/SQ. FT.
VERY SOFT	Less than 0.25
SOFT	0.25-0.50
FIRM	0.50-1.00
STIFF	1.00-2.00
VERY STIFF	2.00-4.00
HARD	4.00 and higher

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance.
FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
LAMINATED - composed of thin layers of varying color and texture.
INTERBEDDED - composed of alternate layers of different soil types.
CALCAREOUS - containing appreciable quantities of calcium carbonate.
WELL GRADED - having a wide range in grain sizes and substantial amounts of all intermediate particle sizes.
POORLY GRADED - predominantly of one grain size, or having a range of sizes with some intermediate sizes missing.

Terms used on this report for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in Technical Memorandum No.3-357, Waterways Experiment Station, March 1953

KEY 9-17-21

APPENDIX B

Well Abandonment Procedures

The Rules and Regulations Pertaining to Public Water Supplies
Section VIII.B.4 - Abandonment of Wells state:

> "All abandoned wells in consolidated formations must be filled from bottom to within two feet of the top with cement. All wells in unconsolidated formations must be filled with sand or natural material from the bottom to twelve (12) feet from the ground surface, and with bentonite or cement from twelve (12) feet to two (2) feet from the ground surface. The record of abandonment must be filed with the Arkansas Department of Health."

Recommended steps for well abandonment:

1. Remove pump, pipe, tubing, or any other material from the well. If the casing is not grouted, try to remove it also.
2. Determine the type of formation into which the well is developed.

A. Consolidated Formations
   1) Cut off the top of the casing or excavate the top of the well to at least two feet below the ground surface.
   2) Fill entire column with impervious cement grout.

B. Unconsolidated Formations
   1) Fill with "clean sand or natural material" (NO top soil or organic matter). Place fill material from the bottom to 12 feet from the surface, and bentonite or cement from 12 to 2 feet from the ground surface.
      - To assure that the fill material is "clean", a solution of 50 parts per million (ppm) or greater chlorine should be used to disinfect the fill material prior to placing it in the well. For example, to obtain a 50 ppm chlorine solution mix:
        - 1 gallon of 5% chlorine bleach per 1000 gallons of water,
        - 1 pint of 5% chlorine bleach per 124 gallons of water, or
        - 0.65 pounds 65% calcium hypochlorite tablets per 1000 gallons of water
   2) Cut off the top of the casing or excavate the top of the well. Ideally, the top of the well will now be approximately 2 feet below the ground surface.
   3) The bentonite or cement grout column (also free of impurities) must be at least 10 vertical feet.

3. After taking photos of seal (for documentation), and the grout has set, backfill the remaining hole and mound top soil to allow for settling.
4. The record of abandonment that is filed with the Arkansas Department of Health must confirm that proper well abandonment procedures were followed.

For additional information, contact:

Arkansas Department of Health, Division of Engineering
4815 West Markham, Slot 37, Little Rock, AR 72205 Phone (501) 661-2623

Arkansas Water Well Construction Commission
101 East Capitol, Suite 350, Little Rock, AR 72201 Phone (501) 682-1025

Arkansas Water Well Construction Commission

Bruce Holland
Executive Secretary

101 East Capitol, Suite 350
Little Rock, Arkansas 72201
www.arkansas.gov/awwcc

Phone: (501) 682-3900
Fax: (501) 682-3991
Jacob.harvey@arkansas.gov

Asa Hutchinson
Governor

Arkansas Water Well Abandonment Form

Contractor/Owner: _____ Contractor #: _____

_____

Date: ____/ _____/_____ (MM/DD/YYYY)

* Well & Formation Diagram: Sketch a diagram showing depths of well, formations, casing (if present), grouting materials &

1. **Well Location:** (Show sketch of location on back of this form) placement, etc.

