

SECTION 270543 – UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including Maryland Department of Transportation/Maryland Aviation Administration Standard Provisions for Construction Contracts Volume 1, Maryland State Highway Administration, Anne Arundel County and Interim Standard Provision Addenda, apply to this Section.
- B. Related Sections:
 - 1. 270526 Grounding and Bonding for Communications Systems
 - 2. 270528 Pathways for Communications Systems
 - 3. 270553 Identification for Communications Systems
 - 4. 271100 Communications Equipment Room Fittings
 - 5. 271300 Communications Backbone Cabling
 - 6. 271900 Exterior Communications Pathways

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Underground ducts and duct banks
 - 2. Handholes
 - 3. Maintenance holes

1.3 REFERENCES

- A. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.
- B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean the latest printed edition of each in effect at the date of contract unless the document is shown dated.
- C. Conflicts:
 - 1. Between referenced requirements: Comply with the one establishing the more stringent requirements.
 - 2. Between referenced requirements and contract documents: Comply with the one establishing the more stringent requirements.

D. References:

1. National Electrical Manufacturers Association (NEMA):
 - a.) RN1 Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Electrical metallic Tubing
 - b.) TC2 Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80)
 - c.) TC3 PVC Fittings for Use with Rigid PVC Conduit and Tubing
2. Underwriters Laboratories Inc. (UL):
 - a.) 651 Schedule 40 and 80 Rigid PVC Conduit
 - b.) 651A Type EB and A Rigid PVC Conduit and HDPE Conduit
3. National Electrical Safety Code (NESC)
4. National Fire Protection Association (NFPA) ANSI/NFPA 70 National Electrical Code (NEC)
5. Telecommunications Industry Association/Electronic Industries Alliance TIA-569-B-2004 Commercial Building Standard for Telecommunications Pathways and Spaces
6. ANSI/TIA/EIA-758 Customer-Owned Outside Plant Telecommunications Cabling Standard
7. Building Industry Consulting Services International (BICSI) Telecommunications Distribution Methods Manual (TDMM)
8. BICSI Customer Owned Outside Plant (CO-OSP) Design Manual
9. Occupational Safety and Health Administration (OSHA) Regulations
10. Local, county, state and federal regulations and codes in effect as of date of purchase
11. Equipment of foreign manufacture must meet U.S. codes and standards. It shall be indicated in the proposal the components that may be of foreign manufacture, if any, and the country of origin.

1.4 SUBMITTALS

- A. The Contractor shall perform no portion of the work requiring submittal and review of record drawings, shop drawings, product data, or samples until the respective submittal has been approved by the Owner. Such work shall be in accordance with approved submittals.
- B. Qualifications: The Contractor shall submit qualification data sheets for firms and persons as specified in the "Quality Assurance" article of this specification to demonstrate their capabilities and experience.

- C. Proposed product data sheets: The Contractor shall submit catalog cut-sheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be handwritten and/or highlighted to indicate exact selection. Identify applicable specification section reference for each product.
- D. Coordination Drawings: Contractor shall submit plan and section drawings showing total requirement for duct banks.
- E. Contractor shall submit calculations associated with sizing and arrangements of ducts and cables.
- F. Record Drawings: Furnish CAD drawings of completed work including cable ID numbers following the Owner's labeling standards. Submit in hardcopy (two full size and two half size) and electronic formats.

1.5 QUALITY ASSURANCE

- A. Contractor Qualifications:
 - 1. The Contractor shall submit references and other related evidence of installation experience for a period of three years prior to the issue date of this Specification.
 - 2. All work shall be supervised on-site by a BICSI Registered Communications Distribution Designer (RCDD). Must demonstrate knowledge and compliance with all BICSI, TIA/EIA, UL, and NEC standards and codes. Contractor shall submit proof of RCDD designation.
- B. Provided products shall meet the following requirements: Items of the same classification shall be identical. This requirement includes equipment, assemblies, parts, and components.
- C. Verify duct banks do not interfere with existing or new underground facilities.
- D. Follow Annex B of National Electrical Code (NEC).
- E. Assure that the "as installed" system is correctly and completely documented including engineering drawings, manuals, and operational procedures in such a manner as to support maintenance and future expansion of the system,

1.6 WARRANTY

- A. General Warranty: Refer to MAA's General and Special Provisions Document for warranty requirements.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify dimensions in areas of installation by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating units without field measurements. Coordinate supports, adjacent construction, and fixture locations to ensure actual dimensions correspond to established dimensions.

