

# **DIVISION 27**

## **Section 27 05 28**

**Technology Systems  
Design and Installation Guidelines  
for Architects and Engineers**



**Pinellas County  
Business Technology Services**

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## SECTION 27 05 28 – RACEWAYS FOR TECHNOLOGY

### PART 1 - GENERAL

#### 1.1 PURPOSE OF THIS DOCUMENT

- A. The purpose of this specification section is to indicate to A&E and designers of low voltage infrastructure, working in construction or renovation projects for Pinellas County Government, the design requirements by BTS when it comes to such infrastructure. This document will be a starting point for completing a set of construction documents but **SHALL NOT** be used unedited as a bid document.

#### 1.2 RELATED DOCUMENTS

- A. Supplemental: Refer to the specification sections identified below for additional requirements, which are supplemented by this section.
  - 1. 27 00 10 Technology General Provisions
  - 2. 27 05 26 Grounding and Bonding for Telecommunications Systems

#### 1.3 DESCRIPTION

- A. General: Furnish and install complete with all accessories a Pathways and Spaces infrastructure for supporting the SCS and housing of technology equipment. The goal of the project is to provide a reliable architecture of the building that shall serve as a support for transport of data, voice telephony, security, and audio/visual cabling throughout the building from designated demarcation points to places located at various walls, floor, ceiling, column, room, and other locations as indicated on the contract drawings and described herein.
- B. General: For pathways, the system shall utilize a combination of conduit, cable tray, and supports for vertical and horizontal cabling support. Pathways shall be provided and located as indicated by the drawings. Pathways shall terminate in rooms or closets using approved fasteners. Termination hardware and bushings shall be reamed to eliminate sharp edges. All Pathways shall be identified at all locations.
- C. All Installers should anticipate that all products and installation procedures shall comply with the ANSI/TIA-569-D requirements at a minimum.

- D. General: Installation of the raceways for communications shall be a complete system including all supports and hangers as required per contract documents and manufacturer's installation guidelines.
- E. Support: All items shall be supported from the structural portion of the building. Supports and hangers shall be of a type approved by Underwriters' Laboratories. Wire shall not be used as support. Boxes and conduits shall not be supported or fastened to ceiling suspension wires or ceiling channels. Do not install any devices supported by ceiling tiles.
- F. Installation: The Installer shall layout and provide his work in advance of the laying of floors or walls, and shall provide all sleeves that may be required for openings through floors, walls, etc. Where plans call for a conduit to be run exposed, provide all inserts and clamps for the supporting of the conduit.

#### **1.4 INSTALLER QUALIFICATIONS**

- A. General: The Installer selected for the Project must be a BICSI certified Installer certified by the manufacturer of the product. The Installer must adhere to the engineering, installation, and testing procedures, and utilize the authorized manufacturer components and distribution channels in provisioning the Project.
- B. General: The Installer directly responsible for this work shall be a " Pathways and Spaces for Structured Cabling System Installer" (PS-SCS); who is, and who has been, regularly engaged in providing and installing commercial and industrial pathways in spaces for telecommunications wiring systems of this type and size for at least the previous five years. Any sub-Installer who will assist the PS-SCS Installer in performance of this work shall have the same training and certification as the PS-SCS Installer.
- C. Certification: The Installer's Project Manager shall possess a current and in good standing BICSI Registered Communications Distribution Designer (RCDD) certificate. All shop drawings submitted by the Installer shall bear the RCDDs seal.
- D. Experience: The Installer shall be experienced in all aspects of this work and shall be required to demonstrate direct experience with recent systems of similar type and size. The Installer shall own and maintain tools and equipment necessary for successful installation and have personnel who are adequately trained in the use of such tools and equipment.

## 1.5 MATERIALS ALTERNATES AND SUBSTITUTIONS

- A. General: Substitutions are allowed for all components of the systems under this specification section when all requirements for substitutions indicated in Specification Section 27 00 10 Technology General Provisions are followed.

## 1.6 SHOP DRAWINGS AND SUBMITTALS

- A. See additional requirements for shop drawings and submittals in Specification Section 27 00 10 Technology General Provisions.
- B. General: The PS-SCS Installer shall provide the following information no later than 30 days after receipt of contract award:
  - 1. Proof of Installer's qualifications per paragraph 1.03 in Specification Section 27 00 10 Technology General Provisions.
  - 2. Cut sheets of all products to be used for the project, highlighting the precise product to be used in each case, when multiple devices are indicated in the cut sheet. At a minimum the following devices shall be submitted with this specification section:
    - a. Supporting devices (J-Hooks) if allowed in the project. See Part 3 of this specification.
    - b. Cable tray system with accessories
    - c. Runway cable tray system with accessories
    - d. Plywood
    - e. Through wall/floor firestop system
    - f. Innerduct
    - g. Detectable tape
    - h. Communications vaults
    - i. Conduit waterfalls
    - j. Firestop system (for small penetrations)
  - 3. Drawings indicating precise location and type of all support for cable tray or ladder tray systems in all areas where they will be used.
  - 4. For all communication vaults, drawings shall be prepared to indicate conduit penetrations on each side of each vault. Vaults shall be labeled to indicate their correct location in the site plan.
  - 5. Pre-cast communication vaults shall be submitted with load calculations signed and sealed by a Professional Engineer.
  - 6. For any directional boring runs, the Installer shall provide a drawing indicating all underground locate surveys and the proposed routing of the conduit as well as the proposed depth.

## **1.7 WORK EXTERNAL TO THE BUILDING**

- A. General: Any work external to the confines of the building as shown on the drawings shall be governed by provisions of this specification.

## **PART 2 - PRODUCTS**

### **2.1 TELECOMMUNICATIONS OUTLET CONDUIT**

- A. All conduits as indicated in Master Specifications Division 26
- B. For new construction or projects utilizing Cat 6A cabling, a minimum of 1" conduits must be installed for telecommunications outlet box locations

### **2.2 TELECOMMUNICATIONS OUTLET BOX**

- A. Telecommunication outlet electrical boxes shall be used to make terminations to limited energy systems described in Division 27 and Division 28 specifications. Telecommunications outlet boxes shall have the following specifications:
  - 1. Material: Steel, 0.6858mm. thickness (minimum) with galvanized zinc coating, 0.013mm. (minimum) thickness on both sides of bracket
  - 2. Construction: Cleanly punched knockouts, welded at 8 points (minimum) with softened edges (no sharp edges)
  - 3. Size (HxW): 4-11/16 x 4 inch to 4-11/16 x 2-1/8 inch
  - 4. Depth: 2-1/8 inch
  - 5. Knockout dimension: At least one inch
  - 6. Listing: UL or ETL
- B. Telecommunications outlet electrical boxes shall be provided with the appropriate one gang, or two gang rings selected for the proper thickness of the drywall in all areas. Standard telecommunications outlets shall use one gang ring, but design documents might indicate the use of two gang rings in selected areas.
- C. For new construction or projects utilizing Cat 6A cabling, the telecommunications outlet boxes must be two gang to allow for proper bend radius.
- D. Knockouts in telecommunications outlet boxes shall not be field punched.
- E. Basis of design: Raco, Steel City, Randal Industries Inc.

