

SECTION 27 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR
COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, maintenance hole and handhole construction, and landscaping.
- B. Related Sections
 1. Division 26 Section — "Basic Electrical Materials and Methods"
 2. Division 27 Section — "Conduit and Backboxes for Communications Systems"
 3. Division 27 Section — "Grounding and Bonding for Communications Systems"

1.03 REFERENCES

- A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
 1. General:
 - a. National Electrical Code (NEC)
 - b. National Electrical Safety Code (NESC)
 - c. Occupational Safety and Health Act (OSHA)
 2. Communications:
 - a. ANSI/TIA/EIA - 758 : Customer-owned Outside Plant Telecommunications Cabling Standard
 - b. ANSI/TIA/EIA - 568: Commercial Building Telecommunications Cabling Standard
 - c. ANSI/TIA/EIA - 569: Commercial Building Standard for Telecommunication Pathways and Spaces
 - d. ANSI/TIA/EIA - 606: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 - e. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Telecommunications
 - f. ISO/IEC IS 11801: Generic Cabling for Customer Premises
 - g. BICSI: BICSI Telecommunications Cabling Installation Manual (CIM)
 - h. BICSI: BICSI Telecommunications Distribution Methods Manual (TDMM)
 - i. BICSI: BICSI Customer-Owned Outside Plant Design Manual (CO-OSP)
 3. Concrete:

- a. Reinforcement:
 - 1) 1) ACI 301: Structural Concrete for Buildings
 - 2) 2) ACI SP-66: American Concrete Institute - Detailing Manual
 - 3) 3) ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement
 - 4) 4) ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel
 - 5) 5) ANSI/AWS D12.1: Reinforcing Steel Welding Code
 - 6) 6) ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement
 - 7) 7) AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction
 - b. Cast-in-Place:
 - 1) 1) ACI 212.3R: Chemical Admixtures for Concrete
 - 2) 2) ACI 301: Structural Concrete for Buildings
 - 3) 3) ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - 4) 4) ACI 305R: Hot Weather Concreting
 - 5) 5) ACI 306R: Cold Weather Concreting
 - 6) 6) ASTM C33: Concrete Aggregates
 - 7) 7) ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 8) 8) ASTM C94: Ready-Mixed Concrete
 - 9) 9) ASTM C150: Portland Cement
 - 10) 10) ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
 - 11) 11) ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 12) 12) ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - 13) 13) ASTM C260: Air Entraining Admixtures for Concrete
 - 14) 14) ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete
 - 15) 15) ASTM C494: Chemical Admixtures for Concrete
 - c. Pre-Cast:
 - 1) 1) ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections
 - 2) 2) ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
 - 3) 3) ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
 - 4) 4) ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures
 - 5) 5) ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
 - 6) 6) ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
4. Trenching and Backfill:
- a. ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.04 DEFINITIONS

- A. Aggregate: Mineral materials such as sand or stone used in making concrete
- B. Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.
- C. Base: Earth material used specifically to level and grade an excavation's subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, maintenance holes or handholes.
- D. Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.
- E. Fill: The collective term for base, bedding, and backfill.
- F. Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.
- G. Maintenance Hole or Manhole (MH): A vault located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work.
- H. RNC: Rigid Non-Metallic Conduit (PVC)

1.05 SYSTEM DESCRIPTION

- A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) .
- B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant pathway system.

