SECTION 26 0533 - ELECTRICAL RACEWAYS

Maintain Section format, including the UH master spec designation and version date in bold in the center columns of the header and footer. Complete the header and footer with Project information.

Revise this Section by deleting and inserting text where indicated in bold to meet Project-specific requirements.

This Section uses the term "Engineer." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

Delete hidden text after this Section has been edited for the Project.

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.

B. The Contractor's attention is specifically directed, but not limited, to the following documents for additional requirements:

1. The current version of the *Uniform General Conditions for Construction Contracts*, State of Texas, available on the web site of the Texas Facilities Commission.
2. The University of Houston's *Supplemental General Conditions and Special Conditions for Construction.*

1.2 STANDARDS

1. Conduit underground shall be nonmetallic schedule. 80, if not encased in concrete duct bank.
2. Schedule 40 if encased in concrete duct bank.

A. Products and installation shall comply with applicable sections of the following standards:

1. ANSI C80.1 Rigid Steel Conduit, Zinc-Coated and UL6.
2. ANSI C80.6 Intermediate Metal Conduit, Zinc-Coated and UL1242.
3. ANSI C80.3 Electrical Metallic Tubing, Zinc Coated and UL797.
4. ANSI/NEMA FB 1 and UL514B Fittings and Supports for Conduit and Cable Assemblies.
5. NEMA TC 3 PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 QUALITY ASSURANCE

A. Manufacturers: Provide products complying with these specifications and produced by one of the following:

1. Rigid Steel and Intermediate Metal Conduit:
   a. Allied Tube & Conduit; a Tyco International Company.

b. Galvite/LTV Steel Tubular Products
c. Republic Conduit.
d. Triangle PWC, Inc.
e. Youngstown Sheet & Tube.
f. Wheatland Tube Company; a division of Zekelman Industries.

2. PVC-coated Rigid Steel:
   a. Allied Tube & Conduit; a Tyco International Ltd. Co.
   b. Flexi-Guard, Inc.
   c. Occidental Coating Company.
   d. Perma-Cote.
   e. Republic Conduit.
   f. Robroy.
   g. Triangle PWC, Inc.
   h. Youngstown Sheet & Tube.
   i. Wheatland Tube Company; a division of Zekelman Industries.
3. Electrical Metallic Tubing:
   a. Allied Tube Conduit; a Tyco International Ltd. Co.
   b. ETP Uni-Couple.
   c. Republic Conduit.
   d. Triangle PWC, Inc.
   e. Youngstown Sheet & Tube.
   f. Wheatland Tube Company; a division of Zekelman Industries.
4. Flexible Metal and Liquidtight Flexible Metal:
   a. AFC Cable Systems, Inc.
   b. Alflex
   c. Anaconda Metal Hose.
   d. Electri-Flex Company.
   e. Flexi-Guard, Inc.
   f. Triangle PWC, Inc.
   g. Wheatland Tube Company; a division of Zekelman Industries.
5. Rigid Nonmetallic Conduit and Inner Duct:
   a. Carlon.
   b. Cantex, Inc.
   c. Triangle PWC, Inc.
6. Raceway Fittings:
   a. Appleton Electric Company.
   b. Cantex, Inc. (PVC).

c. Carlon (PVC).
d. Crouse Hinds.
e. Efcor Division.
f. ETP-Uni-Couple.
g. O. Z/Gedney; a brand of EGS Electrical Group.
h. Raco, Inc.
i. Republic Conduit.
j. Steel City.
k. Thomas and Betts Corporation.

7. Duct Bank Spacers:
   a. Formex.
   b. Carlon.
8. Precast Manholes, Pull Boxes and Accessories:
   a. Brooks.
   b. A. B. Chance.

B. UL Label: All electrical raceways and fittings shall be UL-listed and labeled.

C. NEMA Compliance: All electrical raceways and fittings shall comply with NEMA standards applicable to raceway construction.

D. NEC Compliance: All electrical raceways and fittings shall comply with NEC requirements applicable to construction and installation.

1.4 SUBMITTALS

A. Submittals shall include, but not be limited to, the following:
   1. A list of the proposed manufacturers of electrical raceways and fittings selected from the manufacturers listed herein.
   2. Cut sheets of electrical raceways and fittings.
   3. Manufacturer's data on manholes, pull boxes and accessories.
   4. Additional information as required in Section 26 0001 "Electrical General Provisions."