## 2.3 WIREWAYS

- A. General use: Wireways are to be used in the following cases:
  - 1. As a long pull box for conduits less than two inches
  - 2. To store cable slack above wall mounted panel equipment such as access control panels
- B. General: Wireway shall be sized as shown on drawings, NEMA 1, lay-in type. Wireway sides and bottom shall contain no knockouts unless shown otherwise on the drawings. The Installer shall punch holes required. The cover shall be hinge type with quarter turn fasteners to hold cover shut. Covers and bodies shall be 16-gauge steel. Wireway shall be as manufactured by Hoffman Engineering Company, Square "D" or Steel City.

## 2.4 SUPPORTING DEVICES

- A. Hangers: Hangers shall be made of durable materials suitable for the application involved. Where excessive corrosive conditions are encountered, hanger assemblies shall be protected after fabrication by galvanizing, or approved suitable preservation methods.
- B. Non-continuous cable supports (J-Hooks) shall provide a bearing surface of sufficient width to comply with required bend radii of high-performance cables; UL Listed.
- C. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
- D. Non-continuous cable supports sized 1 5/16 of an inch and larger shall have a cable retainer strap to provide containment of cables within the hanger. The cable retainer strap shall be removable, reusable, and suitable for use in air handling spaces and must be of metallic material. Nylon and plastic cable supports are not acceptable.
- E. Non-continuous cable supports shall have an electro-galvanized or G60 finish and shall be rated for indoor use in non-corrosive environments.
- F. Stainless Steel non-continuous cable supports are intended for indoor and outdoor use in non-corrosive environments or where only mildly corrosive conditions apply.

- G. Anchoring: Insert anchors shall be installed on concrete or brick construction, with hex head machine screws. Recessed head screws shall be used in wood construction. An electric or hand drill shall be used for drilling holes for all inserts in concrete or similar construction. Installed inserts and brick, shall be near center of brick, not near edge or in joint. Drilled and tapped, and round head machine screws shall be used where steel members occur. All screws, bolts, washers, etc., used for supporting conduit or outlets shall be fabricated from rust-resisting metal or accepted substitution. Gunpowder or lead set anchors are not permitted.
- H. Accessories: Non-continuous support systems shall be provided with adequate mounting accessories depending on the location where the support will be installed, such as beam clips, flange clips, C, and Z purlin clips. Nylon and plastic supports are not acceptable.
- I. Accepted manufacturers: Erico or Panduit.

## **2.5 POWER POLES**

- A. General Use: Power poles shall be used in retrofit jobs to feed power and telecommunications outlets to open office work areas when the cubicles are not close to a wall. Power poles shall be limited for new construction.
- B. Power Pole Types: There are two types of use for the power poles in a project, a pass-thru and a terminated power pole. A pass-thru power pole is the one used solely as a raceway, so that power and low voltage cables can come down from the ceiling into the power pole and out a grommet (or a flex conduit, for power) into a modular furniture track. No terminations are done at the actual power pole. A terminated power pole shall be used as a termination device for a device (i.e., large printer) or furniture (without a modular furniture track). In such cases, the power termination shall be a NEMA 5-20 duplex receptacle, and the data terminations shall be a standard telecommunications outlet. The Project Engineer shall clearly indicate the power pole type to be used in the project. Feeding modular furniture from a terminated power pole with long patch cords is not an accepted method of construction.
- C. The Project Engineer shall estimate the size of the power pole used based on the number of cables to be used on each case. The size selection calculation shall be used based on CAT6A cables, even if the power pole is to be used in a leased site.
- D. A single power pole with a divider shall be used for power and data. Separate power poles are not required.
- E. Approved manufacturers: See Division 27 approved material list.

## **2.6 CABLE TRAY AND FITTINGS (BASKET TYPE)**

- A. General use: Basket tray shall be used in hallways and other interior spaces to collect telecommunications wiring going back to the telecom room. They shall not be used in outdoor areas nor inside the telecom room, data centers, or equipment rooms.
- B. General Description: Basket type cable tray system is to be constructed of welded steel wire mesh with continuous safety edge wire lip. The provided mesh system permits for continuous ventilation of cables and maximum heat dissipation.
- C. Materials: Carbon Steel Cable management system to be manufactured from high strength minimum 6-gauge steel wires. Wire to be welded and bent prior to surface treatment.
- D. Finishes: Electro-plated zinc Galvanizing. Electrodeposited zinc coating applied to an average thickness of 0.7 mils to 0.8 mils.
- E. Cable Tray: Dimensions are as shown on drawings.
- F. Fittings: Cable tray fittings to be field manufactured from straight sections through use of hardware and instructions recommended by manufacturer. Provide drop-off, 90° kits and tees as required using manufacturer fabricated products and installation guidelines.
- G. Installation: Cable tray system to be installed using splice connectors, and support components per recommendation of manufacturer.
- H. Loading Cable tray system to be installed and supported per NEMA VE-2 and manufacturer's suggested span load criteria.
- I. The cable tray system shall be UL listed and classified as a continuous bonded tray system providing a continuous grounding path. Cable tray system is required to be tested for grounding adequacy per NFPA 70B, Chapter 18 with a maximum allowable resistance of 1 ohm ( $\Omega$ ).
- J. Approved Manufacturers: See Division 27 approved material list.

## **2.7 TUBULAR RUNWAY CABLE TRAY AND FITTINGS**

- A. General use: Tubular runway shall only be used inside the telecom rooms, data centers, or equipment rooms.
- B. Materials: ASIM A36 steel bar.
- C. Finish: Baked powder painted surface treatment using polyester coating.