1.8 DELIVERY AND STORAGE

- A. Equipment shall be delivered in original packages with labels intact and identification clearly marked.
- B. Equipment shall not be damaged in any way and shall comply with manufacturer's operating specifications.
- C. Equipment and components shall be protected from the weather, humidity, temperature variations, dirt, dust, or other contaminants. Equipment damaged prior to system acceptance shall be replaced at no cost to the Owner.
- D. Containers shall be clearly marked "For Communications Duct Banks Only".

1.9 COORDINATION

- A. Field coordinate installation of ducts with other trades to ensure clearance requirements are met.
- B. Coordinate with all contractors providing equipment outside the scope of this contract.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Definition:
 - 1. For the purpose of this document, the term "Telecommunication Underground Ducts and Raceways" defines a portion of BWI's communication infrastructure. Telecommunication Underground Ducts and Raceways include products provided for the routing, segregation and support of telecommunication cabling both inside and outside of facilities.

2.2 UNDERGROUND DUCT BANKS

- A. Duct material: Schedule 40 rigid PVC with non-magnetic universal interlocking type spacers for both horizontal and vertical duct arrangements. Where all-dielectric cables are used below ground, an additional insulated conductor shall be placed along with the cable to provide means of tone locating. The trace conductor shall be 10 AWG or larger.
- B. Underground Duct Banks, Maintenance holes/Handholes– Design Load Rating:
 - 1. AASHTO Extra Heavy Duty Rating for Aircraft apron / Taxiway / Runway Areas.
 - 2. AASHTO H-20 Rating for Typical Roadway / Commercial Traffic Areas.
- C. Telecommunication Handholes and Maintenance holes (A.K.A. Manholes)
 - 1. Telecommunication Handholes:
 - a) The use of handholes should be limited to low density cable runs. All proposed handhole applications must be reviewed with MAA OAT in the early stages of design.
 - 2. Telecommunication Maintenance holes:

- a) Shall not be used by lighting and power cable plant
- b) Used for Telecommunication cable pulling and splicing
- c) Maintenance hole covers and frames shall be load rated for expected traffic load.
- d) Standard Maintenance hole Configurations:
 - 1) Type A
 - 2) Type J
 - 3) Type V
 - 4) Application specific design as field and cable density/routing conditions require.
 - 5) Typical Maintenance hole Corrosion Resistant Accessories:
 - a) Sump
 - b) Ladder
 - c) Cable Rack/Ladder
 - d) Pulling Eyes
 - e) Grounding hardware

D. Building Entrances

- 1. Pulling Eyes
- 2. Splice Frame
- 3. Grounding /Protection Hardware
- 4. Sealing and capping of conduit and innerducts to prevent migration of, pests, water and vapors into the facility. Concrete and Reinforcing Steel for Encasement: Furnish products following Division 3, except strengths as follows:
 - 1. Compressive Strength: 2500 psi at 28 days, class A.
 - 2. Flexural Strength: 500 psi at 28 days.

2.3 CONDUIT SYSTEMS

- A. Conduit pathways shall be provided as complete Conduit systems including:

1. Conduit with pull strings
2. Pull box / Junction box assemblies
3. Mounting / attachment hardware
4. Labeling
5. Grounding

B. Conduit Fill Calculations.

1. Calculate and provide conduit systems with sizing and quantities to assure conduit wire/cable fill does not exceed pulling tensions, rush limits and performance properties of cables installed.

C. Conduit Trade Sizes:

1. Typical conduit trade sizes used in Outside Plant Telecommunication Pathways are:
 - a.) Trade Size 4 Inch PVC Sch40

2.4 INNERDUCTS

A. Outside plant innerduct shall be installed in UG conduits and duct banks.

1. Outside Plant Inner Ducts shall be 1.25-inch and/or 1.5-inch selected to optimize current and future cable routing through underground conduits. Outside plant innerduct shall include the following features:
 - a.) Innerducts shall be constructed of high-density polyethylene with internal and external longitudinally ribs.
 - b.) Innerducts shall be furnished with factory installed nylon pull ropes.
 - c.) Innerducts shall have a UL 94 V-O rating for flame spread from final maintenance holes to interconnection cabinets within buildings.
 - d.) Innerduct reel lengths shall be provided as necessary to insure that ducts are continuous; one piece runs from maintenance hole/handhole to maintenance hole/handhole. No innerduct connectors will be allowed between maintenance holes/handholes.
 - e.) Pulling accessories used for innerduct shall be compatible with materials being pulled. Accessories shall be furnished as required to complete the installation, including but not limited to, inner duct lubricants, spreaders, applicators, grips, swivels, harnesses, and line missiles.

