

SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Conduit for direct burial.
  - 2. Handholes and boxes.
  - 3. Manholes

1.3 DEFINITION

- A. RNC: Rigid nonmetallic conduit.
- B. RMC: Rigid steel conduit.
- C. Handhole: a large junction box used for site electrical work. In this project the terms “handhole”, “box” or “junction box” are used interchangeably to refer to a junction box installed flush in pavement or grade.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 2. Accessories for manholes, handholes and boxes
  - 3. Warning tape.
- B. Shop Drawings for Factory-Fabricated Manholes, Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
  - 1. Dimensions
  - 2. Cover design.
  - 3. Materials
  - 4. Structural rating

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- B. Comply with ANSI C2.
- C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store manholes, handholes and boxes at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Owner no fewer than thirty (30) days in advance of proposed interruption of electrical service.
  - 2. Do not proceed with interruption of electrical service without Engineer's or Owner's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of conduit, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of conduit, manholes, handholes, and boxes with final locations 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. RNC shall be manufactured by Carlon or Queen City Plastics.
- B. RMC shall be as manufactured by GE, Kaiser, Republic or T&B.

## 2.2 CONDUIT

- A. RNC: NEMA TC 2, Type EPC-40-PVC with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
- B. RMC: Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1. The interior and exterior surfaces of the conduit shall be protected with a metallic zinc coating. Rigid steel conduit shall be galvanized by the Hot-Dip process in accordance with ASTM A 123. Fittings shall be threaded type.

## 2.3 UNDERGROUND CONDUIT ACCESSORIES

- A. Conduit Accessories:
  - 1. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

## 2.4 HANDHOLES AND BOXES

- A. The terms "handhole," "handhole box," "handhole/box," or "box" is used throughout the document to refer to a recessed-in-grade or in-pavement junction or pull box.
- B. Description: Shall be made of polymer concrete, and shall comply with SCTE 77.
  - 1. Color: Gray.
  - 2. Configuration: Units shall be designed for flush burial, stackable, and have open bottom, unless otherwise indicated.
  - 3. Cover: Weatherproof, heavy duty, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and suitable to withstand vehicular traffic. (Tier 15 rating)
  - 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  - 5. Cover Legend: Molded lettering, "ELECTRIC" or "TELECOMMUNICATIONS" as applicable.
  - 6. Handholes minimum dimensions shall be as indicated on drawings.
- C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
  - 1. Manufacturers: Subject to compliance with requirements, including labels indicating third-party agency acceptable listing, provide products by one of the following (Quazite is the University preferred product):
    - a. Quazite
    - b. Armorcast Products Company.
    - c. Carson Industries LLC.
    - d. CDR Systems Corporation.
    - e. NewBasis.

## 2.5 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037.
- B. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by a 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.

## 2.6 MANHOLES/VAULTS:

- A. Underground structures shall be poured in place or may be of precast construction. Horizontal concrete surface of floors shall have a smooth trowel finish. Concrete shall be cured by applying two coats of white pigmented membrane forming-curing compound in strict accordance with the manufacturer's printed instructions, except that precast concrete may be steam cured. Curing compound shall conform to ASTM C 309. Duct entrances and windows shall be located near the corners of structures to facilitate cable racking. Covers shall fit the frames without undue play. Steel and iron shall be formed to shape and size with sharp lines and angles. Casting shall be free from warp and blow holes that may impair their strength or appearance. Exposed metal shall have a smooth finish and sharp lines and arises. Provide all necessary lugs, rabbets and brackets. Set pulling-in irons and other built-in items in place before depositing concrete. The words "electric" and "telephone" shall be cast in the top face of all power and telephone manhole covers, respectively.
- B. Optional Precast Concrete Construction: In lieu of poured-in-place concrete manholes and hand holds, the Contractor may, at his option, provide precast concrete structures subject to the requirements specified below. Precast units shall be the product of a manufacturer regularly engaged in the manufacture of precast concrete products, including precast manholes and handholds.
- C. General: Precast concrete structures shall have the same accessories and facilities as required for poured-in-place structures. Likewise, they shall have plan area and clear heights not less than those of poured-in-place structures. Concrete materials and methods of construction shall be the same as for poured-in-place concrete construction, as modified herein. Slope in floor may be omitted provided precast sections are poured in reinforced steel forms. Concrete for precast work shall have an ultimate 28-day compressive strength of not less than 4000 pounds per square inch. Structures may be precast to the design and details shown for poured-in-place construction, precast monolithically and placed as a unit; or, they may be of assembled sections, designed and produced by the manufacturer in accordance with the requirements specified. All structures shall be identified with the manufacturer's name embedded in, or otherwise permanently attached to, an interior wall face.
- D. Structure top and bottom shall be designed for full dead, superimposed dead and live load including impact. Structure sidewalls shall be designed for lateral earth and hydrostatic pressures plus live load (H2O Truck) adjacent to structure. Tops and walls of structures shall be designed

