



# Standards and Practices for Communications Environments

Information and Communications Technology  
Structured Cabling Standards

DC Office of the Chief Technology Officer



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V1.1

DRAFT

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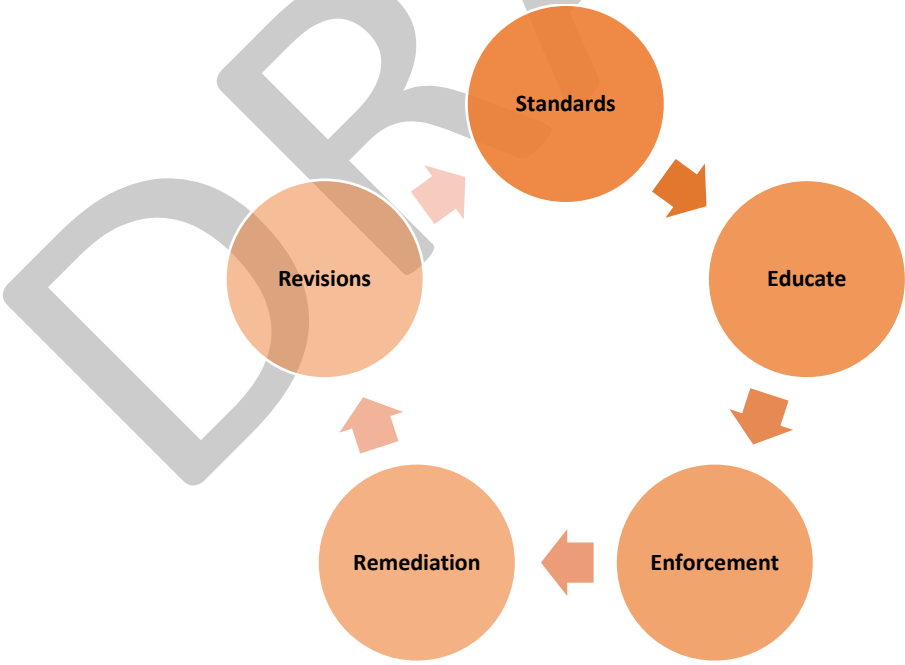
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# 1 Introduction

This document provides guidelines and standards required for all design, installation, testing, modification, and removal of telecommunications cabling infrastructure in buildings where OCTO DC-Net services will be installed.

This guide is for anyone who will install, test, modify, or remove District government owned or operated communications infrastructure or who is responsible for overseeing these tasks, such as District government employees, telecommunications contractors, or 3<sup>rd</sup> party vendors. This document's purpose is to:

- Establish standards, codes, and industry best practices defined by each of the DC-Net functional teams within a single document.
- Educate our partner organizations including the Department of General Services (DGS), DC Public Schools (DCPS), and other entities responsible for overseeing the standards and best practices to provide consistent work product.
- Formalize the inspection process of our partner organizations' vendors and OCTO-managed vendors to improve compliance and resolve issues before work is complete.
- Coordinate remediation efforts with partner organizations for noncompliant infrastructure. Additionally, OCTO will work to remediate outstanding code and standards issues that have occurred before the initiative took shape.
- Evaluate revisions to the process at minimum annually so that we can share the changes with partners.



# 1.1 Document Reference

Where noted, this document follows the Construction Specifications Institute (CSI) Master Format Division 27. The CSI Master Format Division 27 document is commonly referred to as the “Dewey Decimal System” of building construction.

# 1.2 Document Revision History

<b>Date</b>	<b>Version</b>	<b>Description</b>	<b>Author</b>
07/01/2018	1.0	Update DC-Net Cabling Standards	J Burbridge, J Longenecker
07/27/2018	1.1	DC-Net internal team review comments incorporated, standards updated, firestopping updated, equipment room specifications updated	J Burbridge, J Longenecker, J Raye

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## 2 Workmanship, Conduct, and Safety

See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92.

### 2.1 Documentation

#### 2.1.1 Scope of Work

- A. The scope of work included under CSI Master Format Division 27 shall include complete systems as shown in the Contract Documents and specified herein. Any work reasonably inferable or essential to result in a complete installation or the intended operation and performance of the systems, shall be included in the bid except where there is a specific reference to exclusion and incorporation in other references.
- B. This guide does not cover work beyond the scope of installation, test, modification, and removal of District government owned or operated communications infrastructure, including:
  - a. Off-site services
  - b. Provision of electrical wiring and outlets
  - c. Provision of data concentrators, hubs, switches, servers, computers, and other active devices such as PBXs
  - d. Painting
  - e. Removal of asbestos, if required

#### 2.1.2 Documentation and Drawings

- A. OCTO DC-Net expects telecommunication contractors and partner organizations to create drawings and documentation that capture the current communications environments, identify intended changes, and upon completion of work create revisions that reflect the outcome (i.e. “as-built”).
- B. All documentation and drawings should adhere to accepted trade practices.
- C. Distribute documentation and drawings before work initiates and upon completion to partner organizations.
  - a. The sharing of design and red-line documentation will lead to improved expectations and more consistent work products between partner organizations are collaborating.
  - b. OCTO DC-Net will utilize documentation and drawings provided to support future maintenance and upgrades of the communication environments.

- D. Partner organizations and telecommunication contractors are encouraged to provide document and drawing in commonly shared formats such as, Microsoft Word, Adobe PDF, Visio, Auto CAD, etc.

### 2.1.3 Permits, Fees, and Certificates of Approval

- A. Coordinate permitting, fees, and certificates of approval with the property manager.
- B. Keep copies of permits and certificates on hand throughout the period of performance.

## 2.2 Materials

### 2.2.1 General Standards of Materials

- A. Equipment and materials, unless otherwise noted, shall be new, conform to grade, quality, and standards specified, and produced by manufacturers who have been regularly engaged in the manufacture of these products.
- B. Equipment of one type shall be the products of one manufacturer; similar items of the same classification shall be identical and of similar quality—including equipment, assemblies, parts and components.
- C. Materials furnished shall be determined safe by a nationally recognized testing organization, such as Underwriters' Laboratories, Inc., or Factory Mutual Engineering Corporation, and materials shall be labeled, certified, or listed by such organizations. Where third party certification is required for packaged equipment, the equipment shall bear the appropriate certification label.
- D. Any deviations from agreed-upon materials must be approved by OCTO/DC-Net.
- E. For custom made equipment or related installations constructed specially for this project, the manufacturer shall certify the safety of same based on test data.
- F. For contractor's custom-made fabrications, careful consideration given to safety, technical, functional, and aesthetic aspects of equipment and its installation.

### 2.2.2 Compliance with Applicable Codes

- A. Ensure materials furnished and work installed comply with all applicable codes, requirements of the local utility companies, and requirements of governmental departments or authorities having jurisdiction.

### 2.2.3 Warranty

*Note: Insert manufacturer's extended warranty verbiage if requested.*

- A. Unless otherwise specified, unconditionally guarantee in writing the materials, equipment, and workmanship for a period of not less than twenty-five (25) years from

date of acceptance by the property manager. The property manager shall deem acceptance as beneficial use.

- B. The cable manufacturer must be able to extend a NetClear 25-year Static, Dynamic and Applications Warranty to the end user once the Telecommunications Contractor fulfills all requirements under the Cable Manufacturer's warranty program. At least 30 percent of the copper installation and termination crew must be certified by BICSI with a Technician level of training or better.
- C. Transfer manufacturer's warranties and General System Guarantee to the property manager. Submit these warranties on each item in list form with drawings. Detail specific parts within equipment that are subject to separate conditional warranty. Warranty proprietary equipment and systems involved in this contract during the guarantee period. Final payment shall not relieve you of these obligations. Use this as required, typically with active electronics; this is not normally used with a cable only job.
- D. Replace or substitute equipment within 24 hours of first notification. Complete repairs to equipment within 72 hours. If you cannot complete repairs during this time, forward documentation of progress of repairs to the property manager every 72 hours. Include costs anticipated to comply with this requirement in the bid.
- E. Replace or repair any defective equipment, materials or workmanship, including damage to the work provided under other divisions of this contract, at no extra cost to the property manager for the duration of the stipulated guarantee periods.

#### 2.2.4 Delivery, Storage, and Handling

- A. Protect equipment during transit, storage, and handling to prevent damage, theft, soiling, and misalignment. Coordinate with the property manager for secure storage of equipment and materials. Do not store equipment where conditions fall outside manufacturer's recommendations for environmental conditions. Do not install damaged equipment; remove from site and replace damaged equipment with new equipment.
- B. Be responsible for safekeeping of your own and your subcontractors' property, such as equipment and materials, on the job site. The property manager assumes no responsibility for protection of above named property against fire, theft, and environmental conditions.

#### 2.2.5 Spare Equipment

- A. Furnish the following spare equipment and parts:
  - a. Terminal block connectors, if required
  - b. Test set cords, if required
  - c. Install one test cord set in each telecommunications closet
  - d. Five (5) percent of base bid quantity of each type of jack shall be provided
  - e. Five (5) percent of base bid quantity of each type of outlet
  - f. Five thousand (5000) ft. of each type of station cable

- g. One thousand (1000) ft. of one-pair cross-connect wire for each telecommunications closet
- h. One thousand (1000) ft. of two-pair cross-connect wire for each telecommunications closet
- i. Five (5) percent of base bid quantity of protector module

## 2.3 Quality Assurance

### 2.3.1 General

- A. All items of equipment, including wire and cable, shall be designed by the manufacturer to function as a complete system and shall be accompanied by the manufacturer's complete service notes and drawings detailing all connections.
- B. The Contractor shall be an established communications and electronics contractor that has had, and currently maintains, a locally run and operated business for at least three (3) years. The contractor shall be a duly authorized distributor of the equipment supplied with full manufacturer's warranty and service privileges. The Contractor shall be a valid District of Columbia licensed and bonded Contractor. The contractor shall maintain a local service center located within fifty (50) mile radius of the project. The system manufacturer shall maintain engineering and service departments capable of rendering advice regarding installation and final adjustment of the system.
- C. The Contractor shall be a factory-certified, trained, and authorized installer of all equipment to be installed. The contractor shall be certified prior to award of contract. A factory representative or factory authorized school shall train all installers for both copper and fiber optic applications.
- D. Upon request by the engineer/designer, furnish a list of references with specific information regarding type of project and involvement in providing of equipment and systems.
- E. Have all equipment and materials of the type for which there are independent standard testing requirements, listings, and labels, listed and labeled by the independent testing laboratory.
- F. Where equipment and materials have industry certification, labels, or standards (i.e., NEMA - National Electrical Manufacturers Association), this equipment shall be labeled as certified or complying with standards.
- G. Subcontractors shall assume all rights and obligations toward the contractor that the contractor assumes toward the property manager and engineer/designer.

### 2.3.2 Worker Qualifications

- A. Employ job superintendent or project manager during the installation to provide coordination of work of this specification and of other trades and provide technical information when requested by other trades. This person shall maintain current **RCDD**®

(Registered Communications Distribution Designer) registration and shall be responsible for quality control during installation, equipment set-up, and testing.

- B. At least 30 percent of installation personnel shall be **BICSI Registered Telecommunications Installers**. Of that number, at least 15 percent shall be registered at the *Technician Level*, at least 40 percent shall be registered at the *Installer Level 2, Installer Level 2, Copper or Installer Level 2, Optical Fiber*, and the balance shall be registered at the *Installer Level 1*.
- C. Installation personnel shall meet manufacturer's training and education requirements for implementation of extended warranty program.
- D. All contractors and government employees shall meet the requirements of all applicable ICT industry standards, codes, regulations and any other special requirements deemed necessary by the AHJ, (Authority Having Jurisdiction), associated with the planning, designing, installation, project management or safety requirements of OCTO's ICT ISP-OSP-SCS Infrastructures.
- E. All contractors' and government employees' work shall be inspected to ensure industry standard/code compliancy are adhered to associated with the implementation of OCTO's ICT ISP-OSP-SCS infrastructures and any other requirement deemed necessary by the AHJ (Authority Having Jurisdiction). All industry standards and code violations shall be provided to violating contractor in writing. Contractor will be given 30 days to bring all violations into compliance of all applicable ICT industry standards, codes, regulations and any other requirements deemed necessary by the AHJ, (Authority Having Jurisdiction)
- F. If two or more of the ICT industry standards, codes, or regulations in this document conflict, the more applicable, current, or strictest shall apply.

## 2.4 General Work Practices

### 2.4.1 Sequence and Scheduling

- A. Submit the schedule for installation of equipment and cabling. Indicate delivery, installation, and testing for conformance to specific job completion dates. At a minimum, provide dates for bid award, installation start date, completion of station cabling, completion of riser cabling, completion of testing and labeling, cutover, completion of the final punch list, start of demolition, property manager acceptance, and demolition completion.

### 2.4.2 Use of the Site

- A. The property manager shall direct use of the site and access to where work will be performed.

- B. The property manager will occupy the premises during the entire construction period for conducting his or her normal business operations. Cooperate with the property manager to minimize conflict and to facilitate the property manager's operations.
- C. Schedule necessary shutdowns of plant services with the property manager and obtain written permission from the property manager.
- D. Proceed with the work without interfering with ordinary use of streets, aisles, passages, exits, and operations of the property manager.

### 2.4.3 Pre-Installation Site Survey

- A. Prior to start of systems installation, meet at the project site with the property manager's representative and representatives of trades performing related work to coordinate efforts. Review areas of potential interference and resolve conflicts before proceeding with the work. Facilitate with the General Contractor to schedule completion of the equipment room and telecommunications closets.
- B. Examine areas and conditions under which the system is to be installed. Do not proceed until you achieve satisfactory conditions.

### 2.4.4 Installation

- A. Receive, check, unload, handle, store, and protect equipment and materials to be installed as part of the contract. Store in areas as directed by the property manager. Include delivery, unloading, setting in place, fastening to walls, floors, ceilings, or other structures where required, interconnecting wiring of system components, equipment alignment and adjustment, and other related work if expressly defined.
- B. Install materials and equipment per applicable standards, codes, requirements, and recommendations of national, state, and local authorities having jurisdiction, and *National Electrical Code*® (NEC-NFPA-70) 2011-2017 Editions and with manufacturer's printed instructions. (See "Codes and Standards" on page 92.)
- C. Adhere to manufacturer's published specifications for pulling tension, minimum bend radii, and sidewall pressure when installing cables.
- D. Installation shall:
  - a. Use approved wire, cable, and wiring devices
  - b. Perform neat and uncluttered wire termination

### 2.4.5 Protection of Property Manager's Facilities

- A. Protect the property manager's facilities, equipment, and materials from dust, dirt, and damage during construction.
- B. Remove protection at completion of the work.

## 2.4.6 Continuity of Services

- A. Take no action that will interfere with, or interrupt, existing building services unless previous arrangements have been made with the property manager's representative. Arrange the work to minimize shutdown time.
- B. Property manager's personnel will perform shutdown of operating systems. The contractor shall give three (3) days' notice for systems shutdown.
- C. Should services be inadvertently interrupted, immediately furnish labor (including overtime, material, and equipment necessary for prompt restoration of interrupted service).

## 2.5 Firestopping

This section is adapted from CSI Master Format Division 27 Section 27 05 28.28, "Firestopping, Smoke, and Acoustical Sealing Telecommunications and Data Cabling" (accessed July 19, 2018).

### 2.5.1 General

#### 2.5.1.1 SUMMARY

- A. This section includes labor, materials and equipment necessary to complete the installation required for the items specified under this Section, including but not limited to:
  - a. Firestopping of Through Penetrations in Fire Rated Assemblies.
  - b. Smoke and Acoustical Sealing in Non-Rated Assemblies.

#### 2.5.1.2 RELATED SECTIONS

- A. Related Work: Consult all other Sections, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete installation.
- B. This Specification should be considered as an augmentation to Section 07 84 00 Firestopping and any or all sub sections of Section 07 84 00.
- C. This Section address those unique elements that affect the Firestopping of Information Technology cabling systems which may not be addressed in 07 84 00 or any of its sub-sections.

#### 2.5.1.3 REFERENCES

See "Codes and Standards" on page 92.

#### 2.5.1.4 PERFORMANCE REQUIREMENTS

- A. Fire rated cable pathway devices shall be used in fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:
- a. Meet the hourly fire-rating of fire rated wall and or floor penetrated.
  - b. Be tested for the surrounding construction and cable types involved.
  - c. Have UL Systems permitting cable loads from “Zero to 100% Visual Fill.” This requirement eliminates need for fill-ratio calculations to be made by cable technicians to ensure cable load is within maximum allowed by UL System.
  - d. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
  - e. Be “Zero-Maintenance”, zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
    - i. Opening or closing of doors.
    - ii. Spinning rings to open or close fabric liner.
    - iii. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
    - iv. Evaluation Services Report (ESR) from an accredited Nationally Recognized Third-party Laboratory certifying compliance with this definition of “Zero-Maintenance” and all relevant codes and standards.
  - f. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
  - g. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
  - h. Cable Pathway Devices passing vertically through floors shall have equal F & T Rating. (See UL System # F-A-3037, Item #4 “EZ-PATH Grid T Rating Kit” Part # TRK444)
  - i. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
- B. Non-rated cable pathway devices shall be used in non-fire-rated construction for ALL low-voltage, video, data and voice cabling, optical fiber raceways and certain high-voltage cabling where frequent cable moves, adds and changes may occur. Pathways required for high voltage cabling will be detailed on the prints. Such devices shall:
- a. Limit the movement of smoke and sound of wall and or floor penetrated.
  - b. Restore the STC Rating of the penetrated assembly.
  - c. Provide L Ratings of <1 CFM when empty and <2.5 CFM at all other loading up to 100 percent.
  - d. Accommodate cable loads from; “Zero to 100% Visual Fill.”



- e. Not have inner fabric liner that tightens around and compresses cables tightly together encouraging potential cable damage or interference.
  - f. Be “Zero-Maintenance”, zero-maintenance is defined as; No action required by cabling technician to open and/or close pathway for cable moves, adds or changes, such as, but not limited to:
    - i. Opening or closing of doors.
    - ii. Spinning rings to open or close fabric liner.
    - iii. Removal and or replacement of any material such as, but not limited to, firestop caulk, putty, pillows, bags, foam muffins, foam, foam plugs, foam blocks, or foam closures of any sort.
    - iv. Furnish letter from manufacturer certifying compliance with this definition of “Zero-Maintenance”.
  - g. Pathways shall be engineered such that two or more devices may be ganged together for larger cable capacities.
  - h. Pathways shall be engineered to be re-enterable so they can be retrofitted and removed from around existing cables without cutting and re-splicing them.
  - i. Affix adhesive wall label immediately adjacent to devices to communicate to future cable technicians, authorities having jurisdiction and others the manufacturer of the device and the corresponding UL System number installed.
- C. As an alternate to using a fire-rated or non-rated cable pathway device for single low voltage cables (up to 0.27 in. (7 mm) O.D) penetrating one or two-hour, gypsum board/stud wall assemblies or non-rated assemblies, either as a through penetration or as a membrane-penetration, a fire-rated cable grommet may be substituted. The product shall consist of a molded, two-piece, plenum-rated grommet having a foam fire and smoke sealing membrane that conforms to the outside diameter of the individual cable. The grommet product shall be capable of locking into place to secure the cable penetration within the wall assembly. The grommet shall be UL Classified and tested to the requirements of ASTM E814 (UL1479) and CAN/ULC S115.
- D. Where non-mechanical pathways must be utilized, such as sealing (caulking) around single or grouped conduits, provide products that upon curing do no re-emulsify, dissolve, leach, breakdown or otherwise deteriorate over time from exposure to atmospheric moisture, sweating pipes, ponding water or other forms of moisture characteristic during or after construction. Provide letter from manufacturer certifying compliance with this section.
- E. Cable pathway shall replace conduit sleeves in walls and floors, and;
- a. When installed individually in floors, devices shall pass through core-drilled opening utilizing tested floor plates.
  - b. When multiple units are ganged in floors, devices shall be anchored by means of a tested grid.
  - c. When installed individually in walls, devices shall pass through core drilled opening utilizing tested wall plates or integrated flanges.
  - d. When multiple units are ganged in walls, devices shall be anchored by means of a tested grid.

- F. Cable tray shall terminate at each barrier and resume on the other side such that cables pass independently through devices. Cable tray shall be properly supported on each side of the barrier.

*Note to Specifier: Coordinate drawings to show cable tray terminating at wall or floor and resuming on other side.*

#### 2.5.1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00.
- B. Product Data: Provide manufacturer's standard catalog data for specified products demonstrating compliance with referenced standards and listing numbers of systems in which each product is to be used.
- C. Schedule of UL System Drawings for Fire Rated Construction: Submit schedule of all expected opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance ratings.
- D. UL System Drawings for Fire Rated Construction: Furnish copies of all UL Systems identified in schedule above. Include any engineering recommendations.
- E. Certificates: Product Certificate of Compliance from the by manufacturer certifying material compliance with applicable code and specified performance characteristics.
- F. Installation Instructions: Submit manufacturer's printed installation instructions.

#### 2.5.1.6 QUALITY ASSURANCE

- A. Products/Systems: Provide firestopping systems that comply with the following requirements:
  - a. Firestopping tests are performed by a qualified, testing and inspection agency. A qualified testing and inspection agency is UL, or another agency performing testing and follow-up inspection services for firestop system acceptable to authorities having jurisdiction.
  - b. Firestopping products bear the classification marking of qualified testing and inspection agency.
- B. Installer Qualifications: Experience in performing work of this section who is qualified by the firestopping manufacturer as having been provided the necessary training to install firestop products in accordance with specified requirements.

#### 2.5.1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery:
  - a. Manufacturer's original, unopened, undamaged containers, identification labels intact identifying product and manufacturer, date of manufacture; lot number; shelf life, if applicable; qualified testing and inspection agency's classification marking; and mixing instruction for multicomponent products.
  - b. Handle and store products per manufacturer's recommendations published in technical materials. Leave products wrapped or otherwise protected and under clean and dry storage conditions until required for installation.
- B. Storage and Protection:

- a. Store materials protected from exposure to harmful weather conditions and at temperature and humidity conditions recommended by manufacturer.

#### 2.5.1.8 PROJECT CONDITIONS

- A. Do not install products when ambient or substrate temperatures are outside limitations recommended by manufacturer.
- B. Do not install products when substrates are wet due to rain, frost, condensation, or other causes.
- C. Maintain minimum temperature before, during, and for a minimum 3 days after installation of materials.
- D. Do not use materials that contain flammable solvents.
- E. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed per specified requirements.
- F. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- G. Schedule installation of firestopping after completion of penetrating item installation but prior to covering or concealing of openings

## 2.5.2 Products

#### 2.5.2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Specified Technologies Inc., 210 Evans Way, Somerville, NJ 08876. Tel: (800) 992-1180, Fax: (908) 526-9623, Email: [techserv@stifirestop.com](mailto:techserv@stifirestop.com), Website: [www.stifirestop.com](http://www.stifirestop.com).
- B. Substitutions: Not permitted. No known equal.
- C. Single Source: Obtain firestop systems for each type of penetration and construction condition indicated only from a single manufacturer.

