

SECTION 27 02 10

UG PATHWAYS & STRUCTURES FOR COMMS

PART 1 - GENERAL

A. Section Includes:

1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete- encased communications distribution pathways.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 27 Section "General Communications Requirements" for general requirements and related documents that apply to this Section.
- B. Division 27 Section "Common Work Results for Communications" for limited scope general construction materials and methods.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include duct-bank materials, including spacers and miscellaneous components.
2. Include duct, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Include accessories for handholes, boxes, and other utility structures.
4. Include underground line warning tape.

B. Shop Drawings:

1. Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.
2. Precast, or Factory-Fabricated Underground Utility Structures:
  - a. Include plans, elevations, sections, details, attachments to other work, and accessories.
  - b. Include duct entry provisions, including location and duct size.
  - c. Include reinforcement details.
  - d. Include frame and cover design and manhole chimneys.
  - e. Include ladder details.
  - f. Include grounding details.
  - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and sumps.
  - h. Include joint details.
3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
  - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
  - b. Include duct entry provisions, including location and duct size.
  - c. Include cover design.
  - d. Include grounding details.

- e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- 4. Record Drawings: Submit Record Drawings as required by Division 01 and Division 27 Section "General Communications Requirements":
  - a. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections.
  - b. that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
  - 1. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Manhole Shop Drawings: Contractor to provide manhole shop drawings including all specified accessories for engineer review.
- C. Product Certificates: For concrete and steel used in precast concrete manholes, as required by ASTM C858.
- D. Qualification Data: For professional engineer and testing agency responsible for testing nonconcrete handholes and boxes.
- E. Source quality-control reports.
- F. Field quality-control reports.

#### 1.5 DEFINITIONS

- A. Direct-Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials, such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
  - 1. Two or more ducts installed in parallel, with or without additional casing materials.
  - 2. Multiple duct banks.
- D. GRC: Galvanized Rigid Steel Conduit
- E. RMC: Rigid Metal Conduit
- F. RNC: Rigid Nonmetallic Conduit

- G. Refer to Division 27 Section “General Communications Requirements” for additional abbreviations / definitions.

## 1.6 CODE, STANDARDS AND GUIDELINES

- A. The following codes and standards contain provisions that, through reference in this text, constitute provisions of document. At the time of publication the editions indicated were valid. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following standards and codes published by the following organizations, where applicable
1. Federal Communications Commission (FCC)
  2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
  3. National Fire Protection Association (NFPA)
  4. National Electrical Code (NEC)
  5. American National Standards Institute (ANSI)
  6. Telecommunications Industry Association (TIA)
  7. Electronics Components Industries Association (ECIA)
  8. Building Industry Consulting Service International (BICSI)
  9. National Electrical Contractors Association (NECA)
  10. International Building Code (IBC)
  11. FCC Regulations Part 68
  12. NPFA-70 National Electrical Code Chapter 8 – Communications Systems
  13. NFPA-71 Central Signaling Systems
  14. NFPA-780 Protection of Electronic and Computer Data Processing Equipment
  15. NFPA-780 Lightning Protection Code
  16. NFPA-101 Life Safety Code
  17. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
  18. ANSI/TIA-768 Customer-Owned Outside Plant Telecommunications Infrastructure
  19. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Building
  20. TIA-STD-J-607 Commercial Building Bonding and Grounding requirements for Telecommunications
  21. ANSI/NESC – National Electrical Safety Code
- B. BICSI Methodologies
1. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following guidelines published by the following organizations, where applicable
    - a. BICSI Methodologies
    - b. BICSI Telecommunications Distribution Methods Manual
    - c. BICSI ITS Installation Methods Manual
    - d. Customer Owned Outside Plant Design Manual
- C. Additional requirements for Manholes and Handholes:
1. Manholes shall be designed in compliance with the following ASTM standards:
    - a. ASTM C857-87 “Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures”,
    - b. ASTM C478 “Standard Specification for Pre-cast Reinforced Concrete Manhole Sections”,