   County: _____

   Township Range Section (if available)

   _____ _____ _____ _____ ¼ _____¼

   Latitude: _____ Longitude: _____

2. **Owner and Address: _____**

   _____

3. **Use of Well: _____**

4. **Depth of Well: _____ Diameter of Well: _____** inch

5. **Amount of Casing Removed: _____ Diameter: _____** inch

   _____ _____ inch

6. **Sealing Material and Placement:**

	Neat Cement	Sand Cement	Other	Placement
Bags (94 lb):	_____	_____	_____	**From____ ft; To____ ft**
Gals of Water:	_____	_____	_____	**From____ ft; To____ ft**
Yards of Sand:	_____	_____	_____	**From____ ft; To____ ft**

7. **Explain Method of placement of Material:**

APPENDIX C

Stormwater Pollution Prevention Plan (SWPPP) for Construction Activity for Large Construction Sites

National Pollutant Discharge Elimination System (NPDES)
General Permit # ARR150000

Prepared for:
Beaver Water District
301 North Primrose Road
Lowell, AR 72745

Date:
8/5/22

Prepared by:
Olsson
302 E Millsap Rd.
Fayetteville, AR 72703

Revised date: 10/20/2016

Project Name and Location: Beaver Water District Western Corridor Pump Station

Property Parcel Number (*Optional*): _____

Operator Name and Address: Beaver Water District

A. Site Description

a. Project description, intended use after NOI is filed: The project consists of the construction of a pump station associated with a new 60-inch diameter water transmission pipeline to convey treated water to and from existing BWD water treatment and delivery infrastructure.

Sequence of major activities which disturb soils:
General Sequence of activities:
1. Obtain all necessary permits (if required).
2. Know and maintain an Arkansas Department of Energy & Environment - Division Environmental Quality (ADEQ) approved Storm Water Pollution Prevention Plan implemented for construction sites.
3. Inform all personnel and subcontractors of SWPPP and relate where to post the Construction Site Notice and house SWPPP.
4. Have all existing utilities located.
5. Install tree preservation, erosion and sediment control devices in accordance with the Plans and this SWPPP.
6. Grade the site per the grading plan.
6. Construct Improvements (see Plan Set). Maintain temporary erosion and sediment control devices as needed.
7. Bring all areas to final grade.
8. Stabilize all areas, place topsoil, landscaping, and sod.
9. When all construction is completed, the site is 100% stabilized at 80% density, and approved by the Engineer, remove all temporary sediment control BMPs. Stabilize with sodding or seeding any areas disturbed by their removal.

b. Total Area[1]: 36.109 acres Disturbed Area[2]: 6.258 acres

c. Soils Information:

i. Runoff Coefficient Pre-Construction (See Appendix A) : 0.34

ii. Runoff Coefficient Post-Construction (See Appendix A) : 0.41

iii. Describe the soil or the quality of any discharge from the site:

Soil Series	Hydrologic Soil Group
Captina silt loam, 1 to 3 percent slopes	C/D

Elsah soils, occasionally and frequently flooded	B
Nixa very gravelly silt loam, 3 to 8 percent slopes	D
Nixa very gravelly silt loam, 8 to 12 percent slopes	D
Noark very gravelly silt loam, 12 to 20 percent slopes	B
Tonti gravelly silt loam, 3 to 8 percent slopes	C

B. Responsible Parties

Be sure to assign all SWPPP related activities to an individual or position; even if the specific individual is not yet known (i.e. contractor has not been chosen).

Individual/Company	Phone Number	Service Provided for SWPPP (i.e., Inspector, SWPPP revisions, Stabilization Activities, BMP Maintenance, etc.)
Beaver Water District	479-756-3651	Owner/Permittee
Contractor (TBD)		SWPPP revisions, Stabilization Activities, BMP Maintenance, etc.
Olsson	479-443-3404	SWPPP Developer

C. Receiving Waters

a. The following waterbody (or waterbodies) receives stormwater from this construction site: Spring Creek, which flows into Osage Creek, which flows into the Illinois River, which flows into the Arkansas River.

b. Is the project located within the jurisdiction of an MS4? ☒Yes ☐No

i. If yes, Name of MS4: City of Springdale

c. Ultimate Receiving Water:

☐Red River ☐White River
☐Ouachita River ☐St. Francis River
☒Arkansas River ☐Mississippi River

[1]Increases in total acreage require an additional acreage request, an updated SWPPP and a $200 modification fee to be submitted to ADEQ.

[2]Increases in only disturbed acreage require an additional acreage request and an updated SWPPP to be submitted to ADEQ.