for AASHTO standard H20 highway loading, with 30 percent loading added for impact and with design load being that which produces maximum shear and moment. All dead and live loads, as well as impact loading, shall be considered in design. Walls shall be designed to withstand all soil pressures, taking into consideration the soil to be encountered and ground water level present at the site and assuming that the H20 design vehicle will operate on surfaces adjacent to the structure. Ground water level shall be assumed to be three feet below ground surface unless a higher water table is indicated in the boring logs. Design shall also take into consideration stresses induced in handling units. Lifting devices shall be provided for properly handling units. Calculations and shop drawings shall be submitted covering the design and manufacture of precast units and shall bear the seal of registered professional engineer.

- E. Joints: Mating edges of precast components shall be provided with tongue and grooved joints. Joints shall be designed to firmly interlock adjoining components and to provide waterproof junctions. Joints shall be sealed watertight using preformed plastic strip conforming to AASHTO M 198, Type B. Sealing material shall be installed in strict accordance with the sealant manufacturer's printed instructions. Provisions shall be made for waterproofing cable entrances into structures and at covers in the top slab.
- F. Pulling-in irons shall be steel bars bent as indicated on drawings, and cast in the walls and floors. In the floor they shall be centered under the cover, and in the wall they shall be not less than 6 inches above or below, and opposite the conduits entering the structure. Pulling-in irons shall be projected into the structure approximately 4 inches. Irons shall be zinc-coated after fabrication.
- G. Cable racks, including arms shall be made from 50% glass-reinforced nylon or a non-metallic material having equal mechanical strength, thermal resistance, chemical resistance and dielectric physical properties. Cable racks, including rack arms and insulators, shall be sufficient to accommodate the cables. Racks in power manholes shall be spaced not more than 3 feet apart and each manhole wall shall be provided with a minimum of 2 racks.
  - 1. Provide stainless steel hardware for mounting fasteners. Coat threads of anchor bolts with anti-seize compound immediately prior to installing nuts.
  - 2. Rack arms shall be 8", removable type, and rated capable of supporting 450 lbs working load and 1,000 lbs short term rated.
  - 3. Rack arms shall have slots or holes for securing cables with non-metallic cable wire ties.
- H. Precast Manhole/Vault Installation: Commercial precast assembly shall be set on 6 inches of level, 90 percent compacted granular fill, 3/4 inch to one inch size extending 12 inches beyond the manhole on each side. Granular fill shall be compacted by a minimum of four passes with a plate type vibrator. Drain sumps shall be provided for all precast structures.
- I. Install 1/0 bars copper ground conduct around inside perimeter of manhole. Connect to 3/4" x 10' - 0" ground rod inside manhole. Bond with #6 bare copper from ring to manhole cover frame, sump covers, etc.