1.5 STORAGE AND HANDLING

A. Handle raceways and fittings carefully to avoid damage, breaking, denting and scoring. Damaged materials shall not be installed.

B. Store raceways and fittings in a clean dry space and protect from the weather shall be new.

PART 2 - PRODUCTS

2.1 MATERIALS AND COMPONENTS

A. General:
   1. Provide metal conduit, tubing, and fittings of the type, grade, size, and weight (wall thickness) as shown and required for each service. Where type and grade are not

indicated, provide proper selection determined by this Section to fulfill the wiring requirements and complying with the NEC for electrical raceways and UH specifications.

2. For each electrical raceway system indicated, provide a complete assembly of conduit, tubing, or duct with fittings, including, but not necessarily limited to, connectors, nipples, couplings, expansion fittings, bushings, locknuts, other components and accessories as needed to form a complete system of the type indicated.
3. Conduit fittings shall be designed and approved for the specific use intended. Conduit fittings, including flexible, shall have insulated throats or bushings. Rigid conduits shall have insulated bushings, except insulated throat grounding bushings shall be used & conduit where required by NEC Article 250.

B. Rigid Steel or Intermediate Metal Conduit: Rigid Steel shall be UL 6 and ANSI C80.1, hot-dipped galvanized steel. Intermediate Steel shall be UL 1242 and ANSI C80.6, hot-dipped galvanized steel. Both ends of conduits shall be threaded with factory-installed thread protectors. Couplings and fittings shall be threaded Type UL 6/and UL1242 and ANSI C80.1 and C80.6, hot-dipped galvanized steel. Split type couplings and fittings is not acceptable. IMC conduit shall not be used in sizes larger than 4 inch. Expansion fittings shall be OZ Type "DX", Appleton Type "XJ", Crouse-Hinds Type "XC" or an approved equal and shall have bonding jumpers. Cut ends shall be recoated with cold galvanized paint.

C. PVC Externally-Coated Rigid Steel Conduit: Shall be ANSI C80.1 hot-dipped galvanized rigid steel conduit with an external 0.040 inch minimum PVC protective coating per NEMA Standard RN1. Both ends of conduit shall be threaded and thread protectors shall be factory-installed. Fittings shall be threaded type ANSI C80.4, hot-dipped galvanized with a 0.055 inch minimum PVC coating to match the conduit.

D. Electrical Metallic Tubing (EMT): Shall be UL 797 and ANSI C80.3 galvanized steel with plain ends. Fittings, couplings and connectors shall be UL 797 and ANSI C80.4 galvanized steel type. Fittings, couplings and connectors shall be all steel set-screw type. All EMT connectors shall have insulated throats or bushings.

E. Flexible Conduit:

1. Flexible Metal Conduit: UL 1, zinc-coated steel
2. Flexible Metal Conduit Fittings: UL 1, zinc-coated steel, insulated throat.
3. Liquid-tight Flexible Metal Conduit: UL360 Liquid-tight flexible metal conduit comprised of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquid-tight jacket of flexible polyvinyl chloride (PVC) or neoprene. Shall contain ground bond.

F. Liquid-tight Flexible Metal Conduit Fittings: UL 1, liquid-tight, zinc-coated steel, neoprene gaskets and O-rings, insulated throat.

G. Nonmetallic Conduit and Fittings:

1. Schedule 40 Rigid PVC Conduit: Per UL 651, and NEMA TC 2, 90^{o}C conductor temperature rating, only encased in concrete duct bank.
2. Schedule 80 Rigid PVC Conduit: Per UL 651 and NEMA TC 2, 90^{o}C conductor temperature rating not encased in concrete duct bank.

3. Type "EB" Encased Burial PVC Conduit: Per UL 651A and NEMA TC 8, ASTM F512 - heavy wall, 90°C conductor temperature rating.
4. Quaduct PVC Conduit: Composite duct consisting of four nominal 1-1/2 inch Schedule 40 PVC conduits with an integral spacer. Encased in concrete only.
5. PVC Conduit Fittings: Per NEMA TC 3 and compatible with PVC conduit system.
6. Duct Bank Spacers: Spacers shall be interlocking plastic designed for the conduit sizes and nominal 3 inch spacing being used.