D. Documentation of Permit Eligibility Related to the 303(d) list and Total Maximum Daily Loads (TMDL) (https://www.adeq.state.ar.us/water/planning/)

a. Does the stormwater enter a waterbody on the 303(d) list or with an approved TMDL? ☐Yes ☒No

b. If yes:

i. Waterbody identified on 303(d) list:_____

ii. Pollutant addressed on 303(d) list or TMDL: _____

iii. This specific project ,or generally construction activity i.e. surface erosion, is identified on 303(d) list or associated assumptions and allocations identified in the TMDL for the discharge: ☐Yes ☐No

iv. Additional controls implemented: _____

E. Attainment of Water Quality Standards After Authorization

a. The permittee must select, install, implement, and maintain BMPs at the construction site that minimize pollutants in the discharge as necessary to meet applicable water quality standards. In general, except in situations explained below, the SWPPP developed, implemented, and updated to be considered as stringent as necessary to ensure that the discharges do not cause or contribute to an excursion above any applicable water quality standard.

b. At any time after authorization, the Department may determine that the stormwater discharges may cause, have reasonable potential to cause, or contribute to an excursion above any applicable water quality standard. If such a determination is made, the Department will require the permittee to:

i. Develop a supplemental BMP action plan describing SWPPP modifications to address adequately the identified water quality concerns and submit valid and verifiable data and information that are representative of ambient conditions and indicate that the receiving water is attaining water quality standards; or

ii. Cease discharges of pollutants from construction activity and submit an individual permit application.

I understand and agree to follow the above text regarding the attainment of water quality standards after authorization. ☒Yes ☐No

F. Site Map Requirements (Attach Site Map):

a. Pre-construction topographic view;

b. Direction of stormwater flow (i.e., use arrows to show which direction stormwater will flow) and approximate slopes anticipated after grading activities;

c. Delineate on the site map areas of soil disturbance and areas that will not be disturbed under the coverage of this permit;

d. Location of major structural and nonstructural controls identified in the plan;

e. Location of main construction entrance and exit;

f. Location where stabilization practices are expected to occur;

g. Locations of off-site materials, waste, borrow area, or equipment storage area;

h. Location of areas used for concrete wash-out;
i. Location of all surface water bodies (including wetlands) with associated natural buffer boundary lines. Identify floodplain and floodway boundaries, if available;
j. Locations where stormwater is discharged to a surface water and/or municipal separate storm sewer system if applicable,
k. Locations where stormwater is discharged off-site (should be continuously updated);
l. Areas where final stabilization has been accomplished and no further construction phase permit requirements apply;
m. A legend that identifies any erosion and sediment control measure symbols/labels used in the site map and/or detail sheet; and
n. Locations of any storm drain inlets on the site and in the immediate vicinity of the site.

G. Stormwater Controls
   a. Initial Site Stabilization, Erosion and Sediment Controls, and Best Management Practices:
      i. Initial Site Stabilization: Construction will progress as indicated in the sequence of major activities noted in the Plan Set and this SWPPP. Erosion and sediment control measures shall be installed prior to beginning any construction activities as noted on the Erosion Control Sheets. Erosion control devices will be maintained throughout construction activities.
      ii. Erosion and Sediment Controls: Erosion and sediment controls shall include sediment barriers (silt fence), rock ditch checks, inlet sediment traps, and gravel construction entrance/exit. Additionally, to control wind erosion, disturbed areas shall be sprayed with water on an as-needed basis according to site conditions.
      iii. If periodic inspections or other information indicates a control has been used inappropriately or incorrectly, the operator will replace or modify the control for site situations: ☒Yes ☐No

If No, explain: _____

_____

iv. Off-site accumulations of sediment will be removed at a frequency sufficient to minimize off-site impacts: ☒Yes ☐No

If No, explain: _____

_____

v. Sediment will be removed from sediment traps or sedimentation ponds when design capacity has been reduced by 50%: ☒Yes ☐No

If No, explain: _____

_____

vi. Litter, construction debris, and construction chemicals exposed to stormwater shall be prevented from becoming a pollutant source for stormwater discharges: ☒Yes ☐No

If No, explain: _____

_____

vii. Off-site material storage areas used solely by the permitted project are being covered by this SWPPP: ☐Yes ☒No

If Yes, explain additional BMPs implemented at off-site material storage area: _____

_____

b. Stabilization Practices

i. Description and Schedule: Permanent seeding and mulch cover shall be utilized as the primary stabilization practice. Seeding shall be performed by hydro-seeding, by hand, or by a mechanical broadcasting method. Seeding rates and types shall be in accordance with the Contract Documents on which construction activities have ceased (temporarily or permanently). Sodding shall be placed in accordance with the project plans. Exposed bare earth sections should be protected by evenly distributed hay, straw or wood mulch before a rain event. Dust shall be controlled by sufficiently wetting dusty areas, as needed. To all extents possible, construction activities shall be isolated as to limit areas of disturbance. Areas where construction ceases for more than 14 days shall be stabilized with a seed/straw mulch at a coverage rate of 2 tons/acre. Accumulated sediment and erosion control devices will be removed after 100% stabilization at 80% density.