- D. Finish color: To match equipment cabinet finish color. See Specification Section 27 10 00 Technology General Provisions.
- E. Cable management: Tray width as shown on drawings.
- F. Fittings: Cable management fittings and hardware recommended by manufacturer. Provide drop-off, 90°, and tees as required for the equipment served and support of the cable. Provide at least one large radius drop off for each rack/cabinet in the project.
- G. Installation: Cable management system to be installed using support components as recommended by the manufacturer.
- H. Loading: Cable management system to be installed and supported per manufacturer's suggested span load criteria.
- I. Approved Manufacturers: See Division 27 approved material list.

## **2.8 PLYWOOD BOARDS IN TELECOMMUNICATION ROOMS**

- A. General use: Backboards shall be installed in each TR, MDF, IDF and the MTR on walls to a height of 8' AFF.
- B. Acceptable options for plywood boards are:
  1. 3/4-inch AC Grade fire rated plywood painted with two coats of fire-retardant paint on front sides and on the edges.
  2. Pre-manufactured plywood system for telecommunications such as Ready Spec by Pathways and Spaces Inc.
- C. Other specifications:
  1. All imperfections and voids shall be filled, sealed, and sanded prior to being primed and painted.
  2. Fire retardant coating shall be tested to UL723, "Test for surface burning characteristics of building materials."
  3. Paint color shall be grey, white, or blue.
  4. Fire retardant plywood shall be clearly labeled with the name of the Backboard Manufacturer, UL Classification of the Fire-Retardant Coating, NFPA 255 Coating Flame Spread Index Class, and the APA Grade of the plywood.
  5. Plywood shall be installed with best side out.

## 2.9 THROUGH WALL/FLOOR FITTING FIRE STOP SYSTEM

- A. General use: Through wall/floor fittings shall be used in the following cases:
1. At all four-inch conduit stub ups (from floor below).
  2. In such case a cable tray needs to pass through a fire-rated partition. The cable tray shall be stopped before the partition with four-inch conduit sleeves through wall/floor fittings installed and the cable tray shall continue to the other side of the wall.
- B. General: These devices covered under this specification are firestop devices for use in through-penetration firestop systems, which are used to maintain the fire rating of the wall or floor, in addition to routing and protecting power and/or communication cables.
- C. Classification and use: The firestop device for use in through-penetration firestop systems shall have been examined and tested by Underwriters Laboratories Inc. to UL1479 (ASTM E 814) and bear the U.S. and Canadian UL Classification Mark. The device shall be classified for use in one-, two-, three-, and four-hour rated gypsum, concrete, and block walls and provide a maximum L rating of 3.3 cfm. The device shall be classified for use in one-, two-, and three-hour rated concrete floors having a minimum 4 1/2 inch (114mm) thick reinforced lightweight or normal weight (100-150 pcf) (1600-2400 kg/m<sup>3</sup>). The devices shall also be tested by Underwriters Laboratories Inc. to UL2043 and determined to be suitable for use in air handling spaces.
- D. Materials:
1. Box: The fire stop device box shall be constructed of 16 gage G90 steel.
  2. Intumescent block: The fire stop device intumescent block shall be constructed of a graphite base material with expansion starting at 375° F and an unrestrained expansion between 6 to 12 times. The intumescent block shall be held securely by the box to prevent tampering and damage during installation.
  3. Adjustable doors: The fire stop device shall have doors or other systems which can be adjusted to prevent materials from penetrating the device if the device is empty or completely full. The doors shall be constructed of 16 gage G90 steel with no. 10-32 screws used to adjust opening size.
  4. Heat shield: For retrofit applications where an existing in-wall conduit extends out from the wall more than 7/8 inch [22mm], a UL listed Heat Shield must be used to maintain UL Fire Classification. The firestop device is then installed onto the heat shield.

5. Split conduit and wall plate: For retrofit applications where no conduit is installed in the wall to protect existing cables, a split conduit assembly shall be used to protect cables. After installing the split conduit within the wall, a wall plate shall be installed to cover any irregularly shaped hole cut in the wall. The firestop device is then installed onto the conduit.
- E. Sizes: the fire stop device shall be available for two inch and four inch trade size EMT conduit.
- F. Finish: The fire stop device shall be available in safety yellow or orange powder coat, custom colors, and an unpainted galvanized finish.
- G. Design selection: See Division 27 approved material list.

## **2.10 INNERDUCT (REGULAR)**

- A. General use: Innerduct shall be used inside conduits two inches or larger, installed underground, or in a cable tray system to protect fiber optic backbone cables. Armored cable may be substituted.
- B. Flexible raceway systems (also referenced as regular innerduct or innerduct): The innerduct type shall be selected according to the environment where it will be installed. Only use HDPE innerduct outdoors, and plenum or riser rated innerduct indoors. The Installer is responsible for determining the proper selection of innerduct when used in air handling spaces. If at the time of bidding, the Installer is not sure what kind of environment is present in the project, the Installer shall price plenum rated materials.
- C. For plenum rated applications, the specifications of the innerduct shall be:
  1. Material: White or orange Kynar PVDF Resin, a fluoropolymer compound
  2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed on the product
  3. Marking: Footage shall be sequentially marked
  4. Configuration: Corrugated type
  5. Pull line: Built in 900 lb. rated tape
  6. Size: Shall be available in 3/4 inch through two inch diameters

- D. For riser rated applications, the specifications of the innerduct shall be:
1. Material: Orange polyvinyl chloride (PVC)
  2. Listing: Innerduct shall be listed to UL 2024, listing shall be printed on the product
  3. Marking: Footage shall be sequentially marked
  4. Configuration: Corrugated type
  5. Pull line: Built in 900 lb. rated tape
  6. Size: Shall be available in 3/4 inch through two inch diameters

For outdoor applications, the specifications of the innerduct shall be:

7. Material: High Density Polyethylene (HDPE)
  8. Listing: None
  9. Marking: Footage shall be sequentially marked
  10. Configuration: Corrugated type
  11. Pull line: Built in 1,800 lb. rated tape
  12. Size: Shall be available in 3/4 inch through two inch diameters
- E. All innerducts shall be provided with couplings and accessories suitable for the environment where they will be installed.
- F. Design selection: See Division 27 approved material list.