H. Nonmetallic Inner Duct: For fiber optic only.
1. Inner duct: PVC corrugated flexible conduit, Carlon Optic-Gard PVC or an approved equal. Duct shall be available in one inch (1 inch), 1-1/4 inch, 1-1/2 inch and 2 inch sizes and orange, gray and white colors.
2. Couplings: PVC type, external, solvent cement type.

I. Conduit Tubing Accessories: Provide ANSI/NEMA FB I conduit and tubing accessories including straps, hangers and expansion joints as recommended by the conduit and tubing manufacturer and as specified in this Section.

J. Precast Concrete Manholes:
1. General: Provide precast concrete manholes as detailed on the Drawings and as required for installation of new duct bank systems and connection to existing duct bank systems at locations shown on the Drawings.
2. Design: Manholes shall be steel reinforced and the complete manhole assembly shall be designed for H-20-44 bridge loading. Submittals shall clearly indicate all dimensions and reinforcing steel.
3. Concrete: Manholes shall be constructed using concrete with a 4500 psi 28 day strength. Concrete mix shall be designed in accordance with ASTM standards.
4. Reinforcing Steel: Steel shall be intermediate or hard grade billet steel conforming to ASTM A615/A615M, deformed in accordance with ASTM A305.
5. Manholes: Manhole and pull box covers shall be cast iron cover mounted in a 30 inch Type "B" or "WRM" frame and shall be traffic type for heavy vehicular traffic. The frame and neck shall be doweled into the manhole to prevent movement away from the opening.
6. Naming: Power manhole and pull box covers shall be marked "ELECTRIC." Communication manhole and pull box covers shall be marked "COMMUNICATIONS." Voice manhole and pull box covers shall be marked "TELEPHONE." Data manhole and pull box covers shall be marked "DATA."
7. Conduit Entry: Plastic conduits shall include a bell end inside the manhole or pull box, mounted flush and grouted to seal openings. Precast fiber type terminators shall be provided for each duct bank entry.
8. Grounding: A #4/0 bare copper ground wire shall penetrate the side wall in the bottom section of each manhole and pull box and extend 48 inches inside and outside of the manhole pull box.
9. Accessories: Provide knockouts, cable racks, sumps, steps, joint seals and other accessories shown on the Drawings or required for a complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install electrical raceways and fittings as shown, in accordance with the manufacturer's written instructions, applicable requirements of the NEC, and in accordance with recognized industry practices to ensure that products serve the intended function. Complete electrical raceway installation before starting the installation of wire and cable and comply with Owner's master specifications.

B. Conduit Size: Minimum conduit size for power wiring shall be ¾ inch, except ½ inch conduit shall be used for 20 Amps single home-run circuits and **[3/8 inch] [1/2 inch]** flexible metallic conduit may be used for fixture whips. Maximum conduit size for EMT shall be 4 inch. Minimum conduit size for control wiring shall be **[1/2 inch] [3/4 inch]**. Minimum conduit size for voice/data wiring shall be one inch (1 inch).

C. Rigid Steel and Intermediate Metal Conduit: Use rigid steel, aluminum or intermediate metal conduit to run all electrical raceway systems where exposed to weather; in damp or wet locations; where subject to physical damage.

1. EMT conduit may be used instead of rigid steel or IMC for 600 volt feeder raceways, if the location is acceptable for use of EMT as described herein below, and if a properly sized ground wire is included with the feeder conductors in the EMT raceway. Ground wires are required in all conduits.

D. PVC-coated Rigid Steel: Use polyvinyl chloride (PVC) externally-coated rigid steel conduit and fittings for electrical raceway systems for branch circuits to **[cooling towers and other]** wet areas; **[where exposed outdoors;]** and elsewhere, as shown. Install conduit and fittings such that the PVC-coating is continuous and watertight and no portion of the metal conduit or fittings is exposed to moisture.

