
USACE / NAVFAC / AFCEC UFGS-27 10 00 (May 2025)

Preparing Activity: NAVFAC

Superseding
UFGS-27 10 00 (August 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2025

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SECTION 27 10 00

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05/25

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SECTION 27 10 00

BUILDING TELECOMMUNICATIONS CABLING SYSTEM 05/25

NOTE: This guide specification covers requirements for building telecommunications cabling systems using a physical hierarchical star or hierarchical star with redundancy levels network topology for transporting telecommunications signals within a building. Telecommunications cabling systems include the copper and optical fiber horizontal and interior building backbone systems and cable media, patch panels, connecting blocks, firestopping, grounding, cable support, hardware, communications outlets, connectors, and associated hardware; station wiring, work area station outlets and service outlets; pathways; and distribution terminals. This specification covers telecommunication cabling systems supporting customer's voice, data, video, audio, security, digital imaging, facility related control system distribution, and environmental control for transporting information throughout modern buildings using twisted pair and optical fiber cables.

Coordinate telecommunications requirements with electrical, grounding, security, fire alarm, and HVAC requirements. Coordinate all requirements with the proponent Technical Authority.

Adhere to UFC 1-300-02 [Unified Facilities Guide Specifications \(UFGS\) Format Standard](#) when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in a respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a [Criteria Change Request \(CCR\)](#).

NOTE: The designer must provide single line schematic type diagrams of the telecommunications system, site plans, and floor plans showing overhead or underground service entrances, maintenance holes, handholes, conduit sizes, conductor size and type, number of pairs and fibers, and physical locations and layouts of telecommunication entrance facility, telecommunications equipment rooms, campus distributor, building distributors, floor distributors, and telecommunications outlets.

The designer must tailor this document to the operational theater to align with the requirements OCONUS when applicable. The BICSI TDMM contains references for OCONUS but these must be coordinated with the local technical authorities.

The design package is to include but is not limited to the following drawings:

T0 Site drawings, T1 Interior Drawings showing all ICT elements on floor plans, T2 Drawings showing serving zones and pathways, T3 Drawings for all telecommunication spaces, T4 Drawings for details including labeling scheme and cabinet elevations, T5 Drawings showing schedules for cable plant including cutovers, and T6 Drawings including network diagrams, riser diagrams, and boundary diagrams in accordance with ANSI/TIA 606.

NOTE: UFC 3-580-01, "Information and Communications Technology Infrastructure Planning and Design," provides requirements for interior and outside plant (OSP) telecommunications cabling systems for DoD.

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically

place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM D709 (2017) Standard Specification for Laminated Thermosetting Materials

BICSI International Standards Program (BICSI)

ANSI/BICSI N1 (2019) Installation Practices for Telecommunications and ICT Cabling and Related Cabling Infrastructure

ANSI/BICSI N3 (2020) Planning and Installation Methods for the Bonding and Grounding of Telecommunication and ICT Systems and Infrastructure

BICSI TDMM (2024; 15th Edition) Telecommunications Distribution Methods Manual

ELECTRONIC COMPONENTS INDUSTRY ASSOCIATION (ECIA)

ECIA EIA/ECA 310-E (2005) Cabinets, Racks, Panels, and Associated Equipment

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 100 (2000; Archived) The Authoritative Dictionary of IEEE Standards Terms

INSULATED CABLE ENGINEERS ASSOCIATION (ICEA)

ICEA 61196-1-100 (2022) Coaxial Communications Cables-Part 1-100:Electrical test methods General Requirements

ICEA S-83-596 (2021) Indoor Optical Cable

ICEA S-90-661 (2021) Category 3 and 5E Individually Unshielded Twisted Pairs, Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and LAN Communications Wiring Systems

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

ISO/IEC 11801	(2017) Information technology - Part 1-General Requirements-Generic cabling for customer premises
ISO/IEC 14763-2	(2019) Information technology - Part 1 -Implementation and operation of customer premises cabling
ISO/IEC 14763-3	(2024) Information technology - Implementation and operation of customer premises cabling; Part 3: Testing of optical fibre cabling

INTERNATIONAL TELECOMMUNICATION UNION (ITU)

ITU-T G.652	(2024) Characteristics of a single-mode optical fibre and cable
ITU-T G.655	(2009) Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable
ITU-T G.657	(2024) Characteristics of a bending-loss insensitive single-mode optical fibre and cable
ITU-T G.984.1	(2012) Gigabit-capable passive optical networks (GPON): General characteristics
ITU-T G.987.1	(2016; 2020 Corrigendum 1) 10-Gigabit-capable passive optical networks (XG-PON): General requirements

NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION (NECA)

NECA/BICSI 568	(2006) Standard for Installing Building Telecommunications Cabling
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NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

ANSI/NEMA WC 66	(2024) Performance Standard for Category 6 and Category 7 100 Ohm Shielded and Unshielded Twisted Pairs
NEMA BI-50026/VE 2	(2024) Cable Tray Installation Guidelines

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023; ERTA 1 2024; TIA 24-1) National Electrical Code
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TELECOMMUNICATIONS INDUSTRY ASSOCIATION (TIA)

ANSI/TIA-526-7	(2015a; R 2022) Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant, Adoption of IEC 61280-4-2 edition 2: Fibre-Optic Communications
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	Subsystem Test Procedures - Part 4-2: Installed Cable Plant - Single-Mode Attenuation and Optical Return Loss Measurement
ANSI/TIA-526-14	(2023d) OFSTP-14A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant
ANSI/TIA-568 Series	(2023) Building Telecommunications Cabling Standards, includes ANSI/TIA-568.0 (2020e), ANSI/TIA-568.1 (2024e), ANSI/TIA-568.2 (2024e), ANSI/TIA-568.3 (2022e), ANSI/TIA-568.4 (2022), ANSI/TIA-568.5 (2022)
ANSI/TIA-568.1	(2020e) Commercial Building Telecommunications Infrastructure Standard
ANSI/TIA-568.2	(2024e) Balanced Twisted-Pair Telecommunications Cabling and Components Standards
ANSI/TIA-568.3	(2022e) Optical Fiber Cabling Components Standard
ANSI/TIA-568.4	(2022e) Broadband Coaxial Cabling and Components Standard
ANSI/TIA-568.5	(2022; 2024 Am 1) Balanced Single Twisted-pair Telecommunications Cabling and Components Standard
ANSI/TIA-569	(2019e; Add 1 2022) Telecommunications Pathways and Spaces
ANSI/TIA-570	(2024e) Residential Telecommunications Infrastructure Standard
ANSI/TIA-606	(2021d) Administration Standard for Telecommunications Infrastructure
ANSI/TIA-607	(2019d) Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
ANSI/TIA-942	(2024) Telecommunications Infrastructure Standard for Data Centers
ANSI/TIA-1152	(2016; R 2021) Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
TIA TSB-162	(2021) Telecommunications Cabling Guidelines for Wireless Access Points
TIA-455-21	(1988a; R 2012) FOTP-21 - Mating Durability of Fiber Optic Interconnecting Devices

TIA/EIA-598	(2014D; Add 2 2018) Optical Fiber Cable Color Coding
TIA/EIA-604-2	(2004b; R 2014) FOCIS 2 Fiber Optic Connector Intermateability Standard
TIA/EIA-604-3	(2004b; R 2014) Fiber Optic Connector Intermateability Standard (FOCIS), Type SC and SC-APC, FOCIS-3
TIA/EIA-604-10	(2021c) FOCIS 10 Fiber Optic Connector Intermateability Standard - Type LC
TIA/EIA-604-12	(2000) FOCIS 12 Fiber Optic Connector Intermateability Standard Type MT-RJ

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-580-01	(2024) Information and Communications Technology Infrastructure Planning and Design
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U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 68	Connection of Terminal Equipment to the Telephone Network (47 CFR 68)
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UL SOLUTIONS (UL)

UL 50	(2024) UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 444	(2023) UL Standard for Safety Communications Cables
UL 467	(2022) UL Standard for Safety Grounding and Bonding Equipment
UL 486A-486B	(2025) UL Standard for Safety Wire Connectors
UL 514C	(2014; Reprint Apr 2024) UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL 723	(2023) UL Standard for Safety Test for Surface Burning Characteristics of Building Materials
UL 969	(2017; Reprint May 2023) UL Standard for Safety Marking and Labeling Systems
UL 1286	(2022; Reprint Mar 2024) UL Standard for Safety Office Furnishings
UL 1666	(2007; Reprint Sep 2021) UL Standard for Safety Test for Flame Propagation Height

of Electrical and Optical-Fiber Cables
Installed Vertically in Shafts

UL 1863

(2004; Reprint Oct 2019) UL Standard for
Safety Communication Circuit Accessories

UL 2043

(2023) Fire Test for Heat and Visible
Smoke Release for Discrete Products and
Their Accessories Installed in
Air-Handling Spaces

1.2 RELATED REQUIREMENTS

NOTE: Ensure that design provides for adequate
telecommunications spaces using UFC 3-580-01 as a
minimum requirement.

Network type, size and configuration must be
coordinated with the technical manager. The
horizontal and backbone structured cabling must
support the Information Technology (IT) and
Operational Technology (OT) requirements of the end
user.

For Military Construction projects the proponent
property (non-permanent) items are procured from a
distinct funding source separate from MILCON money
and may or may not be included in a MILCON project
construction contract. The infrastructure that
supports those items is real property and is to be
included in the design. The ICT designer must
verify the items that are being procured outside of
the MILCON project construction contract and must
document these items in writing.

Select bracketed Section 27 05 26 GROUNDING AND
BONDING FOR COMMUNICATIONS SYSTEMS when issued.

Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and Section 33 82 00
TELECOMMUNICATIONS OUTSIDE PLANT (OSP)[, and Section 27 05 26 GROUNDING
AND BONDING FOR COMMUNICATIONS SYSTEMS] apply to this section with
additions and modifications specified herein.

1.3 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms
used in this specification must be as defined in ANSI/TIA-568.1,
ANSI/TIA-568.2, ANSI/TIA-568.3, ANSI/TIA-569, ANSI/TIA-606, Federal
Communications Commission (FCC), BICSI TDMM, IEEE 100, and herein.

1.3.1 Distributor C / Campus Distributor (CD)

A distributor from which the campus backbone cabling emanates.
(International expression for main cross-connect (MC).)

1.3.2 Distributor B / Building Distributor (BD)

A distributor in which the building backbone cables terminate and at which connections to the campus backbone cables may be made. (International expression for intermediate cross-connect (IC).)

1.3.3 Distributor A / Floor Distributor (FD)

A distributor used to connect horizontal cable and cabling subsystems or equipment. (International expression for horizontal cross-connect (HC).)

1.3.4 Telecommunications Room (TR)

An enclosed space for housing telecommunications equipment, cable, terminations, and cross-connects. The room is the recognized cross-connect between the backbone cable and the horizontal cabling.

1.3.5 Entrance Facility (EF)

An entrance to the building for both private and public network service cables (including wireless) including the entrance point at the building wall and continuing to the equipment room.

1.3.6 Equipment Room (ER)

An space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a telecommunications room because of the nature of its complexity. It is not necessary for the TR or ER to be positively charged relative to air flow unless it is adjacent to an outside space, storage, warehouse, or an unconditioned space such as a mechanical room.