- f.) Each segment of innerduct shall extend at least twelve inches beyond the end of the service conduit.
2. At Building entrances locations, innerduct shall be extended into racking infrastructure and securely fasten to prevent pull back into the conduit systems.
3. In maintenance holes planned for cable pull through, (non-pull point for cable) innerduct shall be properly racked and secure to minimize congestion in the maintenance holes. In maintenance holes where cable pulling is required, innerducts shall be secured to racking to prevent pull back, and sealed to minimize migration of water, vapors and pests.
4. At each maintenance hole and cable entrance to the facility, the inner ducts shall be labeled to indicate cable (s) supported inside the innerduct.
5. Design Selection: Carlon, Integral or equal.

2.5 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.6 MANUFACTURERS

- A. Subject to compliance with requirements, manufacturers that may be incorporated in the work, include, but are not limited to the following:
 1. PVC Rigid Conduit:
 - a.) Carlon.
 - b.) Robroy Industries, Inc.
 - c.) Cantex.
 2. Conduit Fittings and Bodies:
 - a.) Crouse-Hinds, Appleton Electric.
 - b.) Killark Electric Manufacturing Company.
 - c.) O-Z/Gedney.
 3. Innerduct: Carlon Riser Gard Flexible Raceway (corrugated)

4. Measured pull tape – pull tape printed with sequential footage markings for accurate measurements:
 - a.) Fibertek.
 - b.) Condux International.

2.7 MATERIALS

- A. All conduits, fittings, junction and pull boxes shall be UL rated.
- B. All conduits, fittings, junction and pull boxes shall comply with the NEC.
- C. Non-metallic Conduit and Fittings: Pass NEMA TC2, UL 651 and 651A and FS W-C-1094A. EMT fittings shall be formed steel compression ring type. Die cast fittings are not allowed.
- D. Conduit Bodies: Follow UL 514B and FS W-C-58C. Furnish sufficient coating for touch up after installation.
- E. Conduit Fittings
 1. All fittings shall be compression or threaded.
 2. Fittings shall provide a secure connection for pulling communications cables.
 3. Setscrew fittings are not permitted.
- F. Conduit “condulets” are not permitted.
- G. Flexible conduit is not permitted.
- H. Non-metallic conduits are not permitted in above ground installations. Conversion fittings are required for non-metallic (below ground) to metallic (above ground) transitions.
- I. Innerduct:
 1. All fiber shall be installed in innerduct.
 2. One part segmented
 3. UL Listed with Flame Propagation compliant with UL 2024
 4. Only manufacturer’s fittings, transition adapters, terminators and fixed bends shall be used.

5. 1 ¼ -inch corrugated, non-metallic

J. Measured Pull Tape

1. Pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn
2. Minimum average tensile strength shall be 1250 lbs. for 1½-inch and smaller conduits and innerduct.
3. Minimum average tensile strength shall be 1800 lbs. for conduits larger than 1½ inch.

K. Pull Boxes, Junction Boxes and Gutters

1. All junction boxes, gutters and pull boxes shall comply with NEC Article 314.
2. All junction boxes, gutters and pull boxes shall meet the following minimum material requirements:
 - a.) 16-gauge steel or heavier.
 - b.) Seams shall be continuously welded and grounded smooth.
 - c.) External screws and clamps.
 - d.) External mounting feet (where possible).
 - e.) Oil-resistant gasket and adhesive.
 - f.) ANSI 61 gray polyester powder coating inside and out over phosphatized surface.
 - g.) UL 50 type 12.
3. All junction boxes, gutters and pull boxes shall be provided with bushings for conduits and/or cabling.
4. All junction boxes, gutters and pull boxes shall be securely installed.
5. All junction boxes, gutters and pull box sizes for single and multiple conduit runs shall comply with BICSI TDMM.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Contractor's on-site RCDD supervisor shall review, approve and stamp all shop drawings, coordination drawings and record drawings.
- B. Verify materials are on site in proper condition and of sufficient quantity.
- C. Verify proper excavation depth (minimum 48 inches below finished grade), width, route and support of work. Verify proper location of handholes and maintenance holes (minimum every 350 feet). Communications facilities must be placed in separate handholes and maintenance holes from Electrical facilities.
- D. Trenches greater than or equal to 5 feet deep:
 - 1. Shall be shored to prevent cave-in.
 - 2. Shall have 2 feet clearance from the dirt pile.
- E. Directional boring is a suitable substitute when trenching is impractical or impossible. Locating existing underground utilities is crucial when directional boring is planned because of the potential for the drilling unit to encounter high voltages. Although directional boring machines are manufactured with electrical strike sensing capabilities, which can warn the operator of any contact with a high voltage source, accidents may still occur.
 - 1. Operators of directional boring machines require special protection due to the potential for exposure to high voltage. Therefore, operators must always have a ground mat grid underfoot as insulation protection. In addition, operators must wear insulating boots and gloves, along with hard hats and safety glasses.
- F. Minimum electrical/communications underground cable separation:
 - 1. Concrete: 3 inches
 - 2. Masonry: 4 inches
 - 3. Well-tamped earth: 12 inches
- G. Before encasement, verify ducts are free of debris and properly installed in support and spacer system, are properly fitted together and hold-down hardware is properly installed.