E. Electrical Metallic Tubing (EMT): Use EMT for branch circuit electrical raceway systems where concealed in furred ceilings or in walls. Contractor may use exposed EMT when located inside a building at least 8 feet above finished floor and when not exposed to the risk of physical damage. EMT conduit shall not be installed where exposed to weather or in wet or damp locations. Use steel set screw type fittings, couplings and connectors made-up tight for all conduit sizes. Crimp type fittings, couplings and connectors are not acceptable.

F. Flexible Metal: Use flexible metal conduit (with internal ground wire) and fittings for lay-in lighting fixture connections and for other electrical equipment connections where subject to movement and vibration, but where liquid-tight flexible metal conduit is not specified. Use flexible metal conduit in such lengths as required. The allowable length, unless approved otherwise by the Authority Having Jurisdiction shall be based on NFPA 70-2017, Article 348.30 (A) exceptions 1 through 4. **[[3/8 inch] [1/2 inch] diameter conduit may be used for lighting fixture "pigtails".]** Conduit shall contain grounding conductor. The external grounding bond jumper shall be green insulated and shall be the same size as the equipment grounding conductor of the circuit or larger. The bonding conductor shall run parallel to the flexible conduit and shall be fastened to the flexible conduit using tie wraps. Flexible metal conduit shall not be used as an alternative to factory 90 degree bends or installed in the middle of a conduit installation unless the flexible conduit is being used to connect to the final piece of equipment.

G. Liquid-tight Flexible Metal: Use liquid-tight flexible metal conduit and fittings for all motor connections, including dry-type transformers**[,all connections in kitchens and laundries,] [, computer equipment branch circuits below raised floors,]** and for other electrical equipment connections where subject to movement and vibration and when subject to one or more of the following conditions: exterior location; moist or humid atmosphere where condensate can be expected to accumulate; corrosive atmosphere; subject to water spray; subject to dripping oil, grease or water. Use of SMURF tube is not permitted anywhere. Install **[external ground wire on][internal ground wire in]** liquid-tight flexible conduit with grounding bushings. Maximum length shall comply with NFPA 70-2017 Article 348.30 Article (A), Exceptions 1 thru 4. For sizes 1 inch and greater, an external grounding bond jumper shall be installed. Liquid-tight flexible metal conduit shall not be used as an alternative to factory 90 degree bends or installed in the middle of a conduit installation unless the flexible conduit is being used to connect to the equipment.

H. Rigid Nonmetallic: Use PVC conduit directly buried in earth, in concrete encased duct bank, and where subject to corrosive environment. PVC conduit shall only be used where shown on the Drawings. Use Schedule 40, where in concrete, and Schedule 80 direct buried, where exposed, with size adjusted to have same fill area as if Schedule 40 were used. Type "EB" encased burial duct shall be used in concrete encased applications in trenches where shown on the Drawings. When a ground wire is installed in conduit, the wire shall be installed in rigid non-metallic conduit.

3.2 INTERIOR CONDUIT SYSTEM

A. Ground all metallic conduit in accordance with the requirements of the latest edition of the NEC. All conduit systems require grounding conductors.

B. Install all conduit as a complete system without conductors, continuous from outlet to outlet and from fitting to fitting. Make up threaded joints of conduit carefully in such a manner as to ensure a tight joint. Field-cut threads shall be cold-galvanized after cutting. The entire conduit system shall be secured at all joints and boxes in such a manner that each system shall be electrically continuous throughout. Fasten the entire conduit system securely into position. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting shall not contain more than the equivalent of four quarter bends, including those bends located immediately at the outlet or fitting. Install approved expansion fittings in all conduit runs as specified in paragraph 3.2/Q. Conduit total bends shall not be more than 270 degrees above ground.

C. Ream all ends of conduit properly to remove rough edges. Whenever a rigid steel or IMC conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by the use of a locknut inside and outside and an approved insulating bushing shall be installed. Whenever an EMT conduit enters a switchboard, panelboard, enclosure, or box, it shall be securely fastened by use of an insulated throat connector or a connector with an insulating bushing. Lay out and install all conduit systems in order to avoid all other services or systems, the proximity of which may cause damage to the conduit or the wires or conductors that the conduit confines.