#### 2.5.2.2 MATERIALS

- A. General: Use only products that have been tested for specific fire resistance rated construction conditions or acoustical and smoke related requirements conforming to construction assembly type, penetrating item type, annular space requirements, and rating involved for each separate instance.
- B. Firestop Sealants: STI SpecSeal® Brand single component latex formulations that upon cure do not re-emulsify during exposure to moisture, the following products are acceptable:
  - a. Specified Technologies Inc. (STI) SpecSeal® Series SSS Sealant
  - b. Specified Technologies Inc. (STI) SpecSeal® Series LCI Sealant
- C. Firestop Putty: STI SpecSeal® Brand intumescent, non-hardening, water resistant putties containing no solvents, inorganic fibers or silicone compounds, the following products are acceptable:
  - a. Specified Technologies Inc. (STI) SpecSeal® Series SSP Putty

- D. Firestop Pillows: STI SpecSeal® Brand re-enterable, non-curing, mineral fiber core encapsulated on six sides with intumescent coating contained in a flame-retardant poly bag, the following products are acceptable:
  - a. Specified Technologies Inc. (STI) SpecSeal® Series SSB Pillows
- E. Fire-Rated Cable Grommet: STI SpecSeal® Brand Firestop Grommet is a molded, two-piece grommet with an integral fire and smoke sealing foam membrane for sealing individual cable penetrations through framed wall assemblies. Grommet snaps together around cable and locks tightly into the wall.
  - a. Specified Technologies Inc. (STI) EZ-Firestop™ Grommets
- F. Fire-Rated Cable Pathways: STI EZ-PATH® Fire-Rated Pathway device modules comprised of steel pathway with self-adjusting intumescent foam pads allowing 0 to 100 percent cable fill, the following products are acceptable:
  - a. Specified Technologies Inc. (STI) EZ-PATH® Fire Rated Pathway
- G. Smoke and Acoustical Pathways: STI EZ-PATH® Smoke & Acoustical Pathway device module comprised of a nonmetallic pathway with integral self-adjusting smoke and sound sealing system for cable penetrations through non-fire-resistance rated wall or floor assemblies, the following products are acceptable:
  - a. Specified Technologies Inc. (STI) EZ-PATH® Smoke & Acoustical Pathway; Model No. NEZ33 or NEZ33CK

## 2.5.3 Execution

### 2.5.3.1 EXAMINATION

- A. Before beginning installation, verify that substrate conditions previously installed under other sections are acceptable for installation of firestopping in accordance with manufacturer's installation instructions and technical information.
- B. Surfaces shall be free of dirt, grease, oil, scale, laitance, rust, release agents, water repellants, and any other substances that may inhibit optimum adhesion.
- C. Provide masking and temporary covering to protect adjacent surfaces.
- D. Do not proceed until unsatisfactory conditions have been corrected.

### 2.5.3.2 INSTALLATION

- A. General: Install systems in accordance with Performance Criteria and in accordance with the conditions of testing and classification as specified in the published design.
- B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of products.

### 2.5.3.3 FIELD QUALITY CONTROL

- A. Keep areas of work accessible until inspection by authorities having jurisdiction.
- B. Where deficiencies are found, repair firestopping products so they comply with requirements.

#### 2.5.3.4 ADJUSTING AND CLEANING

- H. Remove equipment, materials, and debris, leaving area in undamaged, clean condition.
- I. Clean all surfaces adjacent to sealed openings to be free of excess firestopping materials and soiling as work progresses.

#### 2.5.3.5 SCHEDULES

Review this list and update as required, Contact STI for assistance.

Table 1: Firestopping Schedule by Penetrant Type

Penetrant Type	Concrete Floor	Concrete Wall	Gypsum Board Wall
Blank Opening	C-AJ-0100, C-AJ-0101, C-AJ-0113, C-AJ-0116	C-AJ-0100, C-AJ-0101, C-AJ-0113, C-AJ-0116	W-L-0020, W-L-0034
Metal Conduits	C-AJ-1080, C-AJ-1240, C-AJ-1353	C-AJ-1080, W-J-1098, W-J-1100	W-L-1049, W-L-1222, W-L-1168
Plastic Conduits/Raceways	C-AJ-2140, C-AJ-2292, F-A-2186, F-A-2210, F-A-2225	C-AJ-2038, C-AJ-2108, C-AJ-2578, C-AJ-2586, W-J-2018, W-J-2076	W-L-2059, W-L-2074, W-L-2093, W-L-2241
Cables	C-AJ-3214, C-AJ-3231, F-A-3015, F-A-3021, F-A-3054	C-AJ-3214, C-AJ-3231, W-J-3098, W-J-3099, W-J-3124, W-J-3150, W-J-3180	W-L-3219, W-L-3248, W-L-3287, W-L-3356, W-L-3377, W-L-3378, W-L-3379, W-L-3390
Cable Trays	C-AJ-3317, C-AJ-8181, C-AJ-4029, F-A-3015, F-A-3037	C-AJ-8181, W-J-4021, W-J-4022, W-J-4033, W-J-3098, W-J-3145, W-J-3158	W-L-3218, W-L-3271, W-L-3286, W-L-3306, W-L-4008, W-L-4029, W-L-4043, W-L-8073

#### 2.5.3.6 DOCUMENTATION

- A. Place system stickers on each side of wall penetrations.
- B. Place a reproduction (photo copy) of the UL System description in a document protector and mount to the wall next to the wall penetration
  - a. Highlight the section of the system description that list the allowed cable types.

Firestopping material must conform to both Flame (F) and Temperature (T) ratings as required by local building codes and as tested by nationally accepted testing agencies per ASTM E814 or UL 1479 fire test in a configuration that is representative of actual field conditions.

## 2.6 Labeling

- A. All labeling shall conform to ANSI/TIA-606-C standards.
- B. Labels shall be permanent, permanently fastened, and created by hand-carried label maker or a software-based label making system. Handwritten labels are not acceptable.
- C. Labeling instructions:
  - a. Label each outlet with permanent self-adhesive label with minimum 3/16 in. high characters.

- b. Label each cable with permanent self-adhesive label with minimum, 1/8 in. high characters, in the following locations:
  - i. Inside receptacle box at the work area.
  - ii. Behind the communication closet patch panel or punch block.
- c. Use labels on face of data patch panels. Provide facility assignment records in a protective cover at each telecommunications closet location that is specific to the facilities terminated therein.
- d. Use color-coded labels for each termination field that conforms to ANSI/TIA/EIA-606(B) standard color codes for termination blocks.
- e. Mount termination blocks on color-coded backboards.
- f. Label cables, outlets, patch panels, and punch blocks with room number in which outlet is located, followed by a single letter suffix to indicate specific outlet within room, i.e., S2107A, S2107B. Indicate riser cables by an R then pair or cable number.
- g. Mark up floor plans showing outlet locations, type, and cable marking of cables.

Table 2: Labeling Instructions by Component

Building Component	Labeling Instructions
Grounding and Bonding	Label TMGB(s) with "TMGB" Label SBBs with "SBB" Label TBB(s) with "WARNING! TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT REMOVE OR DISCONNECT!"
Conduit	
Closet	Racks and patch panels must be labeled. Terminations are grouped by component type in sequential room numbers. Place one open 24 port panel in between component types for spacing and growth.
Cable Tray	Provide the following two labels, alternating one label every 10 feet, along the entire length of the cable tray: A. Label #1: Label shall read "TELECOMMUNICATIONS / LOW VOLTAGE CABLING ONLY". B. Label #2: Label shall read "WARNING! CABLE TRAY SERVES AS A TELECOMMUNICATIONS BONDING CONDUCTOR. DO NOT DISCONNECT!"
Face Plate	Possess recessed designation windows to facilitate labeling and identification. Shall include a clear plastic cover to protect labels in the designation window. Have mounting screws located under recessed designation windows. Comply with ANSI/TIA-606-C labeling specifications.
Outlet	
Wireless AP	Label must be affixed to faceplate, not just place behind clear plastic strip. WAOs should increment from left to right, clockwise from entry door.

# 3 Common Work for Communications Systems

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 270500.

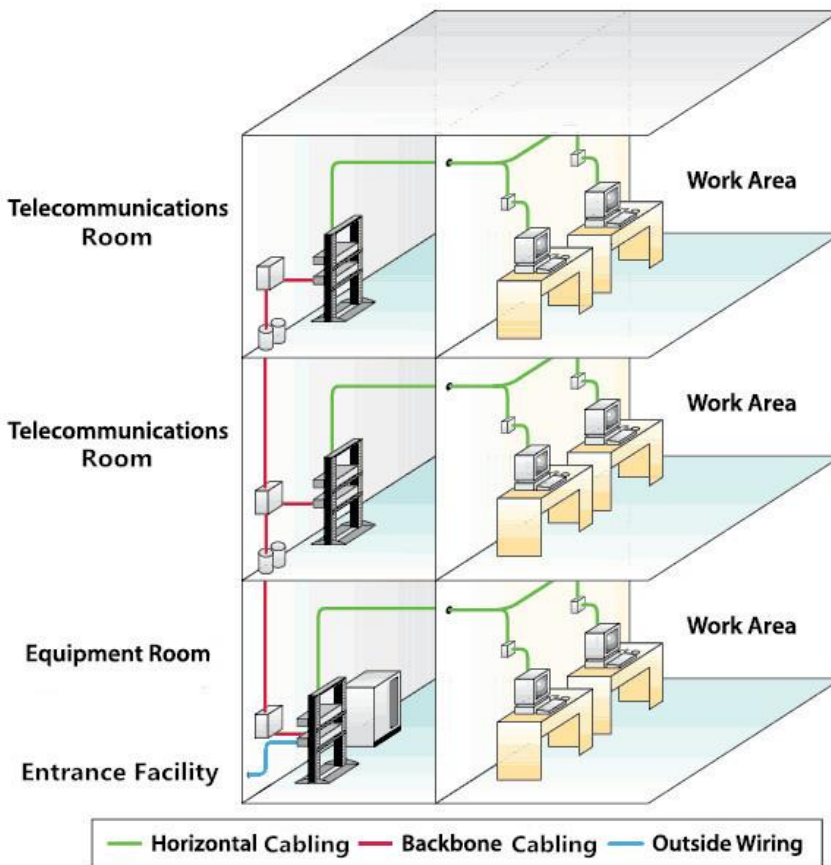
See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92.

## 3.1 Overview

A telecommunications cabling system generally consists of one telecommunications outlet in each workstation, wall telephones in common and mechanical areas, telecommunications rooms (TRs) and telecommunications enclosures (TEs) located on each floor, and the equipment room (ER) is commonly located in the basement at the building’s point of entry for telecommunications cables. The demarcation point (DP) is the provider Outside Plant (OSP) cable point of entry to the rack/cabinet termination point – at a panel or switch – commonly located in the basement.

Figure 1: Telecommunications Cabling Infrastructure



## 3.2 Grounding and Bonding

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 270526.

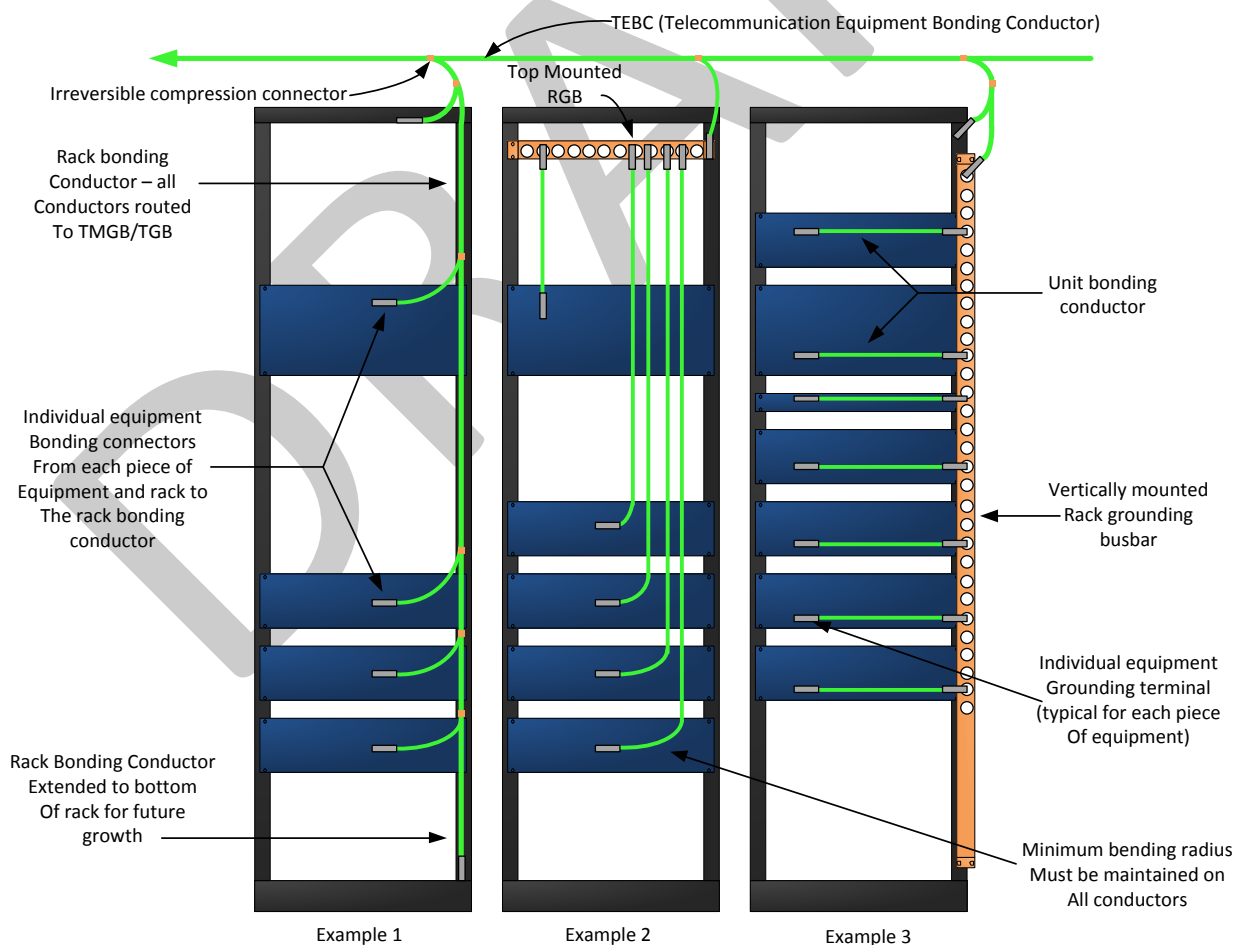
### 3.2.1 General

#### 3.2.1.1 SUMMARY

- A. Provide all materials and labor for installing the grounding and bonding system for the Communications Infrastructure. Provide a permanent grounding and bonding infrastructure for all communications circuits, raceways, ladder rack and cable tray.
- B. Use only approved connections and position these in accessible locations. Connect the grounding conductor to the grounding electrode via exothermic weld, listed lugs, listed pressure connectors, listed clamps or other approved listed alternatives.

Use following figures as guides for grounding and bonding OCTO equipment racks.

Figure 2: Grounding and Bonding OCTO Equipment Racks





### 3.2.1.2 WORK AND SYSTEM DESCRIPTION

- A. Furnish and Install all materials, devices and required accessories to provide a complete, permanent Grounding and Bonding infrastructure for communications circuits, raceways, ladder racks and cable trays as specified in the Contract Documents. The Grounding and Bonding system shall support an ANSI/TIA/EIA and ISO/IEC compliant Structured Cabling System (SCS). (See "Codes and Standards" on page 92.)
- B. Include materials, equipment and apparatus not explicitly mentioned herein or noted in the Construction Documents but which are needed to make a complete working ANSI/TIA/EIA and ISO/IEC compliant Grounding and Bonding system.

### 3.2.1.3 CONTRACTOR WARRANTY

- A. Provide a Contractor-endorsed warranty against defects in materials and workmanship.
  - a. Provide labor aspect to the fulfillment of this warranty at no cost to the Owner.
  - b. The Contractor Warranty period shall initiate upon Owner acceptance of the work.

## 3.2.2 Products

### 3.2.2.1 GENERAL

- B. Materials shall consist of busbars, supports, bonding conductors and other incidentals and accessories as required.

### 3.2.2.2 MATERIALS

- A. Grounding/Bonding:
  - a. Primary Busbar (PBB):
    - i. Large (20" x 4" x ¼"), Pre-drilled: CPI 10622-020, or equivalent
    - ii. Small (10" x 4" x ¼"), Pre-drilled: CPI 10622-010, or equivalent
  - b. Secondary Busbar (SBB):
    - i. Large (20" x 4" x ¼"), Pre-drilled: CPI 10622-020, or equivalent
    - ii. Small (10" x 4" x ¼"), Pre-drilled: CPI 10622-010, or equivalent
  - c. Telecommunications Bonding Backbone: #6 AWG insulated (green) copper conductor.
  - d. Grounding Conductor: #6 AWG insulated (green) copper conductor.
- B. Firestopping Material: See "Firestopping" on page 15.
- C. Labels: See "Labeling" on page 21.

### 3.2.3 Execution

#### 3.2.3.1 GENERAL

- A. The Telecommunications Contractor is exclusively liable for the welfare of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA and with requirements of the National Electrical Safety Code (NESC) and the NEC, except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in "Codes and Standards" on page 92.
- D. Where questions arise concerning standards, references, or codes apply, the more stringent shall prevail.
- E. Replace and/or repair to original condition (or better) any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Telecommunications Contractor during installation at no additional cost to the Owner.
- F. Install the grounding and bonding system in a manner certifying that communications circuits, when installed, are capable of fully complying with ANSI/TIA/EIA and other references listed in "Codes and Standards" on page 92.
- G. Note: The bonding to water pipes is no longer a recommended application, due to plastic fittings and other non-conductive hardware associated with this type of bonding/grounding application/connection.