ii. Are buffer areas required? ☐Yes ☒No

If Yes, are buffer areas being used? ☐Yes ☒No

If Yes, describe natural buffer areas: _____

_____

If No, explain why not: There are no streams within the project area.

iii. A record of the dates when grading activities occur, when construction activities temporarily or permanently cease on a portion of the site, and when stabilization measures are initiated shall be included with the plan.
☒Yes ☐No

If No, explain: _____

iv. Deadlines for stabilization:

1. Stabilization procedures will be initiated 14 days after construction activity temporarily ceases on a portion of the site.
2. Stabilization procedures will be initiated immediately in portions of the site where construction activities have permanently ceased.

c. Structural Practices

i. Describe any structural practices to divert flows from exposed soils, store flows, or otherwise limit runoff and the discharge of pollutants from exposed areas of the site: Sediment barriers (silt fence), and rock ditch checks shall be in place during ongoing earthwork operations.

ii. Describe Velocity Dissipation Devices: Rock ditch checks.

iii. Sediment Basins:

Are 10 or more acres draining to a common point? ☒Yes ☐No
Is a sediment basin included in the project? ☐Yes ☒No

If Yes, what is the designed capacity for the storage?
☐3600 cubic feet per acre = : _____
or
☐10 year, 24 hour storm = :_____
☐ Other criteria were used to design basin: _____

If No, explain why no sedimentation basin was included and describe required natural buffer areas and other controls implemented instead: The quantity of ground disturbance associated with this project does not necessitate a sedimentation basin.

H. Other Controls

a. Solid materials, including building materials, shall be prevented from being discharged to Waters of the State: ☒Yes ☐No

b. Off-site vehicle tracking of sediments and the generation of dust shall be minimized through the use of:

☒A stabilized construction entrance and exit
☒Vehicle tire washing
☒Other controls, describe: Existing roads and gates will be used to access construction site where practicable.

c. Temporary Sanitary Facilities: Portable sanitary waste systems will be required at all times during construction. All sanitary waste will be collected from the portable units as necessary or as required by local regulation by a licensed sanitary waste management contractor. The waste management contractor shall empty the portable sanitary waste systems on a regular basis or when issues arise. Caution will be used during any sanitary sewer relocations.

d. Concrete Waste Area Provided:
☒Yes
☐No. Concrete is used on the site, but no concrete washout is provided.
Explain why: _____
_____
☐N/A, no concrete will be used with this project

e. Fuel Storage Areas, Hazardous Waste Storage, and Truck Wash Areas: At a minimum, any products in the following categories shall be considered hazardous: paints, acids for cleaning masonry surfaces, cleaning solvents, asphalt products, chemical additives for soil stabilization, or concrete curing compounds and additives. In the event of a spill which may be hazardous, the spill coordinator designated by the Contractor should be contacted immediately. Beaver Water District shall also be notified immediately following notification of the spill coordinator. All hazardous waste materials will be disposed of as specified by local or state regulations or by the product manufacturer. Fuel storage will be at least 300 feet from known wetlands or other waterbodies and shall have secondary containment as required by state and federal law. Products will be kept in original containers in covered areas unless they are not resealable. Original labels and material safety data will be retained; they contain important product information. If surplus products must be disposed of, manufacturers' or local and State recommended methods for proper disposal will be followed.

I. Non-Stormwater Discharges

a. The following allowable non-stormwater discharges comingled with stormwater are present or anticipated at the site:
☐Fire-fighting activities;
☐Fire hydrant flushings;
☒Water used to wash vehicles (where detergents or other chemicals are not used) or control dust in accordance with Part II.A.4.H.2;

☒Potable water sources including uncontaminated waterline flushings;
☒Landscape Irrigation;
☒Routine external building wash down which does not use detergents or other chemicals;
☒Pavement wash waters where spills or leaks of toxic or hazardous materials have not occurred (unless all spilled materials have been removed) and where detergents or other chemicals are not used;
☒Uncontaminated air conditioning, compressor condensate (See Part I.B.13.C of the permit);
☒Uncontaminated springs, excavation dewatering and groundwater (See Part I.B.13.C of the permit);
☐Foundation or footing drains where flows are not contaminated with process materials such as solvents (See Part I.B.13.C of the permit);

b. Describe any controls associated with non-stormwater discharges present at the site: To all extents possible, non-stormwater discharges shall be minimized. Discharges shall be monitored and terminated as soon as possible.