## **2.11 INNERDUCT (FABRIC TYPE)**

- A. General use: Innerduct made of fabric material may be used when available raceways are very limited and the use of regular innerduct is not possible due to available space in the raceway system. Innerduct must be used inside conduits two inches or larger and must include fabric type innerduct.
- B. High capacity innerduct made of fabric shall be used inside telecommunication raceways to facilitate the pulling of telecommunication wires in those raceways. The fabric type innerduct (also referenced as textile innerduct) shall have the following specifications:
1. Material: White Polyester and Nylon resin polymer
  2. Standard Outdoor Textile Innerduct: Micro (33mm), two inch, three inch, and four inch single or multi-cell polyester/nylon textile innerduct containing 1250lb polyester flat woven pull tape
  3. Indoor Textile Innerduct (Riser-listed): Micro (33mm), two inch, three inch, and four inch single or multi-cell nylon textile innerduct containing 1250lb polyester flat woven pull tape which meets UL2024A for flame propagation and smoke density values for general applications

4. Plenum-Listed Textile Innerduct: Micro (33mm), two inch and three inch single or multi-cell nylon textile innerduct containing 200lb nylon-resin flat woven pull tape which meets UL2024A for flame propagation and smoke density values for use in air handling spaces
- C. The Installer is responsible for determining the proper selecting of the innerduct when used in air handling spaces. If at the time of bidding the Installer is not sure what kind of environment is present in the project, the Installer shall price plenum rated materials.
- D. Design selection: See Division 27 approved material list.

#### **2.12 DETECTABLE TAPE**

- A. General use: A detectable tape shall be installed above all underground conduit at a minimum depth of 18 inches.
- B. General: The detectable warning tapes shall be constructed with a solid aluminum foil core with a minimum thickness of 5 mils and three inches wide. The detectable warning shall have printed diagonal warning stripes conformed to APWA color recommendations and bold, black legends to identify what type of utility line is buried below. All detectable tapes used for this shall be labeled "fiber optics buried below".
- C. Design selection: See Division 27 approved material list.

#### **2.13 COMMUNICATIONS VAULT (POLYMER CONCRETE)**

- A. General use: Polymer concrete communication vaults shall only be installed in green areas away from regular traffic areas or sidewalks.
- B. In ground communication boxes also referenced in this document as communications vaults (polymer concrete) shall have the minimum specifications:
  1. Construction Material: Precast Polymer Concrete
  2. Listing: UL listed enclosure, tested to ANSI/SCTE 77
  3. Box vertical design load: 22,500 lbs.
  4. Box vertical test load: 33,750 lbs.
  5. Box lateral design load: 800 lbs./sq. ft.
  6. Box lateral test load: 1,200 lbs./sq. ft.
  7. Box dimensions: To be determined by Engineer depending on quantity of conduits to terminate in the communications vault
  8. Box bottom: open bottom

9. Holes for conduit:
  - Holes for conduit shall be cut at the factory and shall not cover more than 25% of the side of the enclosure
  - All sides of the box shall have holes for conduits, even though conduits might not be shown for all sides in the floor plans
  - No less than two holes for standard four-inch conduit shall be at all sides. All unused holes shall be plug with plastic caps
10. Cover ANSI TIER: 22
11. Cover logo: "Pinellas County"
12. Cover screws: Two tamper-resistant penta head screws
13. Cover accessories: Two - seven inch long cover hooks made of electroplated steel
14. In unsecured areas, keyed security bolts must be used. Example: McGard manhole security bolts

C. Design selection: Hubell Quazite PG style box with HH series cover and accessories or approved equal. Approved equals shall comply with all specifications listed above including construction material.

D. All communication vaults shall be provided with the following accessories:

1. Embedded lifters made of galvanized steel
2. All communications vaults with a concrete lid and ring shall be provided with a grade ring or riser made of concrete to bring the cover up to grade level
3. Embedded pulling irons made or carbon steel galvanized
4. Install cable supports such as j-hooks on vault walls
5. Pea gravel/fill ratio (The ideal depth of gravel varies upon application. A minimum of two-four inches of gravel is a workable baseline. Multiplying the area to be covered by the desired depth yields the volume of gravel you will need)

#### **2.14 COMMUNICATIONS VAULT (PRECAST CONCRETE)**

A. General use: Precast concrete communication vaults shall be used in all areas where they could be exposed to vehicular traffic, such as roadways, parking lots or sidewalks.

B. In ground communication boxes also referenced to in this document as communication vaults (precast concrete) shall have the minimum specifications:

1. Construction Material: Concrete 5000 psi at 28 days
2. Rebar: ASTM A 615 grade 60 rebar
3. Mesh: Welded wire fabric ASTM A185 grade 65
4. Size: To be determined by A&E depending on quantity of conduits to terminate in the communications vault
5. Design: Comply with local building code for reinforced concrete

6. Loads:
    - Dead load - concrete 150 PCF
    - Earth cover – 120 PCF
 Lateral Earth pressure on walls:
    - Equivalent fluid pressure above water table + 36 PSF per ft, of depth
    - Equivalent pressure below water table + 81.4 PSF per ft. of depth
  7. Live load: AASHTO HS20-44. 32,000 lbs. rear axle loading
- C. The cover and frame for the communications vault shall have the following specifications:
1. Style: Hatch type: galvanized cover
  2. Cover design (for hatch type or galvanized cover): Hot dip galvanized after fabrication built to an H20 rating for non-roadway applications with dual doors
  3. Cover design (for concrete lid with ring): 30-inch diameter cast or ductile iron, built to an H20 rating up to 150 KIO
  4. Lettering: Covers shall be label as “Pinellas County”
  5. In unsecured areas, keyed security bolts must be used. Example: McGard manhole security bolts
- D. All communications vaults shall be provided with the following accessories:
1. Embedded lifters made of galvanized steel
  2. All communications vaults:
    - With a concrete lid and ring shall be provided with a grade ring or riser made of concrete to bring the cover up to grade level
    - Pre-cast concrete grade rings and cones shall comply with ASTM C 478, except that the wall thickness shall be six inches minimum
    - Provide interlocking keyways on rings and cones
    - Provide cones with cast in place inserts for the vault frame
  3. Embedded pulling irons made or carbon steel galvanized
  4. Install cable supports such as j-hooks on vault walls
  5. Pea gravel
- E. Precast vault construction shall be in the form of monolithic walls or horizontal wall sections. Do not use panel walls.
- F. Minimum wall thickness shall be six inches. Design knockout wall panels to accommodate loading pressures defined above.
- G. Design and construct vaults to be watertight when subjected to groundwater over the entire height of the vault.

- H. Provide openings in precast vaults for piping and access. Provide cast in place inserts in the roof slab and end walls at the locations as shown on the drawings. No field coring of openings is allowed.
- I. When communication vaults are made of different sections, they shall be sealed and bonded with a double layer of plastic sealing compound and made watertight. Plastic sealing compound shall comply with Federal Specification SS-S-00210. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C 387, Type S.