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

- A. System shall consist of single, round bore conduit encased in concrete. The minimum number and size of ducts shall be indicated on the drawings. Changes in direction of runs exceeding 10 degrees shall be accomplished by using special couplings or bends manufactured for this purpose. Duct lines shall be installed so that the top of concrete or future concrete as shown is not less than 30 inches below finished grade or finished paving at any point.
- B. Ducts should be pitched to drain toward manholes and away from buildings and equipment. Minimum slope shall be 4-inches in 100-feet. Where necessary to achieve this between manholes, ducts should be sloped from a high point in the run to drain in both directions.
- C. Concrete encased non-metallic duct shall be supported on plastic separators coordinated with duct size and spacing. Separators shall be spaced close enough to prevent sagging and deforming of ducts. Separators to the earth and to ducts should be secured to prevent floating during placement of concrete. Steel or tie wires should not be used in such a way as to form conductive or magnetic loops around ducts or duct groups.
- D. Where duct lines enter manholes or pull boxes, the conduits shall terminate in end bells. Conduit shall be thoroughly cleaned before laying. During construction and after the duct line is completed, the ends of the conduit shall be plugged to prevent water washing mud into the conduits.
- E. All underground raceways shall be identified by underground line marking tape located directly above the raceway at 6 to 8 inches below finished grade. Tape shall be permanent, bright-colored, continuous printed, metallic tape compounded for direct burial not less than 6 inches wide and 4 mils thick. Printed legend shall be indicative of general type of underground line below. Where it is necessary to cut a tapered end of a piece of conduit at the site, the cut shall be made with a tool or lathe designed to cut a taper to match the taper of the particular conduit to be used.
- F. All ducts should be sealed at terminations, using sealing compound and plugs, as required to withstand 15 psi hydrostatic pressure.
- G. After the duct line has been completed, a mandrel not less than 12 inches long, having a cross section approximately one-fourth inch less than the inside cross section of the conduit shall be pulled through each conduit after which a brush with stiff bristles shall be pulled through to make certain that no particles of earth, sand, or gravel have been left in the lines.
- H. The conduit furnished shall be concrete encased plastic. Concrete shall be colored red for all MV Cable Duct Banks.
- I. Installation of duct banks comprising multiple single conduits: each single conduit shall be completely encased in concrete with a minimum of 3" between conduits and a minimum thickness of concrete encasement of 3" which may be increased to fit the actual shape of the trench. Spacing assembly shall be made of non-metallic, non-decaying material. Joints in conduits shall be staggered at least 6". Ducts shall be securely anchored to prevent movement during the placement of concrete.
- J. Waterproof, 130 pound tensile test marking cord shall be installed (marked at least every foot), in all ducts, including spares, after thoroughly rodding, clearing and swabbing all lines free of any and all obstructions.

- K. Installation of single conduit shall be completely encased in concrete. The thickness of concrete shall be not less than 3" on the sides, bottom and top of conduit.
- L. Concrete: Concrete shall be 3000 psi class. Where a connection is made to an existing duct line, the concrete encasement shall be well bonded to the existing encasement. Use 1/2" diameter stainless steel rod minimum doveled in existing duct bank for cold joints, 2' - 0" into old envelope and 2' - 0" beyond.
- M. Connections to New Manholes: Concrete encased duct lines connecting to underground structures shall be constructed to have a flared section adjacent to the manhole to provide shear strength. Underground structures shall be constructed to provide for keying the concrete envelope of the duct line into the wall of the structure. Vibrators shall be used when this portion of the envelope is poured to assure a seal between the envelope and the wall of the structure.
- N. Connections to Existing Manholes: For duct line connections to existing structures, break the structure wall out to the dimensions required and preserve the steel in the structure wall. Cut the steel and bend it out to tie into the reinforcing of the duct line envelope. Chip out the structure wall to form a key for the duct line envelope.
- O. Design for spare ducts in each power duct bank as follows:
  - 1. 1-3 occupied ducts requires (1) additional spare duct, 4 or more occupied ducts requires (2) spare ducts minimum.
- P. Coordinate number of ducts and associated spares for Telecom duct bank with the University Telecommunications Department.

### 3.2 UNDERGROUND CONDUIT APPLICATION

- A. Underground conduit: Rigid non-metallic conduit, concrete encased or direct-buried.
- B. Conduit stub-ups into pole light fixtures or above-ground boxes shall be accomplished with rigid steel conduit.
- C. Refer to details on the drawings.

### 3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- C. 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 Division 32 Sections "Turf and Grasses" and "Plants."
- D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 32 requirements.

### 3.4 CONDUIT INSTALLATION

- A. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured bends both horizontally and vertically. Use long sweep bends for telecommunication cable conduits.
- B. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- C. Sealing: Provide temporary closure at terminations of conduits that have cables pulled. Seal spare or empty conduits at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- D. Pulling Cord: Install test nylon cord in spare and empty conduits.
- E. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all conduits.
- F. Direct-Buried Conduit :
  - 1. Excavate trench bottom to provide firm and uniform support for buried conduit. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
  - 2. Install backfill and compact as specified in Division 31 Section "Earth Moving."
  - 3. Depth: Install top of conduit at least 24 inches below finished grade, unless otherwise indicated or as otherwise required by NEC.
  - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles, above ground boxes and equipment.
    - a. Refer to details on the drawings.

### 3.5 INSTALLATION OF HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a 12-inch deep level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. For enclosures installed in asphalt paving and subject to occasional, non-deliberate, heavy-vehicle loading, form and pour a 6-inch wide concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.



1. Concrete: 3000 psi (20 kPa), 28-day strength.

3.6 GROUNDING

- A. Ground metallic conduits and metal items according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 CLEANING

- A. Clean internal surfaces of handholes, including sump. Remove foreign material.

END OF SECTION 260543