Figure 3: Grounding and Bonding - Small System Example

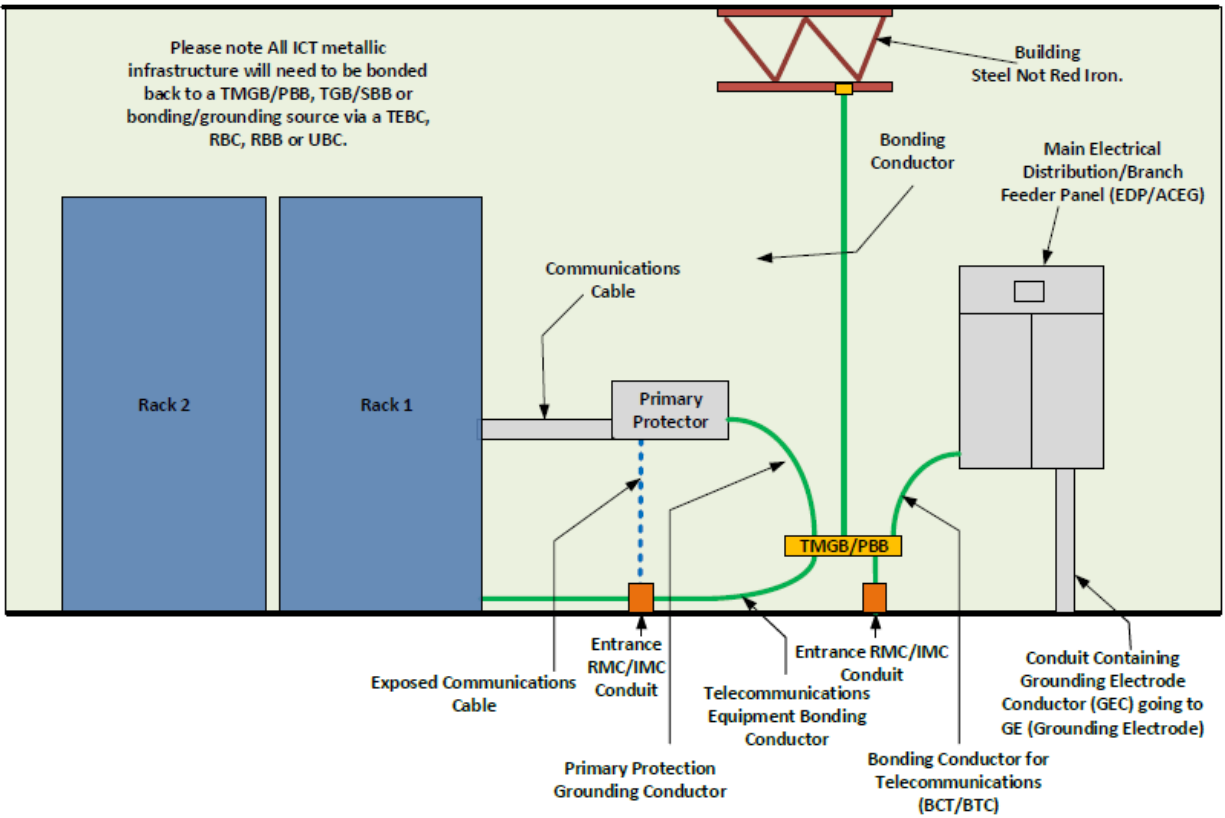


Figure 4: Data Center Rack Grounding

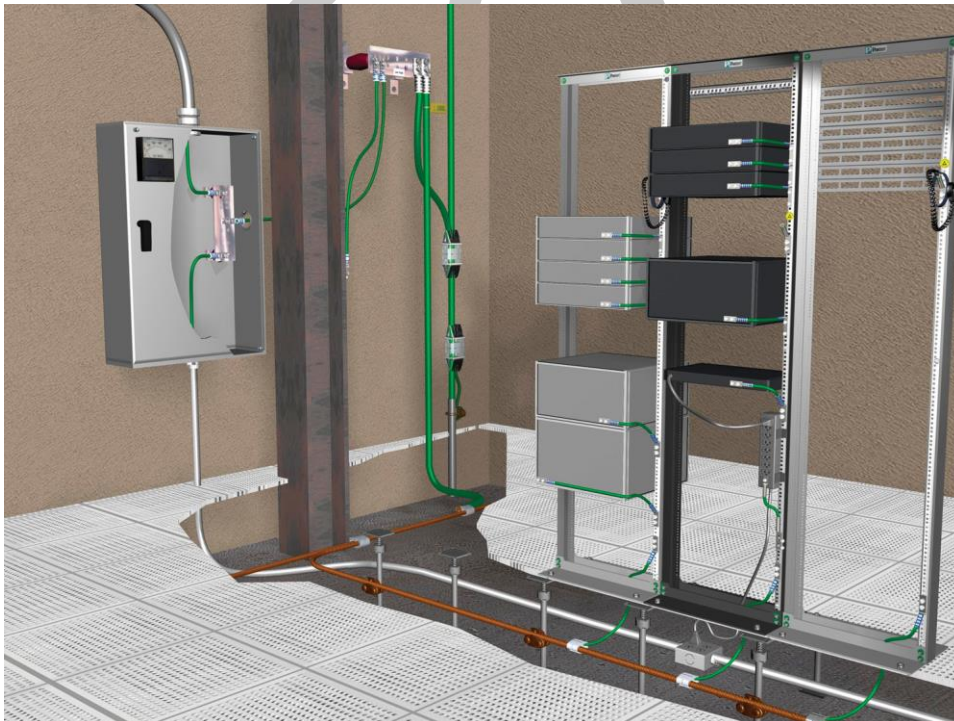


Figure 5: Service Entrance



Figure 6: Telecommunications Room



Figure 7: Mesh Common Bonding Network

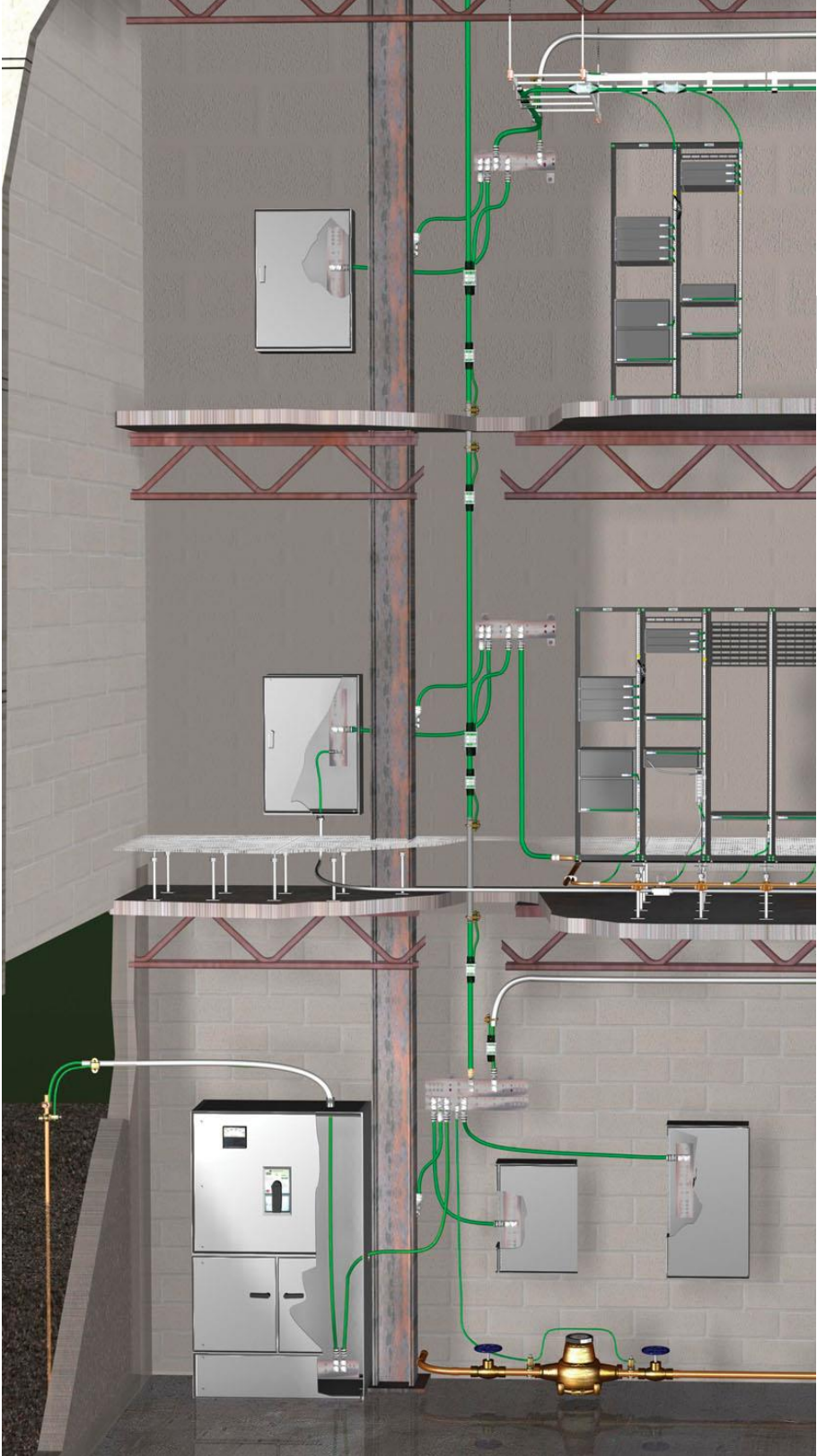
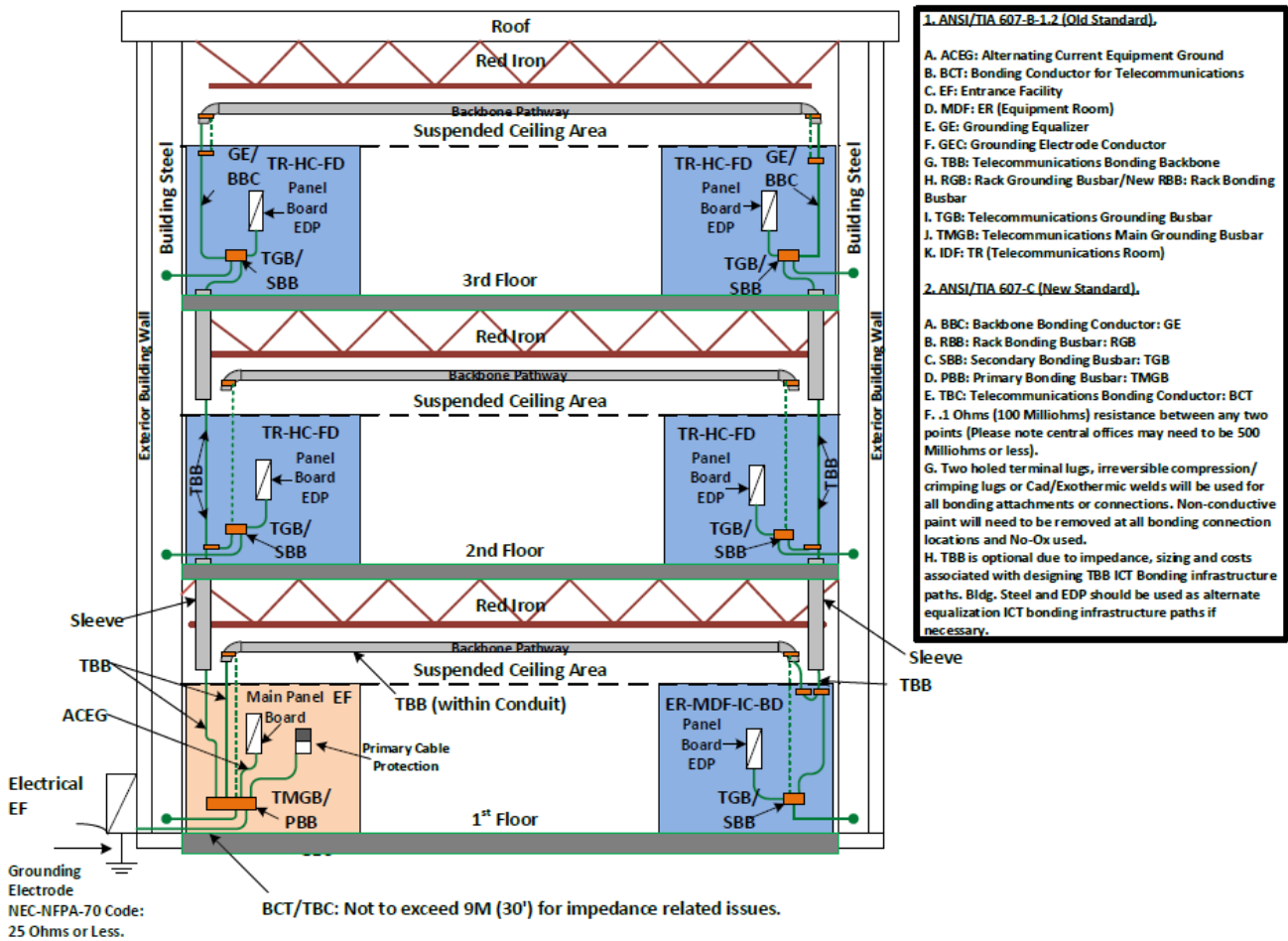


Figure 8: Grounding and Bonding - Large System Example



### 3.2.3.2 INSTALLATION

- A. The Grounding and Bonding infrastructure system shall not utilize the building plumbing system, unless required to do so by the NEC.
  - a. The Telecommunication Contractor shall coordinate the installation of the grounding and bonding system with the electrical power distributions grounding infrastructure.
- B. Grounding/Bonding:
  - a. PBB: Provide a minimum of one PBB per Entrance Room for each building and as shown on Contract Documents. Install PBB(s) and directly bond PBB(s) to electrical service ground and to related TBB(s).
  - b. TGB/SBB: Provide a minimum of one SBB per Telecommunications Room and as shown on the Contract Documents and as required by standards, references and codes listed in "Codes and Standards" on page 92.. Directly bond each SBB to its related TBB and to the nearest building structural steel or other permanent

metallic system. EDPs (Electrical Distribution Panels) are another source for general equalization or bonding of SBBs.

- c. TBB: Provide TBB(s) as shown on the Contract Documents and as required to bond all non-current carrying metal telecommunications equipment and materials to the nearest SBB. Use TBB(s) to connect the PBB to each of the PBB(s). The Contractor shall route along the shortest and straightest path possible with minimum bends. All bends shall be sweeping. TBB(s) shall be continuous (without splices).
  - i. Ensure that all bonding breaks through paint to bare metallic surface of all painted metallic hardware.
- C. Firestopping: (See also “Firestopping” on page 15.)
  - a. The Telecommunications Contractor shall maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during the SCS installation.
    - i. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
    - ii. Install firestops in strict accordance with manufacturers detailed installation procedure.
    - iii. Install firestops in accordance with fire resistance requirements, manufacturer’s recommendations, local fire and building authorities, and applicable codes and standards in “Codes and Standards” on page 92. Apply sealing material in a manner acceptable to the local fire and building authorities.
    - iv. Firestopping material that is used to seal open penetrations through which cable passes shall be re-usable/re-enterable.
- D. Labeling: See “Labeling “ on page 21.

## 3.3 Hangers and Supports

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 270529.

### 3.3.1 General

#### 3.3.1.1 SUMMARY

- A. Support structures are necessary to allow installation of Telecommunications cable, connecting hardware, and associated apparatus. These structures comprise components such as equipment racks, cabinets, distribution rings, hangers, J Hooks, plywood backboard, cable trays, conduits, slots, sleeves, and their associated hardware
- B. When installing pathways, the Contractor shall ensure that the route for the pathway is clear of obstructions, such as HVAC ducts, large pipes, and structural beams within the

building. When fire barriers are penetrated, the contractor shall firestop all penetrations to maintain the fire rated barrier.

### 3.3.1.2 CABLE TRAYS

- A. Cable tray shall be wall mounted or supported by the building structure from above using all threaded rods (ATR) and manufacturer specified attachments. ATR shall be installed using properly sized anchors and attachment hardware. ATR shall be selected to support the maximum load for which the cable tray is designed.
- B. Wall mounted support brackets may be used to support cable tray. Wall bracket supports shall be installed along a wall along the route of the cable tray. The number of brackets and specified spacing interval is dependent upon the rated load the cable tray must support.
  - a. Supporting attachments shall be made on a cable tray not more than 24" from the ends, and at joints between two sections.
  - b. Additional supports are required every 5ft.

## 3.4 Conduits and Pullboxes

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 270533.

### 3.4.1 General

#### 3.4.1.1 SUMMARY

- A. Provide all materials and labor for the installation of a pathway system for inside plant. This section includes requirements for horizontal and building backbone raceways, fitting, and boxes specific to cabling for voice and data.
- B. Related Sections:
  - a. Division 26 Section – “Basic Electrical Materials and Methods”
  - b. Division 27 Section – “Grounding and Bonding for Communications Systems”
  - c. Division 27 Section – “Inside Plant Communications Systems”

#### 3.4.1.2 WORK AND SYSTEM DESCRIPTION

- A. Furnish, install, and place into adequate and successful operation all materials, devices, and essential accessories to deliver a complete Conduit, Raceway system as hereinafter identified and/or reflected in the Contract Documents. The Conduit, Raceway system shall support an ANSI/TIA and ISO/IEC compliant SCS.
- B. The work shall include materials, equipment and apparatus not explicitly stated herein or noted on the Contract Documents but which are required to make a complete working Conduit, Raceway system.



### 3.4.1.3 QUALITY ASSURANCE

See also “Labeling “ on page 21.

- A. Labeling and Listing: Provide conduits, raceways and boxes specified in this Section that are labeled and listed.
  - a. The Terms “Listed” and “Labeled”: As defined in NEC, article 100.
  - b. Listing and Labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.
- B. Comply with NECA’s “Standard of Installation.”
- C. Comply with NEC.

## 3.4.2 Products

### 3.4.2.1 GENERAL

- A. Materials shall consist of conduit, surface metal raceway, outlet boxes, fittings, enclosures; pull boxes, and other raceway incidentals and accessories as necessary for inside plant.

### 3.4.2.2 MATERIALS

- A. Conduit:
  - a. EMT: 1” minimum conduit size. Flexible Metal Conduit (FMC) is not acceptable.
    - i. Conduit: Galvanized steel tubing shall meet ANSI C80.3
    - ii. Couplings: Steel, cast iron, or malleable iron compression type employing a split, corrugated ring and tightening nut, with integral bushings and locknuts.
  - b. RMC: 1” minimum conduit size.
    - i. Conduit: Hot dipped galvanized steel with threaded ends meeting ANSI C80.1
    - ii. Couplings: Unsplit, NPT threaded steel cylinders with galvanizing equal to the conduit.
    - iii. Nipples: Same as conduit, up to 8” in diameter, with no running threads.
- B. Sleeves: ENT conduit, insulated throat bushings on each end.
- C. Surface Raceway: Wiremold V2400 series or equivalent – Two piece, steel, single channel surface raceway.
- D. Outlet boxes:
  - a. Outlet box shall be at least 4” (100 mm) x 4” (100 mm) x 2 ¼ “(57 mm). This size will provide accommodations for one or two 1” conduits.
  - b. If a larger conduit is specified, the outlet box size shall be increased accordingly. A maximum 1 ¼” conduit will require a 4 11/16 “(120 mm) x 4 11/16 “(120 mm) x 2 ½ “(64 mm) outlet box.
- E. Pull Strings: Plastic or nylon with a minimum test rating of 200 lb.

### 3.4.2.3 FIRESTOPPING

See “Firestopping” on page 15.

### 3.4.2.4 LABELING AND ADMINISTRATION

See “Labeling “ on page 21.

## 3.4.3 Execution

### 3.4.3.1 GENERAL

- A. The Contractor is solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.
- B. All work shall comply with applicable safety rules and regulations including OSHA. All work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes and/or regulations are more stringent, in which case the local codes and/or regulations shall govern.
- C. All work shall comply with the standards, references and codes listed in “Codes and Standards” on page 92. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Install the raceway system in a manner ensuring that communications circuits, when installed, can fully comply with the ANSI/TIA/EIA and other references listed in “Codes and Standards” on page 92.
- F. Replace and/or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during construction at no additional cost to the Owner.
- G. Remove surplus material and debris from the job site and dispose of legally.

### 3.4.3.2 EXAMINATION

- A. Examine surfaces and spaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until insufficient conditions have been amended.

### 3.4.3.3 INSTALLATION

#### 3.4.3.3.1 General

- 1. Install raceways, boxes, enclosures, and cabinets as indicated, per the manufacturer’s written instructions. Provide a raceway for each location indicated. Do not gang raceway

into wireways, pullboxes, junction boxes, etc., without explicit approval from the DC-Net Project Manager.

#### 3.4.3.3.2 Conduit

1. Install EMT unless other conduit is shown on the Contract Documents or is required by Code.
2. Install conduit as a complete, continuous system without wires, mechanically secured and electrically connected to metal boxes, fittings and equipment. Blank-off unused openings using factory-made knockout seals.
3. Run conduit in the most direct route possible, parallel to building lines. Do not route conduit through areas in which flammable material may be stored.
4. Keep conduit at least 6 inches away from parallel runs of flues and steam or hot-water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit. Install horizontal conduit runs above water piping.
5. Keep conduit away from sources of electromagnetic interface as follows:
  - a. 5 inches from fluorescent lighting.
  - b. 12 inches from conduit and cables used for electrical power distribution.
  - c. 48 inches from motors and/or transformers.
6. Do not exceed 295 feet total length for a given conduit run to be used for distribution cabling (from outlet box to telecommunications room), including intermediate conduits and junction boxes.
7. Install conduit exposed, except in finished areas or unless shown otherwise on the drawings. Do not install conduit below grade/slab unless specifically shown on the Contract Documents as being installed below grade/slab.
8. Install exposed conduit in lines parallel or perpendicular to building lines or structural members except where the structure is not level. Follow the surface contours as much as practical. Do not install crossovers or offsets that can be avoided by installing the conduit in a different sequence or a uniform line.
  - a. Run parallel or banked conduits together, on common supports where practical.
  - b. Make bends in parallel or banked runs from same centerline to make bends parallel.
9. Conduits concealed above ceilings, furred spaces, etc., which are normally inaccessible may be run at angles not parallel to the building lines.
10. Wherever practical, route conduit with adjacent ductwork or piping and support on common racks. Base required strength of racks, hangers, and anchors on combined weights of conduit and piping.
11. Where conduits cross building expansion joints, use suitable sliding or offsetting expansion fittings. Unless specifically approved for bonding, use a suitable bonding jumper.
12. Support conduits:
  - a. Provide anchors, hangers, supports, clamps, etc. to support conduits from the structures in or on which they are installed. Do not space supports farther apart than five feet.

- b. Provide sufficient clearance to allow conduit to be added to racks, hangers, etc. in the future.
  - c. Support conduit within three (3) feet of each outlet box, junction box, gutter, panel, fitting, etc.
- 13. Ream conduits to eliminate sharp edges and terminate with metallic insulated grounded throat bushings. Seal each conduit after installation (until cable is installed) with a removable mechanical-type seal to keep conduits clean, dry and prevent foreign matter from entering conduits.
- 14. Install a pull string in each conduit.
- 15. For conduits entering through the floor of a telecommunications room, terminate conduits 6" above the finished floor.
- 16. Do not install communications conduits in wet, hazardous or corrosive locations.
- 17. Where conduit is shown embedded in masonry, embed conduit in the hollow core of the masonry. Horizontal runs in the joint between masonry units are not permitted.
- 18. Where conduit is shown embedded in concrete, embed conduit a minimum of two inches from the exterior of the concrete. Do not place conduit in concrete less than 4 inches thick.
  - a. One-inch trade size conduit shall be used. Conduits sized smaller than one-inch trade size conduit are not permitted embedded in concrete without approval from the Owner.
  - b. Run conduit parallel to main reinforcement.
  - c. Conduit crossovers in concrete are not permitted.
- 19. Where conduit exits from grade or concrete, provide a rigid steel elbow and adapter.
- 20. Where conduit enters a space through the floor and terminates in that space, terminate the conduit at 6" above the finished floor.
- 21. Where conduits terminate at a cable tray, the conduits shall be consistently terminated no more than 8" from the cable tray and have a visually uniform appearance.
- 22. Where several circuits follow a common route, stagger pullboxes or fittings.
- 23. Where several circuits are shown grouped in one box, individually fireproof each conduit.
- 24. Bend and offset metal conduit with standard factory sweeps or conduit fittings. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.
  - a. Conduit Sweeps:
    - i. Sweeps shall exceed 90 degrees
    - ii. Do not exceed 180 degrees for the sum of conduit sweeps for a section of conduit (between conduit termination points).
    - iii. Sweep radius shall be at least 10 times the internal diameter of the conduit.
    - iv. 90-degree condulets (LB's) and electrical elbows are not acceptable.
  - b. Factory-manufactured sweeps are required for bends in conduit larger than 1- $\frac{1}{4}$ " trade size.
  - c. For bends in 1  $\frac{1}{4}$ " trade size conduit and larger, field-manufactured bends (using a hydraulic bender with a 1  $\frac{1}{4}$ " boot) are permitted only when factory-

manufactured sweeps are not suitable for the conditions. In all other cases, factory-manufactured sweeps are required. "Hickey-bender" use is prohibited.

25. Connect conduit to enclosures, cabinets and boxes with double locknuts and with insulating type bushings. Use grounding type bushings where connecting to concentric or eccentric knockouts. Make conduit connections to enclosures at the nearest practicable point of entry to the enclosure area where the devices are located to which the circuits contained in the conduit will connect.
26. Penetrations for raceways:
  - a. Do not bore holes in floor and ceiling joists outside center third of member depth or within two feet of bearing points. Holes shall be 1- $\frac{1}{4}$ " diameter maximum.
  - b. Penetrate finished walls and finished surfaces with a PVC or sheet metal sleeve with an interior diameter (ID) at least 1/4" greater than the outer diameter (OD) of the conduit, set flush with walls, pack with fiberglass, seal with silicone sealant.
  - c. Penetrate poured-in-place walls and free slabs with a cast iron sleeve (or Schedule 40 PVC black pipe sleeve for above-grade only) with retaining ring or washer. Set sleeves flush with forms or edges of slab. Pack around conduit with fiberglass and seal with silicone sealant.
27. Raceway terminations and connections:
  - a. Join conduits with fittings designed and approved for the purpose and make joints tight. Do not use set indent-type or screw-type couplings.
  - b. Make threaded connections waterproof and rustproof by applying a watertight, conductive thread compound. Clean threads of cutting oil before applying thread compound.
  - c. Make conduit terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
  - d. Cut ends of conduit square using a hand saw, power saw or pipe cutter. Ream cut ends to remove burrs and sharp ends. Where conduit threads are cut in the field, cut threads to have same effective length, same thread dimensions and same taper as specified for factory-cut threads.
  - e. Provide double locknuts and insulating bushings at conduit connections to boxes and cabinets. Align raceways to enter squarely and install locknuts with dished part against the box. Use grounding type bushings where connecting to concentric or eccentric knockouts.
  - f. Where conduits are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
28. Install conduit sealing fittings per manufacturer's written instructions. Locate fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed conduits, install each fitting in a flush steel box with a blank

cover plate having a finish like that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

- a. Where conduits pass from warm to cold locations, such as the boundaries of air conditioned or refrigerated spaces and where conduits enter or exit buildings from outdoor areas, including underground ducts or conduit runs.
- b. Where otherwise required by the NEC.

29. Conduits shall be clean and dry.

#### 3.4.3.3.3 Sleeves

1. Provide sleeves where required, sized as noted on the Contract Documents. Where not noted, sleeve sizing shall be determined by the type and quantity of cable to be routed through the sleeve per ANSI/TIA-569-D cable capacity standards, plus an additional 20% for future expansion.
2. Provide core drilling where required for installation.
3. Seal between sleeve and wall or floor in which the sleeve is installed. Firestop all penetrations to restore wall or floor to pre-penetration fire-rating.

#### 3.4.3.3.4 Surface Raceway

1. Provide surface raceway for all surface mounted telecommunications outlet boxes and as shown on the Contract Documents.
2. Surface raceway shall be routed parallel to and perpendicular to surfaces or exposed structural members and follow surface contours.
3. Surface raceway color shall match as closely as possible the existing wall finish. Do not paint Surface Raceway.
4. Surface raceway systems shall be completely installed, including insulating bushings and inserts as required by manufacturer's installation requirements. Unused openings in the surface raceway shall be closed using manufactured fittings.
5. Surface raceway shall have a minimum two-inch radius control at all bend points.
6. Surface raceway shall be securely supported by screws or other anchor-type devices at intervals not exceeding 10 feet and with no less than two supports per straight raceway section. Surface raceway shall be securely supported in accordance with the manufacturer's requirements. Tape and glue are not acceptable support methods.
7. Mechanically and electrically continuous surface raceway shall be bonded and grounded to the Telecommunications Grounding system.

#### 3.4.3.3.5 Outlet Boxes

1. Provide outlet boxes and covers as shown on the Contract Documents and as needed. Verify that the appropriate cover type and depth is provided for each type of wall and finish. Provide extension rings as needed.
2. Coordinate box locations with building surfaces and finishes to avoid bridging wainscots, joints, finish changes, etc.
3. Install boxes in dry locations (not wet, corrosive, or hazardous).

4. Attach boxes securely to building structure with a minimum of two fasteners. Provide attachments to withstand a force of 100 lbs. minimum, applied vertically or horizontally.
5. Install boxes at the following heights to the bottom of the box, except where noted otherwise:
  - a. Wall mounted telephones: 48" above finished floor.
  - b. Workstation outlets: 18" above finished floor.
  - c. Place boxes for outlets on cabinets, countertops, shelves, and similar boxes located above countertops two inches above the finished surface or two inches above the back splash. Coordinate and verify size, style, and location with the supplier or installer of these items prior to outlet box installation.
6. Recessed mounted outlet boxes:
  - a. Recess boxes in the wall, floor, and ceiling surfaces in finished areas. Set boxes plumb, level, square and flush with finished building surfaces within one-sixteenth inch for each condition. Set boxes so that box openings in building surfaces are within one-eighth inch of edge of material cut-out and fill tight to box with building materials. Single gang opening shall extend at least to the finished wall surface and extend not more than 1/8 inch beyond the finished wall surface. Provide backing for boxes using structural material to prevent rotation on studs or joists.
  - b. Install floor boxes level and adjust to finished floor surface.
7. Surface-mounted outlet boxes:
  - a. For boxes surface-mounted on finished walls, provide Wiremold outlet box or equivalent. Cut box as necessary to accept conduit.
  - b. For boxes surface-mounted on unfinished walls (i.e. electrical rooms, mechanical rooms), provide 4"x4" (minimum) outlet box with single gang cover.

#### 3.4.3.3.6 Floor Boxes

1. Provide floor boxes as shown on the Contract Documents.
2. Set device boxes plumb, level, square and flush with floor, within 1/16" tolerance for each condition.
3. For floor boxes with combined power and telecommunications circuits, provide metal dividers to separate power from telecommunications circuits.