1.3.7 Open Cable

Cabling that is not run in a raceway as defined by NFPA 70. This refers to cabling that is "open" to the space in which the cable has been installed and is therefore exposed to the environmental conditions associated with that space.

1.3.8 Open Office

A floor space division provided by furniture, moveable partitions, or other means instead of by building walls.

1.3.9 Pathway

A physical infrastructure utilized for the placement and routing of telecommunications cable.

1.3.10 Telecommunications Cable

All copper and fiber cables utilized for the application of transmitting data on a network. Supports all equipment outlets whether indicated as work areas, service, or equipment type.

1.3.11 Activity Specific Telecommunications Manager/Authority

Throughout this document, the term "telecommunications manager" or "technical authority" refers to the following:

For Army, the Network Enterprise Center (NEC)
For Navy, the Base Communications Officer (BCO)
For Marine Corps, the Installation Communications G6
For Air Force, the Base/Installation
Communications Squadron, Commander's
Representative.

1.4 SYSTEM DESCRIPTION

**NOTE: Use Section 33 82 00 TELECOMMUNICATIONS
OUTSIDE PLANT (OSP) to specify exterior distribution
and interbuilding cables and include bracketed
sentence.**

Provide telecommunications pathway systems referenced herein. The telecommunications designer and contractor must coordinate with the technical authority concerning access to and configuration of telecommunications spaces. The building telecommunications cabling, and pathway system must include permanently installed backbone and horizontal cabling, horizontal and backbone pathways, service entrance facilities, work area pathways, telecommunications and service outlet assemblies, conduit, raceway, and hardware for splicing, terminating, and interconnecting cabling necessary to transport the Information Technology (IT) and Operational Technology (OT) (including LAN) between equipment items in a building. The horizontal system must be wired in a star topology from the telecommunications work area to the floor distributor or campus distributor at the center or hub of the star. The backbone cabling and pathway system includes intrabuilding and interbuilding interconnecting cabling, pathway, and terminal hardware.

The intrabuilding backbone provides connectivity from the floor distributors to the building distributors or to the campus distributor and from the building distributors to the campus distributor as required. The backbone system must be wired in a star topology with the campus distributor at the center or hub of the star.[The interbuilding backbone system provides connectivity between the campus distributors and is specified in Section 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP).]

1.5 SUBMITTALS

**NOTE: Review Submittal Description (SD) definitions
in Specification 01 33 00 SUBMITTAL PROCEDURES and
edit the following list, and corresponding submittal
items in the text, to reflect only the submittals
required for the project. The Guide Specification
technical editors have classified those items that
require Government approval, due to their complexity
or criticality, with a "G". Generally, other
submittal items can be reviewed by the Contractor's
Quality Control System. Only add a "G" to an item**

if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Marine Corps, or Air Force projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for Contractor Quality Control approval. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submittals must include the manufacturer's name, trade name, place of manufacture, and catalog model or number. Include performance and characteristic curves. Submittals must also include applicable federal, military, industry, and technical society publication references. Should manufacturer's data require supplemental information for clarification, the supplemental information must be submitted as specified in paragraph REGULATORY REQUIREMENTS. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

T1-T6 Telecommunications Drawings; G, [_____]

SD-03 Product Data

Telecommunications Cabling (Backbone and Horizontal); G, [_____]

Cable Trays; G, [_____]

Non-continuous Cable Supports; G, [_____]

Patch Panels; G, [_____]

Telecommunications Outlet/Connector Assemblies; G, [_____]

Equipment Support Frames; G, [_____]

Connector Blocks; G, [_____]

[Multi-User Telecommunications Outlet Assembly; G, [_____]

] *****

NOTE: Delete submittal for spare parts on Navy projects. Spare parts requirements are provided in Section 01 78 23 OPERATION AND MAINTENANCE DATA on Navy projects.

[Spare Parts; G, [_____]]
[Floor Outlet And Poke-Thru Boxes; G
Plywood Backboards; G
[Consolidation Point; G
] SD-05 Design Data
[Fiber Link Loss Budget; G, [_____]]
] SD-06 Test Reports
Telecommunications Cabling Testing; G, [_____]]
SD-07 Certificates
Telecommunications Contractor Qualifications; G, [_____]]
Key Personnel Qualifications; G, [_____]]
Manufacturer Qualifications; G, [_____]]
Test Plan; G, [_____]]
Factory Reel Tests; G, [_____]]
SD-10 Operation and Maintenance Data
Telecommunications Cabling and Pathway System Data Package 5; G,
[_____]]
SD-11 Closeout Submittals
Record Documentation; G, [_____]]

1.6 QUALITY ASSURANCE

1.6.1 Shop Drawings

In exception to Section 01 33 00 SUBMITTAL PROCEDURES, submitted plan drawings must[be in electronic format, both native and PDF][be a minimum of 279 by 432 mm 11 by 17 in in size using a minimum scale of 1 mm per 100 mm 1/8 inch per foot, except as specified otherwise]. Include wiring diagrams and installation details of equipment indicating proposed location, layout and arrangement, control panels, accessories, piping, ductwork, and other items that must be shown to ensure a coordinated installation. Wiring diagrams must identify circuit terminals and indicate the internal wiring for each item of equipment and the interconnection between each item of equipment. Drawings must indicate required clearance for operation, maintenance, and replacement of operating equipment devices. Submittals must include the nameplate data,

size, and capacity. Submittals must also include applicable federal, military, industry, and technical society publication references.

1.6.1.1 T1-T6 Telecommunications Drawings

NOTE: Registered Communications Distribution Designer (RCDD) approved drawings for all projects.

On government designed (in-house design) projects, the government designer must make sure that the bid documents require an RCDD stamp on the contractor's telecommunications drawings submitted for approval.

For small scale projects, limited to adding drops to existing telecommunications rooms, an RCDD stamp is not required provided the work is being accomplished under the technical authority of an RCDD or the government telecommunications manager.

Activity Specific Telecommunications Manager/Authority:

Throughout this document, the term "telecommunications manager" or "technical authority" refers to the following:

For Army, the Network Enterprise Center (NEC)
For Navy, the Base Communications Officer (BCO)
For Marine Corps, Installation Communications G6
For Air Force, the Base/Installation Communications Squadron, Commander's Representative.

It is expected, per UFC 3-580-01, that these drawings will be provided during design. When the project requires design after award include the below requirements. All drawings must be required as-builts.

Provide Registered Communications Distribution Designer (RCDD) approved drawings in accordance with ANSI/TIA-606. The identifier for each cabinet, rack, termination, and cable must appear on the drawings. Drawings must depict final telecommunications installed wiring system infrastructure in accordance with ANSI/TIA-606. The drawings should provide details required to prove that the distribution system will properly support connectivity from the EF telecommunications rooms and ER telecommunications rooms[, Campus Distributor's (CD)][, Building Distributor's (BD)][and][Floor Distributor's (FD)] to the telecommunications work area outlets.

Provide a plastic laminated schematic of the as-installed telecommunications cable system showing cabling, CD's, BD's, FD's, and the EF and ER for telecommunications keyed to floor plans by architectural wayfinding room number. Mount the laminated schematic in the EF telecommunications space as directed by the Contracting Officer. The following drawings must be provided as a minimum:

- a. T1 - Building Area/Serving Zone Boundaries, Backbone Systems, and Horizontal Pathways. Layout of complete building per floor. The

drawing indicates location of building areas, serving zones, vertical backbone diagrams, telecommunications rooms, access points, pathways, grounding system, and other systems that need to be viewed from the complete building perspective.

- b. T2 - Serving Zones/Building Area Drawings - Drop Locations and Cable Identification (ID'S). Shows a building area or serving zone. These drawings show drop locations, telecommunications rooms, access points and detail call outs for common equipment rooms and other congested areas.
- c. T3 - Drawings in accordance with ANSI/TIA-606 that include telecommunications rooms plan views, pathway layout (cable tray, ladder racks, and conduit), mechanical/electrical layout, and[cabinet,][rack,][backboard,][and] wall elevations. Drawings must show layout of applicable equipment including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks, patch panels and equipment spaces and cabinet/racks. Drawings must include a complete list of equipment and material, equipment rack details, to include conduit and cable tray fill data, proposed layout and anchorage of equipment and appurtenances, and equipment relationship to other parts of the work including clearance for maintenance and operation. Drawings may also be an enlargement of a congested area of T1 and T2 drawings.
- d. T4 - Drawings to include Faceplate Labeling, Firestopping Assemblies, Americans with Disabilities Act (ADA) requirements, etc. Detailed drawings of symbols and typical details such as faceplate labeling, faceplate types, faceplate population installation procedures, detail racking, and raceways. Outlets must be laid out in a logical manner, moving left to right starting from the[telecommunications space served][main entrance door] [_____].
- e. T5 - Drawings to include schedules to show information for cutovers and administrative details.
- f. T6 - Drawings to include network, riser, and boundary diagrams.

1.6.2 Telecommunications Qualifications

NOTE: BICSI Copper and Fiber Cabling Installer, Technician Level certification is preferred for supervisors and installers in lieu of documentation of 3 years' experience. Contractors have the option to submit either BICSI certification or experience documentation. Equivalent training and 3 years of verifiable experience in lieu of the certification may be adjudicated by the COR.

Work and equipment installation under this section must be performed by and provided by approved telecommunications contractor(s) and key personnel. Qualifications must be provided for: the telecommunications system contractor, the telecommunications system installer, and the supervisor (if different from the installer). A minimum of 30 days prior to installation, submit documentation of the experience, and certifications, of the telecommunications contractor and all key personnel.

1.6.2.1 Telecommunications Contractor

The telecommunications contractors must be a firm which is regularly and professionally engaged in the business of the implementation, installation, and testing of the specified telecommunications systems and equipment. The telecommunications contractor must demonstrate experience in providing successful telecommunications systems within the past 3 years of similar scope and size. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the telecommunications contractor.

1.6.2.2 Key Personnel

Provide key personnel who are regularly and professionally engaged in the business of providing implementation, installation, and testing of the specified telecommunications systems and equipment. There may be one key person, or more key persons proposed for this solicitation depending upon how many of the key roles each has successfully provided. Each of the key personnel must demonstrate experience in providing successful telecommunications systems within the past 5 years. Submit documentation for a minimum of three and a maximum of five successful telecommunication system installations for the submitted key personnel. Supervisors, installers, and testers assigned to the installation of this system or any of its components must be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level for both copper and fiber. Submit documentation of current BICSI certification for each of the key personnel. In lieu of BICSI certification, supervisors and installers assigned to the installation and testing of this system or any of its components must have a minimum of [5][_____] years' experience in the installation of the specified copper and fiber optic cable and components and training that is deemed equivalent by the COR. These must include factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products. Documentation for each key person must include at least two successful system installations provided that are equivalent in system size and in construction complexity to the telecommunications system proposed for this solicitation. Include specific experience in installing and testing telecommunications systems and provide the names and locations of at least two project installations successfully completed using optical fiber and copper telecommunications cabling systems.

All the existing telecommunications system installations offered by the key persons as successful experience must have been in successful full-time service for at least 18 months prior to the issuance date for this solicitation. Provide the name and role of the key person, the title, location, and completed installation date of the referenced project, the referenced project owner point of contact information including name, organization, title, and telephone number, and generally, the referenced project description including system size and construction complexity. Indicate that all key persons are currently employed by the telecommunications contractor or have a commitment to the telecommunications contractor to work on this project. Note that only the key personnel identified in the approved submittals of the successful proposal, and approved by the Contracting Officer are permitted to do work on this solicitation's telecommunications system. Key personnel must function in the same roles in this contract, as they functioned in the offered successful experience. Any substitutions for the telecommunications contractor's key personnel requires the resubmission of the qualifications and new approval from The Contracting Officers

Representative (COR).