- c. ASTM C858-83 “Standard Specifications for Underground Pre-Cast Concrete Utility Structures”
  - d. All reinforcing steel shall conform to ASTM 432 “Standard Guide for Selection of a Leak Testing Method”
  - e. ASTM 305 “Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency”.
  - f. ASTM C990, “Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants”
  - g. ASTM 432, “Standard Guide for Selection of a Leak Testing Method:
  - h. Test and inspect pre-cast concrete utility structures according to ASTM C1037
2. Manholes to be designed per ACI 318-02 “Building Code Requirements for Structural Concrete”.
  3. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
  4. Non-concrete Handholes and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

#### 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Comply with local Building Codes.
- C. Comply with BICSI TDMM 14<sup>th</sup> Edition.
- D. Comply with TIA-758 most current version at time of specification issuance.
- E. Field Inspector: Currently registered by BICSI as RCDD or Technician to perform the on-site inspection.
- F. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.
- G. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 5 years.
- H. Communications and Electrical Components, Devices, and Accessories:
  1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
  2. Marked for intended use.
- I. Strength tests shall be for specified tier ratings of products supplied.
  1. Tests of materials shall be performed by an independent testing agency.
  2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards
- J. Refer to Division 27 Section “General Communications Requirements” for additional Quality Assurance requirements.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.
- B. Store pre-cast and other factory–fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.
- C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.9 FIELD CONDITIONS

- A. Seismic Hazard Design Loads:
  - 1. Comply with the project seismic requirements specified in Section 26 05 48 “Vibration and Seismic Controls for Electrical Systems” for products and installation requirements necessary for compliance with seismic criteria.

1.10 PROJECT CONDITIONS

- 1. Interruption of existing communications services to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical and communications services according to requirements indicated.
- 2. Notify Architect no fewer than 4 weeks in advance of proposed interruption of the electrical or communications services.
- 3. Coordinate all service interruptions with the other trades, customer AHJ and architectural team.
- 4. Confirmation of the interruption shall be confirmed with a signed notice from the above mentioned parties.

1.11 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, tracer wires, warning planks, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, tracer wires, warning planks, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Architect.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Rigid steel conduit stub ups:
  - 1. GRC: Comply with ANSI C80.1 and UL 6.
  - 2. Comply with NEMA RN 1.

3. Coating Thickness: 0.040 inch (1 mm), minimum.

B. General Requirements for Metal Conduits and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

2.2 RIGID NONMETALLIC DUCT

A. Underground Plastic Utilities Duct: Type EPC-80-PVC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.

B. General Requirements for Nonmetallic Ducts and Fittings:

1. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
2. Comply with TIA-569-C and TIA-758-C.

C. Solvents and Adhesives: As recommended by duct manufacturer.

2.3 DUCT ACCESSORIES

A. Rigid Innerduct: Smooth HDPE duct, orange in color, designed for installation within a duct or pathway.

B. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling. (3 inches between ducts and exterior envelope wall)

2.4 UNDERGROUND LINE WARNING TAPE

A. Underground- Line Warning Tape: 3M Electronic Marking Solution (EMS) 7900 XT Early Warning Locatable Tape for protecting & locating underground utilities shall be provided and installed over all telecom site utilities.

B. General Requirements

1. Approved Manufacturer: 3M Company or approved equal.
2. All EMS Tape is color coded to APWA standards for visual reference.

Path Marking Frequencies		
Utility	Color	Frequency
Yellow	Gas	53.9 kHz
Orange	Telecom	48.8 kHz
Red	Power	34.9 kHz
Blue	Water	73.5 kHz
Green	Wastewater	41.4 kHz
Purple	GenPur/ Reclaimed Water	44.9 kHz

- a.
3. All EMS Markers shall have their own frequency to signal positive identification of each utility.

4. Two same frequency tapes must be spaced at 3' minimum to be individually locatable. (Joint trench)
5. The buried detectable warning tape can be located with any 3M Dynatel or similar Locator.
6. All Early Warning Locatable Tape shall be custom printed with owner logo. Standard EMS Early Warning Tape is not acceptable.

C. Storage and Handling

1. The tape should be stored inside their shipping containers until ready for placement in the field. The tape should not be stored in direct sunlight or at temperatures in excess of 100° F for an extended period of time.
2. Reasonable care in handling and placement must be taken to prevent damage to tape.