#### 3.4.3.3.7 Junction Boxes

1. Provide junction boxes as shown in the Contract Documents and as required.
  - a. Where sizing is not shown in the Contract Documents, size junction box length and depth per the size of the feeder conduit in the following table:

Feeder Size	Box Length	Box Depth
1"	12"	4"
1 – ¼ "	12"	4"
1 – ½ "	12"	4"

2"	24"	4"
2 – ½ "	24"	6"
3"	36"	6"
3 – ½ "	48"	6"
4"	60"	6"

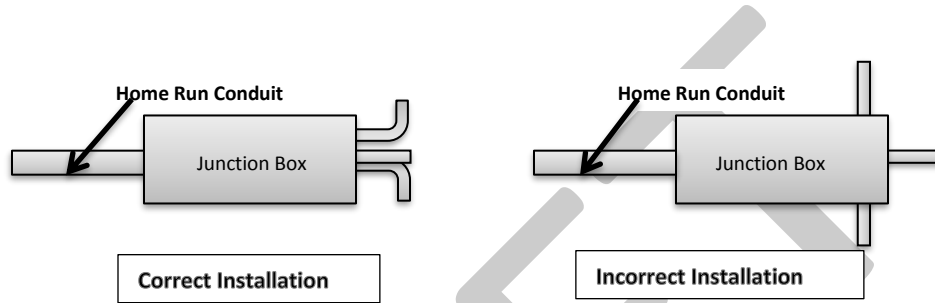
- b. Where sizing is not shown on the Contract Documents, size junction box using the table below. Select the width of the largest conduit on the distribution side of the box. For each additional distribution conduit, add the "Increase Width" value associated with its size to the largest distribution conduit's box width. For example, if the distribution side of the junction box has one 1-¼" distribution conduit and three 1" distribution conduits, the total distribution-side width is 6" + 2" + 2" + 2"=10".
- c. Repeat the above process for the feeder side of the junction box. A single conduit typically feeds junction boxes, so unless the box has more than one feeder conduit, the "Increase Width" is unnecessary. For example, if the feeder side of the junction box has two 2" feeder conduits the total feeder-side width is 8" + 5" = 13".
- d. The larger of the two width calculations (distribution side vs. feeder side) shall be the width of the junction box. For example, if the distribution-side width is 10" and the feeder-side width is 13", provide a 13" wide junction box.

Conduit Size	Box Width	For each additional conduit increase width
1"	4"	2"
1 – ¼ "	6"	3"
1 – ½ "	8"	4"
2"	8"	5"
2 – ½ "	10"	6"
3"	12"	6"
3 – ½ "	12"	6"
4"	15"	8"

2. Do not substitute a junction box for a 90-degree bend. 90-degree condulets (LB's) are not acceptable.
3. Install junction boxes in a location readily accessible both at time of construction and after building occupation. Do not install junction boxes in inaccessible interstitial building spaces.
4. Where junction boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid.
5. Install hinged-cover enclosures and cabinets plumb and supported at each corner.
6. Install junction boxes so that the access door opens from the side where the cable installer will normally work – typically from the bottom (floor side) of the box.



- a. Where a junction box is installed in a ceiling space, coordinate with other trades to provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
  - b. Provide a lockable access cover (or junction box door if junction box is exposed) in hard lid ceilings.
7. Install junction boxes such that conduits enter and exit at opposite ends of the box as follows:



#### 3.4.3.3.8 Pull Boxes

1. Provide pull boxes as shown on the Contract Documents and as required.
  - a. Where sizing is not shown on the Contract Documents, size pull boxes as follows:

Size of Largest Conduit	Box Width	Box Length	Box Depth
1"	4"	12"	4"
1 – ¼"	6"	12"	4"
1 – ½"	8"	12"	4"
2"	8"	24"	4"
2 – ½"	10"	24"	6"
3"	12"	36"	6"
3 – ½"	12"	48"	6"
4"	15"	60"	6"

- a. Where a pull box is required with conduits 1" or smaller, an outlet box may be used as a pull box. Where outlet boxes are used as pull boxes, the outlet boxes shall be dedicated for use as a pull box and shall not host cable termination hardware.
2. Don substitute a pull box for a 90-degree bend. 90-degree condulets (LB's) are not acceptable.
  3. Install pull boxes in an accessible location, readily accessible both at time of construction and after building occupation. Do not install pull boxes in inaccessible interstitial building space.

4. Where pull boxes are to be mounted on ceiling structure above ceiling grid, do not mount higher than 4' above grid (mount on wall instead).
5. Install hinged-cover enclosures and cabinets plumb and supported at each corner.
6. Install pull boxes so that the access door opens from the side where the cable installer will normally work (typically from the bottom, or floor side, of the box).
  - a. Where a pull box is installed in a ceiling space, provide full access to the junction box door and adequate working room for both the installation personnel and for proper looping of cable during installation.
  - b. Provide a lockable access cover (or pull box door if pull box is exposed) in hard lid ceilings.
7. Install pull boxes such that conduits enter and exit at opposite ends of the box.

#### 3.4.3.3.9 Firestopping

See also "Firestopping" on page 15.

#### 3.4.3.3.10 Grounding/Bonding:

- A. Grounding and Bonding work shall comply with Uniform Fire Code, National Electric Code

## 3.5 Cable Trays

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 270536.

### 3.5.1 General

#### 3.5.1.1 SUMMARY

- A. Provide all materials and labor for the installation of a cable tray system to be utilized for communications infrastructure. This section includes requirements for providing a cable tray system for communications circuits.

#### 3.5.1.2 WORK AND SYSTEM DESCRIPTION

- A. Furnish, install, and place into adequate and successful operation all materials, devices, and necessary appurtenances to provide a complete, permanent Cable Tray Infrastructure for Telecommunications Circuits as specified in the Contract Documents. The Cable Tray System shall support an ANSI/TIA/EIA and ISO/IEC compliant telecommunications Structured Cabling System (SCS).
- B. The work shall include materials, equipment and apparatus not explicitly mentioned herein or noted in the Contract Document but which are essential to make a complete working ANSI/TIA and ISO/IEC compliant Cable Tray System.

### 3.5.1.3 SUBMITTAL INFORMATION

- A. Product Data Submittals: Provide submittal information for evaluation before materials are delivered to the site. Provide product data submittals for all products at the same time.
  - a. Submit a letter stating that materials will be provided as indicated, and specifically list any items that will not be provided as indicated. The letter shall also state that the Contractor has reviewed the indicated items and has come to an understanding that they are applicable to the project in all aspects.
  - b. For those items noted as “Or Equal” and which are not being provided as specifically named, submit standard cut sheets or other descriptive information, along with a separate written description detailing the reason(s) for the substitution.
  - c. Provide standard manufacturer’s cut sheets and Operating and Maintenance (O&M) instructions at the time of submittal review for each device in the system. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive said materials.
- B. Closeout Submittals:
  - a. O&M Manual – At the completion of the project, the contractor shall submit and O&M to the OCTO/DC-Net Project Manager, reflecting any changes that occurred during the process of construction.
  - b. Records – Maintain at the project site a minimum of one set of Drawings, Specifications, and Addenda. Drawings shall consist of redline markups, specifications and spreadsheets.
    - i. Document changes to the system from that initially shown from the Contract Documents, and clearly identify component labels and identifiers on Drawings.
    - ii. Keep Drawings at the job site and make available to OCTO/DC-Net and or Designer always.
    - iii. Keep Drawings current throughout the progress of construction. (“Current” is defined as not more than one (1) week behind actual construction).
    - iv. Show identifiers for major infrastructure components on Drawings.

## 3.5.2 Products

### 3.5.2.1 GENERAL

- A. Materials shall consist of tray sections, tray fittings, connectors, supports, expansion joints, barrier strips, radius drops, bonding conductors and other incidentals and accessories as required for a complete, permanent Cable Tray Infrastructure. Provide all incidental and or miscellaneous hardware not explicitly shown in the Contract Documents but that is required for a fully operational system.

- B. Physically verify existing site conditions prior to purchase and delivery of materials.
- C. Cable Tray components must be manufactured by a single manufacturer. Components shall not be intermixed between different manufacturers.
- D. For a given manufacturer, all components shall be part of a single cable tray product line- components shall not be intermixed between a manufacturer's cable tray product line.

#### 3.5.2.2 MATERIALS AND FINISH

- A. Welded wire: Cable Tray shall be constructed of a welded wire mesh (high strength steel wires) with a continuous safety edge wire lip. Cable tray shall be complete with all tray supports, materials, and supplementary and miscellaneous hardware required for a complete cable tray system.
  - a. Finish: Carbon steel with electro-plated zinc galvanized finish.
  - b. Width: Width shall be as shown on the Contract Documents. Where cable tray width is not shown in the Contract Documents, it shall be sized per the amount of cable to be placed in the trays (as shown in the Contract Documents) plus an additional 20% for future expansion.
  - c. Depth: minimum of two (2) inches.
  - d. Mesh: 2 x 4 inches.
  - e. Fittings: Fittings shall be field fabricated from straight sections using manufacturer-approved tools and in accordance with the manufacturer's instructions.
- B. Grounding/Bonding: In accordance with ANSI/NFPA 70 Section 318-7, cable tray shall be complete with bolted splicing hardware for grounding/bonding throughout the entire cable tray system.

#### 3.5.2.3 FIRESTOPPING MATERIALS

See "Firestopping" on page 15.

#### 3.5.2.4 LABELING AND ADMINISTRATION

See "Labeling " on page 21.

### 3.5.3 Execution

#### 3.5.3.1 GENERAL

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

- C. All work shall comply with the standards, references and codes listed in “Codes and Standards” on page 92. Where questions arise regarding which standards, references, or codes apply, the more stringent shall prevail.
- D. All work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.
- E. Replace and or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during construction at no additional cost to DC-Net.
- F. Install the cable tray system in a manner ensuring that telecommunications circuits, when installed, can fully comply with the ANSI/TIA/EIA and other references listed in “Codes and Standards” on page 92.
- G. Remove all surplus material and debris from job site and dispose of them legally.

#### 3.5.3.2 *INSTALLATION*

- A. Provide cable tray, in the locations and widths shown on the Contract Documents and in accordance with manufacturer's requirements and industry practices (NEMA VE 2). Ensure that the cable tray equipment complies with the requirements of NEC, and applicable portions of NFPA 70B and NECA’s “Standards of Installation” pertaining to general electrical installation practices.
  - a. Cable tray shall be installed plumb, level and square with finished building surfaces.
  - b. Provide factory-manufactured connection hardware between each cable tray segment. Cable tray segments shall be mutually aligned. Connection hardware shall be installed per the manufacturer’s requirements.
  - c. Cable tray elevation changes shall be gradual.
- B. Slots/sleeves: Provide slots/sleeves where required and where shown on the Contract Documents. Provide hammer-drilling, core drilling and saw cutting where required for installation. Seal and firestop (firestop only if fire rated barrier) between slot/sleeve and cable tray.
- C. Cable Tray Routing:
  - a. Route cable tray as shown on the Contract Documents. Where not shown on the Contract Documents, route cable tray in the most direct route possible, parallel to building lines.
  - b. Do not route cable tray through areas in which flammable material may be stored or through wet, hazardous or corrosive areas.
- D. Cable Tray Clearance Requirements:
  - a. Clearance requirements for cable tray accessibility:
    - i. Maintain a clearance of 6” between top of cable tray and ceiling structure or other equipment or raceway.
    - ii. Maintain a clearance of 8” between at least one side of cable tray and nearby objects.
    - iii. Maintain a clearance of 6” between bottom of cable tray and ceiling grid or other equipment or raceway.

- b. Clearance requirements from sources of electromagnetic interference (EMI):
  - i. Maintain a clearance of 5" or more from fluorescent lighting.
  - ii. Maintain a clearance of 12" or more from conduit and cables used for electrical power distribution.
  - iii. Maintain a clearance of 48" or more from motors or transformers.
  - iv. Pathways shall cross perpendicularly to electrical power cables or conduits.
- c. Maintain a clearance of at least 6 inches from parallel runs of flues and steam or hot- water pipes or other heat sources operating at temperatures above one-hundred degrees Fahrenheit.
- E. Cable Tray Fittings: Provide field-fabricated fittings from straight sections of cable tray using manufacturer-approved tools and in accordance with manufacturer's instructions. Bends shall be long radius. Short radius bends and T-sections shall not be used unless specifically called out on the Contract Documents.
- F. Cable tray supports shall be provided per the manufacturer's recommendations.
  - a. Supports shall be attached to structural ceiling or walls with hardware or other installation and support aids specifically designed for the cable tray and designed to support the cable tray's weight and required cable weight and volume.
  - b. Where cable trays abut walls, provide wall-mounted supports.
  - c. Do not attach cable tray supports to ceiling support system or other mechanical support systems.
  - d. Trays shall be supported at 5 foot intervals minimum, or more frequently if required by the manufacturer.
- G. Load span criteria: Install tray supports in accordance with the load criteria of L/240, and as shown on the Contract Documents.
- H. Cable tray shall be installed free of burrs, sharp edges, or projections which may damage cable insulation.
- I. Wire-type cable tray shall be cut with a manufacturer-approved cutter with "offset cutting blade" jaws and a minimum 24-inch handle.
  - a. The choice and position of the jaws at the point where the cut is to be made shall allow shearing as close as possible to the intersection of the steel wires.
  - b. Cuts shall ensure the integrity of the galvanic protective layer.
- J. Expansion Joints: Provide cable tray sliding or offsetting expansion joints/fittings where cable tray crosses building expansion joints in addition to where shown on the Contract Documents. Provide bonding jumper except where expansion joints are explicitly approved for bonding.
- K. Thermal contraction and expansion: Install cable tray sections with gap settings between cable tray sections that are appropriate for the range of thermal expansion and contraction expected for the space during construction and during normal occupancy and operation.
- L. Barrier Strips: Provide barrier strips as recommended by manufacturer.
- M. Radius Drops: Provide cable tray radius drops where cable trays cross other telecommunications cable trays or ladder rack in addition to where shown on the Contract Documents.

### 3.5.3.3 GROUNDING AND BONDING

- A. Grounding/Bonding: Grounding and bonding work shall comply with the Uniform Building Code, Uniform Fire Code, National Electrical Code, and UL 467, ANSI/TIA/EIA standards and the references listed in “Codes and Standards” on page 92, as well as local codes which may specify additional grounding and/or bonding requirements.
- B. Bond metallic raceway (including cable tray) together and to the nearest SBB (as provided under Division 27 Section — “Grounding and Bonding for Communications Systems”). Ensure that bonding breaks through paint to bare metallic surface of painted metallic hardware.
- C. Cable tray bonding splices: Provide cable tray splices per manufacturer requirements to create a continuous bonding conductor throughout the entire cable tray.
- D. Bonding Conductors:
  - a. Bond distribution conduits to cable tray.
  - b. Provide bonding jumpers at expansion joints, sleeves and any other locations where electrical continuity is interrupted.
  - c. Provide bonding conductor between cable tray and the electrical power distribution system grounding infrastructure.

### 3.5.3.4 FIRESTOPPING

See also “Firestopping” on page 15.

- A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.
- B. Maintain the fire rating of all penetrated fire barriers. Fire stop and seal all penetrations made during construction.
  - a. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
  - b. Install firestops in strict accordance with manufacturer’s detailed installation procedures.
  - c. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer’s recommendations, local fire and building authorities, and applicable codes and standards in “Codes and Standards” on page 92. Apply sealing material in a manner acceptable to the local fire and building authorities.
  - d. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether the penetrations are used for new cable or left empty after construction is complete.
  - e. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

### 3.5.3.5 CLEANING AND PROTECTION

- A. After completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and in accordance with accepted industry practice, that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.
  - a. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - b. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

#### 3.5.3.6 TESTING

- A. Test cable trays to ensure electrical continuity of bonding and grounding connections. Demonstrate compliance with maximum grounding resistance per NFPA 70B, Chapter 18.

#### 3.5.3.7 LABELING AND ADMINISTRATION

See "Labeling " on page 21.

## 3.6 Underground Ducts and Raceways

### 3.6.1 General

#### 3.6.1.1 SCOPE

- A. Provide all services, labor, materials, tools, and equipment necessary for the complete and proper installation of exterior telecommunications pathways as specified in the contract.
- B. This section includes the minimum requirements and installation methods for the following:
  - a. Cutting and patching of Asphalt and or Concrete.
  - b. Trenching and Excavation.
  - c. Underground Conduit systems.
  - d. Horizontal Drilling (commonly referred to as Directional Boring or Horizontal Boring).

#### 3.6.1.2 QUALITY ASSURANCE

- A. Installation for all exterior telecommunications pathways shall be performed in a professional and workmanlike manner. All construction methods that are not specified in the Contract Documents shall be subject to the control of DC-Net.
- B. Equipment and materials shall consist of the quality and manufacturer indicated in the contract. The equipment specified is based on the acceptable manufactures listed in the contract.



- C. Materials and work specified herein shall conform with the applicable requirements as listed in “Codes and Standards” on page 92.
- D. For horizontal drilling, the Contractor shall follow all safeguards necessary to ensure that crucial aspects of proper directional bore installation are controlled.
- E. Personnel for horizontal directional drilling shall be fully trained in their duties as part of the drilling team.

## 3.6.2 Products

Content in this section follows the CSI Master Format Division 270500 with sections noted.

### 3.6.2.1 TRENCH/BACKFILL MATERIALS

- A. Trenching and Excavation Backfill: Select fill materials as specified in Section 02221
- B. Concrete Slurry: Select Flow Fill as specified in Section 02221
- C. Concrete Pavement: Select concrete paving materials as specified in Section 02520
- D. Asphalt Pavement: Select asphaltic paving materials as specified in Section 02513

### 3.6.2.2 CONDUIT SYSTEM

- A. Non-Metallic Conduit:
  - a. PVC plastic pipe, ASTM D1785, Schedule 40 or 80, Type PVC 1120
  - b. 4” 45 Degree Fiberglass Bend: FRE Composite Inc., 30-4032 Elbow IPS
  - c. 4” 90 Degree Fiberglass Bend: FRE Composite Inc., 30-4030 elbow IPS
- B. Metallic Conduit: GRC with PVC coating (for building entrances, offsets and sweep bends) within 50 feet of the building protection.
- C. Conduit Joint Couplings:
  - a. PVC non-metallic fittings must be installed with solvent applied couplings.
  - b. Approved transition couplings shall be used to connect metal to plastic (PVC) conduits.
  - c. Couplings shall be threaded and or glued to provide a watertight seal at conduit junctions.
- D. Outside Pull-Box: Minimum 14-gauge galvanized steel with weatherproof locking cover and hardware surface mounting as specified in the contract. Dimensions as specified in the contract.

### 3.6.2.3 CABLE ROUTING HARDWARE

- A. Cable Rack with Support Hardware as Required
- B. Cable Rack Steps/Hooks

### 3.6.2.4 HORIZONTAL DRILLING EQUIPMENT

- A. The horizontal directional drilling equipment shall have a drilling device of appropriate capacity to perform the bore; it shall have a guidance system to precisely guide boring operations, and trained personnel to operate said system.

- B. All equipment shall be in good, safe operating condition with appropriate supplies, materials and spare hardware on hand to preserve the systems integrity during the project.
- C. The directional drilling apparatus shall consist of hydraulically powered system to drill into the earth at a variable angle.
  - a. The apparatus shall be anchored to the ground to withstand any pressures required to complete boring.
  - b. The hydraulic system shall be free of leaks.
  - c. The hydraulic power system shall be self-contained with necessary pressure and volume to power the drilling operation.
- D. The Guidance System shall be a proven type and shall be assembled and operated by personnel certified and experienced with this system.
  - a. The operator shall be aware of any magnetic anomalies and shall consider these influences in the operation of the guidance system, if using a magnetic system.

### 3.6.3 Execution

#### 3.6.3.1 INSPECTION

- A. Examine areas and conditions under which the new exterior telecommunications pathways are to be installed. Provide notification, in writing, of conditions detrimental to proper completion of the work.
- B. Beginning of telecommunications pathway indicates Contractor acceptance of existing conditions.

#### 3.6.3.2 TRENCHING AND BACKFILL

- A. Perform all trenching and backfill for new underground conduit system placement as reflected in the Contract Documents.
- B. Perform pavement removal and replacement as specified.
- C. Perform pavement marking as required and specified.
- D. All utilities to be located by contractor and exposed, if necessary, prior to construction.

#### 3.6.3.3 CONDUIT SYSTEM PLACEMENT

- A. Place new conduit system including handholes and manholes as reflected in the Contract Documents.
- B. No pathways shall have more than 180 degrees of bends.
- C. Twelve-inch (12 ") clearance from all utilities is to be preserved. If not possible conduit to be encased in concrete where proper distance cannot be achieved.
- D. Telecommunication ducts shall cross below gas piping.
- E. All conduits must be cleaned thoroughly prior to installation.
- F. During construction all ends of conduit shall be plugged to prevent water and other materials from entering conduits, manholes and buildings.

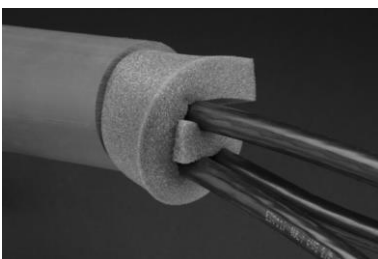
- G. New and reopened trenches located under asphalt roadways shall have concrete cap or be encased in concrete.
- H. Seal all conduit junctions and fittings watertight prior to pouring concrete.
- I. Unless otherwise noted on the Contract Documents a minimum of 24" depth shall be required above conduits.
- J. Transition to PVC conduit five feet (5') from building outside wall penetrations.
- K. Bury underground plastic line marker one foot (1') above telecommunications conduit.
- L. The new conduit shall extend through the wall into the building, tunnel, or crawl space a minimum of 4".
- M. Handholes shall be placed with the long dimension in line with the conduit run. The conduit shall enter opposite ends of the short sides so that the handhole shall not be used as a 90-degree bend during cable installations.
- N. All conduits entering bottom of handhole shall be flush with the inside wall. Dirt shall be removed 6" below the bottom of conduits entering the handhole and pea-gravel shall be placed on the bottom to aid water dissipation.
- O. The ends of all metallic conduits shall be reamed and bushed.
- P. Plug ends of new conduit with watertight conduit plugs, removable conduit caulking compound, or conduit caps to ensure no foreign matter enters.

#### 3.6.3.4 Sealing Ducts and Conduits

- A. Seal all ducts and conduits entering a building to prevent intrusion of liquids and gases. Universal duct plugs are available in a variety of sizes for use in unoccupied ducts and conduits. In conduits where cable has been installed, seal conduits using Foam Sealant, Puttys, Cementitious Compounds, and Hydraulic Cement.
- B. Firestop all innerducts entering a building in accordance with ASTM E814 and UL 1479.
- C. The preferred method for sealing entrance conduits is Foam Sealant.
- D. To seal conduits entering a building utilizing Foam Sealant (Polywater® Duct Sealant) or equivalent follow the instructions below:



Clean conduit with wire brush.



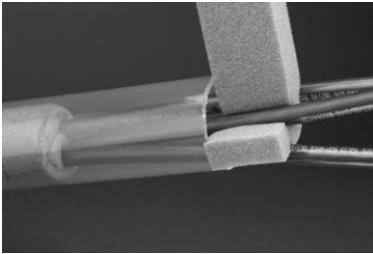
1.) If conduit has loose debris or rust, use a wire brush to remove all loose material. Clean cable(s) and conduit. This will remove contaminants and any residue. Roughing the surfaces with an abrasive such as steel wool or sand paper may increase the effectiveness of the Sealant.

2.) Create a foam dam by wrapping foam strips around the cable (s) so that it fills the space between the cable and the conduit. The tail end of the foam strip should be at the top of the wrap. The foam strip will slow any existing water flow and contain the Sealant. Cut all foam to size.

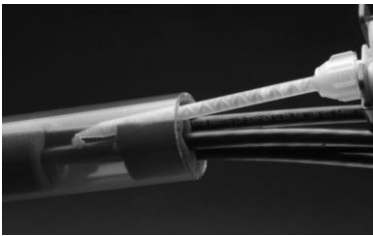
*Wrap cable (s) with foam strip.*



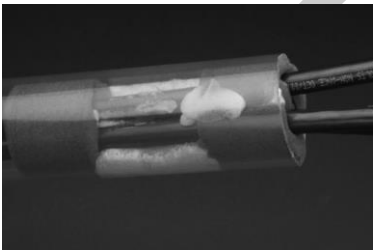
*Insert foam 5 inches.*



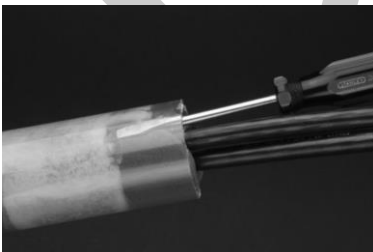
*Separate cable (s) with foam.*



*Dispensing the Foam Sealant.*



*Foam rises.*



*Checking for voids.*

3.) Using a rod or screwdriver, push the foam 5 inches into the conduit. Make sure there are no voids in the foam dam for the Sealant to flow through.