1.6.2.3 Minimum Manufacturer Qualifications

Cabling, equipment, and hardware manufacturers must have a minimum of [3][_____] years' experience in the manufacturing, assembly, and factory testing of components which comply with ANSI/TIA-568 Series.

1.6.3 Test Plan

Provide a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the components and accessories for each cable type specified, [60][_____] days prior to the proposed test date. Include procedures for certification, validation, [fiber link loss budget] and testing. Provide calibration data for equipment and all appurtenances and accessories to be used including but not limited to launch cables.

1.6.4 Test Reports

Provide test reports, in native and PDF format, for each [coax][,][copper] and [fiber] cable installed. In addition to cable test data, each report must indicate the project name, date and time of test, personnel performing the test, software version of cable limits and equipment, and calibration dates of all equipment. Results must include equipment reference testing required when changing equipment locations, when reference cords are removed from equipment, and the start of new testing shifts. Cable ID's on each test result must match those provided in T4 approved submittals.

1.6.5 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "must" or "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Equipment, materials, installation, and workmanship must be in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.6 Standard Products

Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design, and workmanship. Products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year period must include applications of equipment and materials under similar circumstances and of similar size. The product must have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period. Where two or more items of the same class of equipment are required, these items must be products of a single manufacturer; however, the component parts of the item need not be the products of the same manufacturer unless stated in this section.

1.6.6.1 Alternative Qualifications

Products having less than a 2-year field service record will be acceptable

if a certified record of satisfactory field operation for not less than 6000 hours, exclusive of the manufacturers' factory or laboratory tests, is furnished.

1.6.6.2 Material and Equipment Manufacturing Date

Products manufactured more than 1-year prior to date of delivery to site must not be used, unless specified otherwise. Products must not be delivered to site earlier than 6 months prior to installation.

1.7 DELIVERY AND STORAGE

Provide protection from weather, moisture, extreme heat and cold, dirt, dust, and other contaminants for telecommunications cabling and equipment placed in storage. Visual inspection, for damage, of all material must be performed prior to installation.

1.8 ENVIRONMENTAL REQUIREMENTS

Telecommunication spaces must comply with **UFC 3-580-01** paragraph 2-3.1.3.3 and as indicated in Division 23 specifications. Connecting hardware must be rated for operation under ambient conditions of **0 to 60 degrees C 32 to 140 degrees F** and in the range of 0 to 95 percent relative humidity, noncondensing unless more stringent criteria are called out by the designer.

1.9 WARRANTY

The equipment items must be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract and as required in Section **01 78 00** CLOSEOUT SUBMITTALS.

[1.10 SEISMIC REQUIREMENTS

NOTE: Do not use this paragraph for Navy projects.
When directed to meet seismic requirements, edit
Sections 13 48 73 SEISMIC CONTROL FOR NONSTRUCTURAL
COMPONENTS and 26 05 48 SEISMIC PROTECTION FOR
ELECTRICAL EQUIPMENT to suit the project and include
in the contract documents. Edit the following
paragraph and include it in the project
specification. When a government designer is the
Engineer of Record, provide seismic requirements on
the drawings.

Provide seismic details[conforming to[Section **13 48 73** SEISMIC CONTROL FOR NONSTRUCTURAL COMPONENTS][and to][Section **26 05 48** SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT]][as indicated].

]1.11 MAINTENANCE

1.11.1 Operation and Maintenance Manuals

Commercial off the shelf manuals must be furnished for operation, installation, configuration, and maintenance of products provided as a

part of the Telecommunications Cabling and Pathway System, Data Package 5. Submit draft operations and maintenance data, drawings, and record documentation prior to the start of final acceptance testing and commissioning. Submit final operations and maintenance data in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA and as specified herein not later than [2][_____] months prior to the date of beneficial occupancy. In addition to requirements of Data Package 5, include the requirements of paragraphs TELECOMMUNICATIONS DRAWINGS, TELECOMMUNICATIONS SPACE DRAWINGS, and RECORD DOCUMENTATION. Ensure that these drawings and documents depict the as-built configuration.

1.11.2 Record Documentation

NOTE: ANSI/TIA-606 describes the necessary data fields and reports for hard copy, spreadsheet, and electronic media as well as cable management software requirements. Check with activity technology manager to determine if cable management software is currently employed at the activity and provide necessary data input to the existing system to include information associated with project installation in the coordinated/approved/proper format.

Provide T5 drawings including documentation on cables and termination hardware in accordance with ANSI/TIA-606. T5 drawings must include schedules to show information for cut-overs and cable plant management, patch panel layouts and cover plate assignments, cross-connect information, and connecting terminal layout as a minimum. T5 drawings must be provided[in hard copy format][on electronic media using Windows based computer cable management software.][A licensed copy of the cable management software including documentation, must be provided.] Provide the following T5 drawing documentation as a minimum:

- a. Cables - A record of installed cable must be provided in accordance with ANSI/TIA-606. The cable records must[include only the required data fields][include the required data fields for each cable and complete end-to-end circuit report for each complete circuit from the assigned outlet to the entry facility] in accordance with ANSI/TIA-606. Include manufacture date of cable with submittal.
- b. Termination Hardware - A record of installed patch panels, cross-connect points, distribution frames, terminating block arrangements and type, and outlets must be provided in accordance with ANSI/TIA-606. Documentation must include the required data fields[as a minimum][only] in accordance with ANSI/TIA-606.

[1.11.3 Spare Parts

NOTE: Delete this paragraph for Navy projects.

In addition to the requirements of Section 01 78 23 OPERATION AND MAINTENANCE DATA, provide a complete list of parts and supplies, with current unit prices and source of supply, and a list of spare parts recommended for stocking.

]PART 2 PRODUCTS

2.1 COMPONENTS

NOTE: Pathway requirements are included in paragraph TELECOMMUNICATIONS PATHWAYS in this section for open cable systems including cable tray. Refer to SECTION 26 20 00 INTERIOR DISTRIBUTION SYSTEM for conduit requirements. SECTION 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP) provides requirements for campus backbone cable systems.

For specialized circuits such as classified networks, coordination is required with the Technical Authority. Provide electrical and telephone outlets installed per the ADA to accommodate TTD's and other devices.

Components must be UL, or third party certified by a nationally recognized testing laboratory (NRTL). Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations, submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance. In lieu of the label or listing, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Contracting Officer. The certificate must state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard. Provide a complete system of telecommunications cabling and pathway components using star topology for the intra building backbone and the horizontal cabling. When redundancy is required by the mission utilize appropriate level of redundancy to ensure reliability. Provide support structures and pathways, complete with outlets, cables, connecting hardware and telecommunications cabinets/racks.

Cabling and interconnecting hardware and components for telecommunications systems must be UL listed, or third-party independent testing laboratory certified and must comply with NFPA 70, ANSI/TIA-569, and conform to the requirements specified herein.

2.2 TELECOMMUNICATIONS SPACES

NOTE: For projects that do not include SECTION 33 82 00 TELECOMMUNICATIONS OUTSIDE PLANT (OSP) for termination of interbuilding cables, copy paragraph BUILDING PROTECTOR ASSEMBLIES and PROTECTOR MODULES from SECTION 33 82 00 and paste the paragraphs into this section as part of the telecommunications spaces. Include these for projects that include OT cabling to endpoint devices, non-person entities, that are outside of the NFPA 780 protection zone for the building and served by copper cabling. Provide protected entrance terminals (PET) in accordance with ANSI/TIA-758. Equip PETs with modules to

protect the inside plant cabling and equipment from power surges. Furnish solid state or gas tube modules adequate for all used pairs plus 25 percent, but not to exceed the total pair count. Provide 110-type insulation displacement connector (IDC) terminal blocks or cable stubs. Provide 710-type connector for legacy only applications.

Navy projects adhere to color coding standards in accordance with the following colors from ANSI/TIA-606.

Cross-Connect Field Color Codes	
Color	Identifies
Orange	Demarcation point (e.g., central office terminations).
Green	Network connections (e.g., network and auxiliary equipment).
Purple	Common equipment, private branch exchange (PBX), local area network (LANs), multiplexers (e.g., switching and data equipment).
White	First-level backbone (e.g., CD (MC) to an FD (HC) or to a BD (IC)).
Gray	Second-level backbone (e.g., BD (IC) to an FD (HC)).
Blue	Horizontal cable (e.g., horizontal connections to telecommunications outlets).
Brown	Interbuilding backbone (campus cable terminations).
Yellow	Miscellaneous (e.g., auxiliary, alarms, security).
Red	Reserved for future use (also, key telephone systems).
NOTE: Brown takes precedence over white or gray for interbuilding runs.	

Provide connecting hardware and termination equipment in the[data center ANSI/TIA-942][telecommunications entrance facility][and][telecommunication equipment room[s]] to facilitate installation as shown on design drawings for terminating and cross-connecting permanent cabling. Provide telecommunications interconnecting hardware color coding in accordance with ANSI/TIA-606 and as approved by the technical authority.

2.2.1 Plywood Backboards

Provide void-free, fire retardant treated A/C interior grade plywood. Plywood must comply with International Building Code, Section 2303.2 and painted only if required for illumination reflectance or by the Technical Authority. 19 mm 3/4 in thick [1200 by 2400 mm] [4 by 8 ft][as indicated]. Backboards must be fire rated by manufacturing process. Fire stamp must be clearly visible. Paint applied over fire retardant backboard must be UL 723 fire retardant paint. Provide label including

paint manufacturer, date painted, UL listing and name of installer. When painted, paint label and fire stamp must be clearly visible and outside of where equipment is likely to be installed. Backboards must be provided on a minimum of two adjacent walls in the telecommunication spaces or on walls indicated to support wall mounted equipment.

2.2.2 Equipment Support Frames

NOTE: Provide equipment support frames only when patch panels or cabinet/rack mounted interconnecting equipment are provided. In most applications, a 42U channel rack in locked communications room is sufficient. Provide lockable cabinets in locations where additional security is required. Use wall-mounted brackets for small systems where only a few patch panels are required.

Provide adequate space in telecommunications spaces to facilitate tenant owned telecommunications system support equipment requirements. Coordinate with the Information Communications Technical Authority to determine the space and weight requirements for the USG-provided active equipment.

DoR must coordinate power requirements with Using Agency and tailor requirements accordingly.

Horizontal cable management is not required when angled patch panels are otherwise specified.

Provide in accordance with ECIA EIA/ECA 310-E and UL 50.