D. Installation

1. Recommended maximum depth 18 inches from surface on final grade. This is to take full advantage of the Early Warning Line Strike Prevention benefits.
2. Placement should allow for the locator to be about 6' above surface during the locating process.
3. Locatable tag is locatable down to 59" from tag.
4. Recommend placement of 3M EMS 7902 XT Tape 12" to 24" above asset to allow an excavator some leeway.

## 2.5 POLYMER HANDHOLES AND BOXES

A. Handholes shall be provided complete with all appurtenances and accessories required.

1. Manufacturers:
  - a. Hubbell Power Systems, Inc. / Quazite
  - b. Oldcastle Pre-cast Group
2. Requirements
  - a. Comply with
    - 1) UL-Listed per ANSI/SCTE-77
    - 2) ASTM G-154
    - 3) RUS 7CFR 1755.910 (PE-91)
    - 4) ASTM D-543
    - 5) ASTM D-570
    - 6) ASTM D2444
    - 7) ASTM D-756, procedure E
  - b. Available materials
  - c. Polyolefin Blend
  - d. Aggregate combined with polymer resin and reinforced with fiberglass
  - e. Fiberglass reinforced polymer (FRP)
  - f. Structural foam molded high density polyethylene (HDPE)
3. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Engineer prior to procurement and implementation.

B. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.

C. The cover shall have the following legend lettering molded into the cover:

1. LINE 1 "COMMUNICATIONS", LINE 2 "HANDHOLE DESIGNATOR"
  2. Bolts: LockDown LockOut™ Bolts
- D. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
- E. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
1. Extension shall provide increased depth of 12 inches.
  2. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.
- F. Duct entrances into handhole walls shall duct-terminating fittings in the wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated.
  2. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable
  3. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons.

## 2.6 PRECAST HANDHOLES AND BOXES

- A. Description: Pre-cast handholes shall be constructed of reinforced concrete with a minimum 28-day concrete compressive strength for concrete at 4,000PSI (min). All concrete used in the construction of the handhole shall contain steel reinforcing bars to conform to all applicable building codes. All reinforcing steel shall conform to ASTM432 "Standard Guide for Selection of a Leak testing Method" and ASTM 305 " Standard Practice for Mechanical mixing of Hydraulic Cement pastes and Mortars of Plastic Consistency".
- B. Handholes shall be provided complete with all appurtenances and accessories required.
1. Manufacturers: Subject to compliance with requirements and hold a current NPCA certification, provide products by one of the following:
    - a. Carder Concrete Products.
    - b. Christy Concrete Products
    - c. Elmhurst-Chicago Stone Co.
    - d. Oldcastle Pre-cast Group
    - e. Riverton Concrete Products; a division of Cretex Companies, Inc.
    - f. Utility Concrete Products, LLC
    - g. Utility Vault Co.
    - h. Wausau Title, Inc.
  2. Comply with ASTM C858 for design and manufacturing process.
  3. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Engineer prior to procurement and implementation.
- C. The cover finish shall be a nonskid finish with a minimum coefficient of friction of 0.50.

- D. The cover shall have the following legend lettering molded into the cover:
  - 1. LINE 1 "COMMUNICATIONS", LINE 2 "HANDHOLE DESIGNATOR"
  - 2. Include locking cover bolts.
- E. Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
- F. Extensions and slabs shall be designed to mate with bottom of enclosure and shall be same material as enclosure.
  - 1. Extension shall provide increased depth of 12 inches.
  - 2. Slab shall be same dimensions as bottom of enclosure, and arranged to provide closure.
- G. Windows shall be included as pre-cast openings in walls arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
  - 1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
  - 2. Window openings shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
  - 3. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
- H. Duct entrances into handhole walls shall have cast end-bell or duct-terminating fittings in the wall for each entering duct.
  - 1. Type and size shall match fittings to duct or conduit to be terminated.
  - 2. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable
  - 3. Rigid steel conduits shall be hot-dipped galvanized malleable iron or steel threaded to the end if the conduit is cast in place in the wall of the manhole. .
  - 4. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- I. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4" through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.