#### **2.15 CONDUIT WATERFALLS**

- A. General use: All four inch EMT conduit terminations with communication cable entering/exiting the conduit from a cable tray (or tubular runway) system and the vertical separation between raceways is larger than seven inches shall be fitted with a device to control the bend radius of the communication cable to a minimum of a four inch radius. The device to control the bend radius shall be called a conduit waterfall and must comply with all National Electrical Code requirements and TIA/EIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, UL 94V-0 approved to reduce the spread of flame, and approved by UL for use in air handling spaces. The device to provide bend radius control must support a static load of 40 lbs. (177.9 N) and have a fastening device that allows for incremental adjustments to conform to variances in conduit diameters.
- B. Basis of design: Panduit CWF 400 or approved equal.

#### **2.16 FIRE STOP SYSTEMS (FOR SMALL PENETRATIONS)**

- A. General use: Fire stop system based on caulk shall be used in the following cases:
  - 1. When stubbing into a telecom room, where the wall is rated but the conduit is less than two inches.
  - 2. When conduit sleeves smaller than two inches are used to run low voltage cables through a fire rated partition.
- B. General: Fire stop system shall be selected by the PS-SCS Installer as to comply with the following requirements:
  - 1. Selected system shall be UL listed for the condition on which it will be installed. These conditions include wall/slab type (masonry, drywall, etc.), hour rating, and accessibility type.

- C. Acceptable systems: See Division 27 approved material list.

## **2.17 EXPANSION FITTINGS**

- A. General use: Provide expansion fittings in each conduit run wherever it crosses an expansion joint. Install the fitting on one side of the joint with its sliding sleeve end flush with joint, and with a length of bonding jumper in expansion equal to at least three times the normal width of joints.
- B. Location: Provide expansion fittings in each conduit run which is mechanically attached to separate structures to relieve strain caused by shift on one structure in relation to the other.
- C. Length: Provide expansion fittings in straight conduit runs above ground which are more than one hundred feet in length.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION PRACTICES**

- A. See additional requirements indicated in part 3 of Specification Section 27 00 10 Technology General Provisions.

### **3.2 TELECOM ROOM DESIGN: Requirements by BTS for telecom rooms shall be:**

- A. Size: Telecom rooms (IDF & MDF) shall be no less than 12' by 15', with enough space for at least three racks. If the room requires housing cabinets with equipment like servers, security racks, or Audio-visual racks, the size of the room might need to be increased to accommodate such equipment. Telecom rooms shall not be shared spaces with electrical equipment such as transformers, and HVAC equipment not serving the telecom room. Telecom rooms should not be adjacent to large mechanical or elevator rooms. Electrical panels are acceptable if they are only serving outlets inside the Telecom room. All Telecom rooms must adhere to current ADA specifications for access and mobility including but not limited to:
  1. MDF
  2. IDF
  3. TSER
  4. Data center rooms
  5. Other - Security or Audio-Visual equipment rooms, etc.

- B. Access: Access to telecom room shall not be through electrical rooms or through an enclosed office space. Access shall be through a hallway or a common space in the building.
- C. Location: Telecom rooms shall be located centered in the area they are serving to maximize the coverage of the room. When telecom rooms are located far to a side of the building, the chances of having to add a second room, increase. Telecom room shall be on the same floor as the areas being served. Telecom rooms shall not be planned directly below any restrooms or kitchens.
- D. Architectural Elements: All telecom rooms shall have the following finishes:
  - 1. All walls shall be from slab to deck/roof above. If the room will hold any DAS equipment for life safety, all walls shall be two-hour rated. If no DAS equipment will be installed inside the room, the walls do not require a fire rating.
  - 2. All floors shall have anti-static VCT flooring. Sealed concrete finish is not acceptable.
  - 3. Ceiling is not required inside the telecom rooms unless the structure above must be sprayed with fire protection. In such case, a ceiling is required and shall be mounted as high as possible to make sure all tubular runways and conduit stubs inside the room are below the ceiling.
  - 4. When possible, door shall open out. Doors to telecom rooms shall have card access. If the building will not have card access, the door shall have a cypher lock to provide access.
  - 5. Telecom room shall not have floor drains.
  - 6. Telecom room shall not have windows.
  - 7. Plywood boards shall be installed in all walls of the telecom room.
  - 8. Walls and plywood must be painted with fire rated paint.
- E. Cooling: Cooling shall be provided for all telecom rooms through dedicated equipment. Feeds from existing duct work from office spaces to provide cooling to telecom rooms is not acceptable. The cooling load shall be estimated per equipment load and growth by the Engineer but in all cases, the load shall be no less than one ton of cooling per rack in the room. The standard room layout shall include three racks. Data centers and other larger equipment room shall be designed with larger cooling loads.
- F. Redundancy: Telecom rooms do not require redundant cooling equipment. Data centers and other larger equipment rooms require redundant cooling equipment. In all cases, temperature alarms must be provided inside all telecom rooms, connected to the building automation system, monitored by building manager.
- G. Location of Cooling Equipment: Smaller Direct Expansion (DX) air conditioning equipment will be located above the door to the telecom room. Drainpipes for the DX equipment will

be run outside of the telecom room. If the room is cooled through VAV or air handlers, such equipment shall be located outside of the telecom room and air shall be ducted in and out of the room. VAVs or air handlers above racks are not acceptable.

- H. Fire Protection: If local code requires, all rooms in the building must have fire sprinklers. Fire sprinkler heads must not be located above the racks or equipment and must be located between the racks and the walls. Standard telecom rooms do not require a clean agent fire suppression system. Data Centers and other large equipment rooms will require clean agent fire suppression. Telecom rooms with DAS equipment also requires clean agent fire suppression. All fire protection must adhere to local codes and standards.
- I. Fire Alarm Relays and Fire Alarm Monitoring: Fire alarm relays might be required next to access control panels if electromagnetic locks are being used as the main locking device for access-controlled doors. Fire alarm monitoring modules are required for monitoring DAS equipment head end or distribution equipment, when mounted in telecom rooms.
- J. Lighting: All telecom rooms shall have lighting to accomplish at least 50 ft. cd in all areas. Light fixtures shall be located both in front and behind the racks, never directly above the racks. Maintain industry standards for separation of high and low voltage systems.
- K. Power Receptacles: Telecom rooms shall be designed with three types of power outlets as follows:
  - 1. Convenience outlets for connecting power tools or temporary equipment shall be installed at each wall (one per wall) at 18 inches A.F.F. These outlets do not need to be on generators or dedicated circuits. They shall be terminated in a duplex NEMA 5-20 receptacle.
  - 2. Wall power for wall mounted equipment shall be a dedicated circuit mounted at 48 inches A.F.F on generator backup power. For paging, DAS and CATV equipment, power shall be terminated in NEMA 5-20 quad receptacles. For access control panels, the power termination shall be coordinated by the A&E with the equipment selection, it could be a junction box (hard wired) or a quad receptacle NEMA 5-20.
  - 3. Rack power each rack shall be provided with at least one power outlet on dedicated circuits, mounted in between racks close to the floor and plugged into the generator and UPS power if available in the building. The type of termination plug shall be coordinated with the UPS or PDU indicated in Specification Section 271000 Technology General Provisions. These receptacles shall be simplex receptacles and could be an L14-30 or similar plug. Do not assume they will be a NEMA 5-20 receptacle. When rooms have equipment cabinets, power receptacles could be different from wiring racks. In such cases, all power receptacles shall be coordinated with BTS.