- [a. Bracket, wall mounted, 8-gauge aluminum. Provide hinged bracket compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting.
-] [b. Racks, [wall][floor] mounted 2-post modular type, 42U [16-gauge steel][or][11-gauge aluminum] construction, minimum, treated to resist corrosion. Provide rack with vertical[and horizontal] cable management and [horizontal][42U vertical] ground bar. Provide [____][1] vertical surge protected Power Distribution Units (PDU) per rack with 42U, duplex 24 C13's and 18 flexible C39's, which accepts C14 and C20 plugs power receptacles. PDU must have indicator lights, but no integral on/off switch[and be capable of monitoring]. Rack must be compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting.
-] [c. Channel Racks, 42U [762 mm][____] [30 in][____] depth floor mounted, aluminum construction, painted[white][black] rated for 2000 lbs load. Provide channel rack with vertical[and horizontal] cable management and [horizontal][42U vertical] ground bar.[Provide [____][2] vertical rear mounted surge protected 42U Power Distribution Units (PDU) with duplex 24 C13's and 18 flexible C39's, which accepts C14 and C20 plugs. PDU must have indicator lights, but no integral on/off switch[and be capable of monitoring].][Provide ceiling mounted fan.] Rack must be compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting.

-] [d. Racks, floor mounted 4-post, [16-gauge steel][or][11-gauge aluminum] construction, minimum, treated to resist corrosion and painted[white][black]. Provide rack with vertical[and horizontal] cable management and[vertical][horizontal] ground bar.[Provide [2][_____] 42U vertical rear mounted surge protected Power Distribution Units (PDU) with duplex 24 C13's and 18 flexible C39's, which accepts C14 and C20 plugs. PDU must have indicator lights, but no integral on/off switch[and be capable of monitoring].] Rack must be compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting.
-] [e. Cabinets, freestanding modular type, [16-gauge steel][or][11-gauge aluminum] construction , minimum, treated to resist corrosion and painted[white][black]. Cabinets with 63 percent mesh doors with blanks and baffling to ensure front-to-rear air flow and avoid intra-cabinet air circulation unless another cooling method is designed. In instances where other air flow is needed, use manufacturer-approved penetrations and sealing to maintain airflow. For hot and cold aisles, use an airflow scheme engineered for the solution. Cabinet must have removable and lockable side panels, front and rear doors with at least 63 percent mesh, and have adjustable feet for leveling. Cabinet must have cable access in the roof and base and be compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting. Provide cabinet with[vertical][horizontal] grounding bar[,][[rack][roof] mounted 15 cu. m 550 CFM fan with filter][and two vertical rear mounted surge protected Power Distribution Units with duplex 24 C13's and 18 flexible C39's, which accepts C14 and C20 plugs]. All cabinets must be keyed alike to local activity key requirement unless in an entrance facility for Service Providers or as required for differing security levels.
-] [f. Cabinets, wall-mounted modular type, [16 gauge steel][or][11 gauge aluminum] construction, minimum, treated to resist corrosion and painted[white][black]. Cabinet must have lockable front[and rear] door[s], louvered side panels, [7 cu. m 250 CFM[roof][rack] mounted fan,] ground lug, and top and bottom cable access. Cabinet must be compatible with [482.6 mm][584 mm] [19 in][23 in] panel mounting. Provide a duplex AC outlet[and a 1U vertical mounted surge protected Power Distribution Unit that supports C13's and flexible C39's which accepts C14 and C20 plugs]. All cabinets must be keyed alike to local activity key requirement unless in an entrance facility for Service Providers or as required for differing security levels.

12.2.3 Connector Blocks

NOTE: Type 66 blocks are not permitted. Select 710-style for legacy installation only.

Provide insulation displacement connector (IDC)[Style 110][Style 710] for Category systems aligned with cable type. Provide blocks for the number of horizontal and backbone cables terminated on the block plus 25 percent spare.

2.2.4 Cable Guides

Provide cable guides specifically manufactured for the purpose of routing cables, wires, and patch cords horizontally and vertically on[[482.6 mm][584 mm] [19 in][23 in] equipment[racks][cabinets]][and][

telecommunications backboards]. Provide Cable guides of ring or bracket type devices[panels][backboard] for horizontal cable management and individually mounted for vertical cable management. Mount cable guides with screws,[and][or] nuts and lock washers. Provide one horizontal cable manager for every[24 port appearances below or above][48 port appearances below and above] each patch panel unless angled patch panels are specified.

2.2.5 Patch Panels

Provide ports for the number of horizontal and backbone cables terminated on the panel plus[25] [_____] percent spare. Provide pre-connectorized[optical fiber][and][copper] patch cords for patch panels equal to the number of installed horizontal cables. Provide patch cords, as complete assemblies, with matching connectors as specified.[Provide fiber optic patch cables with crossover orientation in accordance with ANSI/TIA-568.3]. Patch cords must meet minimum performance requirements specified in ANSI/TIA-568 Series for cables, cable length, and hardware specified.

2.2.5.1 Connector Block to Patch Panel

NOTE: Provide individual patch panels with a maximum of 48 adapter ports per patch panel for Navy projects. Larger patch panel cross-connect fields are more difficult for cable and administrative management. Army projects allow the use of 96 port adapter patch panels.

Wire 8-pin modular ports to T568A configuration unless specifically requested and approved by the authority having jurisdiction.

Provide in accordance with ANSI/TIA-568 Series, ANSI/TIA-569 standards. Panels must be third party verified. Panel must be constructed of 2.2 mm 0.09 in minimum aluminum and must be[cabinet][rack][wall] mounted and compatible with an ECIA EIA/ECA 310-E [482.6 mm][584 mm] [19 in][23 in] equipment[cabinet][rack]. Panel must provide [48][_____] [Flat][Angled], non-keyed, 8p8c wired to[T568A][T568B]. Patch panels must terminate the building cabling on[Type 110 IDCs][RJ45 type connector] and must utilize a printed circuit board interface. The rear of each panel must have incoming cable strain-relief and routing guides. Panels must have each port factory numbered.

2.2.5.2 Fiber Optic Backbone Patch Panel

NOTE: Provide rack/cabinet mount patch panels with either a vertical or horizontal orientation for the entire project. Provide quantities of LGX distribution panels to terminate all of the fiber being deployed plus 25 percent spare LGX space that must be covered with blanking panels. Provide space for fusion splice trays and cassettes in fiber patch panels.

Do not use SC, ST, or MT-RJ fiber optic adapters and connectors for new construction unless specifically

required for interface with existing equipment reused on installations. Check with activity for specific requirements for SC, ST, and MT-RJ adapters and connectors.

Provide housing for maintenance and cross-connecting of optical fiber cables. Panel must be constructed of[[16][18] gauge steel][or][11-gauge aluminum] minimum and must be[cabinet][rack][wall] mounted and compatible with an ECIA EIA/ECA 310-E [482.6 mm][584 mm] [19 in][23 in] equipment rack. Each panel must provide[12] [_____] [multimode][single-mode] adapters as[MPT-type 12 fiber connector cassettes broke out to six duplex LC UPC connectors,][duplex LC UPC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex LC APC for RF applications including but not limited to DAS] in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves[duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic]. Provide dust cover for all unused adapters. The rear of each panel must have a cable management tray a minimum of 203 mm 8 in deep with removable cover, incoming cable strain-relief and routing guides, and able to support 1 m 3 ft of cable slack. Panels must have each adapter factory numbered and be equipped with laminated plastic nameplates above each adapter. Must be equipped with factory bonding terminal. Patch panels must be sized to support all known connections plus 25 percent spare.

2.2.5.3 Fiber Optic Distribution Patch Panel

[Cabinet][Rack][Wall]mounted optical fiber distribution panel (OFDP) must be constructed in accordance with ECIA EIA/ECA 310-E utilizing[[16][18] gauge steel][or][11-gauge aluminum] minimum. Panel must be divided into two sections, distribution and user. Distribution section must have strain relief, routing guides, splice tray and must be lockable, user section must have a cover for patch cord protection[MPT-type 12 fiber connector cassettes multiplexed out to six duplex LC UPC connectors,][duplex LC UPC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex LC APC for RF applications including but not limited to DAS in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic][ST in accordance with TIA/EIA-604-2 with metallic] alignment sleeves. Provide dust covers for adapters. Provide patch cords as specified in the paragraph PATCH PANELS.

2.3 TELECOMMUNICATIONS PATHWAY

NOTE: Indicate cable tray layout on the drawings. When multiple types and sizes are used, indicate size and type of cable trays on the drawings. When using "as indicated" option, ensure information required is shown on the drawings. The RCDD must coordinate with structural engineer when designating the Span/Load Class category. This designation is found in NEMA BI-50016/VE 2. Provide designation on drawings and/or in this specification.

Provide telecommunications pathways in accordance with ANSI/TIA-569, conduit types specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM,

and as specified here. Provide system furniture pathways in accordance with [UL 1286](#).

Provide the following: Submit [cable trays](#) design, including dimensional layout, load and seismic calculations, and fill calculations. Dimensional layout includes cable spacings, cable tray splices, and supports. Fill calculations include an index of cables for each section and identification of the lb/ft, cross sectional area, and insulation voltage class for each cable.

- a. Cable trays: form a wireway system, with a nominal[[75](#)][[100](#)][[150](#)] mm [[3](#)][[4](#)][[6](#)] in][as indicated] depth. Cable tray is to have a span/load class designation of [_____] per [NEMA BI-50026/VE 2](#).
- b. Cable trays: constructed of[aluminum][copper-free aluminum][steel that has been hot-dipped galvanized after fabrication].
- c. Cable trays: include splice and end plates, dropouts, and miscellaneous hardware.
- d. Edges, fittings, and hardware: finished free from burrs and sharp edges.
- e. Fittings: ensure not less than load-carrying ability of straight tray sections and have manufacturer's minimum standard radius.
- f. Radius of bends: [[305](#)][[610](#)][[915](#)] mm [[12](#)][[24](#)][[36](#)] in.][as indicated.]
- [g. Accessories: ensure cable transitions required to proper support cable, bonding hardware, are indicated and provided.

]2.3.1 Basket-Type Cable Trays

NOTE: Basket cable tray is a fabricated structure consisting of wire mesh bottom and side rails.

Provide[size as indicated][of nominal[[50](#)],[[100](#)],[[150](#)],[[200](#)],[[300](#)],[[450](#)],[and][[600](#)] mm[[2](#)],[[4](#)],[[6](#)],[[8](#)],[[12](#)],[[18](#)],[and][[24](#)] in width and[[25](#)],[[50](#)],[and][[100](#)] mm[[1](#)],[[2](#)],[and][[4](#)] in depth] with maximum wire mesh spacing of [50](#) by [100](#) mm [2](#) by [4](#) in.

2.3.2 Trough-Type Cable Trays

NOTE: Trough or ventilated cable tray is a fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and utilizing 75 percent or less of the plan area of the surface to support cables.

Provide[size as indicated][of nominal [[150](#)][[305](#)][[455](#)][[610](#)][[760](#)][[915](#)] mm [[6](#)][[12](#)][[18](#)][[24](#)][[30](#)][[36](#)] in width].[Cable tray must be suitable for use as an equipment grounding conductor.]

2.3.3 Ladder-Type Cable Trays

NOTE: Ladder cable tray is a fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs). Ladder cable tray is best suited for pathways in telecommunications spaces.

Provide[size as indicated][of nominal [150][305][455][610][760][915] mm [6][12][18][24][30][36] in width] with maximum rung spacing of [150][225][305][455] mm [6][9][12][18] in in each EF and TR.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.3.4 Channel-Type Cable Trays

NOTE: Channel cable tray is a fabricated structure consisting of a one-piece ventilated-bottom or solid-bottom channel section, not exceeding 152 mm 6 inches in width.