1.06 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Provide product data submittals for all products at the same time.
 - 1. Submit a letter stating that the materials will be provided as specified, and specifically listing any items that will not be provided as specified. The letter shall also state that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
 - 2. For those items noted as allowing "or equal," and which are not being provided as specifically named, submit standard manufacturer's cut sheets or other

- descriptive information, along with a written description detailing the reason for the substitution.
3. Provide standard manufacturer's cut sheets and the operating and maintenance (O&M) instructions at the time of submittal review for each device in the system, regardless of whether it is submitted as specified or as an approved equal. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.
- B. Quality Assurance/Control Submittals: Provide submittal information for review as follows:
1. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.
- C. Closeout Submittals: Provide submittal information for review as follows:
1. O&M Manual for Communications - At the completion of the project, submit O&M information from product data submittals (above), updated to reflect any changes during the course of construction, to the Designer in the telecommunications-specific O&M Manual for Communications binder labeled with the project name and description.
 2. Records - Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
 - a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
 - b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
 - c. Keep Record Drawings current throughout the course of construction. ("Current" is defined as not more than one week behind actual construction).
 - d. Show identifiers for major infrastructure components on Record Drawings.
- 1.07 SEQUENCING
- 1.08 CONTRACTOR WARRANTY:
- A. Provide a Contractor-endorsed two-year service warranty against defects in materials and workmanship.
 1. Provide labor attributable to the fulfillment of this warranty at no cost to the Owner.
 - a. The Contractor Warranty period shall commence upon Owner acceptance of the work.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.02 BASE, BEDDING AND BACKFILL

- A. Use of on-site soils for base, bedding, and backfill is not acceptable.
- B. Base: Readily compactable and meet the following gradation requirements.

- 1. For Maintenance Holes and Handholes (provide gravel):

Sieve Size	Percent Passing
1" Square	100
¼" Square	25 - 80
U.S. No. 200	15 max
Sand Equivalent	30 min

- 2. For Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 - 55
U.S. No. 100	0 - 10
U.S. No. 200	0 - 3

- C. Bedding: Same as Base - For Trenches, above.

- D. Backfill:

- 1. For Maintenance Holes and Handholes - Same as Base - For Maintenance Holes and Handholes, above.
- 2. For Trenches

Sieve Size	Percent Passing
½" Square	100
¼" Square	65 - 100
U.S. No. 10	40 - 100
U.S. No. 50	3 - 50
U.S. No. 100	0 - 4
U.S. No. 200	0 - 3

2.03 CAST-IN-PLACE CONCRETE

- A. Formwork:

1. Forms: Metal or plywood in good condition
 - a. Form Release Agent: Burke Form Coating (or equal)
 2. Gypsum board
- B. Reinforcement:
1. Reinforcing Steel: ASTM A615, Grade 40. Uncoated, free from rust, dirt, and loose scale.
 2. Tie Wire: 18 gauge 40 or heavier black annealed wire.
 3. Embedded Anchor Bolts: Mild galvanized steel, cold bent.
- C. Concrete:
1. Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:
 - a. ASTM C150-7, type 1.
 - b. 2500 psi. minimum compressive at 28 days per ASTM C39.
 - c. 4 inches maximum slump per ASTM C-143.
 2. Aggregate:
 - a. Course: ASTM C33-71 with a maximum size of 1-1/4”.
 - b. Fine: ASTM C33-71.
 3. Water: Fresh, clean, potable and not detrimental to concrete.
 4. Admixtures:
 - a. Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5% to 7% air entrainment.
 - b. Other: Not allowed without prior approval from the Designer.
 5. Curing Compound: Conform to ASTM C309. Free from petroleum resins or waxes. Formulated for sealing, surface hardening, and curing concrete.

2.04 CONDUIT AND DUCTBANKS

- A. Conduit
1. Rigid Non-Metallic Conduit (RNC):
 - a. UL listed, NEMA TC2 and TC6 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for burial with concrete encasement.
 - b. Fittings: NEMA TC3 and TC9, matched to conduit and material.
 2. Fittings:
 - a. Sweeps: Factory manufactured with a single arc of not less than a 15 foot radius.
 - b. End Caps (Plugs): Pre-manufactured and water-tight. Tape is not an acceptable end cap or cover.
 3. Pull Ropes: 1/4 inch polypropylene with a minimum tensile strength of 200 pounds.
- B. Ductbanks:
1. Conduit Spacers/Supports: High-density plastic interlocking spacers/supports.
 2. Warning Tape: Not less than 6” wide by 4 mils thick metallic warning tape, red in color and printed with the words “Caution Communications line buried below”.
 3. Grounding/Bonding: #2 bare copper ground