4.) Wrap a second foam strip around the cable (If more than one cable, separate cables with foam strip). Tail end of the foam strip should be at the top of the wrap. Push second foam strip into the conduit until the edge is flush with the conduit entrance.

5.) Insert the mixing nozzle into top wrap of foam so the tip extends into the space between foam strips. Inject Sealant above cable for better coverage. Use desired amount of foam Sealant. Rapid injection will produce better mixing.

*Sealant will expand fully in 2 to 5 minutes.*

6.) Remove cartridge and mixing nozzle. Sealant may seep between the crevices of the foam dam as it expands. Excess sealant may be trimmed and removed.

*Sealant will harden (set) in 10-15 minutes.*

7.) After the Sealant has fully set and cured, use a screwdriver to check for voids in the Sealant. Foam Sealant should be solid throughout the conduit. If any holes or voids are detected during the inspection, use a screwdriver to cut into foam and enlarge a path for new material. Attach a new mixing nozzle and inject Sealant directly into the void area.

#### 3.6.3.5 HORIZONTAL DIRECTIONAL DRILLING

- A. Notify DC-Net OSP Team project manager 48 hours in advance of starting horizontal directional drilling. The drilling shall not begin until a DC-Net OSP project manager is on site and agrees that the proper preparations for the procedure have been made.
- B. No work shall commence until all Traffic Control and proper permits are in place as applicable for the specific operation.
- C. Site Preparation:
  - a. Prior to any alterations to the work site, all entry and exit points shall be legibly marked.
  - b. No alterations to the work site beyond what is required shall be made.
- D. Path Survey:
  - a. The entire drill pathway shall be precisely surveyed with entry and exit stakes placed at their appropriate locations within the areas reflected in the Contract Documents.
  - b. In the case of magnetic guidance systems, the drill pathway must be surveyed for any surface geomagnetic deviation and or anomalies.
- E. All pertinent environmental regulations shall be observed.
- F. Following drilling operations, all equipment shall be de-mobilized and the work site returned to its original condition. All excavations shall be backfilled and compacted to 95% of original density. Landscaping shall be restored to its original site condition.

#### 3.6.3.6 SAFETY

- A. The contractor must comply with all Government regulations for asbestos, lead, and confined spaces.
- B. All applicable federal and local safety regulations shall be adhered to and conducted in a safe manner.
- C. Manholes shall be guarded per NESC: IEEE C-2-2017, 423.A: When covers of manholes, handholes, or vaults are removed, the opening must be protected with a barrier, temporary cover, or other suitable safeguard.
- D. Test for gas in manholes and unventilated vaults per NESC: IEEE C-2-2017, 423.b and C including but not limited to:
  - a. The atmosphere shall be tested for combustible or flammable gas(es) before entry.
  - b. When combustible or flammable gas(es) are detected, the work area must be ventilated and made safe before entry.
  - c. Unless utilizing continuous forced ventilation, test for oxygen deficiency.
  - d. Make provisions for adequate continuous supply of air. This statement reflects evaluation of both the quantity and quality of the air.
  - e. No smoking shall be permitted in manholes, handholes, and or vaults.
  - f. Where open flames may be used in manholes, handholes, or vaults, extra precautions must be taken to ensure adequate ventilation.
- E. All outside plant (OSP) construction must be fenced off and holes must be covered off hours and when not in use.

# 4 Communications Equipment Room Fittings

Content in this section follows the Construction Specifications Institute (CSI) Master Format Division 271100.

See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92

## 4.1 Equipment Room Fittings

### 4.1.1 General

#### 4.1.1.1 *SCOPE OF WORK*

- A. Make available all services, labor, materials, tools, and equipment essential for the complete and proper installation within the Telecommunications Rooms (TRs) and the Equipment Rooms (ERs) as specified in the Contract Documents.
- B. This section includes the minimum requirements and installation methods for the following:
  - a. Equipment Racks and Cable Routing Hardware
  - b. Copper Terminations Equipment
  - c. Fiber Termination Equipment
  - d. Grounding and Bonding

#### 4.1.1.2 *QUALITY ASSURANCE*

- A. All installation work in the TRs and ERs shall be performed in a professional and workmanlike manner. All methods of construction that are not explicitly described shall be subject to the control of DC-Net.
- B. All equipment and materials shall be of the quality and manufacturer indicated in the Contract Documents. The equipment specified is based on the acceptable manufacturer listed.
- C. Materials and work specified herein shall comply with the relevant requirements listed in “Codes and Standards” on page 92.

#### 4.1.1.3 *ARCHITECTURAL REQUIREMENTS*

- A. New Telecommunications Rooms (TRs) and Equipment Rooms (ERs) shall be designed in compliance with the space, electrical, and environmental requirements of ANSI/TIA - 569 -A – Commercial Building Standard for Telecommunications Pathways and Spaces. Smaller spaces or enclosures shall not be acceptable without prior written approval from DC-Net.

- B. The locations for all TRs and ERs shall be designed to be within a 150' radius of all areas to be served with the understanding to maintain ANSI/TIA distance standards for telecommunications cabling.
- C. Corridor access with the door to swing out is required for all new TRs and ERs, which shall comply with common area access requirements. No other rooms shall lead directly to or from the TR or ER.
- D. All walls of the TRs and ERs will be covered with rigidly fixed ¾" A - C fire - resistant or non-combustible plywood backboard, void free, 8' high, painted with two coats of light colored fire retardant paint.
- E. TRs and Telecom ERs shall be open to the structure above (no suspended ceiling).
- F. The floor, walls and ceiling of the TRs and ERs shall be sealed to reduce dust. The floor shall be sealed concrete.
- G. The TRs and ERs shall not be shared for other purposes including, but not limited to, custodial, access services, electrical, mechanical, storage, etc.
- H. Equipment not related to the support of the TR or ER (e.g., piping, ductwork, pneumatic piping, electrical equipment, plumbing, etc.) should not be installed in, pass through, or enter the room.
- I. No equipment, hardware, piping, etc. shall be added in or near any TR or ER that will change the temperature or humidity of these rooms without written agreement from DC-Net prior to design and installation.
- J. The ER shall be designed to allow future UPS floor space in the footprint. A minimum of 10' X 16' is recommended and larger for ERs depending on the overall usable and non-usable floor space that is associated with any given building per ANSI/TIA-569-D. This is to help take public safety, future growth, proper clearances and technician access for preventative maintenance into consideration. Install empty conduits running from the UPS location to each data closet. Ensure sufficient wall space is available for future electrical breaker panels that will feed all communication rooms.
- K. New TRs and ERs shall not be adjacent to any electrical room or room containing a transformer or motors. Electrical power systems in or adjacent to the TRs and ERs should be configured such that their electromagnetic fields, (EMC/EMI, harmonics, AC-DC waveforms and other electrical principals of transmission related issues), do not interfere with telecom cabling or equipment.
- L. As-built files shall be a part of the final punch list and not complete until DC-Net receives the final as-built files.

#### 4.1.1.4 COMMUNICATIONS REQUIREMENTS

- A. New Telecommunications Rooms (TRs) and Equipment Rooms (ERs) shall be designed in compliance with the space, electrical, and environmental requirements of ANSI/TIA #569-A – Commercial Building Standard for Telecommunications Pathways and Spaces. Smaller spaces or enclosures shall not be acceptable without prior written approval from DC-Net.
- B. The locations for all TRs and ERs shall be designed to be within a 150' radius of all areas to be served with the understanding to maintain ANSI/TIA #569-D distance standards for telecommunications cabling.

- C. All walls of the TRs and ERs will be covered with rigidly fixed  $\frac{3}{4}$ " A - C fire - resistant or non-combustible plywood backboard, void free, 8' high, painted with two coats of light colored fire retardant paint.
- D. The TRs and ERs shall not be used for other purposes including, but not limited to, custodial, access services, electrical, mechanical, storage, etc.
- E. Equipment not related to the support of the TR or ER (e.g., piping, ductwork, pneumatic piping, electrical equipment, plumbing, etc.) should not be installed in, pass through, or enter the room.
- F. No equipment, hardware, piping, etc. shall be added in or near any TR or ER that will change the temperature or humidity of these rooms without written agreement from DC-Net prior to design and installation.
- G. The MDF shall be designed to allow future UPS floor space in the footprint. Empty conduits are to be installed running from the UPS location to each data closet. Ensure sufficient wall space is available for future electrical breaker panels that will feed all communication rooms.
- H. New TRs and ERs shall not be adjacent to any electrical room or room containing a transformer or motors. Electrical power systems in or adjacent to the TRs and ERs should be configured such that their electromagnetic fields do not interfere with telecom cabling or equipment.
- I. DC-Net supplied prints shall be used for design on all projects with updates for each project.
- J. Communication as-built files shall be a part of the final punch list and not complete until DC-Net receives the final as -built files.
- K. A minimum of two 4-inch conduits shall be installed in all drywall ceilings greater than 3 feet wide and at all corners that are drywall.

## 4.1.2 Products

### 4.1.2.1 *EQUIPMENT RACK AND RACK MANAGEMENT*

- A. Equipment rack(s) shall be provided for the telecommunication system. The rack shall be upright, floor standing, steel, or extruded aluminum. Equipment racks shall conform to EIA Standard RS-310C for 19" x 84" racks, capable of supporting up to 600 pounds, with Type B universal mounting rail hole pattern, and shall be complete with all mounting hardware. All unused rack space shall be blanked off with matching steel panels.
- B. Racks shall be mounted on an isolation pad and utilize non-conductive washers with appropriate sized lag screws to secure the rack to the floor. Provide Chatsworth #10605-019 rack/floor isolation kit or equivalent. Racks shall be secured to the floor with four screws per rack. Floor-mounted open racks shall be secured from the top rail to the backboard in the room with a length of cable runway to prevent movement. All racks shall be grounded to the isolated ground bar within the Telecommunications Closet (TC) and Main Cross-Connect (MC) using a standard ground lug and #6 AWG jacketed green



cable in accordance with 007 portion of ANSI/TIA Standards unless otherwise required NEC. Provide ground lug kit for data rack bonding.

- C. Provide horizontal and vertical cable management organizers as elsewhere specified in this section. Vertical wire management shall be Hubbell VC76H and horizontal wire management Hubbell HC219ME3N or approved equals. Each TC shall be connected to the ER. Provide a minimum of four (4) rows of 5 count split front "D" ring horizontal cable management panels per rack.
- D. Racks and supporting fixture shall be from Newton Instrument Company or approved equal.
- E. Use a 12" ladder rack for all horizontal bulk cable management within TCs. Acceptable Parts: Cablofil CF105 Series, Hubbell 12" (w) Steel, 9" Ladder Series, or approved equivalent.
  - a. Install 2" x 6" x 10" wire mesh cable tray in ceiling and telecommunications closets where deemed necessary to facilitate proper cable management. Contractor shall have the option to provide j-hooks or mesh cable tray for cable supports for distributing cables through the building. Contractor shall provide only cable tray in each ER and TC for cable support.
  - b. Install cable management system at locations specified. Coordination with other trades will be necessary in this installation. Bring any major corrections of the path to the attention of the Owner and the Engineer.
- F. The Contractor shall provide wall-mounted, split-front "D"-type wire management rings above, below, and between each wall-mounted termination panel.
- G. The Contractor shall provide 2" (or larger as necessary) J-shaped hooks, with rolled edges; gray baked enamel finish; complete with necessary hardware for attachment to sidewall, ceiling, or joist. J-hooks shall be used to support voice and data cable above suspended ceilings. The Contractor shall supply the quantity necessary. J-hooks shall be spaced a maximum of four feet (4').
- H. Cable Ties:
  - a. The Contractor shall provide Velcro-type cable ties. Velcro-type cable ties shall be used exclusively for cable management within the racks in the telecommunications closets. The contractor shall supply quantities as necessary for each system.
  - b. The Contractor shall provide plastic "zip" tie wraps. Zip tie wraps shall be used for general cable management throughout the areas outside the telecommunications closets. The Contractor shall supply the quantity necessary.
- I. The Contractor shall provide 3/4" deep fire-retardant-treated plywood backboards. Plywood backboards shall conform to Product Standard PS1, Grade B-D, with one finish smooth side (Class A surface). Minimum size shall be 4 feet wide x 8 feet high.

#### 4.1.2.2 GROUNDING AND BONDING

- A. #4 and #6 AWG wire suitable for grounding application.
- B. All bonding/grounding connections shall be made with irreversible compression/crimping or Exothermic/CAD weld connections with the appropriated listed materials and hardware.

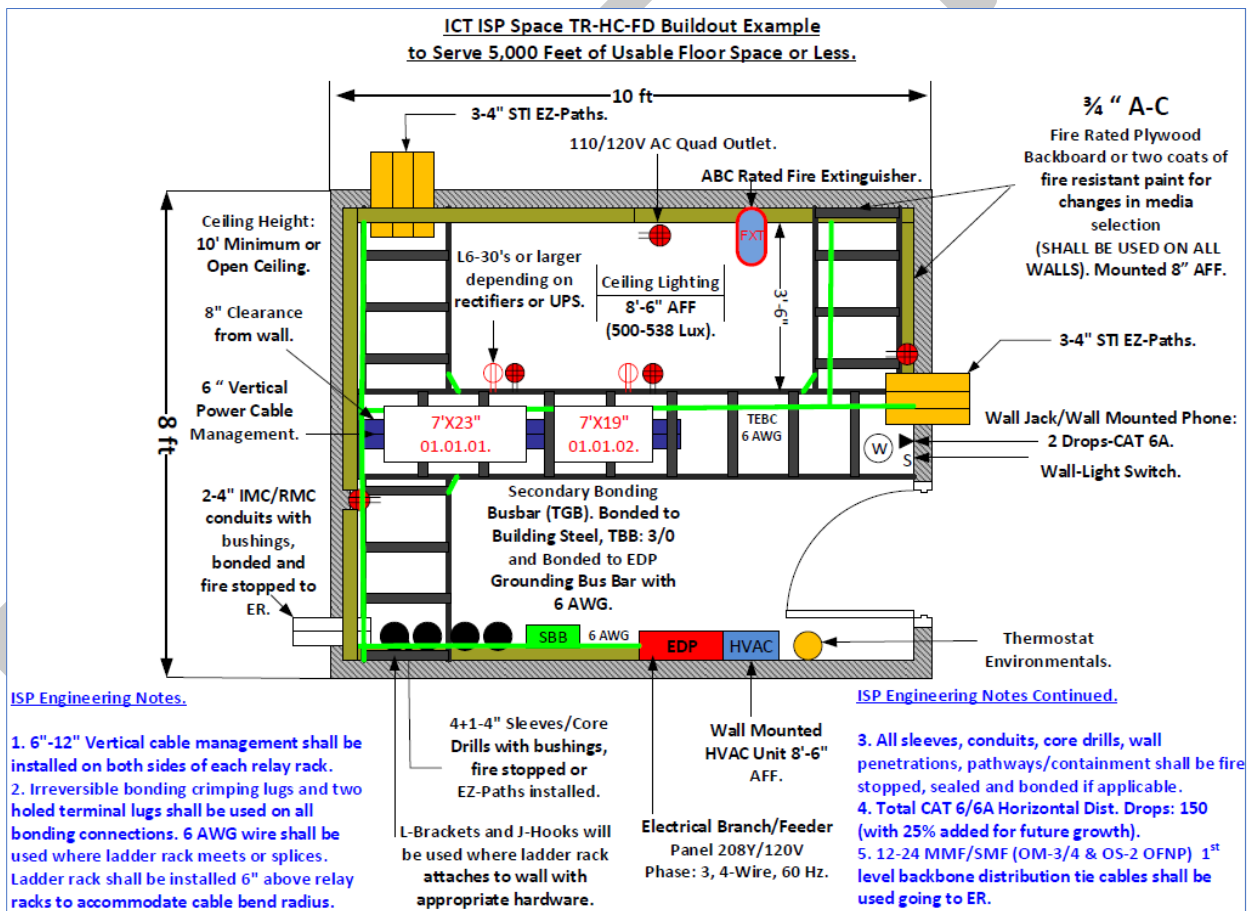
- C. Terminals shall be solderless compression type, copper long-barrel NEMA two bolt.
- D. Telecommunications Bonding Backbone (TBB): Minimum No. 6 AWG insulated copper conductor.
- E. Secondary Bonding Busbar (SBB): Minimum 6 mm thick x 50 mm wide predrilled copper busbar with standard NEMA bolt hole sizing and spacing.
- F. All grounding equipment shall be UL listed for that purpose.

### 4.1.3 Execution

#### 4.1.3.1 EQUIPMENT ROOM/TELECOMMUNICATIONS CLOSET DIMENSIONS

- A. OCTO Model #1 Information and Communications Technology (ICT) Space (0-5,000' of Usable Floor Space Served TR-HC-FD): minimum dimensions of 8' x 10'.

Figure 9: ICT Space - Model 1

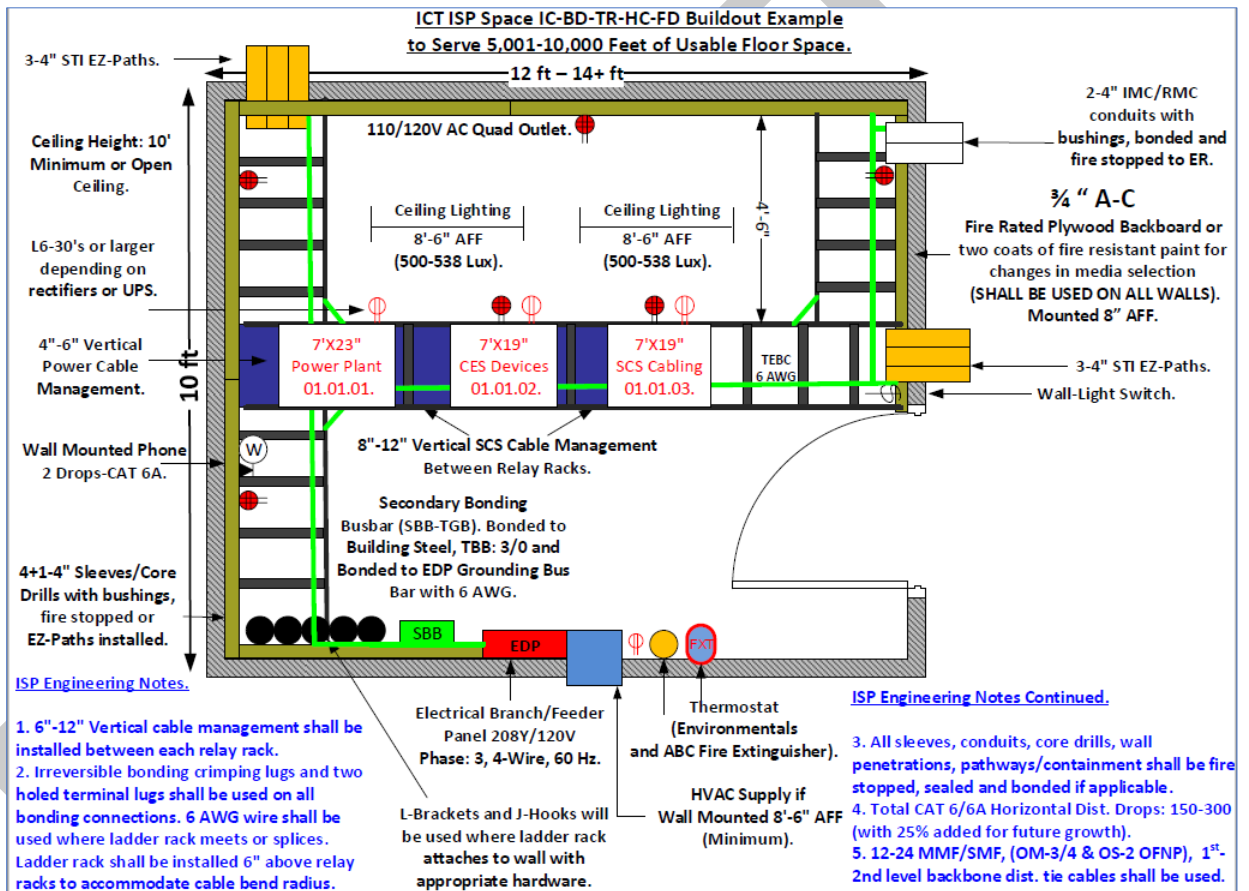


- B. OCTO Model #2 ICT Space (5,001'-10,000' of Usable Floor Space Served IC-BD-TR-HC-FD): minimum dimensions of 10' x 12'. However, 10' x 14'+ dimensions are recommended to support larger vertical cable managements, public safety, moves/adds/changes (MACs), renovation work, clearances, large amounts of cross

connecting, and engineer/technician access for preventative maintenance into consideration associated with these types of ICT spaces, for these types ICT spaces (per ANSI-TIA #569-D Best Practices).

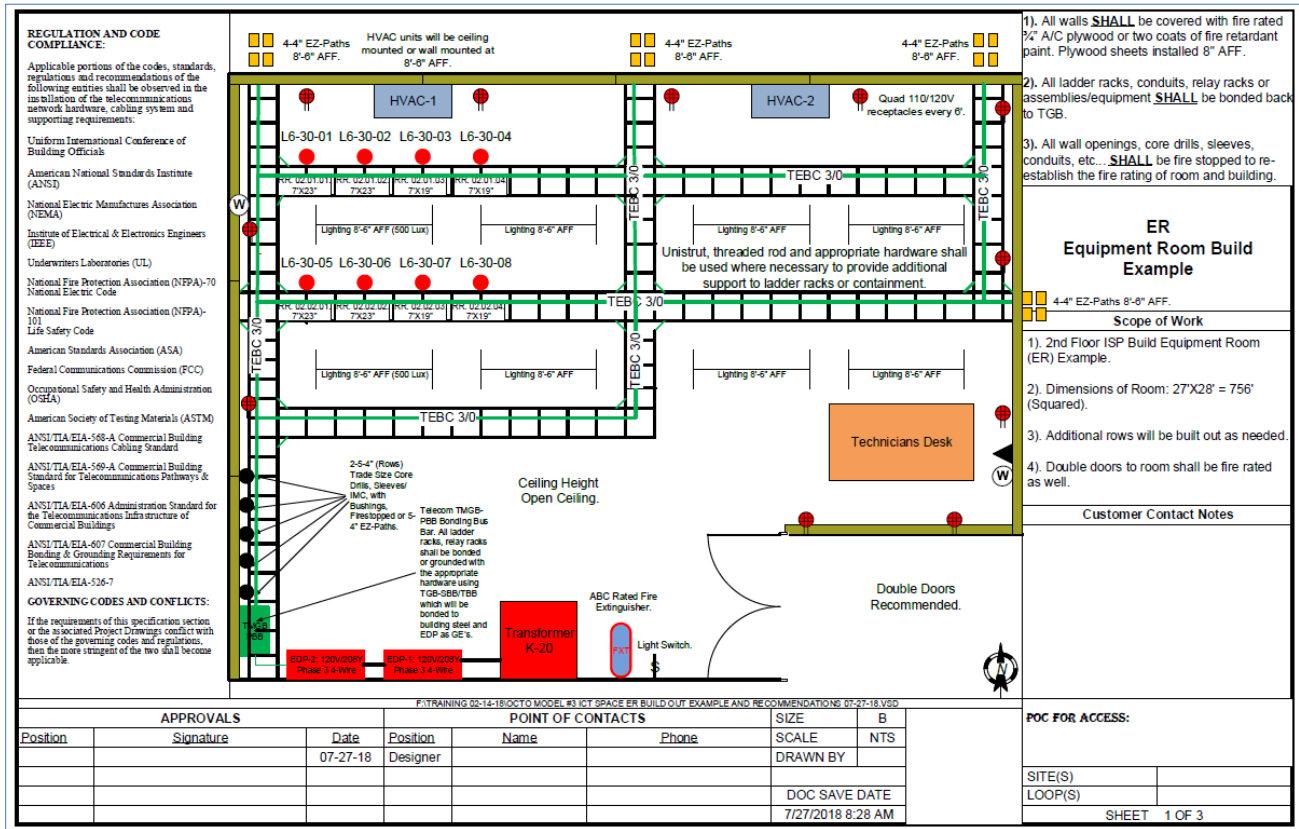
- a. There should be a minimum of at least one ICT space on every floor associated with multiple floored buildings. There should be additional ICT spaces proposed for every additional 10,000' of usable/non-usable floor space served on any given floor associated within any building (ANSI-TIA #569-D Best Practices).
- b. All ICT spaces should be stacked vertically between floors if possible (ANSI-TIA #569-D Best Practices).
- c. See ANSI-TIA #569-D for additional recommendations.