Provide[size as indicated][of nominal [75][100][150] mm [3][4][6] in width]. Provide trays with one-piece construction having slots spaced not more than 115 mm 4 1/2 in on centers.[Cable tray must be suitable for use as an equipment grounding conductor.]

2.3.5 Solid Bottom-Type Cable Trays

NOTE: Solid bottom or non-ventilated cable tray is a fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

Center hung cable tray is not allowed for UMC projects and is not preferred for any other proponent.

Provide[size as indicated][of nominal [150][305][455][610][760][915] mm [6][12][18][24][30][36] in width]. Provide solid covers.[Do not provide solid covers.]

2.3.6 Non-continuous Cable Supports

NOTE: Utilize telecommunications cable supports (J-Hooks / J-Supports / D-rings) only as specifically permitted in UFC 3-580-01, Telecommunications Interior Infrastructure Planning and Design.

The use of cable tray mounted hooks mounted to the outside edge of cable tray is the preferred method for installation of Distributed Antenna System coax. The intent is to prevent the heavier cabling

from having to transition thru BTP and fiber optic cabling.

Provide cable supports in accordance with UL 2043. Provide[[galvanized][zinc-coated][stainless] steel] cable supports[as indicated]. Use cable trays for horizontal distribution to the maximum extent possible (maximum horizontal distance: 6 m 20 ft in open face hangers). The remaining pathway to the work area outlet may be implemented in a variety of ways combining conduit, non-continuous cable supports, and stub-ups/outs.

2.3.7 Sleeves and Conduit

Provide sleeves and conduit in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM and as further required in ANSI/TIA-569. Conduit must be minimum 25.4 mm 1 in, runs must not exceed 30 m 100 ft without installation of appropriate type, and sized pull box. There must be no aggregated bends between pull boxes in excess of 180 degrees. Pull boxes must not be installed as a change in pathway direction.

2.3.8 Floor Outlet and Poke-Thru Boxes

Telecommunications floor outlets: consisting of recessed outlets flush with the finished floor[aluminum][stainless steel][brass] housing with receptacles as specified in[Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM][as indicated] and a minimum of [1][2][_____] 25 mm 1 in bushed side opening. Must be hinged type, not requiring a special tool to open, and provides latching style ports for cable egress protection when in use.

2.3.9 Outlet Boxes for Telecommunications System

NOTE: When using "as indicated" option, ensure information required is shown on the drawings. Choose 100 mm 4 inch square boxes for single gang, four outlet, copper telecommunications configurations that do not have provision for fiber optic cabling. Choose 120 mm 4 11/16 inch square boxes for 35 mm 1 1/4 inch conduit installations and for outlet boxes that have or may require fiber optic cabling. Larger boxes are required to meet bend radii requirements for fiber optic cable and for situations when conduit larger than 1 inch are required.

Provide the following:

- a. Standard type [100 mm square by 54 mm deep][120 mm square by 54 mm deep][130 mm square by 73 mm deep] [4 in square by 2 1/8 in deep][4 11/16 in square by 2 1/8 in deep][5 inches square by 2 7/8 in deep].
- [b. Outlet boxes for wall-mounted telecommunications outlets: 100 by 54 by 54 mm 4 by 2 1/8 by 2 1/8 in deep.
-] c. Depth of boxes: large enough to allow manufacturers' recommended conductor bend radii.
- [d. Outlet boxes for fiber optic telecommunication outlets: include a

minimum 10 mm 3/8 in deep single or two gang plaster ring as shown and installed using a minimum 27 mm 1 in conduit system.

-]e. Outlet boxes for handicapped telecommunications station: [100 by 54 by 54 mm][130 mm square by 73 mm deep] [4 by 2 1/8 by 2 1/8 in][5 in square by 2 7/8 in] deep. Design outlet box for recess mounting with the faceplate flush with the wall surface, at the same height as the electrical outlets.
-] f. Extension rings are not permitted for new construction. Use only on existing boxes in concealed conduit systems where wall is furred out for new finish.

2.4 TELECOMMUNICATIONS CABLING (BACKBONE AND HORIZONTAL)

NOTE: Cables must be terminated within telecommunications rooms, telecommunications equipment rooms, and work areas. Cross-connect jumpers may be provided as part of the contract if required to provide the customer a complete and usable facility. Optical fiber and copper patch cords must be provided by the Contractor when patch panels are installed. Optical fiber media may be single-mode, multimode, or hybrid combination. For information on optical fiber local area network system, visit <https://www.tiafotc.org/>.

It is recommended that the labeling requirements be provided as a detail on drawings and approved by the technical authority/technology manager during design.

Air Force Medical Facilities are installed and labeled in accordance with HEADQUARTERS AIR FORCE MEDICAL SUPPORT AGENCY DESIGN AND IMPLEMENTATION GUIDELINES MEDICAL SYSTEMS INFRASTRUCTURE MODERNIZATION PROGRAM (2001) for Air Force medical projects. All other projects are labeled in accordance with ANSI/TIA-606. Coordinate with the facility on labeling standards in place and include in the design.

When systems furniture is provided as part of the construction contract, ensure that systems furniture specifications require compliance with ANSI/TIA-568 Series cabling standards as applicable.

NFPA 70 provides detailed information for optical fiber cables and communications circuits in various spaces and locations. Article 770, table 770-154(a), provides application of optical fiber cables and article 800, Table 800.154(a), provides application for communications circuits (copper).

Table 770.179 provides the following definitions for optical fiber cable:

- OFNP Nonconductive optical fiber plenum cable
- OFCP Conductive optical fiber plenum cable

- OFNR Nonconductive optical fiber riser cable
- OFCR Conductive optical fiber riser cable
- OFNG Nonconductive optical fiber general-purpose cable
- OFCG Conductive optical fiber general-purpose cable
- OFN Nonconductive optical fiber general-purpose cable
- OFC Conductive optical fiber general-purpose cable
- CI Circuit Integrity, Fire Resistive Cable System, or Electrical Circuit Protective Systems

Table 800.179 provides the following definitions for communications circuits:

- CMP Communications plenum cable
- CMR Communications riser cable
- CMG Communications general-purpose cable CM, CATV, BM, and BL Communications general-purpose cable, Community Antenna coax, Network-powered Broadband medium power, and network-powered Broadband low power
- CI Circuit Integrity, Fire Resistive Cable System, or Electrical Circuit Protective Systems
- CMP-LP, CMR-LP, CMX Communications cable, limited use
- CMUC Under-carpet communications wire and cable

NOTE: In passive optical network (PON) topologies, specify single mode fiber since it is currently the only viable cabling solution. PON technology is not supported by all current networks and must be coordinated with the agency specific telecommunications manager (NEC, BCO, G6) and additionally for the Navy, with the NMCI/COSC/NGEN Contractor. Design PON when required with two fibers to the WO and SO to support growth and technology advancements IAW UFC 3-580-01. The designer will need to add the appropriate ITU references into the body of each section as appropriate.

Cabling must be UL listed for the application and must comply with ANSI/TIA-568 Series Standards ISO/IEC 11801 and NFPA 70. Provide a labeling system for cabling as required by[as indicated,] ANSI/TIA-606, and UL 969. Ship cable on reels or in boxes bearing manufacture date for balanced twisted pair (BTP) in accordance with ICEA S-90-661[and optical fiber cables in accordance with ICEA S-83-596][coax in accordance with ICEA 61196-1-100] for all cable used on this project. Cabling manufactured more than 12 months prior to date of installation must not be used.

2.4.1 Backbone Cabling

NOTE: 150 ohm shielded twisted pair (STP)is not

allowed for new construction. Backbone cable lengths must not exceed guidelines of ANSI/TIA-568.1, ANSI/TIA-568.2, and ANSI/TIA-568.3. STP 100-ohm backbone and horizontal cable may be required for EMI isolation in complex buildings.

Use fiber optic cable for backbone data service, unless expanding an existing site where other backbone cable types are required or requested by user.

2.4.1.1 Backbone Copper

NOTE: ANSI/TIA-568.1 recognizes Category 5e rated cable as the minimum backbone transmission media. Use of cables rated higher than Category 5e are not required since the copper backbone cable is only used for voice systems. Choose the first bracketed jacket color for the preferred color code for cable jackets. Coordinate with activity and choose the second bracketed jacket color option to specify an activity preferred color. Color coding for conductors within the 25 pair bundles is covered by the reference to industry standards.

ICEA S-90-661 specifies a different cable marking interval for copper cables when marked in SI versus empirical units. This standard requires: "Length marking must appear at intervals not to exceed 1 meter 3.3 feet and the word "METER" must appear after each length marking. If specified by the user, length marking must be provided in feet and must appear at intervals not to exceed 0.6 meters 2 feet. The word "FEET" must appear after each length marking".

Copper backbone cable must be solid conductor, 24 AWG, 100 ohm, [25][____]-pair, Category 5e, UTP or greater, in accordance with ANSI/TIA-568.1, ANSI/TIA-568.2, and UL 444, formed into 25 pair binder groups covered with a [gray][____] thermoplastic jacket[and overall metallic shield]. Cable must be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) at regular length marking intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable must be permitted in accordance with NFPA 70.

2.4.1.2 Backbone Optical Fiber

NOTE: In a fiber optic communication cable, a buffer is one type of component used to encapsulate one or more optical fibers for the purpose of providing such functions as mechanical isolation, protection from physical damage, and fiber

identification. The buffer may take the form of a miniature conduit, contained within the cable and called a loose buffer, or loose buffer tube, in which one or more fibers may be enclosed, often with a lubricating gel. A loose buffer is typically used in outside plant applications. A tight buffer consists of a polymer coating in intimate contact with the primary coating applied to the fiber during the manufacturing process. A tight buffer is typically used for interior distribution. If a transition under-slab or through an underground duct system is designed, the use of indoor/outdoor rated fiber optic cabling is recommended.

Indicate the proper color coding of optical fiber cabling on design drawings. TIA/EIA-598 color coding scheme for cordage jackets used on military projects is as follows:

Fiber type	Fiber diameter in micrometer (um) and Class	Jacket color	
Multimode	50/125um Laser Optimized (OM5)	Lime green	
	50/125um Laser Optimized (OM4)	Violet or aqua	
	50/125um Laser Optimized (OM3)	Aqua	
	50/125um (OM2)	Orange	Legacy only to support extending existing installation OM2
	62.5/125um (OM1)	Slate	Legacy only to support extending existing installation OM1
Single-mode	OS1 (ranges between 8um and 10um)	Yellow	Legacy only to support extending existing Installation OS1
	OS1a (ranges between 8um and 10um)	Yellow	
	OS2 (ranges between 8um and 10um)	Yellow	

NOTE: The Army Installation and Campus Area Network (ICAN) Guide standard dictates the use of single

mode fiber cables for building backbones on Army projects.

For Navy projects provide single mode fiber cables (OS1a) for building backbones on all new projects to future proof the network and standardize the backbone. Additionally, this permits the option of flattening the network via direct connection to switches in TRs other than the main TR.

In existing facilities with multimode cables and switches, coordinate with the activity and the NMCI/COSC/NGEN contractor to determine whether the switch optics will be changed to utilize the single mode backbone, or if multimode cable must also be provided in addition to the single mode. If using multimode, OM3 (which permits data rates up to 10 Gig) is first choice. OM2 and OM1 should only be used to supplement existing systems.

For Air Force projects, coordinate fiber cable requirements with the Installation Communications Squadron.