2.05 UNDERGROUND SPACES

- A. General: Underground spaces include Maintenance Holes (MH) and Handholes (HH). Incidental and miscellaneous equipment supplied with a MH or HH shall be supplied by the same manufacturer.
- B. Maintenance Holes: If precast, conform to ASTM C478 and other ASTM standards and specifications as listed in REFERENCES above. If cast-in-place, reference appropriate Sections. Complete with concrete floors, lockable covers, permanently installed ladders, pulling eyes, and 12" diameter closed sumps.
1. Precast
 - a. Utility Vault Company: 4484-TA 6'-0" W x 6'-0" L x 7'-2" H (interior dimensions). Complete with Alternate Top Section 4484-T42E, Center Section 4484-MT, Base Section 4484-BT, and section gaskets. Equipped with (3) galvanized "C" imbedded channels per longitudinal side. Manufactured with conduit entry knockouts: 4" TERM-A-DUCT '90.
 - b. Or equivalent
 2. Cast in place:
 - a. Re-bar reinforced concrete rated at 4000 psi at 28 days
 3. Sizes and Types:
 - a. 6'-0" W x 6'-0" L x 7'-0" H (interior dimensions) minimum. Complete with necessary alternate top sections, center sections, base sections, and section gaskets. Equipped with (3) galvanized "C" imbedded channels per longitudinal side. Manufactured with conduit entry knockouts: 4" TERM-A-DUCT '90 or equivalent.
 4. Covers and Frames: Covers shall be circular cast ductile iron, shall be engraved with 1/8" high letters stating "COMMUNICATIONS", and shall conform to AASHTO H20 loading if located in a roadway and to AASHTO H10 loading otherwise. Cover frames shall be cast ductile iron, conforming to the same AASHTO requirements as the covers.
 - a. 30" Diameter Casting with standard hight Frame
 5. Racking and Hardware: Galvanized.
 6. Risers:
 - a. 4 inch high: Utility Vault Company No. 4204 (or equivalent)
 - b. 6 inch high: Utility Vault Company No. 4206 (or equivalent)
 - c. 12 inch high: Utility Vault Company No. 4212 (or equivalent)
- C. Handholes: Precast, conform to ASTM C478 and other ASTM standards and specifications as listed in REFERENCES above. Complete with concrete floors, lockable covers, pulling eyes, and 12" diameter closed sumps.
1. Sizes and Types:
 - a. Utility Vault Company: 444-LA 4'-0" W x 4'-0" L x 4'-0" H (exterior dimensions). Complete with Cover Section 44-332P, Base Section 444-BL, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4" TERM-A-DUCT '90.
 - b. Utility Vault Company: 504-LA 4'-8" W x 4'-8" L x 4'-0" H (exterior dimensions). Complete with Cover Section 55-332P, Base Section 504-BL, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) galvanized pulling iron per corner (four (4) total). Manufactured with conduit knockouts: 4" TERM-A-DUCT '90.

- c. Utility Vault Company: 25-TA 2'-3" W x 5'-2.5" L x 2'-7.5" H (exterior dimensions). Complete with Cover Section 38/25-T, Base Section 25-T, and section gaskets. Equipped with one (1) galvanized "C" channel per longitudinal side and one (1) pulling insert per end (two (2) total).
 - d. Or equivalent
 - 2. Covers: Rectangular diamondplate covers, equipped with a self latching stainless steel slam lock, recessed lift inserts, lock down bolts, shall be labeled with 1/8" high letters stating "COMMUNICATIONS". Shall conform to AASHTO H20 loading if located in a roadway and to AASHTO H10 loading otherwise.
 - 3. Racking and Hardware: Galvanized
 - D. Grounding:
 - 1. 3/4" x 10' copperclad steel ground rods
 - 2. #4/0 pigtail for connection to interior ground conductors.
- 2.06 FIRESTOPPING MATERIAL:
- A. Conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted test agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of the actual field conditions.
- 2.07 LABELS:
- A. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, typed, and created by a hand-carried label maker or an approved equivalent software-based label making system. Handwritten labels are not acceptable.
 - 1. Hand-carried label maker:
 - a. Brady: ID Pro Plus (or approved equal).
 - 2. Labels:
 - a. Brady: Bradymaker Wire Marking Labels WML-511-292 (or approved equal)
- 2.08 LANDSCAPING:
- A. Topsoil: Imported from off construction site.