Figure 10: ICT Space - Model 2



- C. OCTO Model #3 (ER-MC-CD-IC-BD-TR-HC-FD): minimum dimensions 10' X 16' and larger depending on the overall usable and non-usable floor space associated with any given building (per ANSI-TIA #569-D Best Practices).

Figure 11: ICT Space - Model 3



#### 4.1.3.2 RACKS AND CABLE ROUTING HARDWARE

- The Telecommunications Rooms (TRs) and Equipment Rooms (ERs) may be equipped with some existing hardware, such as plywood backboards, grounding bus bars, equipment racks, ladder cable runway, horizontal and vertical cable management, and copper and fiber termination equipment. Existing hardware already be in place will be shown on the project drawings.
- Examine TRs and ERs and verify conditions are as shown on project drawings. Provide notification in writing of conditions deviating from drawings or detrimental to proper completion of the work.
- Beginning of installation in the TRs and ERs indicates Contractor acceptance existing conditions.
- Install new equipment racks with vertical and horizontal cable management in the TRs and ERs as required for project and as shown on drawings. All equipment racks shall be securely anchored to the concrete floor using minimum 3/8" hardware or as specified by rack manufacturer.
- Install new ladder cable runway for cable routing in the TRs and ERs as required for project and as shown on drawings. All ladder cable runway shall be securely anchored to the walls with support kits and brackets as specified by manufacturer. Secure equipment racks to ladder cable runway with all-thread covered with EMT conduit sleeve.

- F. Install plywood backboard on the walls in the TRs and ERs as required for the project and as shown on drawings. Anchor all plywood backboard securely to the walls.
- G. Install D-Rings on plywood backboard for cable routing in the TRs and ERs as required for the project and as shown on drawings. D-Rings are not to be used in place of or as a substitute for a telecommunication pathway.
- H. All new cables shall be supported using ladder rack, basket tray, cable runway, cable management hardware and shall be neatly dressed-out in all TRs and ERs.
- I. Clamp all new cables at the entrance to the TRs and ERs for strain relief.
- J. Firestop all sleeves and conduit openings after the cable installation is complete.
- K. The hardware layout in the racks shall follow the DC-Net standard format as shown in the typical rack layout drawings.
- L. Coordinate equipment placement with DC-Net staff.

#### 4.1.3.3 UPS

- A. Provide one (1) UPS unit in each data equipment rack. The UPS System shall be line interactive design with a maximum transfer time of 4 milliseconds. The UPS shall be a single conversion modular UPS System with SNMP Management.
  - a. The UPS System shall provide a minimum of 2000 VA of output power with 120 Volt input.
  - b. The UPS System shall provide a minimum battery runtime of 20 minutes at full load.
  - c. The output waveform of UPS shall be true sine-wave.
  - d. The UPS System shall be provided with a minimum of six NEMA 5-15R output receptacles.
  - e. The system shall be covered by a two-year on-site warranty.
  - f. The front panel display shall indicate load level, battery charge level, and replacement battery indication.
  - g. The UPS System shall be rack-mounted in the bottom of each 19" equipment rack.
  - h. Provide grounding per ANSI/TIA-607-C requirements.

#### 4.1.3.4 SURGE PROTECTION

- A. The Contractor shall provide transient surge protection on the AC power feeds to all equipment, feeds and on all telephone station and central office lines leaving or entering the main building, all classrooms, and portable classrooms (as applicable). This protection shall include equipment with switches, hubs, and similar devices.
- B. The Contractor shall note in the submittal drawings, the type and location of these protection devices as well as all wiring information.
- C. Provide ventilation panels, louvers, blower fans, etc., as required to provide heat dissipation to conform to the equipment manufacturers' environmental specifications.
- D. Surge protection devices shall be grounded as required by the equipment manufacturers and comply with UL, ANSI, NEC, State and local agencies.
- E. Surge protection devices shall have a 5 nanosecond or less response time for clipping excessive voltage. The devices shall consist of solid state circuitry, shall automatically

reset after an operation with no degradation in protective capability, and shall have an indicating light to indicate when the unit is now operational. Devices shall be direct plug-in type, plug strip type, or hard-wired connection type as applicable to the respective component of equipment.

- F. Provide devices for AC power system surge protection.
- G. Provide devices for data/telephone systems surge protection.

#### 4.1.3.5 PATCH PANELS

- A. Patch panel shall be high density such that 24-ports occupy 1 rack unit and 48-ports occupy 2 rack units, and 96-ports occupy 4 rack units.
- B. Use Category 6, UMJ8 RJ45 jacks in 6- or 8-port modules. Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110D type insulation displacement contact, printed circuit board or lead frame mounted connector.
- C. Patch panel jack shall support termination of 22, 24 and 26 AWG solid conductor; four pair unshielded twisted pair copper cable.
- D. Angled patch panels are preferred, but not required.

#### 4.1.3.6 GROUNDING AND BONDING

- A. Mount new SBBs on plywood backboard in TRs as shown on project drawings. The location for the SBBs shall be coordinated with DC-Net.
- B. Mount new PBB on plywood backboard in main ER as shown on project drawings. The location for the PBB shall be coordinated with DC-Net.
- C. Install new TBB from the PBB in the ER to the SBBs in the TRs as shown on project drawings. Connect the TBB to the PBB and SBBs in accordance with ANSI/TIA-607-C and NEC. Place all grounding conductors leaving the ER and TRs in a separate conduit from all communication cabling.
- D. Bond all metallic surfaces of new racks, ladder cable runway, and equipment in the TRs and ERs to the SBB or PBB in the same room with #6 AWG grounding wire as straight as possible.
- E. Bond all metallic raceways (conduit, cable tray, etc.) entering the TRs and ERs to the SBB or PBB in the same room with #6 AWG grounding wire as straight as possible.
- F. Install all grounding items in complete compliance with Division 26 – Electrical and NEC.

# 5 Communications Backbone Cabling

Content in this section follows CSI Master Format Division 271300.

See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92

## 5.1 Communications Copper Backbone Cabling

Content in this section follows CSI Master Format Division 271313.

### 5.1.1 General

#### 5.1.1.1 GENERAL

- A. This section provides the requirements for the installation of multi-pair unshielded twisted pair (UTP) cables and associated hardware for copper backbone cabling. Included in this section are the product requirements for cable, termination hardware and other required hardware. Installation practices and test requirements are also indicated in this section. Contractor shall provide a complete tested and warranted Structured Cabling System (SCS).
- B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, ANSI/TIA/EIA commercial building wiring standards, ANSI/NECA/BICSI 568.2006 standard or current edition for installing telecommunications systems and all relevant BICSI manuals. Contractor must submit Drawings and receive approval from DC-Net’s Project Manager for any deviations from standards or drawings due to field conditions.

#### 5.1.1.2 SUBMITTALS

- A. Product Data:
  - a. The contractor shall submit product data sheets and samples for all products specified under this section.
  - b. Products requiring submittals and samples shall include but not limited to the following:
    - i. All cabling and wire
    - ii. Patch Cables
    - iii. All connectors and required tools
    - iv. All termination system components for each cable type
    - v. All equipment room and telecommunications room horizontal cable management
    - vi. All grounding system components

- vii. All firestop systems (including manufacturer published installation requirements)
  - viii. All cable raceway and support hardware
  - ix. Other apparatus required for a complete and functional system.
- B. Drawings: The contractor shall submit Drawings.
- C. Project Closeout Test Data: The contractor shall provide test documentation.
- D. As-Built Documentation: The contractor shall submit as-built documentation.
- E. Warranty: The contractor shall provide a warranty.

## 5.1.2 Products

### 5.1.2.1 CABLE

- A. Multi Pair Category 3 (for analog voice service only)
- a. Category 3, 24 AWG. The cable shall be available in 100, 200, and 300 pair counts. The cable shall be conformance tested to meet ANSI/TIA-568-D.2 for category 3 cables. Where 300 pair cables are specified, three 100-pair cables of equal quality may be substituted.
  - b. Pairs shall be color coded in accordance with ANSI/ICEA S-80-576. Cables with more than 25 pairs are to be assembled with sub-units of 25 pair and have continuous color-coded binders. The core shall be overlaid with a corrugated aluminum sheath, which is bonded to an outer jacket of PVC plastic to form an alvyn sheath. The PVC sheath shall have improved frictional properties, allowing the cable to be installed in conduit without the use of pulling lubricants.
  - c. Cable jacket material shall conform to Article 800 NEC for use as non-plenum cables. Cables shall be UL® type CMR (riser) and/or UL® listed for fire safety.
  - d. Armored cable shall be in a flexible metal jacket for crush resistance.
- B. 25-Pair Category 3 (for analog voice service only)
- a. 25- pair count cable shall be comprised of 24 AWG twisted pair copper conductors individually insulated with PVC and sheathed in a riser rated thermoplastic outer jacket. Pairs shall be color coded in accordance with ANSI/ICEA S-80-576.
  - b. Cable jacket material shall conform to Article 800 NEC for use as plenum or non-plenum cables. Cables shall be UL® type CMR (riser) and/or UL® listed for fire safety.
  - c. Cable meet or exceed ANSI/TIA-568-D.2 for category 3 compliance.

### 5.1.2.2 PATCH PANELS

- A. Patch panel shall be high density such that 24-ports occupy 1 rack unit and 48 ports occupy 2 rack units.
- B. Patch panel shall use Category 6+, RJ45 jacks in 6- or 8- port modules.
- C. Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110D-type insulation displacement contact, printed circuit board, to lead frame mounted connector.



- D. Patch panel jack shall be universal modular jack, 8 position, un-keyed unless noted otherwise.
- E. Patch panel jack shall support termination of 22, 24 and 26 AWG solid conductor, four pair, unshielded twisted pair copper cable.
- F. Patch panel shall have rear-mounted cable management bar to ensure proper bend radius and strain relief for cabling.
- G. Patch panel shall accept color-coded identification tabs and port protecting shutters.
- H. Patch panel shall be compliant with ANSI/TIA-606-D labeling specifications.

#### 5.1.2.3 SUPPORTING HARDWARE

- A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.
- B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

### 5.1.3 Execution

#### 5.1.3.1 GENERAL

- A. The backbone cabling systems shall provide interconnections between telecommunications rooms, equipment rooms and entrance facilities. The system includes backbone cables, intermediate and main cross-connects, mechanical terminations used for backbone cross-connects.
- B. Specified pulling tensions and bend radius shall be used in the installation of cables.
- C. The proximity of backbone cabling to potential sources of RFI and EMI shall be considered when installing cable.
  - a. Maintain at least 6 inches of clearance away from fluorescent lighting fixtures and electrical conductors up to 2 kVA.
  - b. Maintain at least 24 inches of clearance away from electrical conductors up to 5 kVA.
  - c. Maintain at least 36 inches of clearance away from electrical conductors more than 5 kVA.
  - d. When cabling is required to cross over electrical conductors, they must do so at a 90-degree angle.
  - e. Electrical cabling is not permitted to lie on top of communication cabling.
- D. The contractor shall bond both ends of all cable shields to the appropriate PBB.
- E. All cabling shall be labeled per specifications.
- F. All backbone cabling shall be run with no splices.
- G. Contractor shall adhere to ANSI/TIA 568-D/569-D specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.

#### 5.1.3.2 INSIDE PLANT CABLE

- A. The backbone cabling shall be configured in a logical star topology.

- B. The backbone shall be limited to no more than two hierarchical levels of cross-connects. No more than one cross-connect may exist between a main and a horizontal cross-connect and no more than three cross-connects may exist between any two horizontal cross-connects.
- C. The distance between the terminations in the entrance facility and the main cross-connect shall be documented by the Contractor and shall be made available to the access provider.
- D. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.

#### 5.1.3.3 PATCH CABLES

- A. Patch color codes are determined by their application. Patch cord color shall be coordinated with DC-Net Project Manager.
- B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

#### 5.1.3.4 TESTING INSIDE PLANT CABLE

- A. Perform testing of all copper wiring before system cutover. Test 100 percent of the horizontal, riser and inter-cabinet wiring pairs for opens, shorts, polarity reversals, transposition and presence of AC voltage.
- B. Test multi-pair cables to each TR. Test cable runs for conformance to the specifications of ANSI/TIA-568-D.1 and ANSI/TIA-568-D.2.
- C. Testing shall include length, mutual capacitance, characteristic impedance, attenuation, and near-end and far end crosstalk. Any pairs not meeting the requirements of the standard shall be brought into compliance by the contractor or replaced at no cost to DC-Net.
- D. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.
- E. Submit current calibration certificate(s) for each piece of test equipment to be utilized. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
- F. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to DC-Net in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically The Contractor shall provide one copy of software and appropriate license with the test data.
- G. Each test shall be given a test identification number. For high pair count UTP backbone cables, the cable identification shall be used as the test identification. High-count UTP backbone cables shall be divided into 1-pair increments and each shall have a unique test identifier.
- H. Test data shall be organized and grouped by individual Telecommunications Room (TR) with the summary report followed by a detailed test sheet for each cable tested. All results shall be sorted by test identification numbers and bound in 3-ring binders (no larger than three (3) inches thick each).

- I. Project closeout test report shall include the following:
  - a. Installation company name, contact information, project manager and installation supervisor name.
  - b. Project scope including project start and end dates, building name and address, floors where installation work was completed.
  - c. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
  - d. 4-pair cable testing data including, at a minimum, test identification, cable length, pass/fail, test parameter title, test data and test time.
  - e. Installation Contractor Warranty.
  - f. Structured Cabling Manufactures Warranty.
  - g. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
  - h. Elevation and plan view drawings for cabinet and rack elevations.
- J. Acceptable copper test sets:
  - a. Fluke
  - b. Agilent Technologies
  - c. Engineer approved equal
- K. Test results must be provided prior to acceptance.

## 5.2 Communications Optical Fiber Backbone Cabling

Content in this section follows CSI Master Format Division Section 271323.

### 5.2.1 General

#### 5.2.1.1 SUMMARY

- A. This section provides the requirements for the installation of fiber optic systems. Included in this section are the product requirements for the fiber optic cables, termination hardware and required support apparatus. In addition, installation and testing requirements for fiber optic systems is included in this section.
- B. Contractor shall install all structural cabling elements in accordance with the most stringent requirements of the NEC, local building codes, ANSI/TIA/EIA commercial building wiring standards, ANSI/NECA/BICSI 568.2006 standard or current edition for installing telecommunications systems and all relevant BICSI manuals including 11th Edition. Contractor must submit shop drawings and receive approval from Owner for any deviations from standards or drawings due to field conditions.

### 5.2.1.2 SUBMITTALS

- A. Product Data:
  - a. The contractor shall submit product data sheets and samples for all products specified under this section.
  - b. Products requiring submittals and sample shall include but not limited to the following:
    - i. All Cabling and Wire
    - ii. Patch Cables
    - iii. All connectors and required tools
    - iv. All termination system components for each cable type
    - v. All equipment room and telecommunications room horizontal cable management
    - vi. All grounding system components
    - vii. All firestop systems (including manufacturer published installation requirements)
    - viii. All cable raceway and support hardware
    - ix. Other apparatus required for a complete and functional system
- B. Drawings: The contractor shall submit shop drawings.
- C. Project Closeout Test Data: The contractor shall provide test documentation.
- D. As-Built Documentation: The contractor shall submit as-built documentation.
- E. Warranty: The contractor shall provide a warranty.

## 5.2.2 Products

### 5.2.2.1 CABLE

- A. Singlemode Fiber Optic Cable (OS1-OS2)
  - a. Singlemode fiber optical cables shall have the following features:
    - i. All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic singlemode step index cables with the following operational and construction features:
      - 1. Reinforced with Aramid yarn for superior strength, no central strength member.
      - 2. Color-coded PVC buffers for easy installation, yellow jacket.
      - 3. Used for both vertical and horizontal applications in buildings.
      - 4. UL® listed type of OFNR (riser) and OFNP (plenum). All cables shall conform to Articles #700-#800 NEC-NFPA-70.
    - ii. Where armored cable is called for, cable shall be protected by flexible metal armor.
    - iii. Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound. Indoor/outdoor

rated cables shall meet the environmental spaces that they are being pulled through and placed into.

- b. Single mode fiber optic cables shall meet the following physical specifications:

Cladding Diameter:	125.0 +/- 0.7 $\mu\text{m}$
Cladding Non-Circularity:	< 1.0%
Colored Fiber Diameter:	250 +/- 12 $\mu\text{m}$
Core Diameter: 8.3 $\mu\text{m}$	
Core/Cladding Concentricity Error:	0.8 $\mu\text{m}$
Minimum Proof Strength:	0.70 Gpa (100kpsi)
Fiber Macrobend (100 turns, 75 mm diameter)	0.05dB @ 1310 nm / 0.10dB @ 1550 nm
Fiber Macrobend (1 Turn @ 32 mm diameter)	0.5dB @ 1550 nm
Coating Strip Force:	1.3 N < F < 8.9

- c. Single mode fiber optic cables shall meet or exceed the following optical specifications:

Index of Refraction:	0.37%
Mode Field Diameter	8.8 +/- 0.5 $\mu\text{m}$ @1310 nm
Attenuation (maximum):	0.34 dB/km @ 1310 nm
	0.31 dB/km @ 1383 nm
	0.21 dB/km @ 1550 nm
	0.24 dB/km @ 1625 nm
Attenuation at Water Peak:	2.0 dB/km @ 1385nm
Point Discontinuities:	<=0.05 dB
Zero-Dispersion Wavelength:	1302 - 1322 10 nm
Zero Dispersion Slope:	0.092 ps/nm <sup>2</sup> -km
Fiber Polarization Mode Dispersion for Individual fiber (maximum):	<= 0.2 ps/ $\sqrt{\text{km}}$
Cable Cutoff Wavelength	<=1260 nm

**B. 50 $\mu\text{m}$  Laser Optimized Multimode Fiber Optic Cable (OM-3/OM4+).**

- a. 50 $\mu\text{m}$  multimode fiber optical cables shall have the following features:
- i. All optical fiber cables shall be factory-fabricated, low-loss, glass-type fiber optic singlemode step index cables with the following operational and construction features:
    1. Reinforced with Aramid yarn for superior strength, no central strength member.
    2. All OCTO Owned OFCP/OFNR cables shall be bonded back to a bonding/grounding source per NEC/NFPA-70 code requirements, Article #770.114.
    3. Color-coded PVC buffers for easy installation.
    4. Aqua color-coded cable jacket.
    5. Used for both vertical and horizontal applications in buildings.
    6. UL<sup>®</sup> listed type of OFNR (riser) and OFNP (plenum). All cables shall conform to Article 800 NEC.

7. Supports 10 Gbps Ethernet applications to 300 meters or 1 Gbps to 1,000 meters.
  8. Legacy support: Ethernet, Fast Ethernet, Token Ring, ATM, FDD.
  9. Dual coating for excellent environmental performance and long-term reliability.
  10. Compliant with IEC 60793 and EIA/TIA 492 specifications.
- ii. Where armored cable is called for, cable shall be protected by flexible metal armor.
  - iii. Where indoor/outdoor cable is called for, cable shall be specifically rated for indoor and outdoor use and shall include UV-resistant flame-retardant outer jacket and dry water blocking compound.
- b. Multimode fiber optic cables shall meet the following physical specifications:

Core Diameter:	50 $\mu\text{m}$ +/- 3 $\mu\text{m}$
Core/Cladding Concentricity Error:	$\leq$ 1.5 $\mu\text{m}$
Cladding Non-Circularity:	$<$ 2.0%
Coating Diameter (uncoated):	245 +/- 10 $\mu\text{m}$
Proof Test Levels:	0.7 Gpa minimum
Operating Temperature Range:	-60o C to 85o C
Core Non-Circularity:	$\leq$ 5%
Cladding Diameter:	125 $\mu\text{m}$ +/- 2 $\mu\text{m}$
Colored Fiber Diameter:	250 +/- 15 $\mu\text{m}$
Coating/Cladding Concentricity Error:	+/- 8 $\mu\text{m}$
Minimum Tensile Strength:	100,000 psi

- c. Multimode fiber optic cables shall meet or exceed the following optical specifications:

Maximum Attenuation:	2.4 dB/km at 850 nm 0.7 dB/km at 1300 nm
Minimum Bandwidth:	3500 MHz-km at 850 nm (overfilled) 500 MHz-km at 1310 nm (overfilled) 4700 MHz-km at 850 nm (laser) 500 MHz-km at 1300 nm (laser)
Numerical Aperture:	0.200 + 0.015
Nominal Refraction Index Difference bw Peak of Core and Cladding:	1.00%
Effective Group Index of Refraction @ 850 nm:	1.483
Effective Group Index of Refraction @1300 nm:	1.479
Point Discontinuities @ 850 nm and 1300 nm:	$\leq$ 0.2 dB

5.2.2.2 CONNECTORS

A. Singlemode

a. LC

- i. All singlemode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Singlemode LC connectors must have the following features:
  - 1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
  - 2. LC connectors shall meet ANSI/TIA-568-D.3 standard and are duplexable.
- ii. Singlemode LC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Singlemode</u>
Insertion Loss	6.10 dB typical
Return Loss	<- 20 dB
Durability	500 rematings, <0.30 dBchange
Temperature Cycling	<0.30 dB Change
Material	Ferrule Tip: Ceramic Housing: Thermoplastic
Average Loss	0.2 dB, standard deviation 0.1 dB

- iii. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- iv. Acceptable manufacturers and products: Corning Cabling Systems.

b. SC

- i. Where required for use, Singlemode SC connectors must have the following features:
  - 1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
  - 2. SC connectors shall meet ANSI/TIA-568-D.3 standard and are duplexable.
  - 3. New one-step crimp ring with jacket retention.
- ii. Singlemode SC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Singlemode</u>
Insertion Loss	0.15 dB typical
Reflectance	<- 40 dB for Super PC
Durability	1000 rematings, <0.20 dBchange
Tensile Strength	20 lb, <0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule Tip: Zirconia Housing: Thermoplastic

- iii. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- iv. Acceptable manufacturers and products: Corning Cabling Systems.
- v. Where required for the Distributed Antenna System (DAS) SC Angled Polished Connectors (APC) shall be used.

c. ST

- i. Where required for use, Singlemode ST connectors must have the following features:
  - 1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
  - 2. ST connectors shall meet ANSI/TIA-568-D.3 standard.
- ii. Singlemode ST connectors shall meet the following specifications:

<b><u>Parameter</u></b>	<b><u>Singlemode</u></b>
Insertion Loss	0.15 dB typical
Reflectance	<- 40 dB for Super PC
Durability	1000 rematings, <0.20 dBchange
Tensile Strength	20 lb, <0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule Tip: Zirconia Housing: Thermoplastic

- iii. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.
- iv. Acceptable manufacturers and products: Corning Cabling Systems.

B. Multimode

a. LC

- i. All multimode cables are to be terminated with LC-duplex type connectors at each end of each strand unless specified otherwise. Multimode LC connectors must have the following features:
  - 1. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
  - 2. LC connectors shall meet ANSI/TIA-568-D.3 standard and are duplexable.
- ii. Multimode LC connectors shall meet the following specifications:



<u>Parameters</u>	<u>Multimode</u>
Interconnection	LC connectors
Compatibility	
Insertion Loss	Composite ferrule: 0.5 dB typical Standard ceramic ferrule: 0.3 dB typical
Durability	1000 rematings <0.20 dB change
Tensile Strength	20 lb, ≤ 0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule: Preradiused Zirconia Housing: Thermoplastic

iii. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.

b. SC

- i. Where required for use, SC connectors are to have the following features:
- ii. Connectors shall be on factory pre-terminated pigtails which shall be fusion spliced to the individual fiber strand.
- iii. Multimode SC connectors shall meet the following specifications:

<u>Parameter</u>	<u>Multimode</u>
Interconnection	SC connectors
Compatibility	
Insertion Loss	Composite ferrule: 0.5 dB typical Standard ceramic ferrule: 0.3 dB typical
Durability	1000 rematings, < 0.20 dB change
Tensile Strength	20 lb, ≤ 0.20 dB change
Temperature Cycling	-40o C to + 80oC, 40 cycles, <0.30 dB change
Material	Ferrule: Preradiused Zirconia Housing: Thermoplastic

iv. Contractor shall provide all consumable and incidental material required for proper termination of all fiber optic connectors.