- L. Other MEP Infrastructure: The following infrastructure shall not pass through the telecom room:
- Power feeders serving panels not located inside the telecom room
  - Drainpipes or rainwater leaders
  - Water mains for fire suppression, potable water
  - Chilled water pipes
  - Hydraulic fluid lines for elevators
- M. Rack Layout: Racks and cabinet shall be lined in rows, side by side along the length of the room, with no less than three feet of clearance from the front of the rack to the wall and from the back of the rack to the wall. A rack row, including vertical manager, shall start no closer than six inches from the side wall. Refer to **Appendix E, diagram 21, page 33** in **Division 27 Appendices** document.
- N. Conduit Stub Ups: When telecom rooms have conduit stub ups, they shall be located as close to the wall as possible. Any stub ups from below grade or floor below shall extend no less than 12 inches above the finish floor. The amount of conduit stubs shall be calculated by the A&E to not use more than 50% of day one capacity.
- O. Tubular Runway: Tubular runway cable tray shall run above racks and along all walls in the room, with the exception of the door if the tubular runway will be lower than the door. Tubular runway shall be mounted six inches above the racks and shall be no less than 12 inches in width. If the telecom room will hold more than 250 cable drops, the tubular runway shall be expanded to 18 inches in width or two layers of 12-inch tubular runway shall be provided. At all conduit stub ups, a section of vertical tubular runway shall be installed to strap the cables in route to the horizontal tubular runway. If the room has conduit stubs higher than two inches above the racks, a section of vertical runway shall be installed below the conduit support the cables and relief tension.

### **3.3 INDOOR CONDUITS BELOW GRADE AND ABOVE GRADE**

- A. Bend Radius: Conduits shall utilize long radius sweeps at all 90-degree transitions. The inside radius of a bend in conduit shall be at least six times the internal diameter. When the conduit size is greater than two inches, the inside radius shall be at least ten times the internal diameter of the conduit. For fiber optic cable, the inside radius of a bend shall always be at least ten times the internal diameter of the conduit.
- B. Maximum Distance Between J Boxes: For indoor installation, no section of conduit shall be longer than one hundred feet or contain more than two 90-degree bends between pull points or pull boxes.

- C. Labeling: All indoor conduits shall be labeled at both ends when these conduit runs are continuous between two rooms and going through multiple walls or slabs. Labeling materials shall be as indicated in Specification Section 27 00 10 Technology General Provisions. Conduit sleeves two inches or larger penetrating just one wall is not required to be labeled.
- D. Pull Strings: All conduits for technology systems shall be installed with pull strings. Pull strings shall be nylon and shall be impervious to moisture. Pull strings installed in one inch and smaller conduits shall have a tensile strength of not less than 30 lbs. Pull strings installed in conduits larger than one inch shall have a tensile strength not less than 200 lbs.

### 3.4 UNDERGROUND TELECOMMUNICATIONS DUCT LINES

- A. Description: Underground duct lines shall be of individual conduits. The conduit shall be of plastic, PVC Schedule 40. The conduit used to bring telecom service into a building shall not be smaller than four inches in diameter, inside.
- B. Concrete Encasing: This is not generally required for telecom conduits. In cases where telecom lines are carrying sensitive services, such as emergency call (911) circuits, they may be required.
- C. Duct Lines: Shall have a continuous slope downward toward communication vaults and away from buildings with a pitch of not less than 0.125 inches per ft. Changes in direction of runs exceeding a total of ten degrees either vertical or horizontal shall be accomplished by long sweep bends having a minimum radius of curvature of twenty-five feet, except that manufactured bends may be made up on one or more curved or straightened sections or combinations thereof. Manufactured bends shall have a minimum radius of 48 inches.
- D. Distance: The maximum distance between vaults (manholes) shall not be longer than five hundred feet or contain more than two 90-degree bends between pull points or pull boxes are required.
- E. Conduits:
  - 1. Shall terminate in end-bells where duct lines enter manholes or communications vaults.
  - 2. Provide four to six inch reducers as required.
  - 3. Separators shall be of pre-cast concrete, high impact polystyrene, steel, or any combination of these.
  - 4. The joints of the conduits shall be staggered by rows to provide a duct line having the maximum strength.

5. During construction, partially completed duct lines shall be protected from the entrance of debris, such as mud, sand, and dirt by means of suitable conduit plugs.
  6. As the duct line is completed, a testing mandrel not less than 13 inches long with a diameter a 1/4 inch less than the size of the stiff bristles shall be drawn through until the conduit is clear of all particles of earth, sand, or gravel; conduit plug shall then be immediately installed.
  7. Plastic conduit, fittings and joints should not be stored in the sun or weather, heated spaces, or unevenly supported during storage. Use and installation shall be in accordance with the National Electrical Code requirements for the installation of non-metallic rigid conduit. Plastic conduit shall be protected against the direct rays of the sun prior to installation. Conduit shall be Carlon Type EB, Queen City Plastics, or accepted substitution. Conduit shall be UL listed and conform to NEMA Standard TC6 1972.
  8. Above ground stub-ups must be rigid.
  9. All ends must have bushings.
- F. Trenches for Duct Banks: Shall be completely dry before setting conduits or pouring concrete. Well pointing as required shall be provided, if necessary, to keep trench dry.
- G. Excavation: Backfilling shall be in layers not more than eight inches deep and shall be thoroughly tamped. The first layer shall be earth or sand, free from particles that would be retained on a 1/4-inch sieve. The succeeding layers shall be excavated material having stones no larger than that which would pass through a four-inch ring. The backfill shall be level with adjacent surface, except that in sodded or paved areas, a space equal to the thickness of the sod or paving shall be left. See **Appendix D - TG106 Premises Cable Conduit Fill Quick Reference** in **Division 27 Appendices** document.
- H. Finish: The surface disturbed during the installation of duct shall be restored to its original elevation and condition if not refinished in conjunction with site work.
- I. Plugging: All unused conduit openings shall be plugged or capped with a suitable device designed for the purpose; caulking compound shall not be used for plugging conduit openings.
- J. Stubs: Spare conduit stubs shall be capped and marked in the field and accurately dimensioned on the as-built drawings.
- K. Spacers: All conduit runs underground or stubbed above floor shall be separated with plastic interlocking spacers manufactured specifically for this purpose or shall be strapped to Kindorf channel supported by conduit driven into the ground or tied to steel.
- L. Minimum Burial Depth: All underground raceways (with exception of raceways installed under floor slab) shall be installed in accordance with Section 300.5(l) of the NEC except

that the minimum cover for any conduit or duct bank shall be two feet, unless otherwise indicated. See **Appendix D** in **Division 27 Appendices** document.