## 2.7 PRECAST CONCRETE MANHOLES AND BOXES

- A. Description: Pre-cast manholes shall be constructed of reinforced concrete with a minimum 28-day concrete compressive strength for concrete at 4,000PSI (min). All concrete used in the construction of the manhole shall contain steel reinforcing bars to conform to all applicable building codes. All reinforcing steel shall conform to ASTM432 "Standard Guide for Selection of a Leak testing Method" and ASTM 305 " Standard Practice for Mechanical mixing of Hydraulic Cement pastes and Mortars of Plastic Consistency".
- B. Manholes shall be provided complete with all appurtenances and accessories required.

1. Manufacturers: Subject to compliance with requirements and hold a current NPCA certification, provide products by one of the following:
    - a. Barbour Concretes.
    - b. PreTech Corp.
    - c. Precision Precast Co.
    - d. Oldcastle Pre-cast Group.
    - e. Utility Concrete Products, LLC.
  2. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Engineer prior to procurement and implementation.
- C. Comply with ASTM C478, "Standard Specification for Precast Reinforced Concrete Manhole Sections", as specified in Part 3 "Underground Enclosure Application" and with interlocking mating sections, complete with accessories, hardware, and features.
- D. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to facilitate racking of cables on walls.
  2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
  3. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
  4. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
1. Type and size shall match fittings to duct or conduit to be terminated
  2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable
  3. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- F. Concrete Knockout Panels: 1-1/2 to 32 inches thick, for future conduit entrance and sleeve for ground rod.
- G. Each manhole shall provide a sump drywell of at least 8" in diameter
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- I. Bonding Ribbon
1. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and

between wall- mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 4" through manhole/handhole floor.

- J. Sizing: Provide appropriately sized manholes to accommodate conduit terminations.
- K. Comply with ASTM C858 for design and manufacturing processes.

## 2.8 UTILITY STRUCTURE ACCESSORIES

- A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
  - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 36 inches; cover to be rated for heavy traffic H-20, UON. Provide
    - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
    - b. Special Covers: recess in face of cover designed to accept finish material in paved areas
    - c. For any manhole or vault 12' to 20' in length two (2) covers shall be provided; for MV over 20' three (3) covers shall be provided.
  - 2. Include locking cover bolts.
  - 3. Cover Legend: Cast-in molded lettering with manhole designation.
    - a. Line One – "COMMUNICATIONS"
    - b. Line Two – "MANHOLE DESIGNATOR"
  - 4. Manhole Chimney Components: Pre-cast concrete rings with dimensions matching to those of roof opening.
    - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used. Manhole Sump Frame and Grate: ASTM A48/A 48M, Class 30B, gray cast iron.
    - b. Extensions and Slabs: Designed to mate with bottom of enclosure and made of same material as enclosure.
- C. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch- (50-mm-) diameter eye, and 1-by-4-inch (25-by-100-mm) bolt.
  - 1. Working Load Embedded in 6-Inch (150-mm), 4000-psi (27.6-MPa) Concrete: 13,000-lbf (58-kN) minimum tension.
- D. Pulling-In and Lifting Irons in Concrete Floors: 7/8-inch- (22-mm-) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
  - 1. Ultimate Yield Strength: 40,000-lbf (180-kN) shear and 60,000-lbf (270-kN) tension.
- E. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch (13-mm) ID by 2-3/4 inches (69 mm) deep, flared to a minimum of 1-1/4 inches (31 mm) at base.

1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
  - F. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip, with 1/2-inch (13-mm) bolt, 5300-lbf (24-kN) rated pullout strength, and minimum 6800-lbf (30-kN) rated shear strength.
  - G. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer.
    1. Stanchions: *Minimum* nominal 36 inches (900 mm) high by 4 inches (100 mm) wide, with minimum of nine holes for arm attachment.
    2. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches (75 mm) with 450-lb (204-kg) minimum capacity to 20 inches (500 mm) with 250-lb (114-kg) minimum capacity. Top of arm shall be nominally 4 inches (100 mm) wide, and arm shall have slots along full length for cable ties.
  - H. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic duct, metallic duct, duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
  - I. Fixed Manhole Ladders: Arranged for attachment to roof wall and floor of manhole. Ladder, mounting brackets, and braces shall be fabricated from hot-dip galvanized steel.
  - J. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater Two required.
- 2.9 GROUNDING
- A. Ground Rod Sleeve: 3-inch (75-mm), PVC duct sleeve in manhole floors 2 inches (50 mm) from the wall adjacent to, but not underneath, the duct entering the structure.
  - B. Grounding System: Contractor shall include copper 10-x 3/4" ground rod, 2"x6" copper ground bus on stand offs with 2/0 AWG grounding conductor between ground bus and ground rod. Bond conduit Tracer wire directly to ground bus. Contractor to provide #6 AWG ground between permanent ladder and ground bus.
  - C. Grounding Conductors
    1. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
    2. Underground Conductors: Bare- copper conductor, No. 2/0 AWG minimum solid, unless otherwise indicated.
    3. Bare Copper Conductors: Comply with the following:
      - a. Solid Conductors: ASTM B 3.
      - b. Assembly of Stranded Conductors: ASTM B 8.
      - c. Tinned Conductors: ASTM B 33.
    4. Copper Bonding Conductors: As follows:
      - a. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
      - b. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.