5.2.2.3 *TERMINATION HARDWARE*

- A. Contractor shall provide and install fiber optic patch panels as indicated on drawings.
- B. 144 Port Fiber Optic Fiber Termination Shelves.
  - a. 144 port fiber optic Fiber Termination Shelves are to have the following features:
    - i. 144 Port
    - ii. 4 RU height max
    - iii. 19" rack mountable
    - iv. Front loading panels
    - v. Fully loaded with bulkheads as required

- vi. Comply with ANSI/TIA-606-C labeling
- vii. Front cable management rings
- C. 48 Port Fiber Optic Fiber Termination Shelves.
  - a. 48 port fiber optic Fiber Termination Shelves are to have the following features:
    - i. 48 port
    - ii. 1 RU height Maximum
    - iii. 19" rack mountable
    - iv. Front loading panels
    - v. Fully loaded bulkheads as required
    - vi. Comply with ANSI/TIA-606-C Labeling
    - vii. Front cable management rings for patch cord slack.

#### 5.2.2.4 PATCH CORDS

- A. The contractor shall provide each of the following patch cords to the DC-Net Project manager when required for DC-Net installation of network and/or workstation equipment.
- B. All patch cords are to be factory fabricated.
- C. All patch cords are to be the recommended series intended by the manufacturer to integrate with the installed cable segments and termination hardware. All patch cords are to be manufactured by the same vendors as the optical fiber cable and hardware.
- D. Contractor shall provide patch cords in the quantities indicated in the drawings. Contractor shall provide a schedule of all cords indicating the planned lengths, quantities and colors to DC-Net for approval prior to placing any orders for cords.

#### 5.2.2.5 SUPPORTING HARDWARE

- A. Use only the manufacturer's approved cable supporting hardware such as split mesh support grips (Kellum grips) or messenger wire approved for use.
- B. Messenger Wire shall be rated such that the planned installation weight of the cabling shall not exceed 60% of the rated breaking strength.

### 5.2.3 Execution

#### 5.2.3.1 GENERAL

- A. Optical fiber cabling shall be provided between facilities and furnished with the quantity of fibers as designed on the contract drawings. All fiber cable runs shall be from the same manufacturer and shall be of the same type.
- B. Design shall allow for migration of the pull-through, interconnect or splice implementation to a cross-connection implementation. Sufficient space shall be left in the telecommunications room to allow for the addition of patch panels needed for the migration of the pull-through, interconnect or splice to a cross-connection. Sufficient cable slack shall exist in the telecommunications room to allow movement of the cables when migrating to a cross- connection.

- C. Fiber cable shall have enough cable slack at the termination point to allow for routing cable through the termination hardware and back to a work table for fiber terminations, plus an additional 3 meters.
- D. Slack may be stored as either cable or unjacketed fiber. Slack storage shall provide bend radius control so that the cable and fiber bend radius limitations are not violated. Fiber slack shall be stored in a protective enclosure and slack cable may be stored on walls, cable trays or enclosures within the telecommunications.
- E. All cabling shall be labeled per specifications.
- F. All armored and non-armored fiber optic cable shall be run in conduit/innerduct. Multiple fiber cables may be run in a single conduit/innerduct.
- G. Contractor shall adhere to ANSI/TIA/EIA 568-D/569-D specifications regarding bend radius, maximum tensile strength, and maximum vertical rise.
- H. The use of field terminated connectors shall be limited to backbone cabling, campus cabling, or vendor specific requirements.
- I. All fiber optic cabling shall be terminated with either SC or LC connectors unless a vendor specific requirement requires a different type of connector for a specific and limited application.
- J. The following installation practices shall be followed:
  - a. Fiber optic cable sheaths are not permitted to be deformed. Use only approved cable fasteners such as hook and loop.
  - b. Do not pull fiber optic cabling with copper cabling.
  - c. Do not exceed the fiber optic cable maximum pulling tension.
  - d. In multiple fiber optic pulls, pull fiber optic cables of the same weight and design.
  - e. Do not exceed the maximum pulling tension of the lowest rated fiber optic cable.
  - f. Do not pull fiber optic cable over existing cables. Friction could be excessive and cause damage.
  - g. Do not exceed maximum bend radius, both pulling and installed radius.
  - h. Do not pull fiber optic cable around sharp corners such as support brackets, rods, etc.
  - i. Protect fiber optic connectors when using pre-connectorized cables. Use approved pulling grips.
  - j. The use of lubricants is recommended for all fiber optic cable pulls. Lubricants should be approved for use with the fiber optic cable type. Never use detergent based lubricants when installing loose tube fiber optic cable.
- K. Non-armored fiber optic cables installed within conduit shall be protected by using innerduct. If fiber optic cable is to be installed in conduit without any innerducts, the installer shall install innerducts to sectionalize the conduit. Each innerduct shall have pull tapes/line in each empty innerduct.
- L. Fiber optic cables are not permitted to provide support for other cables or hardware. Never secure other cables or hardware to fiber optic cabling. Cable that is individually supported may be taped or tied together every 3 meters for cable management but not for support.
- M. When routing fiber optic cabling along walls to the termination or splice enclosure, protect fiber optic cabling by installing in innerduct. Place fiber optic warning signs

along innerduct. Ensure there is enough cable slack to be able to be able to move the fiber optic termination hardware to any potential installation area in the room.

- N. Fiber optic cabling termination shall follow the ANSI/TIA/EIA 598 color code chart. To retain the correct polarity through the cabling system, the correct fiber polarity must be followed. Fiber cabling must be installed to pair an odd-numbered fiber with the next sequential even-numbered fiber. Each fiber pair shall be installed in a pair crossover orientation. Off-numbered fibers at position A at one end are at position B at the other end. Even-numbered fibers are at position B at one end and position A at the other end.

#### 5.2.3.2 *INSIDE PLANT FIBER*

- A. Riser cable shall be supported on every other floor using cabling manufacturer approved supporting hardware.
- B. Vertical fiber optic cable placement shall be installed by working from the top down when possible.
- C. Install a split wire mesh support grip at the top of each run. Fiber optic cable shall have its own split wire mesh support grip at the top of the run.
- D. Fiber shall be provided between the TCs and ER and provided with twelve (12) strands as designated on the contract drawings.
- E. All fiber shall be from the same manufacturer. A mix of fibers from different manufacturers may not be used without written permission.
- F. All Multimode Fiber shall meet the following specifications:
  - a. Fibers shall comply with ANSI/TIA-492A specifications and IS 11801 standards.
  - b. Fibers shall have dual wavelength capability; transmitting at 850 and 1300nm ranges.
  - c. All fibers shall be color coded to facilitate individual fiber identification.
  - d. Fibers shall have D-LUX<sup>®</sup> coating or approved equivalent to ensure color retention, minimize microbending losses and improve handling. The coating shall be mechanically strippable.
  - e. Short Term: 340 lbs. Long Term: 170 lbs.

#### 5.2.3.3 *PATCH CABLES*

- A. Patch color codes are determined by their fiber type OM3 cable shall be aqua colored. OS1-OS2 shall be yellow.
- B. Excessive patch cord lengths are not permitted. All patch cords shall be appropriately sized while maintaining proper cable bend radius.

#### 5.2.3.4 *TESTING*

- A. The contractor shall test all optical fiber cable prior to the installation of the cable. The contractor shall assume all liability for the replacement of the cable if it is found defective later.
- B. Test equipment shall be specifically rated for the cabling being tested, properly configured, and calibrated per manufacturer's requirements.

- C. Loss Budget:
- a. Loss budget. Contractor shall provide calculations indicating the maximum loss budget for each fiber using the following formula.
  - b.  $(\text{Allowable cable loss per KM}) * (\text{KM of Fiber in Link}) + (\text{MFR Published Connector Loss}) * (\text{Number of Connectors}) \text{ loss} = \text{Maximum Allowable Loss}.$
  - c. The contractor shall provide loss budgets to DC-Net for review prior to testing.
  - d. The contractor shall notify Dc-Net in writing a minimum of 72 hours prior to the start of testing and provide a complete testing schedule to allow for witnessing of testing.
  - e. The contractor shall submit calibration certificate(s) indicating that the test set(s) has been calibrated by the manufacturer. No test shall be performed with a test set that has not been calibrated within 6 months prior to testing.
  - f. End-to-end loss shall be less than the loss budget. Any link not meeting the requirements of the standard shall be brought into compliance by the contractor, at no cost to DC-Net.
- D. Test Data:
- a. No handwritten test results will be accepted. Complete, end-to-end test results and loss budget calculations must be submitted to DC-Net in both electronic format (CD or DVD format) and hard copy. If special software or license is required to review test data electronically contractor shall provide one copy of software and appropriate license with the test data.
  - b. Test data shall reflect the DC-Net labeling scheme.
  - c. A sample Test Instrument Data Sheet is attached.
  - d. A sample Reference Power Measurement Form is attached.
- E. Project closeout report shall include the following:
- a. Installation company name, contact information, project manager and installation supervisor name.
  - b. Project scope including project start and end dates, building name and address, floors where installation work was completed.
  - c. Project summary including number of work areas or equipment cabinets/racks cabled, total number of drops and type of cabling system installed. List the types of backbone cabling installed, number of backbone space locations, and number of connections terminated. List any special or unique information regarding site conditions.
  - d. Fiber optic loss test data and OTDR test data including, at a minimum, test identification, pass/fail, test parameter title, test data and test time.
  - e. As-built drawings showing cable placement pathways and termination spaces (work areas, telecommunications rooms, equipment rooms, entrance facilities, etc.).
  - f. Elevation and plan view drawings for cabinet and rack elevations.
- F. Multimode:
- a. Testing shall be performed on all fibers in the completed end to end system. Testing shall consist of a bi-directional end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all

multimode strands over 100 meters) and bi-directional end-to-end light source-power meter test (all multimode strands). All tests shall be performed in accordance with ANSI/TIA-568-D.3 and ANSI/TIA-526-14A Method B: Intra-building or Riser. The system loss measurements shall be provided at 850 and 1300 nanometers for all fibers.

- b. Acceptable multimode fiber optic test sets:
  - i. Noyes
  - ii. Corning Cable Systems
  - iii. Alcoa Fujikura
  - iv. Tektronix
  - v. Engineer approved equal
- c. Acceptable tests for light source-power meter testing of multimode fiber optic cables:
  - i. Agilent Technologies
  - ii. Corning Cable Systems
  - iii. Fluke
  - iv. Engineer approved equal

G. Singlemode:

- a. Testing shall be performed on all fibers in the completed end-to-end system. Testing shall consist of a bi-directional end-to-end optical time domain reflectometry (OTDR) trace (all singlemode strands) and a bi-directional end-to-end lightsource-power meter test (all singlemode strands). All tests shall be performed in accordance with ANSI/TIA-568-D.3 and ANSI/TIA-526-7 method A and method B. The system loss measurements shall be provided at 1310 and 1550 nanometers for all fibers.

# 6 Communications Horizontal Cabling

Content in this section follows CSI Master Format Division 271500.

See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92

## 6.1 General

- A. This section provides the requirements for the installation of 4-pair unshielded twisted pair channels and special systems cabling for distributed antenna system, Wi-Fi antennas and security system. Included in this section are the product requirements, installation requirements and testing requirements for the cable channels. Contractor shall provide a complete and operational, as well as tested and documented 4-pair UTP system.

### 6.1.1 Submittals

- A. Product Data:
- a. The contractor shall submit product data sheets and samples for all products specified under this section.
  - b. Products requiring submittals and samples shall include but not limited to the following:
    - i. All cabling and wire
    - ii. Patch cables
    - iii. All connectors and required tools
    - iv. All termination system components for each cable type
    - v. All equipment room and telecommunications room horizontal cable management
    - vi. All grounding system components
    - vii. All firestop systems (including manufacturer published installation requirements)
    - viii. All cable raceways and support hardware
    - ix. Other apparatus required for a complete and functional system
  - c. Drawings: The contractor shall submit shop drawings.
  - d. Project closeout data: The contractor shall submit test documentation.
  - e. As-Built Documentation: The contractor shall submit As-Built documentation.

## 6.2 Products

### 6.2.1 Category 6 Channels

#### A. Cable

- a. All Category 6 UTP cables shall consist of a 4-pair, 23/24 gauge solid conductor UTP and shall terminate on 8-pin modular jacks at each information outlet.
- b. All cable jacket material shall conform to article 800 NEC for use as plenum or non-plenum cables. Cables shall be UL<sup>®</sup> type CMP (plenum), CMR (riser) or type CM (general) as appropriate. All cables running in raised floor space shall be plenum rated.
- c. All cable shall be tested and guaranteed to meet or exceed the requirements for Category 6 performance as defined in ANSI/TIA-568-D.2 and be part of the UL<sup>®</sup> LAN certification and follow-up program.
- d. Category 6 cables are intended for use in data applications including but not limited to 100Base-T, 1000Base-T, and 1000Base-TX.
- e. Cable shall have the following electrical requirements in accordance with ASTM D4566:
  - i. Resistance  $\leq 9.38$  ohms per 100m at 20°C
  - ii. Resistance unbalance between 2 conductors of any pair  $\leq 5\%$  at 20°C
  - iii. Capacitance @1 kHz @20°C  $\leq 330$  pF/100m
  - iv. Characteristic impedance 100 ohms + 15% from 1MHz to highest referenced frequency.
- f. Cables shall meet the following physical requirements:
  - i. Shall consist of four (4) 23/24 AWG twisted pairs.
  - ii. Shall be suitable for the environment in which they are to be installed.
  - iii. The overall diameter of the cable shall be less than 0.25 inches.
  - iv. Cable shall withstand a bend radius of 4 times the cable diameter at -20°C without damage to jacket or insulation and shall have min. ultimate breaking strength of 90 lb./ft.
- g. Provide all installation materials and consumables including straps, mounting hardware, hangers, fire stop material, labels, etc.
- h. Plenum shall be plenum rated and meet applicable requirements of ANSI/ICEA S-80-576 for plenum. All four pairs must be insulated with F.E.P. No constructions that use mixed insulation materials will be allowed.

#### B. Telecommunications Outlets

- a. Category 6 Information Outlets shall meet the following requirements:
  - i. All Category 6 information outlets shall meet or exceed NEXT and all other Category 6 transmission performance requirements for connecting hardware, as specified in ANSI/TIA-568-D.2 Commercial Building Telecommunications Cabling Standard and be part of the UL<sup>®</sup> LAN Certification and Follow-up program.



- ii. All Category 6 information outlets shall be capable of being utilized in a modular patching situation or as a modular telecommunication outlet (TO) supporting all intended data applications including but not limited to 100Base-T, 1000Base-T, and 1000Base-TX.
  - b. Faceplates
    - i. UL® listed and CSA certified.
    - ii. Constructed of high-impact, ABS plastic UL® 94V-0 construction (except where noted otherwise).
    - iii. Faceplates shall be available in a variety of colors to match other utilities or raceways installed.
    - iv. Possess recessed designation windows to facilitate labeling and identification.
    - v. Shall include a clear plastic cover to protect labels in the designation window.
    - vi. Have mounting screws located under recessed designation windows.
    - vii. Comply with ANSI/TIA-606-C labeling specifications.
    - viii. All unused ports shall have a blank cover.
- C. Termination Hardware
  - a. Patch Panels
    - i. Patch panel shall be high density such that 24-ports occupy 1 rack unit and 48-ports occupy 2 rack units, and 96-ports occupy 4 rack units.
    - ii. Shall use Category 6, UMJ8 RJ45 jacks in 6- or 8-port modules
    - iii. Patch panel jack (UMJ 8 position/8 conductor) shall terminate to a 110Dtype insulation displacement contact, printed circuit board or lead frame mounted connector.
    - iv. Patch panel jack shall be universal modular jack, 8 positions, un-keyed unless noted otherwise.
    - v. Patch panel jack shall support termination of 22, 24 and 26 AWG solid conductor, four pair, unshielded twisted pair copper cable.
    - vi. Patch panel shall have cable management bar to ensure proper bend radius and strain relief.
    - vii. Patch panel shall accept color-coded identification tabs and port protecting shutters.
    - viii. Patch panel shall be compliant with ANSI/TIA-606-A labeling specifications.

## 6.3 Execution

### 6.3.1 Cable Routing and Installation

- A. All communications cabling used throughout project shall comply with the requirements of the National Electrical Code (NFPA 70) Articles; 90, 100, 250, 300, 725, 760, 770, 800

and Chapter #9 in addition to all local building codes per DCRA/DCMR or AHJ. All copper cabling shall bear CM, CMR, CMP and/or other appropriate markings for the environment in which they are installed.

- B. Cables running in cable tray or duct shall not be bundled. Cables in these areas shall be loosely arranged to minimize alien crosstalk.
- C. Structural concrete on steel members shall not be drilled or pierced without prior approval from a licensed structural engineer and the authority having jurisdiction.
- D. All cable shall be installed utilizing an independent cabling support system. Cables shall not be attached to ceiling grid supports and shall not be laid directly on the ceiling grid. Cables shall not be attached to conduits, pipes, or ducts.
- E. Cable shall not be attached to or supported by fire sprinkler systems components or any environmental sensor located in the ceiling space.
- F. All cable runs between the termination hardware and the telecommunications outlet shall be continuous without any splices.
- G. Contractor shall schedule work under this contract in a manner to complete all above ceiling work prior to the installation of ceiling tile. If ceiling tiles are to be removed, the Contractor shall coordinate the activity with other trades.
- H. Cabling shall not be run adjacent to or parallel to power cabling on fluorescent lighting fixtures.
  - a. Maintain at least 6 inches of clearance away from fluorescent light fixtures and electrical conductors up to 2 kVA.
  - b. Maintain at least 24 inches of clearance away from electrical conductors up to 5 kVA.
  - c. Maintain at least 36 inches of clearance away from electrical cabling more than 5 kVA.
  - d. When cabling is required to crossover electrical conductors, they must do so at a 90-degree angle.
  - e. Electrical cabling is not permitted to lie on top of communications cabling.
- I. J-Hooks installation spacing shall meet or exceed the manufacturer or local code requirements. Standard J-hook spacing is not to exceed 5 feet on center. No more than 48 cables are permitted per J-hook unless cabling manufacturer installation requirements permit it. Cables installed in J-hooks shall be secured using approved cable ties.
- J. Cable Trays shall be securely fastened in place using approved materials and methods as recommended by the manufacturer or AHJ. All supporting rod installation intervals shall be for the full load rating of the cable tray, not the rating of the tray with the planned volume of cabling. Cable fill for cable trays is not to exceed 40% of the maximum fill capacity rating of the support allowed by the manufacturers or local AHJ.
- K. Cabling placed in ceiling spaces shall maintain:
  - a. 3 inches of clear vertical space above cabling and conduits.
  - b. 12 inches of clear vertical space above the cable tray.
  - c. 3 inches of clear vertical space between the top of the ceiling grid and the bottom of the cable tray.

- d. 3 inches of clear vertical space between the top of the ceiling grid and structured cabling.
- e. Cabling passing from fire rated areas shall be fire stopped to meet local and national codes.
- f. Cabling passing from one floor level to another should be fire stopped unless cabling is placed inside a fire rated shaft and meets the approval of the AHJ.
- L. All telecommunications cabling installed within ceiling spaces or below raised access floors shall be routed parallel or perpendicular to building structure.
- M. The minimum bend radius, under no-load conditions, for 4-pair UTP cables shall be one (1) inch or four times the diameter of the cable across its major axis, whichever is greater.
- N. Open cable tray fill ratio shall not exceed 30% or as allowed by code or the AHJ.
- O. Cable fill-in conduits and enclosed raceways shall not exceed 38% or as allowed by code or the AHJ (Per NEC/NFPA-70: 1-Cable 53%, 2-Cables 31% and 3 or More Cables 40%).
- P. All cabling shall be labeled per specifications and as indicated on drawings.

### 6.3.2 Horizontal Cabling

- A. Contractor shall provide horizontal cables to connect each telecommunications outlet to the backbone subsystem on the same floor unless noted otherwise.
- B. Terminate each horizontal cable onto a dedicated telecommunications outlet and onto termination hardware in the Telecommunications Room (TR).
- C. Unless noted otherwise on the telecommunications drawings or elsewhere within this document, the type of horizontal cables used for each telecommunications outlet shall be 4-pair unshielded twisted pair (UTP).
- D. The 4-pair UTP cables shall be installed using a star topology from the Telecommunications Room (TR) to each individual telecommunications outlet. All cable routes shall be submitted and approved by DC-Net prior to installation of any cabling.
- E. The length of each run of horizontal cable from the termination point in the TR on each floor to the telecommunications outlet shall not exceed 295 feet (90M).

### 6.3.3 Voice Cabling

- A. Cabling for all locations shall be four (4) pair, unshielded, Category 6+ plenum-rated jacket from each jack to a Patch Panel in Communications Closet. Horizontal Category 6+ cabling and components shall be as specified in "Data Cabling System."
- B. All Voice Outlets shall be identical to Cat6 data outlets specified below for the data cabling system.
- C. All backbone cable pairs shall be end-to-end terminated on Category 6 110 type mass termination blocks.
- D. Voice Backbone:

- a. Unshielded 24 AWG multi-pair copper cables shall be used as the vertical riser cables to connect the TCs to the ER. The cable shall support voice and low speed data.
- b. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation. The multi-pair copper cables shall be in non-plenum form and placed in conduit as required.
- c. The cable shall consist of solid-copper conductors insulated with expanded polyethylene covered by a Plenum-Rated skin, be conformance tested to meet ANSI/EIA-568A for Cat6 cables, be UL7 Listed as CMP. The copper riser cable shall meet or exceed the following electrical specifications listed below:

i. Electrical Specifications:

Average DC Resistance	26.5Ω/1,000 ft (8.7Ω/100m), maximum
Average DC Resistance Unbalance	1.7%, maximum
Mutual Capacitance @ 1kHz	16 nF/1000 ft (5.25 nF/100 m), maximum
Capacitance Unbalance (pair to ground)	201pF/1,000 ft (65.94 pF/100m) maximum

ii. Attenuation (db/100 m):

Frequency	Attenuation (Max.)
1.00 MHz	2.3 dB
5.00 MHz	4.9 dB
10.00 MHz	8.5 dB
16.00 MHz	12 dB

iii. Near-End Crosstalk (NEXT) dB/100 m [328 ft]:

Frequency	Pair-to-Pair NEXT (Max.)
1.00 MHz	13.8 dB
4.00 MHz	11.2 dB
10.00 MHz	10.2 dB
16.00 MHz	9.2 dB

- iv. Cable shall be available in 25 pair counts. UL7 Listed for Fire Safety. ISO 9001 Certified Manufacturer.

### 6.3.4 Data Cabling

- A. Provide a complete data communications system consisting of the following:
  - a. Accessories and Appurtenances

- b. Cable Management Devices
- c. Fiber Optic Cable and Terminators (as indicated on drawings)
- d. Copper and Fiber Patch cables
- e. Remote Jacks
- f. Termination/Patch Panels
- g. Twisted Pair Data Cables

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# 7 Work Areas

This section provides basic specifications, installation instructions, and utilization guidance for work products and materials. For DC-Net products and services, see <http://servicecatalog.dcnet.dc.gov/>.

See reference sections:

- “Acronyms and Definitions” on page 89.
- “Codes and Standards” on page 92.

## 7.1 Work Area Outlets

- A. All Category 6 work area outlets shall meet or exceed NEXT and all other Category 6 transmission performance requirements for connecting hardware, as specified in ANSI/TIA-568-D.2 Commercial Building Telecommunications Cabling Standard and be part of the UL® LAN Certification and Follow-up program.

## 7.2 Indoor Wi-Fi Access Points

### 7.2.1 Acceptable Wi-Fi AP Models

Acceptable AP models are listed in the DC-Net services pricing guide.