D. Conceal conduit systems in finished areas. Concealed metallic conduits shall be run in a direct manner, basically parallel to, and at right angles with the lines of the building, and with as long a bend as possible. Conduit may be exposed in mechanical rooms and where otherwise shown

or indicated. On exposed systems, run the conduit parallel or perpendicular to the structural features of the building and rigidly support clamps at intervals as required by NEC or on conduit racks, neatly racked and bent in a smooth radius at corners insofar as practicable. All bends shall be field-made using an approved bending machine designed for the purpose, or using standard ells having a radius not less than that shown in Chapter 9, Table 2 of the National Electrical Code, and with approved fittings or connectors. All bends shall be free from dents or flattening. Prefab bends for 2 inches and more are Contractor's option.

E. All conduit shall be run without traps. Where traps are unavoidable, a junction or pull box shall be placed at the low point. Metallic conduit systems that are exposed to the weather or water shall be made watertight. As soon as conduit has been permanently installed in place, conduit shall be capped or plugged with standard accessories. All metallic conduit shall be swabbed after plaster and dry wall is finished and dry. All outdoor exposed conduit shall have a drain at low point.

F. Support exposed raceway or grouped concealed raceways on galvanized or stainless steel channel using compatible galvanized fittings (bolts, beam clamps and similar items) and galvanized threaded rod pendants to secure raceway to channel and channel to structure. Support single conduit runs using a properly sized galvanized conduit hanger with galvanized closure bolt/nut and threaded rod. Support-spacing shall not exceed 10 feet apart for all EMT/IMC conduit and rigid conduit 2 inches and smaller and 15 feet apart for rigid conduit 2-1/2 inches and larger and within 3 feet from boxes and changes in direction. Support flexible conduit on maximum 4.5 feet centers and within one foot of boxes. All raceway support system materials shall be galvanized and manufactured by Kindorf, Unistrut, Superstrut, Caddy, or Spring Steel Fasteners, Inc. Provide chrome or nickel-plated escutcheon plates on all conduit passing through walls and ceilings in finished areas. Work shall comply with the NEC.

G. Support 1 inch and smaller EMT conduit concealed in ceiling cavities with No. 13 AWG galvanized iron wire pendants, spaced not to exceed 10 feet apart and 3 feet from boxes and changes in direction, secured to conduit with clips and properly secured to structure. Perforated strap shall not be used for conduit supports. Branch circuit EMT conduit ¾ inch trade size and smaller may be suspended using "caddy clips" attached to independent ceiling wire. Contractor shall paint electrical support wires to identify. Support conduit sized one inch and larger as described in Paragraph F above.

H. Make all joints and connections to ensure mechanical strength and electrical continuity. PVC conduit shall be joined, or have fittings attached, by using a fusing (solvent) compound recommended by and applied as instructed by, the conduit manufacturer.

I. Run conduit to avoid proximity to heat producing equipment, piping and flues, keeping a minimum of 8 inches clear. Whenever possible, install horizontal raceway runs above water piping.

J. Unless shown otherwise, all roof penetrations shall be made in adequate time to allow the roofer to make proper flashings. Roof penetrations made by Division 26 are the ultimate responsibility for the Division 26 Contractor to ensure that penetrations are correctly flashed and sealed. Coordinate any roof penetrations in an existing roof with the Owner to ensure the roof's warranty is maintained.

K. Carefully review architectural, structural, mechanical, plumbing, and electrical Drawings and place boxes and conduit to avoid conflicts with structural members or other general construction.

L. All conduit passing through the housing on connected equipment shall pass through a cleanly cut hole protected with an approved grommet and shall be sealed with fire seal or duct seal.

M. Metallic conduit installed below grade shall have its entire length painted with two coats of protective finish. Each coat shall consist of 5 mils of PPG "Coat Cat Epoxy Coating" applied in accordance with the manufacturer's recommendations. The entire length of metallic conduit, including fittings, shall be protected to a point 6 inches above finished grade (or concrete slab).

N. Coordinate locations of raceways in fire rated partitions so as not to affect the fire rating of the partition. Notify the Architect in writing where additional construction is required to maintain the partition fire rating.