- c. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

D. Grounding Connector Products

1. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
2. Bolted Connectors: Bolted-pressure-type connectors
3. Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87.
4. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.10 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C1037.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Communications: Type EPC-80-PVC , in concrete-encased duct bank unless otherwise indicated.
- B. Underground Duct Crossing (Paved Paths, Walks, Driveways, and Roadways: Type EPC-80-PVC, encased in reinforced concrete.
- C. Stub-Ups for Communications: Concrete-encased GRC.

3.3 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes: Precast concrete.
  1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H- 20 structural load rating.
  2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non- deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading
5. Handholes shall be used as pull-through points only. Handholes shall not be used as splice points, unless authorized in writing by the design team.
6. Handholes shall not be used in conduit runs that have more than (3) three 4" conduits.
7. Joint use of handholes by other trades is not allowed.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

### 3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area after construction in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation and re-establish original grades unless otherwise indicated.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and utility structures according to the "Cutting and Patching" Article in Section 017300 "Execution."

### 3.5 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Maintain a minimum trench depth to allow for the top row of conduits in the duct bank to be 36" below grade.
- C. Contractor shall remove all rock and debris from backfill material. Contractor shall remove all excess material from the site and compact the excavation. Unpaved areas shall be finished flush with the surrounding natural ground. Contractor shall restore damaged grassed areas.
- D. Install duct and duct bank according to NEMA TCB 2 and TIA-758-C.

- E. Slope: Pitch duct and duct bank a minimum slope of 1:100 down toward manholes and handholes and away from buildings and equipment. Slope duct and duct bank from a high point in runs between two manholes, to drain in both directions.
- F. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of at least 10 times inner conduit diameter both horizontally and vertically, at other locations unless otherwise indicated.
  - 1. Installation must comply with all NEC article 770 and local building codes as well as meet the minimum requirements included in ANSI/TIA-758-C Customer Owned OSP Infrastructure.
  - 2. Duct and duct banks shall have maximum of two 90-degree bends, or the total of all bends shall be no more 180 degrees between pull points.
  - 3. The maximum distance between two telecommunications Pull points must not exceed 600-feet. Maximum distance between pull points shall be derated 100-feet per 90 degrees of bend within duct bank.
- G. Required separation from other utilities.
  - 1. Power up to 1KVA:
    - a. 12" of well-packed earth
    - b. 4" of masonry
    - c. 3" of concrete
  - 2. Gas, Oil, Water, etc.:
    - a. 12" of well-packed earth
- H. Joints: Use solvent-cemented joints in duct and fittings, and make watertight according to manufacturer's written instructions. Stagger couplings, so those of adjacent ducts do not lie in same plane.
- I. Installation Adjacent to High-Temperature Steam Lines: Where duct or duct banks are installed parallel to underground steam lines, perform calculations showing the duct or duct bank will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct or duct bank crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- J. End-Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
- K. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for 4-inch (100-mm) duct, and vary proportionately for other duct sizes.
- L. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct slope away from the building or forming a trap in the duct. Use fittings manufactured for RNC duct-to-GRC conduit transition. Install GRC penetrations of building walls as specified in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