PART 3 - EXECUTION

3.01 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NEC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.

- C. All work shall comply with the standards, references and codes listed in PART 1 -- REFERENCES above. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.
- F. Remove surplus material and debris from the job site and dispose of legally.

3.02 EXCAVATING, TRENCHING AND FILL

- A. Excavation:
 - 1. Do not excavate when the outside temperature is less than 35° F or when there is standing water or snow on the subgrade.
 - 2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.
 - 3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered structural Designer employed by the Contractor prior to proceeding with the work.
 - 4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that ductbanks, maintenance holes, and handholes have a minimum separation of twelve (12) inches between the ductbank and/or MH/HH and the nearest underground utility after installation. For gas lines a minimum separation of eighteen (18) inches is required. For water a minimum separation of thirty-six (36) inches is required. Contact the Designer prior to proceeding if minimum separation distances can not be achieved.
 - 5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
 - 6. Install, operate and maintain pump or dewatering equipment as necessary to prevent water from accumulating in the excavation.
 - 7. Excavation Depth/Width
 - a. For MH/HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum 6"-12" of base. Excavate to a sufficient width to provide a minimum of 6" clearance around each side of the MH/HH.
 - b. For trenches: Excavate to a sufficient depth to provide a minimum of 30" cover over the conduit or ductbank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of 6" to each side of the ductbank formation.

8. Over-excavate, fill, and compact any soft spots in the subgrade.
 9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.
 10. Slope trench grade to fall 3" per 100 feet in general and ¼" per foot where possible.
 - a. Slope trench toward lower MH/HH or from high points toward MH/HH at both ends.
 - b. Slope trench away from building entrances.
- B. Fill:
1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.
 2. Do not place frozen fill.
 3. Base:
 - a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.
 - b. Moisture-condition base material to within three (3) percent of optimum moisture content and place in loose, horizontal layers.
 - c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.
 4. Bedding: Do not exceed 4" depth of bedding lifts/layers before compacting
 5. Backfill: Do not exceed 6" depth of backfill lifts/layers before compacting.
 6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
 - a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
 - b. Backfill: Compact material up to two (2) feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from two (2) feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.
- C. Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.
- 3.03 CAST-IN-PLACE CONCRETE
- A. Construct concrete in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and/or amendments) listed in Section 1, References.
- B. Formwork:
1. Construction:
 - a. Forms: Use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections will be permitted. Form surfaces in true planes within ¼" in 10 feet. Clean forms and remove debris prior to pouring concrete. Make braces unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer

strips fabricated to produce uniform smooth lines and tight edge joints for exposed corners and edges. Note: chamfer strips are not required for concrete encased ductbank corners and edges.

- 1) 1) Gypsum board shall not be used for forms except to form concrete encased ductbank.
 - b. Reinforcement: Construct reinforcement in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.
 - c. Where metal or plywood forms are used, coat the forms with a form release agent prior to placement of concrete. Coat faces and edges of forms applied at a rate of 500 to 550 square feet per unit.
 - d. Curved Surfaces: Use only curved forms for constructing curved structures and surfaces.
2. Slope: For flatwork, construct forms with 1% side slope to both south and east sides.
 3. Joints:
 - a. Control: Build into form.
 - b. Expansion: Build expansion joints into form, premolded ½" thick, and conforming to ASTM D1751. Seal the top ½" of expansion joints with an approved joint sealer.
 4. Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 4000 psi.
 - a. Where gypsum board forms are used to form concrete encased ductbank they can be left in place and backfilled after the specified curing period.