O. Install expansion fittings in all conduit as follows:

1. All conduits crossing building expansion joints; unless some other form of thermal expansion compensation is approved in writing by the Engineer.
2. All conduit straight runs in excess of 200 feet and on 400 foot centers in all longer conduit runs.
3. All conduits entering environmental rooms (i.e., rooms designed for the purpose of controlling temperature and humidity for such applications as cold storage, cultivation and incubation).
4. Locations subject to thermal expansion and as required by NEC.
5. Unless expansion fitting has an integral bonding braid, an external braid, approved for the purpose, shall be installed around the fitting.

3.3 EXTERIOR CONDUIT SYSTEMS

A. Exterior conduit systems shall meet all of the general installation requirements for interior conduit systems.

B. All exterior conduit systems shall be completely watertight. All hangers, fasteners, and supports used with exterior conduit systems shall be hot dip galvanized steel, aluminum or stainless steel.

C. Conduit routed across roofs shall be attached to an approved electrical support stand with uni-strut sleepers spaced at maximum 5 feet intervals, unless otherwise detailed on the Drawings. Sleepers shall be installed in pitch pans or as otherwise detailed on the Drawings.

D. Install underground conduits with sealing glands manufactured by OZ-Gedney Type "FSK," or approved substitution; exterior conduits with sealing glands manufactured by OZ-Gedney Type "CSB," or approved substitution; and internally with sealing glands at the point where conduits enter the building to prevent water seepage. Refer to Section 01 2500 “Substitution Procedures” to propose substitutions.

E. Direct buried conduits, not installed in duct bank, shall be installed a minimum of 2 feet below grade. Comply with NEC unless noted otherwise on the Drawings. Maintain 12 inches of earth or 2 inches of concrete separation between electrical conduits and other services or utilities below grade. Maintain 10 feet separation between parallel underground power and voice/data

conduits. Where power and voice/data conduits cross below grade, crossing shall be at right (90 degree) angles with a minimum 2 feet vertical separation.

1. Install breathers and drains unless the electrical equipment is installed indoors. Breathers and drains shall also be installed in enclosures to ensure draining of all liquids that condense or otherwise enter the enclosure. Conduit systems shall be installed in such a manner as to minimize the accumulation of moisture at low points and pockets. Where low points and pockets are unavoidable, a conduit fitting at the low point with a drain plug shall be installed. Vertical conduits located outdoors that enter equipment or device enclosures shall be low point drain fittings; conduit entry to enclosures shall be through the side or bottom. Conduit top entries shall be avoided and if required shall be reviewed and approved by Authority Having Jurisdiction. Conduits entering buildings shall have low point drain fittings installed to prevent liquids that have collected in the conduits from entering the building conduit system.

3.4 POWER DUCTBANK SYSTEMS

A. Power duct banks shall be of individual conduit encased in reinforced concrete. Conduit shall be **[rigid PVC Schedule 40] [Type "EB"]** except that rigid steel conduit shall be used for the final 10 feet at the beginning and end of each duct bank and for all elbows. **[Unless shown otherwise, the type of conduit used shall not be mixed in any one duct bank and shall not be smaller than 4 inches in diameter.]** The reinforced concrete encasement surrounding the duct bank shall be rectangular in cross section, having a minimum concrete thickness of 3 inches. Conduits shall be separated by a minimum concrete thickness of 2 inches, except that light and power conduit shall be separated from control and signal conduits by a minimum concrete thickness of 3 inches. Encasement concrete shall be red in color and rough out.

B. The power duct bank shall be routed underground and the top of the concrete envelope shall be a minimum 3 feet below grade. Provide continuous yellow plastic marking tape centered over power duct banks and located 12 inches above the envelope. Tape shall indicate: “Caution: Electrical Cables Below.”

C. Changes in direction of duct bank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5 feet. All bends in a run shall be separated by a minimum of 10 feet of straight conduit, where possible.

D. During construction, partially completed duct banks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the duct bank is completed, a testing mandrel shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed and temporarily sealed.

E. Ducts in concrete encased duct banks shall be independently supported by interlocking module spacers manufactured by Formex or approved substitution. Spacers shall provide separation between adjacent ducts as specified hereinabove. Spacers shall be installed at maximum 6 feet intervals.

F. Ducts in concrete encased duct banks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators manufactured by Formex or approved substitution. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place.