J. Permanent Controls for Post-Construction Stormwater Management:

Describe measures installed during the construction process to control pollutants in stormwater discharges that will occur after construction operations have been completed: A detention basin will be installed and the existing drainage swale will be expanded to control stormwater discharges that will occur after construction operations have been completed.

K. Applicable State or Local Programs: The SWPPP will be updated as necessary to reflect any revisions to applicable federal, state, or local requirements that affect the stormwater controls implemented at the site. ☒Yes ☐No

L. Inspections

a. Inspection frequency:

☒Every 7 calendar days
or
☐At least once every 14 calendar days and within 24 hours of the end of a storm even 0.25 inches or greater (a rain gauge must be maintained on-site)

b. Inspections:

Completed inspection forms will be kept with the SWPPP.

☒ ADEQ's inspection form will be used (See Appendix B)

or

☐ A form other than ADEQ's inspection form will be used and is attached (See inspection form requirements Part II.A.4.L.2)

c. Inspection records will be retained as part of the SWPPP for at least 3 years from the date of termination.

d. It is understood that the following sections describe waivers of site inspection requirements. All applicable documentation requirements will be followed in accordance with the referenced sections.

i. Winter Conditions (Part II.A.4.L.4)

ii. Adverse Weather Conditions (Part II.A.4.L.5)

M. Maintenance:

The following procedures to maintain vegetation, erosion and sediment control measures and other protective measures in good, effective operating condition will be followed: All erosion and sediment controls shall be maintained in good working order. If a repair is necessary, it shall be done at the earliest date possible, but no later than three (3) calendar days after the surrounding exposed ground has dried sufficiently to prevent further damage from heavy equipment. The areas adjacent to creeks and drainage ways shall have priority followed by devices protecting any drainage ditches.

Any necessary repairs will be completed, when practicable, before the next storm event, but not to exceed a period of 3 business days of discovery, or as otherwise directed by state or local officials.

N. Employee Training:

The following is a description of the training plan for personnel (including contractors and subcontractors) on this project: Training shall be given by a knowledgeable and qualified trainer to all project related personnel prior to them working at the project site. The Contractor shall be required to have a qualified individual as defined in the permit.

**Note, Formal training classes given by Universities or other third-party organizations are not required, but recommended for qualified trainers; the permittee is responsible for the content of the training being adequate for personnel to implement the requirements of the permit.

Certification

"I certify under penalty of law that this document and all attachments such as Inspection Form were prepared under my direction or supervision in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Signature of Responsible or Cognizant Official: _____

Title: _____ Date: _____

Computation Sheet for Determining Runoff Coefficients

Total Site Area =	36.109 Acres	[A]

Existing Site Conditions

Impervious Site Area [1] =	2.43 Acres	[B]
Impervious Site Area Runoff Coefficient [2, 4] =	0.95	[C]
Pervious Site Area [3] =	33.679 Acres	[D]
Pervious Site Area Runoff Coefficient [4] =	0.30	[E]

Pre-Construction Runoff Coefficient

$$\frac{[B \times C] + [D \times E]}{[A]} = 0.34$$

Proposed Site Conditions (after construction)

Impervious Site Area [1] =	5.96 Acres	[F]
Impervious Site Area Runoff Coefficient [2, 4] =	0.95	[G]
Pervious Site Area [3] =	30.149 Acres	[H]
Pervious Site Area Runoff Coefficient [4] =	0.30	[I]

Post-Construction Runoff Coefficient

$$\frac{[F \times G] + [H \times I]}{[A]} = 0.41$$

1. Includes paved areas, areas covered by buildings, and other impervious surfaces.
2. Use 0.95 unless lower or higher runoff coefficient can be verified.
3. Includes areas of vegetation, most unpaved or uncovered soil surfaces, and other pervious areas.
4. Refer to local Hydrology Manual for typical C values.

Note: The impervious and pervious surfaces should equal the total area.