- For DC-Net District government customers, see: <http://servicecatalog.dcnet.dc.gov/> (available through dc.gov user access).
- For Community Anchor customers, see <https://dcnet.dc.gov/publication/community-anchor-services-pricing-guide> (available on public Website).
- For Federal government customers, see <https://dcnet.dc.gov/publication/dc-net-federal-services-pricing-guide> (available on public Website).

### 7.2.2 Design and Installation

1. Wi-Fi Design
  - a. OCTO designs in-building Wi-Fi for District-managed Wi-Fi systems. (Under extenuating circumstances, a partner agency may complete design and installation; in this case, OCTO identifies risks to quality of service and will turn over user experience helpdesk tickets to customer agency.)
  - b. Customer to provide to OCTO complete floorplan indicating telecom closet that will serve the data patch cords.
2. Acquire materials per design requirements.
  - a. External – customer purchase
  - b. Internal – OCTO

3. Complete horizontal cabling per OCTO requirements.
  - a. Process:
    - i. External – DGS/customer agency vendor installs cabling.
    - ii. Internal – OCTO installs cabling.
  - b. Requirements:
    - i. Use two Cat 6 cable patch cords for each wireless AP. Cable patch cords must be orange.
    - ii. Terminate all Cat 6 cables in the designated locations on Cat 6 Keystone style Jack.
    - iii. Do not use RJ45 for direct termination.
    - iv. Whoever installs horizontal cabling, conducts end-to-end cable testing and provides test results.
4. Install APs following OCTO design and specifications.
  - a. Options for who can install APs:
    - i. External – DGS/customer agency vendor installs APs.
      1. Provide inventory and Mac address of APs.
      2. OCTO creates label or customer vendor creates label per OCTO labeling standard and provides as-built AP installation document to OCTO that includes floor plan, AP location, and exact label information. See “Labeling .
    - ii. Internal – OCTO installs APs.
  - b. Mount APs per OCTO guidelines.
    - i. General guidelines:
      1. Place all wireless APs to be aesthetically compatible with their environment.
      2. APs have a universal mounting bracket that will either snap on the ceiling metal grid or affix to the wall. Mount to the ceiling grid.
    - ii. Mounting guidelines:
      1. Drop ceilings 12 ft. or less– mount on ceiling grid.
      2. Solid ceilings and ceilings above 12 ft. – mount on wall.
        - a. Mount 8 ft. above floor.
        - b. Use a surface mount box with Cat 6 Keystone style jacks with a printed label and a written label. For example: Panduit CBX2WHAY, Hellermann Tyton SMBDUAL-W or similar product line.
        - c. Surface mount box dimensions must be close to 4.9"H x 3.25"W x 1.8"D.
        - d. Anchor all surface mount raceway and boxes to the drywall using 1/8" toggle bolts or twist and lock screw anchors.
          - i. 1/8" toggle can safely hold 30 lbs. on 1/2" drywall.
          - ii. Twist and lock screw anchors support up to 75 lb. on 1/2" drywall.

- e. Do not use the double-sided tape that typically comes with the surface mount boxes for mounting.
5. Terminate end-points.
- a. Terminate at the AP
    - i. Wi-Fi cables must be different from data cable.
  - b. Terminate at the telecommunications closet
    - i. Patch panel labeling – Whoever runs horizontal cabling (step 3) terminates.
    - ii. Patching to network equipment – OCTO terminates.

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## 8 Acronyms and Definitions

ACEG – Alternating Current Equipment Ground

ADA – Americans with Disabilities Act

ADAAG - ADA Accessibility Guidelines

AHJ - Authority Having Jurisdiction

ANSI - American National Standards Institute

APC - Angled Polished Connectors

ASTM - American Society for Testing Materials

ATR - Above using threaded rods

BCT – Bending Conductor for Telecommunications

BICSI - Building Industry Consulting Service International

CPVC - Chlorinated Polyvinyl Chloride

Conditioned – Spaces directly provided with heating and cooling.

Contractor – Person or team who will install, test, modify, or remove District government owned or operated communications infrastructure or who is responsible for overseeing these tasks, such as District government employees, telecommunications contractors, or 3rd party vendors.

CSI - Construction Specifications Institute

DAS - Distributed Antenna System

DP – Demarcation Point. The provider Outside Plant (OSP) cable point of entry to the rack/cabinet termination point – at a panel or switch – commonly located in the basement.

EDP – Electrical Distribution Panel

EF – Entrance Facility

EIA - Electronic Industries Alliance

EDP – Electrical Distribution/Branch/Feeder Panels

EMI – Electromagnetic Interference

EMT – Electrical Metallic Tubing

ER – Equipment Room

Finished Space – Space other than mechanical rooms, electrical rooms, furred spaces, pipe chases, and unheated spaces immediately below roof, space above ceilings, unexcavated spaces, crawl spaces, tunnels, and interstitial spaces.

FMC - Flexible Metal Conduit

GE – Ground Equalizer

GEC – Grounding Electrode Conductor

HVAC - Heating Ventilation and Air Conditioning

IC-BD – Interconnecting Cross-Connect/Building Distributor

ID - Interior diameter

IDF - Intermediate Distribution Frame. See also Telecommunications Room

IEEE - Institute of Electrical and Electronic Engineers

Junction Box – Pullbox wherein a conduit run transitions from a feeder conduit to multiple distribution conduits.

LAN – Local Area Network

LEA - Local Education Agency

MC - Main Cross-Connect

MC-CD – Main Cross Connect/Campus Distributor

MDF - Main Distribution Frame. See also Equipment Room.

NEC - National Electrical Code

NEMA - National Electrical Manufacturers Association

NESC - National Electrical Safety Code

NEXT - Near-End Crosstalk

NVR - Network Video Recorder

O&M Manual - Operating and Maintenance Manual

OD - Outer diameter

OSHA - Occupational Safety and Health Act

OTDR - Optical Time Domain Reflectometry

PB – Polybutene

PBB – Primary Busbar. There is typically one (1) PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

Pullbox – Metallic box with a removable cover, used to assist pulling cable through conduit runs longer than 100' or in which there are more than 180 degrees of bends. Pullboxes shall have no more than one (1) conduit entering and one (1) conduit exiting the box.

PVC – Polyvinyl Chloride

RCDD – Registered Communications Distribution Designer

Raceway – Any enclosed channel for routing wire, cable or busbars.

RMC – Rigid Metal Conduit

RNC – Rigid Nonmetallic Conduit

SBB – Secondary Bonding Busbar. There is typically one (1) SBB per Telecommunications Room. The SBB is connected both to the PBB and to the building structural steel or other permanent metallic systems.

SCS - Structured Cable Systems

SMR – Surface Metal Raceway

TBB – Telecommunications Bonding Backbone

TC – Telecommunications Closet

TDMM – BISCI Telecommunications Distribution Methods Manual

TE – Telecommunications Enclosure

TEBC – Telecommunication Equipment Bonding Conductor

TBB – Telecommunications Bonding Backbone. The TBB is a conductor used to connect PBBs to SBBs. It is optional. Building Steel and EDPs (Electrical Distribution Panels) are now recommended as general equalization points due to impedance related issues associated with TBBs.

TGB/SBB - Telecommunications Grounding Busbar/Secondary Bonding Busbar

TIA – Telecommunications Industry Association

TMGB/PBB - Telecommunications Main Grounding Busbar/Primary Bonding Busbar. There is typically one (1) PBB per building, located in the main telecommunications room. This busbar is directly bonded to the electrical service ground.

TO – Telecommunication Outlet

TR – Telecommunications Room

TR-HC-FD – Telecommunications Room/Horizontal Cross Connect/Floor Distributor

UCC – Unified Communication and Collaboration

UI – User-Interface

UTP – Unshielded Twisted Pair

WAN – Wide Area Network

Unconditioned – Spaces without heating or cooling including ceiling plenums.

## 9 Codes and Standards

The pertinent portions of the following codes, regulations, specifications, and standards shall be incorporated by reference into these specifications. Note:

- Codes are mandatory; standards are optional.
- For codes and standards, the latest editions/publications shall apply.
- Where two codes are referenced, the more stringent codes shall apply.

Links to standards are provided in case they apply to any other platforms or applications associated with OCTO's ICT infrastructure or networking systems.

### 9.1 Adherence to DC Municipal Regulations

OCTO/DC-Net applies all current and applicable industry standards, codes, and DC Department of Consumer and Regulatory Affairs/DC Municipal Regulations (DCRA-DCMR) requirements for telecommunications environments and the ICT services that it provides as a government-owned access and service provider.

For current DCRA-DCMR codes, see: <https://codes.iccsafe.org/public/chapter/content/9172/>

### 9.2 General

The NEC-NFPA-70 2011 Edition was the current accepted NFPA in the District of Columbia as it pertains to the DCRA-DCMR. The current released NEC-NFPA-70 is the 2017 Edition.

1. National Electrical Code (NEC 2011-2017 Editions)
2. National Electrical Safety Code (NESC: IEEE C.2-2017)
3. Occupational Safety and Health Act (OSHA)
4. ANSI/TIA-526-7 – Measurement of Optical Power Loss of installed Singlemode Fiber Plant Cable.
5. ANSI/TIA-758-B – Customer Owned Outside Plant Telecommunications Cabling Standard.
6. ANSI/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers.
7. ASTM A653 – Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process, Structural (Physical) Quality.
8. ASTM A123 – Specification for Zinc (Hot Galvanized) Coatings on products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip.
9. ASTM A1011 – Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with improved Formability.
10. ASTM A1008 – Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy Formability.
11. ASTM B633 – Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
12. NEMA VE 1 – Metallic Cable Tray Systems

## 13. NEMA VE 2 – Cable Tray Installation Guidelines

### 9.3 Firestopping

1. ASTM E 814, “Fire Tests of Through Penetration Firestops”
2. ANSI/UL1479, “Fire Tests of Through Penetration Firestops”
3. ASTM E90, “Standard Test Method for Laboratory Measurement of Airborne
4. Sound Transmission Loss of Building Partitions and Elements”
5. Underwriters Laboratories Inc. (UL) – Fire Resistance Directory
6. National Fire Protection Association (NFPA) – NFPA 101: Life Safety Code
7. National Fire Protection Association (NFPA) – NFPA 70: National Electrical Code
8. ANSI/TIA-1179-2010 “Healthcare Facility Telecommunications Infrastructure Standard”
9. ANSI/TIA-EIA-569 “Commercial Building Standard for Pathways and Spaces”

### 9.4 Communications

1. ANSI/TIA-568-D.0-D.4: Commercial Building Telecommunications Cabling Standard
2. ANSI/TIA-569-D: Commercial Building Standard for Telecommunication Pathways and Spaces
3. ANSI/TIA-606-C: The Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
4. ANSI/TIA-607-C: Commercial Building Grounding and Bonding Requirements for Telecommunications
5. ISO/IEC IS 11801: Generic Cabling for Customer Premises
6. BICSI ITSIMM: BICSI Telecommunications Cabling Installation Manual #7.
7. BICSI TDMM: BICSI Telecommunications Distribution Methods Manual #13.
8. BICSI CO-OSP: BICSI Customer-Owned Outside Plant Design Manual #6

### 9.5 Equipment Room Fittings

1. ANSI/NFPA 70 – National Electrical Code (NEC) Articles 250, 300 and 645
2. ANSI/TIA-568-D.0- Generic Telecommunications Cabling Standard
3. ANSI/TIA-568-D.1- Commercial Building Telecommunications Cabling Standard
4. ANSI/TIA-568-D.2- Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components, including applicable addendum.
5. ANSI/TIA-568- D.3 – Optical Fiber Cabling Components Standard
6. ANSI/TIA-569- D – Commercial Building Standard for Telecommunications Pathways and Spaces
7. ANSI/TIA -604 Series – Fiber Optic Connector Intermateability Standards
8. ANSI/TIA-606-C – Administration Standard for Telecommunications Infrastructure of Commercial Buildings

9. ANSI/TIA-607-C – Commercial Building Grounding and Bonding Requirements for Telecommunications
10. BICSI Telecommunications Distribution Methods Manual
11. FCC CFR 47 Part 68 – Connection of Terminal Equipment to the Telephone Network

## 9.6 Underground Ducts and Raceways

1. NEC/NFPA 70 (2011-2017 Editions)
2. IEEE C.2 2017/NESC
3. NEMA
  - a. NEMA, RN1, PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit
  - b. NEMA, TC3, PVC Fittings for use with Rigid PVC Conduit and Tubing
  - c. NEMA, TC6, PVC and ABS Plastic Utilities Duct for Underground Installation
  - d. NEMA, TC8, Extra Strength PVC Plastic Utilities Duct for Underground Installation
  - e. NEMA, TC9, Fitting for ABS and OVC Plastic Communications Duct and Fittings for Underground Installation
  - f. NEMA, TC10, PVC and ABS Plastic Communications Duct and Fittings for Underground Installation
4. UL Standards
  - a. UL 6 Rigid Metal Electrical Conduit
  - b. UL 651 Schedule 40 and 80 PVC Conduit
5. ANSI-C80.2 Specification for Rigid Steel Conduit, Enameled
6. ANSI/TIA-569-D Commercial Building Standard for Telecommunications Pathway and Spaces
7. ANSI/TIA-607 Commercial Building Grounding and Bonding Requirements for Telecommunications
8. ANSI/TIA-758-B/C Customer Owned Outside Plant Telecommunications Cabling Standard
9. BICSI TDMM – latest edition applies
10. BICSI Outside Plant Design Reference Manual – latest edition applies

## 9.7 Communications Backbone Cabling

1. NFPA 70 National Electric Code.
2. Authority having jurisdiction (AHJ)
3. Local Building Codes
4. UL® for wiring: UL® Standard 910 “Test method for fire and smoke characteristics of cable used in air handling spaces.” Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program. UL® Standard 1666 “Test for Flame Propagation Height of Electrical and Optical- Fiber Cables Installed Vertically in Shafts.”

5. American National Standards Institute/Telecommunications Industry Association (ANSI/TIA), including associated Addenda:
  - g. ANSI/TIA-568-D.1 -Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements
  - h. ANSI/TIA-568-D.3 -Commercial Building Telecommunications Cabling Standard, Part 3 Optical Fiber Cabling Components Standard
  - i. TIA-569-D - Commercial Building Standard for Telecommunications Pathways and Spaces
  - j. ANSI/TIA-606-C - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
  - k. ANSI-J-STD-607-C - Commercial Building Grounding Earthing and Bonding Requirements for Telecommunications
  - l. ANSI/TIA-526-7 -Measurement of Optical Power Loss of installed Singlemode Fiber Plant Cable
  - m. ANSI/TIA-526-14A - Optical Power Loss Measurements of installed Multimode Fiber Cable Plant
  - n. ANSI/TIA-758-B - Customer Owned Outside Plant Telecommunications Cabling Standard
  - o. ANSI/TIA-568-B-2001 - Optical Fiber Cable Color Coding
  - p. ANSI/TIA-942-B – Telecommunications Infrastructure Standard for Data Centers
6. National Electrical Manufacturers Association (NEMA)
7. ANSI/NECA/BICSI 568-2001 Standard for Installing Commercial Building Telecommunications Cabling or latest edition
8. American Society for Testing Materials (ASTM)
9. Institute of Electrical and Electronic Engineers (IEEE)

## 9.8 Horizontal Cabling

1. NFPA 70 National Electric Code
2. Authority having jurisdiction (AHJ: DCRA/DCMR)
3. Local Code
4. UL® for wiring: UL® Standard 910 Test method for fire and smoke characteristics of cable used in air handling spaces. Provide products that are UL® listed and labeled for such use. UL® testing bulletin. Underwriters Laboratories (UL®) cable certification and follow up program.
5. American National Standards Institute/Telecommunications Industry Association/Electronic Industries Alliance
  - a. ANSI/TIA-568-D.1 - Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
  - b. ANSI/TIA-568-D.2 - Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components
  - c. TIA-569-D - Commercial Building Standard for Telecommunications Pathways and Spaces

- d. ANSI/TIA-606-C - Administration Standard for Commercial Telecommunications Infrastructure
  - e. ANSI-J-STD-607-C - Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
  - f. ANSI/TIA-862 – Building Automation Systems Cabling Standard for Commercial Buildings
  - g. ANSI/TIA-942-B – Telecommunications Standard for Data Centers
6. National Electrical Manufacturers Association (NEMA)
  7. NECA/BICSI 568-2006 Standard for Installing Commercial Building Telecommunications Cabling
  8. American Society for Testing Materials (ASTM)
  9. Institute of Electrical and Electronic Engineers (IEEE)

## 9.9 TIA Standards and Technical Service Bulletins

(Accessed 7/15/18)

The following table lists the current version of the TIA standards and Technical Service Bulletins managed by the TR-42 committee as of September 2017. This is a list of standards that have been published or in the process of being published. They are available through TIA or HIS (global.ihs.com). This list does not include new standards being developed or revisions to existing standards that have not been approved for publication. (Note: Highlighted items indicate standards newly approved for publication.)

Table 3: Current Revision of TIA Standards Available (Accessed July 16, 2018)

Document Number	Document Name	Date Published
ANSI/TIA-492AAAE (WBMMF)	DETAIL SPECIFICATION FOR 50-M CORE DIAMETER/125-M CLADDING DIAMETER CLASS 1A GRADED-INDEX MULTIMODE OPTICAL FIBERS WITH LASER-OPTIMIZED BANDWIDTH CHARACTERISTICS SPECIFIED FOR WAVELENGTH DIVISION MULTIPLEXING	06/16
ANSI/TIA-526-7-A	MEASUREMENT OF OPTICAL POWER LOSS OF INSTALLED SINGLE-MODE FIBER CABLE PLANT, ADOPTION OF IEC 61280-4-2 EDITION 2: FIBRE-OPTIC COMMUNICATIONS SUBSYSTEM TEST PROCEDURES – PART 4-2: INSTALLED CABLE PLANT – SINGLE-MODE ATTENUATION AND OPTICAL RETURN LOSS MEASUREMENT	07/29/2015
ANSI/TIA-526-14-C	OPTICAL POWER LOSS MEASUREMENT OF INSTALLED MULTIMODE FIBER CABLE PLANT; MODIFICATION OF IEC 61280-4-1 EDITION 2, FIBER-OPTIC COMMUNICATIONS SUBSYSTEM TEST PROCEDURES- PART 4-1: INSTALLED CABLE PLANT-MULTIMODE ATTENUATION MEASUREMENT	04/01/2015
ANSI/TIA-568.0-D	GENERIC TELECOMMUNICATIONS CABLING FOR CUSTOMER PREMISES	09/14/15
ANSI/TIA-568.1-D	COMMERCIAL BUILDING TELECOMMUNICATIONS INFRASTRUCTURE STANDARD	09/09/15



*ANSI/TIA-568-C.2	BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARDS	04/2010
ANSI/TIA-568-C.2-1 (category 8 Addendum)	BALANCED TWISTED-PAIR TELECOMMUNICATIONS CABLING AND COMPONENTS STANDARD, ADDENDUM 1: SPECIFICATIONS FOR 100CATEGORY 8 CABLING	06/30/16
ANSI/TIA-568.3-D	OPTICAL FIBER CABLING COMPONENTS STANDARD	09/16
ANSI/TIA-568.4-D	BROADBAND COAXIAL CABLING AND COMPONENTS STANDARD	6/27/17
ANSI/TIA-569-D	TELECOMMUNICATIONS PATHWAYS AND SPACES	11/19/15
ANSI/TIA-569-D-1	TELECOMMUNICATIONS PATHWAYS AND SPACESADDENDUM 1, REVISED TEMPERATURE AND HUMIDITY REQUIREMENTS FOR TELECOMMUNICATIONS SPACES	10/21/16
*ANSI/TIA-570-C	RESIDENTIAL TELECOMMUNICATIONS INFRASTRUCTURE STANDARD	08/16/12
ANSI/TIA-604-18	FOCIS 18 Fiber Optic Connector Intermateability Standard- Type MPO- 16	11/23/2015
ANSI/TIA-606-C	ADMINISTRATION STANDARD FOR TELECOMMUNICATIONS INFRASTRUCTURE	6/19/17
ANSI/TIA-607-C	GENERIC TELECOMMUNICATIONS BONDING AND GROUNDING (EARTHING) FOR CUSTOMER PREMISES	11/19/15
ANSI/TIA-607-C-1	GENERIC TELECOMMUNICATIONS BONDING AND GROUNDING (EARTHING) FOR CUSTOMER PREMISES ADDENDUM 1 – BONDING IN MULTI-TENANT BUILDINGS	01/2017
*ANSI/TIA-758-B	CUSTOMER-OWNED OUTSIDE PLANT TELECOMMUNICATIONS INFRASTRUCTURE STANDARD	03/27/12
ANSI/TIA-862-B	BUILDING AUTOMATION SYSTEMS CABLING STANDARD	02/29/16
ANSI/TIA-862-B-1	BUILDING AUTOMATION SYSTEMS CABLING STANDARD ADDENDUM 1: UPDATED REFERENCES, ACCOMMODATION OF NEW MEDIA TYPES	09/17
ANSI/TIA-942-B	TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR DATA CENTERS	07/12/17
ANSI/TIA-1005-A	TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR INDUSTRIAL PREMISES	05/03/12
ANSI/TIA-1152-A	REQUIREMENTS FOR FIELD TEST INSTRUMENTS AND MEASUREMENTS FOR BALANCED TWISTED-PAIR CABLING	11/10/2016
ANSI/TIA-1179-A	HEALTHCARE FACILITY TELECOMMUNICATIONS INFRASTRUCTURE STANDARD	08/21/17
ANSI/TIA-1183-A (Mainly for manufacturer qualification)	MEASUREMENT METHODS AND TEST FIXTURES FOR BALUN-LESS MEASUREMENTS OF BALANCED COMPONENTS AND SYSTEMS, EXTENDING FREQUENCY CAPABILITIES TO 2 GHZ	02/2017
ANSI/TIA-4966	TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR EDUCATIONAL FACILITIES	05/12/14
ANSI/TIA-4966-1	TELECOMMUNICATIONS INFRASTRUCTURE STANDARD FOR EDUCATIONAL FACILITIES ADDENDUM 1: UPDATED REFERENCES, ACCOMMODATION OF NEW MEDIA TYPES	09/17

ANSI/TIA-4994	STANDARD FOR SUSTAINABLE INFORMATION COMMUNICATIONS TECHNOLOGY	03/18/15
ANSI/TIA-5017	TELECOMMUNICATIONS PHYSICAL NETWORK SECURITY STANDARD	02/19/16
ANSI/TIA-5048	AUTOMATED INFRASTRUCTURE MANAGEMENT (AIM) SYSTEMS-REQUIREMENTS, DATA EXCHANGE AND APPLICATIONS	06/22/17
<i>The following are TIA Technical Service Bulletins (TSBs) that provide guidance on installation &amp; design best practices, mitigation techniques, etc. on a variety of topics.</i>		
TIA TSB-155-A	GUIDELINES FOR THE ASSESSMENT AND MITIGATION OF INSTALLED CATEGORY 6 CABLING TO SUPPORT 10GBASE-T	10/01/14
TIA TSB-162-A	TELECOMMUNICATIONS CABLING GUIDELINES FOR WIRELESS ACCESS POINTS	11/1/13
TIA TSB-184-A	GUIDELINES FOR SUPPORTING POWER DELIVERY OVER BALANCED TWISTED-PAIR CABLING	02/2017
TIA TSB-185	ENVIRONMENTAL CLASSIFICATION (MICE) TUTORIAL	June 2017 (reaffirmed)
TIA TSB-190	GUIDELINES ON SHARED PATHWAYS AND SHARED SHEATHS	06/01/11
TIA TSB-5018	STRUCTURED CABLING INFRASTRUCTURE GUIDELINES TO SUPPORT DISTRIBUTED ANTENNA SYSTEMS	06/16
TIA TSB-5019	HIGH PERFORMANCE STRUCTURED CABLING USE CASES FOR DATA CENTERS AND OTHER PREMISES	04/01/15
TIA TSB-5021	GUIDELINES FOR THE USE OF INSTALLED CATEGORY 5E AND CATEGORY 6 CABLING TO SUPPORT 2.5GBASE-T AND 5GBASE-T	01/01/2017