G. Install underground conduits with sealing glands manufactured by OZ-Gedney Type "FSK," or approved substitution; exterior conduits with sealing glands manufactured by OZ-Gedney Type "CSB," or approved substitution; and internally with sealing glands at the point where conduits enter the building to prevent water seepage into the building. Seal all conduits emerging from underground. Refer to Section 01 2500 “Substitution Procedures” to propose substitutions.

H. Furnish the exact dimensions and location of power duct bank to be encased in time to prevent delay in the concrete work.

I. Power duct bank shall be installed per Power Company standards.

3.5 VOICE/DATA DUCTBANK SYSTEMS

A. Exterior voice/data duct banks shall be of individual PVC conduit, **[direct buried without concrete encasement under landscaping grassy areas and sidewalks] [and] [concrete-encased below driveways, fire lanes, streets and roadways]**. Conduit shall be rigid PVC Schedule 80. Interior duct banks shall be of individual conduit and conduit shall be PVC. The type of conduit used shall not be mixed in any one duct bank and shall not be smaller than 4 inches in diameter. Install inner ducts and pull strings in conduit and duct bank where noted.

B. Where the voice/data duct bank is routed underground, the top of the duct bank shall be a minimum 30 inches below grade.

C. Changes in direction of voice/data ductbank runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished by long sweep bends having a minimum radius of curvature of 5 feet. All turn ups to above grade shall be long radius RGS elbows, coated as specified in Paragraph 2.1.B. All bends in a run shall be separated by a minimum of 10 feet where possible. There shall be no more than two 90 degree bends in any run of voice/data ductbank.

D. During construction, partially completed ductbanks shall be protected from the entrance of debris such as mud, sand, and dirt by means of suitable conduit plugs. As each section of the ductbank is completed, a testing mandrel with diameter ¼ inch smaller than the conduit shall be drawn through each conduit. A brush with stiff bristles shall be drawn through until each conduit is clear of all particles of earth, sand, or gravel. Conduit plugs shall then be immediately installed.

E. Sleeves for voice/data ductbank passing through basement walls shall be rigid steel conduit and shall extend a minimum of 24 inches outside the basement wall.

F. Ducts in concrete encased ductbanks shall be independently supported by interlocking modular spacers. Spacers shall provide separation between adjacent ducts as shown on the Drawings. Spacers shall be installed at 6 feet maximum intervals.

G. Ducts in concrete encased ductbanks shall be terminated in manholes, pull boxes, and vaults with interlocking terminators. A watertight tapered plug shall be furnished and installed in unused duct openings. Where terminators are installed in new work, they shall be poured-in-place. Seal all conduit emerging from underground.

H. Voice/data ductbank shall be installed per Telephone Company standards.

3.6 DUCTBANK MANHOLES AND PULL BOXES

A. Install manholes and pull boxes in accordance with the manufacturer's written installation instructions. Manholes shall be rigidly supported and level with the top of manhole rings flush with finished paving or grade at the point of installation.

B. Seal all joints and openings to prevent the entry of water.

C. Unless otherwise specified and approved by Owner, pull and splice points for power ductbanks shall be above ground.

3.7 VOICE/DATA AND SIGNAL SYSTEM RACEWAYS

A. General: Conduit shall be installed in accordance with the previous specified requirements for conduit and tubing and with the additional requirements that a conduit run shall not exceed 100 feet for ¾ inch trade sizes and 150 feet for one inch or larger trade sizes and shall not contain more than two 90 degree bends or the equivalent thereof. Pull or junction boxes shall be installed to comply with these requirements. Empty voice/data and signal system raceways shall include a pull wire or cord, as described in Paragraph 3.8 herein below. Install innerducts with pull cords in raceways where noted.

3.8 EMPTY CONDUIT RACEWAY SYSTEMS

A. General: Empty conduit in which wire is to be installed by others shall have pull wires installed. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic having not less than 200 pounds tensile strength. Not less than 12 inches of slack shall be left at each end of the pull wire.

3.9 Direct Buried Cables:

A. Direct buried cables shall not be installed unless approved by the Owner.

3.10 IDENTIFICATION

A. General: Refer to Section 26 0553, "Identification for Electrical Systems", for requirements concerning painting and marking of raceways and fittings.

END OF SECTION 26 0533