C. Concrete:

1. Transport: Comply with ACI 304. Transport concrete from the mixer to the construction location via methods preventing separation of materials.
2. Application:
 - a. Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.
 - b. Deposit concrete in forms in layers not deeper than 24" and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.
 - c. Deposit concrete in a plastic condition and uniformly work around reinforcements.
 - d. Consolidate concrete using internal machine vibration (stinger) during pouring.
 - e. Once concrete work has commenced, work continuously until the work segment and/or section has been completed.
 - f. Cold Weather: Protect concrete from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 40° F, heat water and aggregates before mixing to obtain a concrete mixture of not less than 50° F and not more than 80° F.
 - g. Hot Weather: Protect concrete from damage caused by hot weather in compliance with ACI 305R. When temperature is above 90° F chill water before mixing to obtain a concrete mixture of not more than 90° F. Cover reinforcing steel with water-soaked burlap if it becomes too hot

- immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.
3. Curing:
 - a. Curing method and rate of application shall be according to manufacturer's recommendations.
 - b. Protect concrete from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.
 - c. Cure concrete for 7 days in accordance with ACI 301 and keep continuously moist during this time. Maintain concrete temperature between 50° and 90° F during the curing period.
 - d. Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.
 4. Finish:
 - a. Consolidate, level and screen surfaces for evenness and uniformity. Remove excess concrete. Fill low spots. Float the surface after water sheen has disappeared from surface.
 - b. Finish flatwork with a special tool to match patterned finish of adjacent existing concrete.
 - c. Tool edges, control, and expansion joints to make finish work straight and even.
 5. Ductbanks:
 - a. Reinforce ductbanks along full length with formed sides. Install reinforcement at each corner of the conduit spacers/supports.
 - b. Do not pour concrete against trench walls. Consolidate concrete during placement using an internal concrete vibrator.
 - c. Provide each MH/HH penetration with reinforcing bars tied to MH/HH reinforcement. Dowel reinforcement in foundation wall of building penetrations.
 - d. Secure conduit spacers/supports and reinforcing to prevent movement during concrete placement. Use stakes and/or tie wire to minimize floating and spreading.
 6. Protection for exposed concrete: Cover exposed concrete (i.e. sidewalk, driveway, etc.) with plywood, weighted with concrete blocks or similar heavy object in order to prevent surface damage.
 7. Bond and ground reinforcement bars to the nearest approved ground.

3.04 CONDUITS AND DUCTBANKS

- A. Conduits:
 1. Outdoor underground: Provide RNC Schedule 40 (Type 1), concrete encased.
 2. Outdoor exposed: Provide RGC.
 3. Sweeps:
 - a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
 - b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.
 - c. Do not exceed 90 degrees for an individual sweep.

- d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
 - e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
 - f. Two 90-degree sweeps separated by less than 10 feet is not permissible.
 - g. Construct sweeps for conduits within a common ductbank parallel, measured from the same center-point.
 - h. Do not install LB's, condulets, or 90 degree electrical elbows.
4. Fittings:
 - a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see below).
 - b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the work day and on conduits at night. Leave end caps in place upon final completion of the work.
 - c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls. Do not use TERM-A-DUCT.
 5. Sealing: Apply a solvent-type cement (for RNC) to make conduit connections waterproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.
 6. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
 7. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.
 8. Conduit Entrances:
 - a. MH/HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a MH/HH in any position enters the next MH/HH in the same relative position.
 - b. Buildings: Terminate conduits a minimum of 6-inches above the finished floor.
 9. Length: Unless otherwise shown on the Drawings, do not exceed 400 feet of ductbank between pulling points. Contact the Designer prior to proceeding if a ductbank section will exceed 400 feet.