- M. Directional Boring: For all applications requiring directional boring the following installation practices shall be followed:
1. The Installer shall select the directional boring equipment based on the length of the pulls, soil conditions, pipe size, and pipe quantities.
  2. When multiple pipes are run, each pipe must have permanent identification markings at each end.
  3. Any pipe run less than 1,500 feet, shall be run as a single pull without splices.
  4. Any splices done to HDPE pipes shall be done with manufacturer's approved methods.

### **3.5** INSTALLATION OF COMMUNICATIONS VAULTS

- A. Excavating and Backfilling for Vaults: Provide six-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend 12 inches beyond the edges of the vault. After repairing the waterproofing, backfill and compact around the vault with structural backfill material. Excavated material may be used for structural backfill, provided it conforms to the standard specifications for structural backfill material.
- B. Installing Vaults and Risers: Set each concrete vault section or riser plumb on a double layer bed of sealant at least 1/2-inch-thick to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.
- C. Waterproofing: Waterproofing shall be factory applied to all exterior surfaces of vaults and risers. This includes the bottom of the vault to be coated as an exterior surface. Apply two coats at a rate of 65 sq. ft. per gallon per coat. Prior to backfilling, field apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

### **3.6** CUTTING AND PATCHING

- A. Core Drilling: The Installer shall be responsible for all core drilling as required for work under this section, but in no case shall the Installer cut into or weld onto any structural element of the project without the written approval of the A&E. Any post tension slabs or slabs with embedded electrical raceways shall be X-rayed prior to coring by the Installer.

- B. Cutting and Patching: All cutting, rough patching, and finish patching shall be provided as specified in the contract documents. All cutting and patching shall be performed in a neat and professional manner.
- C. Openings and Sleeves: Locate all openings required for work performed under this section. Provide sleeves, guards, or other accepted methods to allow passage of items installed under this section.
- D. Roof Penetration: All roof penetration for raceways part of technology systems shall be approved by A&E prior to execution of work. All roof penetrations shall be as accepted by the roof manufacturer.

### **3.7 IDENTIFICATION OF BOXES**

- A. Tags: During installation of pull strings, all pull strings shall be marked with waterproof vinyl tags indicating where the opposite end may be found.

### **3.8 BLANK PLATES**

- A. Plates: Unless otherwise noted all unused outlet boxes shall receive blank plates matching the finish of plates for electrical devices in the same room.

### **3.9 RACEWAY INSTALLATION**

- A. Support: All raceways shall be run in a neat and professional manner properly supported in accordance with the latest edition of the NEC code and BICSI guidelines. Supporting conduit and boxes with wire is not acceptable. Exposed raceways, where allowed, shall be supported with clamp fasteners with toggle bolt on hollow walls with no lead expansion shields on masonry. All conduits shall be securely fastened in place with at least one support per eight-foot section. Support within one foot of changes in direction. All required hangers, supports, and fastenings shall be provided at each elbow and at no more than one foot from the end of each straight run terminating at a box or cabinet. The use of perforated iron for supporting conduits shall not be permitted. The required strength of the supporting equipment and size and type of anchors shall be based on the combined weight of conduit, hanger, and cables. Horizontal and vertical conduit runs may be supported by one-hole malleable straps, clamp-backs, or other accepted devices with suitable bolts, expansion shields (where needed), or beam-clamps for mounting to building structure or special brackets.

- B. Hanger Installation: Where two or more conduits one inch or larger run parallel, trapeze hangers may be used consisting of concrete inserts, threaded solid rods, washers, nuts, and galvanized "L" angle iron, or Unistrut cross members. These conduits shall be individually fastened to the cross member of every other trapeze hanger with galvanized cast one-hole straps, clamp backs, bolted with proper size cadmium machine bolts, washers, and nuts. If adjustable trapeze hangers are used to support groups of parallel conduits, U-bolt type clamps shall be used at the end of a conduit run and at each elbow. J-bolts, or approved clamps, shall be installed on each third intermediate trapeze hanger to fasten each conduit.
- C. Non-Continuous Cable Supports Installation: J-hooks shall be installed only as recommended by manufacturer not exceeding the load ratings of the device. Install non-continuous cable supports in spans no longer than four feet. Whenever there are changes in elevation additional supports shall be required to avoid stress on cable or sharp bends.
- D. Fire Stopping: For four-inch sleeves, the PS-SCS Installer shall provide through wall/floor fittings, firestop system, and other smaller sleeves or wall penetrations through fire rated partitions. The PS-SCS Installer can use the same type of firestop system, or a fire stop system for small penetrations in compliance with products described in part two of this specification.
- E. Penetrations in Fire Rated Partitions: Installation of electrical boxes or equipment backboxes in fire rated walls and smoke barriers shall follow the following requirements:
  - 1. Electrical boxes and or technology system backboxes can be installed in one or two hour rated walls when all requirements indicated in the proper Building Code, National Electrical Code, and nationally recognized testing laboratories are met.
  - 2. As a summary, some of the requirements indicated by the codes listed above are:
    - a. Boxes shall be metallic or listed for that purpose
    - b. The area of the boxes shall not exceed 16 square inches, provided the aggregate area of the openings through the membrane does not exceed 100 square inches in any 100 sq. ft. of wall area
    - c. The spacing between the wall membrane and the box shall not exceed 1/8 of an inch
    - d. Boxes on opposite sides of the walls shall be separated by no less than 24 inches, or boxes shall be covered by listed putty pads, or a listed material and method used
  - 3. Electrical boxes or technology system backboxes shall not be installed in a 3- or 4-hour fire rated walls.
- F. Routing: Conduits shall run parallel to building walls wherever possible, exposed, or concealed as specified, and shall be grouped. Crisscrossing of conduits shall be minimized.