3.2 INSTALLATION

- A. Install work following drawings, manufacturer's instructions and approved submittal data.
- B. Install conduit in excavations following Drawings. If directional boring is utilized, cable or flexible conduits can be attached to the unit and pulled back to the origination point (after the drilling unit reaches its destination).
- C. Handholes shall be sized in accordance with BICSI CO OSP Manual but no larger than four feet by four feet and shall be constructed of 2-inch thick cement covered with 3/8

inch steel plate. The handhole or maintenance hole shall rest on a 4-inch blanket of sand, and four inches around the side walls shall be filled with sand.

- D. Each handhole or maintenance hole which contains a pedestal shall have four bollards installed 18 inches diagonally from each corner, with a cross member welded at 30 inches connecting the four corners. These barriers shall be constructed of four-inch rigid conduit filled with concrete, driven four feet in the ground and extending 36 inches above the protective cover.
- E. Install watertight penetrations through foundation, handhole and maintenance hole walls. Wherever a handhole is used to simply pass through, the conduit entrances and exits shall be situated at opposite ends of the handhole instead of 90 degree angles.
- F. Assemble duct banks with non-magnetic saddles, spacers and separators. Position separators for 2-inch minimum concrete separation between outer surfaces of adjacent ducts.
 - 1. Make uniform required bends with a minimum of a 24-inch radius for conduits less than 3 inch diameter, and a 48 inch radius for conduits 3 inches and larger.
 - 2. Maintain vertical or horizontal separations of 12 inches of well-packed topsoil from any electrical service conduit run parallel to communications conduits.
- G. Install reinforcing. Install concrete encasement fully surrounding reinforcing steel and ducts.
 - 1. Unless otherwise noted on the drawings, reinforce with No. 5 longitudinal steel bars placed at each corner and along each face at maximum parallel spacing of 12 inches o.c., and No. 5 tie-bars transversely placed at 12 inches o.c. maximum longitudinal. Maintain maximum clearance of 2 inches from bars to edge of forms and ducts.
 - 2. Place concrete with minimum 3-inch cover surrounding ducts and reinforcement.
 - 3. Maintain ducts in proper place during concrete placement.
- H. Transition from Schedule 40 rigid PVC non-metallic to metallic conduit where duct banks enter structures or turn upward for continuation above grade.
- I. Where ducts enter structures such as handholes, maintenance holes, pullboxes, or buildings, terminate ducts in proper end bells, insulated L-bushings, Meyers hubs or couplings on steel conduits.
- J. Extend below grade conduits to 4 inches above the finished floor inside a building.
- K. Tag conduits entering pull boxes with stamped stainless steel tags following cable and conduit schedule.
- L. Backfill after concrete cures 24 hours.
- M. Install one bare stranded copper duct bank ground cable following Section 270526 in each duct bank envelope. Make ground electrically continuous throughout duct bank system. Connect to each handhole and maintenance hole ground rod.

- N. Pull a 12-inch long mandrel (1/4 inch smaller than duct diameter) through ducts. Pull a rag swab or sponge through to remove debris, until it shows clean.
- O. Where fiber optic cables will be installed, place innerducts inside each Trade Size 4 inch conduit as designated on the drawings for this purpose. See Section 270528 for innerduct specifications.
- P. Provide a measured pull tape in all underground conduits.

3.3 CLEANING

- A. Remove all unnecessary tools and equipment, unused materials, packing materials, and debris from each area where Work has been completed unless designated for storage.

3.4 ACCEPTANCE

- A. Once all work has been completed, test documentation has been submitted and approved, and the Owner is satisfied that all work has been completed in accordance with contract documents, the Owner will notify Contractor in writing of formal acceptance of the system.
- B. Acceptance shall be subject to completion of all work and submittal and approval of full documentation as described above.

END OF SECTION 270543