Provide in accordance with ICEA S-83-596, ITU-T G.655, ANSI/TIA-568.3, UL 1666, and NFPA 70. Cable must be imprinted with fiber count, fiber type and aggregate length at regular intervals not to exceed 1 m 40 in. Provide the number of strands indicated, (but not less than 12 strands between the main telecommunication room and each of the other telecommunication rooms), of single-mode (OS1a), tight buffered fiber optic cable. Specify For premises applications deploying 10 Gigabit-Passive Optical Network (10G-PON) ITU-T G.987.1, ITU-T G.984.1, and ITU-T G.657. For longer reaches directly mating to OSP specify bend-insensitive fiber meeting ITU-T G.652.

Provide tight buffered fiber optic multimode, [50/125-µm diameter laser optimized (OM5)][50/125-µm diameter laser optimized (OM4)][50/125-µm diameter laser optimized (OM3)][50/125-µm diameter (OM2)][62.5/125-µm diameter (OM1)] cable as indicated. Provide OM1 or OM2 only when mating to legacy installations. Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70. Substitution of a higher rated cable must be permitted in accordance with NFPA 70. The cable cordage jacket, fiber, unit, and group color must be in accordance with TIA/EIA-598. For industrial applications or where subjected to physical damage armored conductive cables should be considered with appropriate bond and hardware.

2.4.2 Horizontal Cabling

NOTE: Coordinate project requirements and use of fiber optic cable and coax for horizontal cabling with the technical authority.

Remove requirements for copper infrastructure for US Marine Corp projects unless specifically exempted.

Provide horizontal cable in compliance with NFPA 70 and performance characteristics and installation in accordance with ANSI/TIA-568 Series applicable for the type of horizontal media.

2.4.2.1 Horizontal Copper

NOTE: Choose the first bracketed jacket color for the preferred color code for cable jackets. Coordinate with activity and choose the second bracketed jacket color option to specify an activity preferred color. Cabling, patch panels, connector blocks, work area outlets, and cable connectors must be color-coded to distinguish their classification level. If color-coding is not possible, cabling must be clearly marked to indicate classification level. Provide detail sufficient for the security officer to submit and obtain approval from the certified TEMPEST technical authority. Design submittals must document RED/BLACK and checklist items from Intelligence Community Directive (ICD) Tech Spec, including the TEMPEST checklist items specific to telecommunications systems.

ICEA S-90-661 specifies a different cable marking interval for copper cables when marked in SI versus empirical units. This standard requires "Length marking must appear at intervals not to exceed 1 meter, and the word "METER" must appear after each length marking. If specified by the user, length marking must be provided in feet and must appear at intervals not to exceed 3.3 feet. The word "FEET" must appear after each length marking.

Screened twisted pair cable (ScTP) may be required OCONUS, in AV applications, or in secure areas, confirm with technical authority. Coordinate with Activity for specific requirements and applicable reference standards.

The following are minimum cable Types for PoE System Application Data minimum requirements:

Workstation and Service Outlets	Cat 6A
BAS	Cat 6
AV	Shielded Cat 6A
Lighting	Cat 6 23 AWG
WAPs	2 each Cat 6A
Elevator	2 each Cat 6A

Provide horizontal copper cable, UTP, 100-ohm in accordance with ANSI/TIA-568.2, UL 444, ANSI/NEMA WC 66. For Workstation Outlets provide four each individually twisted pair, minimum size 24 AWG conductors, Category 6A, with a [blue][green] [_____] thermoplastic jacket.

For Service Outlets and Facility Related Control Systems (FRCS) that do not require 10G horizontal capability, provide [four][one] each individually twisted pair, minimum size 24 AWG conductors, Category 6, with a [green][_____] thermoplastic jacket. For AV that contain

uncompressed HDMI signals, provide four each individually twisted pair, minimum size 24 AWG conductors, Shielded Category 6A, with a [White][_____] thermoplastic jacket. For Wireless Access Points (WAP) provide 2 Category 6a cables to each outlet in accordance with TIA TSB-162. Cable must be imprinted with manufacturers name or identifier, flammability rating, gauge of conductor, transmission performance rating (category designation) and length marking at regular intervals in accordance with ICEA S-90-661. Provide plenum (CMP), riser (CMR), or general purpose (CM or CMG) communications rated cabling in accordance with NFPA 70. Substitution of a higher rated cable must be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs must be UL listed and labeled for wet locations in accordance with NFPA 70.[Provide residential ANSI/TIA Category 6 cabling in accordance with ANSI/TIA-570.]

2.4.2.2 Horizontal Optical Fiber

NOTE: When using fiber to the work area outlet, the design can use the multimode or single mode optical fiber for horizontal cabling. If using multimode, OM3 (which permits data rates up to 10 Gig) is first choice. OM2 and OM1 are legacy solutions and should only be used to supplement existing systems. Coordinate with Telecommunications Manager.

Centralized cabling provides connection from the work areas to the centralized cross connect by allowing the use of pull through cable, an interconnect, or a splice in the TR or ER. Although this is using the same cable as horizontal, the industry standard permits runs up to 300 m 984 ft for OM3 and 400 m 1,312 ft for OM4/OM5. These distances support 10GBASE-SR using MMF.

In passive optical network (PON) topologies, specify single mode fiber as it is currently the only viable cabling solution. PON technology is not supported by all current networks and must be coordinated with the agency specific telecommunications manager approval from the technical authority. Best practice is when designing PON is to design with two fibers to support a differing infrastructure if the network architecture changes.

For horizontal cabling, OM3 or better multimode optical fiber is recommended for: - Distances up to 90 m 295 ft in the horizontal.

Provide optical fiber horizontal cable in accordance with ANSI/TIA-568.3. Cable must be tight buffered,[multimode, 50/125-µm diameter laser optimized, OM3][,][single-mode, 8/125-µm diameter, OS1a with ITU-T G.657 fiber][single-mode, 8/125-µm diameter, OS1a with ITU-T G.652 fiber]. Cable must be imprinted with manufacturer, flammability rating and fiber count at regular intervals not to exceed 1 m 40 in.

Provide plenum (OFNP), riser (OFNR), or general purpose (OFN or OFNG) rated non-conductive, fiber optic cable in accordance with NFPA 70.

Substitution of a higher rated cable must be permitted in accordance with NFPA 70. Cables installed in conduit within and under slabs be UL listed and labeled for wet locations in accordance with NFPA 70. The cable jacket must be of single jacket construction with color coding of cordage jacket, fiber, unit, and group in accordance with TIA/EIA-598.

2.4.3 Work Area Cabling

NOTE: Verify with Telecommunications
Manager/Technical Authority

2.4.3.1 Work Area Copper

NOTE: Choose the first bracketed jacket color for
the preferred color code for cable jackets.
Coordinate with activity for alternate color coding
and choose the second bracketed jacket color option
to enumerate activity preferred color code.
Coordinate work area cabling color code with work
area adapter color code. When selecting 2-pair UTP,
verify component compatibility.

Provide work area copper cable in accordance with ANSI/TIA-568.2, with a[
blue,][green] [_____] thermoplastic jacket.

2.4.3.2 Work Area Optical Fiber

Provide optical work area cable in accordance with ANSI/TIA-568.3.

2.4.3.3 Service Outlets

Provide service outlet[single pair copper][4-pair copper][fiber optic]
cabling to support all operational technology (OT) outlets as indicated in
accordance with ANSI/TIA-568 Series.

2.5 TELECOMMUNICATIONS OUTLET/CONNECTOR ASSEMBLIES

NOTE: When a building has elevators, all necessary
four-pair copper cable with an eight-position
modular outlet adapter location must be verified
with the elevator installer or Contractor.

When a building has OT that requires structured
cabling provide Service outlets with a four-pair
copper cable with an eight-position modular outlet
or 2-pair copper cabling if vendor equipment accepts
this new connection type.

Conduit bend radius must be coordinated with cable
bend radius. Conduit entries at outlet and junction
boxes must be arranged so that cables passing
through the box must enter and exit at opposite
sides of the box. Provide grounding and bonding as
required by ANSI/TIA-607.

Wire 8-pin modular outlet/connectors to T568A configuration unless specifically requested and approved by the Telecommunications Manager. The term RJ-45 refers to 8-pin modular adapters/connectors wired to T568A or T568B configurations. Ensure drawings indicate work area outlet adapter color code functionality if color coding of adapters is a requirement of the project.

Remove requirements for copper infrastructure for US Marine Corp projects unless specifically exempted.

[2.5.1 Outlet/Connector Copper

NOTE: Coordinate outlet/connector color with Telecommunications Manager/Technical Authority.

Outlet/connectors must comply with FCC Part 68, ANSI/TIA-568.1, and ANSI/TIA-568.2[ANSI/TIA-568.5]. UTP outlet/connectors must be UL 1863 listed, non-keyed, 8-pin modular, constructed of high impact rated thermoplastic housing and must be third party verified by a nationally recognized testing laboratory. Outlet/connectors provided for UTP cabling must meet or exceed the requirements for the cable provided. Outlet/connectors must be terminated using a RJ45 type connections, color-coded for both T568A and T568B wiring. Each outlet/connector must be wired[T568A][or][T568B]. UTP outlet/connectors must comply with ANSI/TIA-568.2 for [200][_____] mating cycles.[UTP outlet/connectors installed in outdoor or marine environments must be jell-filled type containing an anti-corrosive, memory retaining compound.]

]2.5.2 Optical Fiber Adapters(Couplers)

NOTE: LC style adapters and connectors are the default standard for new construction due to smaller form factor (size) allowing higher density at both the patch panel and the outlets.

Do not use SC, ST, or MT-RJ fiber optic adapters and connectors for new construction unless specifically required for interface with existing equipment reused on installations. Check with activity for specific requirements for SC, ST, and MT-RJ adapters and connectors.

Sleeves are used in adapters to align the fibers and reduce insertion loss. Zirconia ceramic split sleeves are more expensive but provide higher durability than phosphor bronze split sleeves.

Provide optical fiber adapters suitable for[duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,][duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic alignment sleeves,][MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic alignment

sleeves,] and] ST crimp style connector in accordance with TIA/EIA-604-2 with metallic alignment sleeves] as indicated. Provide dust cover for adapters. Optical fiber adapters must comply with TIA-455-21 for [500][_____] mating cycles.

2.5.3 Optical Fiber Connectors

Provide in accordance with TIA-455-21.[Optical fiber connectors must be] duplex LC in accordance with TIA/EIA-604-10 with zirconia ceramic alignment sleeves,] duplex SC in accordance with TIA/EIA-604-3 with zirconia ceramic] MT-RJ in accordance with TIA/EIA-604-12 with thermoplastic] ST in accordance with TIA/EIA-604-2 with metallic] ferrule, epoxy less[crimp style] compatible with[[62.5/125][50/125] multimode][8/125 singlemode] fiber. The connectors must provide a maximum attenuation of 0.3 dB at[850][1300][1310][1550] nm with less than a 0.2 dB change after 500 mating cycles.]

2.5.4 Cover Plates

NOTE: Coordinate cover plate color with Section
26 20 00 INTERIOR DISTRIBUTION SYSTEMS.

Telecommunications cover plates must comply with UL 514C, and ANSI/TIA-568 Series;[flush][or][oversized][flat][angled] design constructed of[stainless steel][high impact thermoplastic material][ivory][white][brown] in color][to match color of receptacle/switch cover plates specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM]][302 stainless material][or][brass material]. Provide 2-Post, stainless material cover plates for all wall mounted telephone locations. Provide labeling in accordance with the paragraph LABELING in this section.