- M. Sealing: Provide temporary closure at terminations of duct that has cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-  
psig (1.03-MPa) hydrostatic pressure.
- N. All conduits shall be mandrelled prior to installation of cable or (for spare conduits) prior  
to substantial completion; the OD of the test mandrel shall be no smaller than 80% of the  
conduit internal diameter.
- O. Innerduct: Install immediately after mandreling duct. Size and type as indicated on  
Drawings.
- P. Measuring Pull Tape Rope: Install (1) measuring pull tape,  $\frac{3}{4}$ -Inch with the Tensile  
Strength of 2500-lb (1134-Kg) into each empty duct and innerduct. Mule tape rope must  
be marked with descending 1-foot increments to measure conduit runs.
- Q. Concrete-Encased Duct and Duct Bank:
  - 1. Excavate trench bottom to provide firm and uniform support for duct or duct bank.  
Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes  
less than 6 inches (150 mm) in nominal diameter.
  - 2. Width: Excavate trench 12 inches (300 mm) wider than duct or duct bank on each  
side.
  - 3. Depth: Install top of duct and duct bank at least 24 inches (600 mm) below finished  
grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm)  
below finished grade in deliberate traffic paths for vehicles unless otherwise  
indicated.
  - 4. Support duct and duct bank on duct spacers coordinated with duct size, duct  
spacing, and outdoor temperature.
  - 5. Minimum Space Between Duct: 3 inches (75 mm) between edge of duct and  
exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4  
inches (100 mm) between power and communications ducts.
  - 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming  
of duct, with not less than *four* spacers per 20 feet (6 m) of duct. Place spacers  
within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches  
(150 mm) between tiers. Secure spacers to earth and duct to prevent floating  
during concreting. Tie entire assembly together using fabric straps; do not use tie  
wires or reinforcing steel that may form conductive or magnetic loops around duct  
or duct bank.
  - 7. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at  
changes of direction in duct run unless otherwise indicated. Extend concrete  
encasement throughout length of elbow.
  - 8. Reinforcement: Reinforce concrete-encased duct and duct bank where they cross  
disturbed earth and where indicated. Arrange reinforcing rods and ties without  
forming conductive or magnetic loops around ducts or duct groups.
  - 9. Forms: Use trench walls to form side walls of duct and duct bank where soil is self-  
supporting and concrete envelope can be poured without soil inclusions;  
otherwise, use forms.
  - 10. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between  
edge of duct to exterior envelope wall, 2 inches (50 mm) between ducts, and 4  
inches (100 mm) between power and communications duct.
  - 11. Concreting Sequence: Pour each run of envelope between manholes or other  
terminations in one continuous operation.

12. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between ducts and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto duct. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

### 3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
  1. Comply with ASTM C891 unless otherwise indicated.
  2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
  3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
  1. Manhole Roof: Install with rooftop at least 15 inches (380 mm) below finished grade.
  2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
  3. Where indicated, cast handhole cover frame integrally with handhole structure.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated. (as required)
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
  1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
  2. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.
- E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, cable arms, as required for installation and support of cables and conductors and as indicated.
- F. Waterproofing: Apply waterproofing to exterior surfaces of manholes and handholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days
- G. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- H. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (97 mm) for manholes and 2 inches (50 mm) for handholes, for field-installed anchor bolts installed. Use a minimum of two anchors for each cable stanchion.

- I. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

### 3.7 GROUNDING

- A. Manholes and Handholes: Install a driven ground rod close to wall and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.

1. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

- B. Equipment Grounding Conductors

1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
2. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.

- C. Connections

1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
  - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
  - b. Make connections with clean, bare metal at points of contact.
  - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  - d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
2. Compression Fittings: Permanent compression-type fittings may be used for the following:
  - a. Connecting conductors together.
  - b. Connecting conductors to ground rods

- D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.

- E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- F. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
  - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
  - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii and test for out-of-round duct. Provide a minimum 12-inch- (300-mm-) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
  - 3. Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
    - a. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
    - b. Perform point-to-point megohmmeter tests between the ground rod and all cable shields, splice cases, locate wires, and racking hardware to determine the resistance.
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris.
- B. Clean internal surfaces of manholes, including sump.
  - 1. Sweep floor, removing dirt and debris.
  - 2. Remove foreign material.

### 3.10 INSTALLATION ACCEPTANCE

- A. Acquire written approval from the Owner prior to backfilling any duct banks or covering manholes/ hand holes.

END OF SECTION 27 02 10