- G. Protection During Construction: All raceway runs, whether terminated in boxes or not, shall be capped during construction until wires are pulled in and covers are in place. No conductors shall be pulled into raceways until the raceway system is clean and complete.
- H. Protective Bushings: All un-terminated conduits shall have an insulated protective bushing to avoid cable damage at the edge of the conduit.
- I. Avoiding EMI: To avoid EMI for Telecommunications cabling and/or conduit containing cabling, all raceways shall provide clearances a minimum of four feet from motors or transformers; one foot from conduit and cables used for electrical-power distribution; and five inches from fluorescent lighting. Raceways shall cross perpendicular to fluorescent lighting, electrical-power cables, and conduits. The Installer shall not place any raceways alongside power lines.
- J. Coordination: All raceways shall be kept clear of mechanical equipment and plumbing fixtures to facilitate future repair or replacement of said fixtures without disturbing wiring. Except where it is necessary for control purposes, all raceways shall be kept away from items producing heat.
- K. Masonry Installation: All raceway runs in masonry shall be installed at the same time as the masonry so that no face cutting is required, except to accommodate boxes.
- L. Use of Conduit in Different Areas: When low voltage cable technology systems must be run above ground in a space without an accessible ceiling, both interior and exterior, all cable runs shall be encased in conduit continuing the raceway to the nearest accessible ceiling in the direction of the telecom closet or grouping the raceways into a single larger diameter conduit with the same or larger cross-sectional area than the sum of all the conduits coming into it. The use of J-Hooks to support low voltage cables in areas with no ceiling or a hard ceiling shall not be allowed. This type of condition is often not indicated in the drawings. Design drawings do not show conduits smaller than two inches. Per BTS standards, it shall be provided as stated herein.
- M. Use of Conduit for Different Systems: The following paragraphs indicate the design intent for all technology systems raceways:
  - 1. For all systems under Division 27: Conduit stub up from the outlet to the nearest accessible ceiling, non-continuous support system to the nearest cable tray system or telecom room.
  - 2. Non-continuous support systems (J-Hooks) are allowed in projects as a horizontal support system for cables above ceilings.
  - 3. Conduits feeding gas pump islands must be explosion-proof and meet municipal code.

### **3.10 CABLE TRAY INSTALLATION**

- A. Inspection: Examine area for clearances to allow proper installation of the tray according to the routing indicated on the drawings. Check existing building steel and other supporting structures to establish the type of tray hangers to be used at the proper spans.
- B. Installation Criteria: Installation shall be in accordance with equipment manufacturer's instructions with recognized industry practices to ensure that cable tray equipment complies with requirements of NEC and applicable portions of NFPA 70B. Reference NEMA-VE2 for general cable tray installation guidelines
- C. Support: Cable tray support shall be by means of welded angle brackets to structural components. Brackets shall be as manufactured by the cable tray manufacturer. Complete straight section of cable tray shall have at least one support at 1/4 of the length of the section. Additional supports are required at tray ends, offsets, bends, and changes of elevation.
- D. Grounding: All conduits terminating within 12 inches of a cable tray shall be bonded with a ground in accordance with the National Electric Code.
- E. Coordination: When applicable the preference is to install horizontal cable trays above water and steam piping. Coordinate installation of tray with other trades for clearances, to avoid conflicts. A minimum of 12-inch access headroom shall be provided and maintained above the cable tray system or cable runway. A minimum of six-inch access headroom shall be provided and maintained at both sides (one side of the tray is supported at the wall). Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, structural elements) do not restrict access. The cable tray must be installed with at least three inches of clear vertical space above the ceiling tiles and support channels (T-bars) to ensure accessibility. When crossing other building components with the cable tray or runway the above specified clearances shall be maintained.

### **3.11 RUNWAY CABLE TRAY SYSTEM INSTALLATION**

- A. General: Runway cable tray system shall be installed following manufacturer's recommendations for installation.

- B. Support Locations: Supports shall be provided as recommended by the manufacturer, but as a minimum support shall be located as follows:
  - 1. Before each 90-degree turn
  - 2. No continuous section shall have more than three feet of span without a support
  - 3. At each two-post rack or four-post rack
  - 4. At each change in elevation
- C. Support Type: When runway cable tray is to be installed against the wall, the only support type to be used is a wall bracket supporting from the bottom of the tray. For sections of runway cable tray to be installed over racks, the preferred support system is to the racks themselves. Trapeze style support brackets shall only be used when no other method of support is possible. Center hung support systems are not permitted.
- D. Vertical Runways: Runway cable tray systems shall be installed vertically and continuously in all telecommunications rooms for the project from sleeves coming from the ground (or floor below) to the sleeves going to the floor above, whether indicated in the drawings or not. The runway installed shall have the same width as the total width of the sleeves coming into the telecommunications room, although multiple sections installed together are acceptable. If the sleeves from the floor below to the floor above do not line up in a straight line, two vertical sections are acceptable, one to the horizontal runway cable tray and one from the horizontal runway cable tray to the sleeves above. Runway cable trays installed vertically shall have supports to the floor, wall, and slab above.
- E. Cable Dropout: At each rack or cabinet that has a runway cable tray system running on top of it, a cable dropout shall be installed to protect the bend radii of the cable. This dropout accessory shall have a bend radius of no less than four inches.
- F. Bonding: Any two continuous sections of runway cable tray system shall be bonded together with a #1 bonding jumper (600A) 15 inches long. All bonding jumpers shall be made of steel with yellow, zinc-dichromate finish. All fasteners shall be made of steel with zinc-plated finish
- G. Protective End Caps: All end sections of runway cable tray sections shall be protected with plastic protective end caps.

### **3.12 INSTALLATION OF INNERDUCT**

- A. Protect products from the effects of moisture, UV exposure, corrosion, and physical damage during construction.
- B. When inner duct is laid on a cable tray, it shall be strapped to cable tray with nylon ty-wraps at periodic intervals of no less than four feet.

- C. When multiple inner ducts are in a single conduit, and innerduct are of the same size, they shall be different colors for identification or have different color electrical tape wrapped on the ends to identify them at the end of each conduit.

**3.13 AS-BUILT DOCUMENTS AND CLOSEOUT INFORMATION**

- A. See Specification Section 27 00 10 Technology General Provisions (Section 3.7) for as-built documents and closeout information on these requirements.

**END OF SECTION 27 05 28**