2.6 ZONE CABLING ASSEMBLIES

NOTE: Zone Cabling Assemblies such as MUTOA's and CP's are termination devices used for open office cabling. The use of these assemblies allows horizontal cabling to change more easily when the open office plan is reconfigured. Work area cables originating from the MUTOA should be routed through work area pathways (e.g., furniture pathways). The work area cables must be connected directly to workstation equipment without the use of any additional intermediate connections. MUTOAs must be located in an open office area so that each furniture cluster is served by at least one MUTOA. The MUTOA must be limited to serving a maximum of twelve work areas. 90 meter 295 feet maximum permanent link requirements remain. Spare capacity must also be considered when sizing the MUTOA. MUTOA's are not allowed above ceiling spaces.

Passive consolidation points (with no provisions for active network components) can be designed to allow horizontal cabling to be changed more easily when the open office plan is reconfigured. This introduces another connection point in the cabling

infrastructure and should be coordinated with the telecommunications manager/Technical authority prior to design.

[2.6.1 Multi-User Telecommunications Outlet Assembly (MUTOA)

Provide MUTOA(s) in accordance with ANSI/TIA-569.

]2.6.2 Consolidation Point (CP)

Provide CP(s) in accordance with ANSI/TIA-569.

]2.7 BONDING PRODUCTS

NOTE: Indicate bonding components and conductor sizes on drawings. Use the following guidelines until Section 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS is issued.

Provide in accordance with UL 467, ANSI/TIA-607, and NFPA 70. Components must be labeled as required by ANSI/TIA-606 and as indicated.

2.7.1 Bonding Conductors

NOTE: A Telecommunication Bonding Backbone (TBB) is required between the Primary Bonding Busbar (PBB) and all Secondary Bonding Busbars (SBBs). A TBB is not required for installation with only a single SBB or PBB. A Telecommunications Bonding Conductor (TBC) is required between the PBB and the building grounding electrode system

Sizing of the TBC, TBB, and BBC	
TBB length linear m ft	TBB Size AWG
less than 4 13	6
4 - 6 14 - 20	4
6 - 8 21 - 26	3
8 - 10 27 - 33	2
10 - 13 34 - 41	1
13 - 16 42 - 52	1/0
16 - 20 53 - 66	2/0
20 - 26 67 - 84	3/0

If longer lengths are necessary, reference chart in ANSI/TIA 607 Section 6.3	
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Choose the second bracketed options where lightning protection system is provided in the job and specified in other sections. Choose insulated TBB when pathway is a dissimilar metal than copper. See ANSI/TIA-607 E Section 6 for further information. Choose BBC bracketed conductor when two or more stacks of TR's are present.

When a tower or antenna is installed, the installation shall meet the meet the bonding and grounding requirements of ATIS 0600334. See annex B of ANSI/TIA-607 for information regarding bonding and grounding of towers and antennas.

ASTM B1, solid bare copper wire for sizes No. 8 AWG and smaller diameter; ASTM B8, Class B, stranded bare copper wire for sizes No. 6 AWG and larger diameter. Conductors must be installed using two-hole compression type lugs in accordance with ANSI/TIA-607 and UL 486A-486B.

Provide a copper TBB between the telecommunications main grounding busbar (PBB) and the electrical service ground in accordance with ANSI/TIA-607. Size the bonding conductor for telecommunications the same as the TBB.[Provide insulated TBB with insulation as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM paragraph INSULATION and meeting the fire ratings of its pathway.]

2.7.1.1 Telecommunications Bonding Backbone (TBC)

Provide a copper Telecommunication Bonding Conductor (TBC) between the primary bonding busbar (PBB) and the electrical service ground in accordance with ANSI/TIA-607. Size the TBC the same as the largest TBB conductor.[Provide insulated TBCB with insulation as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM paragraph INSULATION and meeting the fire ratings of its pathway.]

2.7.1.2 Telecommunications Bonding Backbone (TBB)

Provide a copper telecommunications bonding backbone (TBB) between the PBB and all SBB's in accordance with ANSI/TIA-607. Size the TBB in accordance with ANSI/TIA-607 based on total length.

[2.7.1.3 Telecommunications Backbone Bonding Conductor (BBC)

Provide a copper telecommunications backbone bonding conductor(BBC) between the top most floor SBB's in accordance with ANSI/TIA-607. Size the BBC the same as the largest TBB conductor. Provide insulated conductors with insulation as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM paragraph INSULATION and meeting the fire ratings of its pathway.

2.7.1.4 Telecommunications Equipment Bonding Conductor (TEBC)

Provide a copper conductor in accordance with ANSI/TIA-607 with a minimum No. 6 AWG to bond all raceways,[rack RBB][cabinet RBB][wall mounted equipment cabinet RBB] to the[PBB][SBB]. Provide insulated conductors with insulation as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM paragraph INSULATION and meeting the fire ratings of its pathway.]

2.7.2 Bonding Busbars

NOTE: Minimum width for the Primary bonding busbar (PBB) is 100 mm 4 in and for the Secondary bonding busbar (SBB) is 50 mm 2 in. Telecommunications bonding busbar provides bonding termination for all metallic elements in the telecommunications systems. Choose the bracketed option for Secondary bonding busbars (SBB) when there are more than one telecommunications room or telecommunications equipment rooms included in the project.

Provide corrosion-resistant bonding busbar suitable for[indoor][outdoor] installation in accordance with ANSI/TIA-607. Busbars: plated for reduced contact resistance. Provide a Primary bonding busbar (PBB) in the telecommunications entrance facility[and a Secondary bonding busbar (SBB) in all other telecommunications rooms and equipment rooms]. The Primary bonding busbar (PBB)[and the secondary bonding busbar (SBB)]: sized in accordance with the immediate application requirements and with consideration of future growth. Provide[vertical][horizontal] Rack Bonding Busbar (RBB) in each[rack][cabinet]. Provide bonding busbars with the following: a. , b. ; c. Listed by a nationally recognized testing laboratory.

- a. Predrilled copper busbar provided with holes for use with standard sized two-hole lugs,
- b. Minimum dimensions of 6 mm 0.25 in thick by 100 mm 4 in wide for the PBB[and 50 mm 2 in wide for SBBs] with length as indicated and 6 mm 0.25 in thick by[[762 mm][648 mm] [30 in][25.5 in] [_____] for a vertical RBB][[483 mm 19 in] [_____] for a horizontal RBB].
- c. Listed by a nationally recognized testing laboratory.

2.8 FIRESTOPPING MATERIAL

NOTE: Firestopping material requirements are specified in Section 07 84 00 FIRESTOPPING.

Provide as specified in Section 07 84 00 FIRESTOPPING. Ends of conduit stubs must be treated as part of the overall assembly.

2.9 MANUFACTURER'S NAMEPLATE

Each item of equipment must have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be

acceptable.

2.10 UNIQUE IDENTIFICATION NAMEPLATES AND LABELS

Provide[laminated plastic nameplates per [ASTM D709](#)][thermal ink transfer process][laser printer] for each equipment[rack][cabinet],[wall mounted cabinet,] patch panels, outlet[and active equipment device]; as specified[or as indicated on the drawings].[Nameplates must be melamine plastic, 3 mm 0.125 in thick, white with [black][_____] center core. Surface must be matte finish. Corners must be square. Accurately align lettering and engrave into the core. Minimum size of nameplates must be 25 by 65 mm 1 by 2.5 in.] Lettering must be[a minimum of 6.35 mm 0.25 in high normal block style.][sized for the equipment, white with [black][_____] text. Labels must be sized to fit the devices/equipment being labeled.]

2.11 TESTS, INSPECTIONS, AND VERIFICATIONS

2.11.1 Factory Reel Tests

Provide documentation of the testing and verification actions taken by manufacturer to confirm compliance with[[ANSI/TIA-568.2](#) for BTP copper][[ANSI/TIA-568.3](#) and [ANSI/TIA-526-7](#) for single mode optical fiber][, and [ANSI/TIA-526-14](#) for multimode optical fiber] cables.

PART 3 EXECUTION

3.1 INSTALLATION

NOTE: Delete last sentence associated with cabling guides for single family resident ANSI/TIA installations.

Cable installation logic must be approved by the proponents technical authority/telecommunications manager.

Install telecommunications telecommunication spaces, pathway systems, and cabling (including the horizontal and backbone cable), telecommunications outlet/connector assemblies, and associated hardware as detailed in [NECA/BICSI 568](#), [ANSI/BICSI N1](#), [ANSI/BICSI N3](#), [ANSI/TIA-568.1](#), [ANSI/TIA-568.2](#),[[ANSI/TIA-568.3](#),] [ANSI/TIA-569](#), [NFPA 70](#), and UL standards as applicable. Pathways and outlet boxes must be types as specified in PART 2. Install cabling in a star topology network[redundant star for C5ISR and other facilities with a mission that supports telecommunications infrastructure redundancy].[Install residential cabling in a star wiring architecture from the distribution device as required by [ANSI/TIA-570](#).] Install telecommunications cabling with copper media in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment. The interference ceiling must not exceed 3.0 volts per meter measured over the usable bandwidth of the telecommunications cabling. Cabling must be run with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment. To ensure a logical sequence of installation, and ease of maintenance, organize cables from top-to-bottom, left-to-right across the front of each patch panel. WAO must start from the[building's main entrance][serving telecommunications room] working

left-to-right around each room and left-to-right throughout the building. SO's[may be included in sequence][managed separately from WAO's as approved by the COR and technical authority].

3.2 TELECOMMUNICATION SPACE EQUIPMENT

Install all termination hardware necessary to support required Category [6a][____][and][optical fiber] system[s] and network equipment as indicated on the drawings.

3.2.1 Plywood Backboards

Install A/C grade plywood backboards on walls as indicated on the drawings and in accordance with ANSI/TIA-569. Mount plywood vertically, with the bottom of the plywood [150 mm][203 mm] [6 in][8 in] [____] above the finished floor with the best side toward the room. Mounting anchors utilizing[galvanized][zinc plated][stainless steel] hardware with a flat head. Finished installation must be flush with countersunk screw head to prevent splitting. Drywall screws are not acceptable.

3.2.2 Equipment Support Frames

Install equipment support frames, patch panels, cable management, and cable guides in accordance with ANSI/TIA-569. Verify coordinated placement of all equipment and utilities. Maintain required clearances per PART 2 and approved shop drawing. Mount required PDU's along the sides of equipment frames per manufacturers recommendation[as indicated on the drawings].

- a. Bracket, wall mounted. Mount bracket to plywood backboard in accordance with manufacturer's recommendations. Mount rack so height of highest panel does not exceed 1980 mm 78 in above floor.
- b. Racks, floor mounted modular type. Permanently anchor rack to the floor in accordance with manufacturer's recommendations. Anchor at the top in accordance with seismic requirement found elsewhere in design.
- c. Cabinets, freestanding modular type. When cabinets are connected, remove adjoining side panels for cable routing between cabinets.[Mount rack mounted fan in[roof][base] of cabinet.]
- d. [Cabinets][Rack], wall-mounted modular type. Mount[cabinet][rack] to plywood backboard in accordance with manufacturer's recommendations. Mount cabinet so height of highest panel does not exceed 1980 mm 78 in above floor.
- e. Allow a minimum of 914 mm 36 in working clearance in[front and rear of floor mounted equipment frames][front of wall mounted equipment frames]. Clearance of 153 mm 6 in is required for equipment frames adjacent to a wall and a minimum of 762 mm 30 in is required at the end of each row.