10. Pull Ropes: Install in each conduit immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped and tied off at each end of the conduit.
 11. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair any Rigid Non-metallic Conduit damage with matching touchup coating recommended by the manufacturer.
- B. Ductbanks:
1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct ductbanks in a concrete encasement. Use concrete encased RNC (see CAST-IN-PLACE CONCRETE, above).
 2. Encased in Concrete:
 - a. See CAST-IN-PLACE CONCRETE, above.
 3. Conduit Spacers/Supports: Place supports on eight (8) foot centers if encased in concrete and five (5) foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least six (6) inches vertically.
 4. Warning Tape: Install metallic warning tape half the distance between the top of the ductbank and finished grade.
 5. Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of MH/HH and to building service grounds.
 6. Slope ductbank grade to fall 3 inches per 100 feet in general and ¼" per foot where possible.
 - a. Slope ductbank toward lower MH/HH or from high points toward MH/HH at both ends.
 - b. Slope ductbank away from building entrances.

3.05 UNDERGROUND SPACES

- A. Provide maintenance holes and handholes in the sizes and locations shown on the Drawings.
- B. Precast maintenance holes and handholes shall be free from damaged joint surfaces, cracks, or other damage that would permit infiltration. Repair of defects is not acceptable. MH/HH and incidental and miscellaneous equipment (such as cable racking brackets and supports) shall be supplied by a single manufacturer.
- C. Install MH/HH according to manufacturer's instructions.
- D. Covers and Frames: Provide 30" wide x 10" high circular frames/covers and provide with minimum 4" and maximum 12" high circular maintenance hole entrance riser sections as required. Use the riser sections to maintain the top of the cover 1" above the existing ground line or finished grade. Taper pavement surfaces up to the top of the maintenance cover. Provide lock-down bolts for HH covers. Covers and frames shall be of uniform quality, free from blowholes, porosity, shrinkage, distortion, cracks and other defects. Repair of defects is not acceptable. Mating surfaces between covers and frames shall be machine-finished to ensure a non-rocking fit.
- E. Setting and Placement: Remove water from excavation and properly install bedding material prior to setting the MH/HH. Clean MH/HH section seal surfaces so that they are free from dirt or other material.

1. Set MH/HH in place by lowering each section into the excavation, ensuring that the section is level, plumb, and firmly positioned, and ensuring that the section gasket/seal is properly installed and watertight prior to setting the next section.
 2. Carefully set the MH/HH to ensure that the rim or lid elevation is set one inch above finished grade. For vaults located in paved areas, taper pavement up to the MH/HH rim.
- F. Knockouts: Open conduit entry knockouts with care preserving the TERM-A-DUCT sidewalls. Glue conduits entering the vault to the opened TERM-A-DUCTs with PVC cement. Preserve intact the conduit entry knockouts that are not intended for current use.
- G. Grouting: Apply grout in a manner to insure filling of voids in the joints being sealed. Apply grouting to conduit entrances, risers, and covers in addition to any other voids.
- H. Racking and Hardware: Install racking and hardware and incidental materials. Provide three (3) cable racks per longitudinal side (six (6) racks total) per maintenance hole. Provide eight (8) 7-1/2" cable support arms per manhole. Provide additional incidental hardware for mounting racks and cable support arms.
- I. Risers: Provide riser sections that are a minimum of 4" high and a maximum 12" high, sized for the MH entrance. Provide riser sections in quantities sufficient to meet the minimum and maximum height requirements discussed above.
- J. Grounding/Bonding: Provide a minimum of one 3/4" x 10' copperclad steel ground rods, and one #4/0 pigtail for connection to interior ground conductors. Bond metallic hardware in the vault to the pre-cast bonding tabs. Bond the bonding tabs to the ground rod.
- K. Cleaning: Clean and dry the MH/HH after construction activity is complete and prior to releasing the MH/HH to the Owner for the Owner's use.