3.2.3 Connector Blocks

Install[cabinet][rack][wall] mounted[110-Type][710-type] connector blocks in orderly rows and columns. Adequate vertical and horizontal wire routing areas must be provided between groups of blocks. Install in accordance with industry standard wire routing guides per ANSI/TIA-569.

3.2.4 Patch Panels

Patch panels must be mounted[in equipment[cabinets]][racks][on the plywood backboard] with sufficient ports to accommodate the installed cable plant plus [25][_____] percent spares.

- a. Copper Patch Panel. Copper cable entering a patch panel must have additional support and be secured to the panel as recommended by the manufacturer to prevent movement of the cable and reduce component strain. Land cabling left-to-right, top-to-bottom in the same logic as room's are identified.
- b. Fiber Optic Patch Panel. Fiber optic cable loop must be [900][_____] mm [3][_____] ft in length. The outer jacket of each cable entering a patch panel must be secured to the panel to prevent movement of the fibers within the panel, using clamps or brackets specifically manufactured for that purpose.

3.2.5 Cable Management

Install horizontal and vertical cable management in accordance with ANSI/TIA-569.

- a. Horizontal Cable Management: Install one rack unit (RU) horizontal manager for every one RU of patch panel or switch port appearances. Horizontal cable management must be installed to support ports without overlapping/crossing/impinging on other port appearances.

Vertical Cable Management: Install vertical cable management between racks[and at each end of each row]. Vertical cable management panels must be a minimum of 150 mm 6 in wide and deep and additionally sized based on total anticipated cable fill plus 50 percent. Allow space against wall for operation of management covers.

3.3 TELECOMMUNICATIONS PATHWAYS

NOTE: Do not use metal flex conduit for telecommunications wiring unless used to connect floor boxes under raised floors.

For guidelines on conduit sizing, see UFC 3-580-01, "Information and Communications Infrastructure Planning and Design" and NFPA 70.

Install in accordance with ANSI/TIA-569 and NFPA 70.

- a. Horizontal Pathway: Telecommunications pathways from the work area to the telecommunications room: installed and cabling length requirements in accordance with ANSI/TIA-568 Series. Size conduits[wireways][and cable trays] in accordance with ANSI/TIA-569[and][as indicated]. Install a minimum of 25 mm 1 in conduit for telecommunications work area and service outlets. Conduit size must be increased if required by cable diameter and fill requirements.
- b. Backbone Pathway: Telecommunication pathways from the telecommunications entrance facility to telecommunications rooms, and,

telecommunications equipment rooms (backbone cabling): installed in accordance with ANSI/TIA-569 and as indicated. Size conduits[, wireways][, and cable trays] for telecommunications risers in accordance with ANSI/TIA-569[and][as indicated].

- c. Service Entrance Conduit, Overhead: Install service entrance overhead as specified in Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.3.1 Interior Distribution System

Install conduit in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM PART 3 except as indicated below. Install wall mounted outlet boxes as specified in PART 2. Provide pull boxes for telecommunications systems in accordance with ANSI/TIA-569. No conduit runs must exceed 30 m 100 ft without a pull box placed. Pull boxes must not be used for a change in direction. Conduit bends must not exceed more than the equivalent of two 90 degree bends or 180 degrees total without the addition of a pull box in accordance with ANSI/TIA-569. Conduits must enter and exit pull boxes in accordance with ANSI/TIA-569. Install firestop penetrations in accordance with Section 07 84 00 FIRESTOPPING. Install conductors run through smoke and fire partitions in 103 mm 4 in rigid steel conduits with bond bushings, extending 305 mm 12 in beyond each side of partitions. Seal conduit on both ends to maintain smoke and fire ratings of[partitions][listed fire barrier pathways].

3.3.2 Pull Cords

Pull cords must be installed in conduit serving telecommunications outlets that do not have cable installed. Pull cords must be labeled on each end and indicate the service in which they were installed to support, the location of all pull boxes, and room number of the far ends. Spare outlet locations must be included in record documentation.

3.3.3 Cable Tray

Install cable tray as specified in PART 2. Cable tray access and working clearances of 305 mm 12 in on one side and above the tray must be coordinated with other utilities. Side and top encroachment distance of less than 914 mm 3 ft in a 6 m 20 ft span is allowable provided it does not prohibit access to raceways or conduits that feed into the tray and is approved prior to cable installation. These encroachments must be approved by the Building Information Modeling (BIM) Coordination Team with final approval by the Information Communications Technical Authority. Install cable tray using[wall mounted brackets][ceiling hung brackets]. Do not install cable tray using a single center hanger.

Install and bond in accordance with NFPA 70, ANSI/TIA-569, and ANSI/TIA-607. Install cable trays parallel with or at right angles to ceilings, walls, and structural members. Cable tray and tray supports must not partially nor completely obstruct access to the room. Support[in accordance with NEMA BI-50026/VE 2 and with manufacturer recommendations but at not more than [1830][_____] mm [6][_____] ft intervals][as indicated by the manufacturer]. Coat contact surfaces of aluminum connections with an antioxidant compound prior to assembly. Adjacent cable tray sections bonded together by connector plates of an identical type as the cable tray sections. Terminate cable trays 55 mm 10 in from both sides of smoke and fire partitions. Install cable tray supports to resist forces of 0.5 times the equipment weight in any direction and 1.5 times the equipment weight in the downward direction. Ensure edges, fittings, and hardware

are finished free from burrs and sharp edges.

3.3.4 Non-Continuous Cable Supports

NOTE: Utilize non-continuous telecommunications cable supports (J-Hooks / J-Supports / Bridle rings/ D-rings) only as specifically permitted in UFC 3-580-01, Telecommunications Interior Infrastructure Planning and Design. If allowed, verify design notes are included on drawings.

For Navy projects, install cabling in a wireway/raceway pathway system only. Delete bracketed sentences associated with cabling not in wireway and pathway, structural member routing, cable placement and coiling of cables.

- [Install open top and closed ring cable supports on 1.2 m to 1.5 m 4 ft to 5 ft centers to adequately support and distribute the cable's weight. Use these types of supports to support a maximum of 20 6.4 mm 0.25 in diameter cables. Support cable not in a wireway or pathway minimum of [200][_____] mm [8][_____] in above ceilings and no greater than 1.2 m to 1.5 m 4 ft to 5 ft centers to adequately support and distribute the cable's weight. Open top and closed ring cable supports must be suspended from or attached to the structural ceiling or walls with hardware or other installation aids specifically designed to support their weight.
-] Cable must not be run through structural members or in contact with pipes, ducts, or other potentially damaging items. Placement of cable parallel to power conductors must have a minimum separation of 300 mm 12 in. Cable routed exposed under raised floors must be plenum rated. Plenum cables must comply with flammability plenum requirements of NFPA 70. Install cabling after the flooring system has been installed in raised floor areas and arranged to not impede underfloor airflow.[Cable [1.8][_____] m [6][_____] ft long must be neatly coiled not less than [300][_____] mm [12][_____] in in diameter below each feed point in raised floor areas.]

3.3.5 Floor Outlet and Poke-Thru Boxes

Install floor outlet boxes in accordance[with manufacturer's instructions][and][as indicated]. Boxes must be flush with finished floor surfaces. If electrical power is provided in the same box, the box must be fully partitioned.

3.3.6 Telecommunication Penetrations

Seal openings around telecommunication penetrations through fire resistance-rated wall, partitions, floors, or ceilings as specified in Section 07 84 00 FIRESTOPPING.

3.4 TELECOMMUNICATIONS CABLE

3.4.1 Backbone Cable

- a. Copper Backbone Cable. Install intrabuilding backbone copper cable, in indicated pathways, between the campus distributor, located in the telecommunications entrance facility or room, the building

distributors and the floor distributors located in telecommunications rooms and telecommunications equipment rooms as indicated on drawings.

- b. Optical fiber Backbone Cable. Install intrabuilding backbone optical fiber in indicated pathways. Prepare cable for pulling by cutting outer jacket 250 mm 10 in leaving strength members exposed for approximately 250 mm 10 in. Twist strength members together and attach to pulling eye. Vertical cable support intervals must be in accordance with manufacturer's recommendations. Fusion-splice backbone fibers to factory produced pigtails.

3.4.2 Horizontal Cable

Install UTP[and][optical fiber] telecommunications cabling system as detailed in ANSI/TIA-568 Series based on media type[and ANSI/TIA-570 for residential cabling]. Screw terminals must not be used except where specifically indicated on plans. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations. Terminate on a workstation outlet, service outlet, or MPTL on the field end and a patch panel in the TR. Do not exceed manufacturers' cable pull tensions for copper and optical fiber cables. Provide a device to monitor cable pull tensions. Do not exceed 110 N 25 lbs pull tension for four pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by cable manufacturer. Do not use any support methods that allow over cinching of cables, or crush cables with staples. For UTP cable, bend radii must not be less than four times the cable diameter. For fiber optic cables the bend radius must not be less than 20 times the diameter during pulling and must not be less than 10 times the diameter after installation. All cabling must be terminated; no cable must contain unterminated elements. Cables must not be spliced. Label cabling in accordance with paragraph LABELING in this section. Install cable rated for their listed environment.

- a. Install copper horizontal cabling as indicated on approved shop drawings. Do not untwist Category UTP cables more than 12 mm 1/2 in from the point of termination to maintain cable geometry. Install a slack cable a minimum of [3 m] [10 ft] [_____] along the longest pathway in the TR. Install 300 mm 12 in of cable slack above ceiling at the WOA or service outlet.
- b. Install fiber horizontal cabling as indicated on approved shop drawings. Install a slack loop a minimum of [3 m] [10 ft] [_____] in the form of a managed figure-eight (not a service loop) on the back wall field of the telecommunications room. Install fiber optic cable in innerduct.

3.5 OUTLETS

3.5.1 Work Area Outlets

Terminate copper work area outlet cable in accordance with ANSI/TIA-568.1,[ANSI/TIA-568.2][ANSI/TIA-568.4][ANSI/TIA-568.5] and wiring configuration T568A.[Terminate fiber optic cables in accordance with ANSI/TIA-568.3.]

3.5.2 Service Outlets (SO)

Terminate copper cable in accordance with ANSI/TIA-568.1,[ANSI/TIA-568.2][ANSI/TIA-568.4][ANSI/TIA-568.5] [TIA TSB-162] and wiring configuration as specified.[Terminate fiber optic cables in accordance with

ANSI/TIA-568.3.] Male (MPTL) may be used in place of a SO in applications where a SO and patch cord are not accessible, or the OT equipment is not conducive to this type of installation.

3.5.3 Cover Plates

As a minimum, each outlet/connector must be labeled with the unique number to identify cable link in accordance with the paragraph LABELING in this section and as shown on the approved shop drawings.

3.6 ZONE CABLING ASSEMBLIES

[3.6.1 Multi-User Telecommunications Outlet Assembly (MUTOA)

Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a MUTOA in each individual zone. MUTOAs must not be located in ceiling spaces, or any obstructed area. MUTOAs must not be installed in furniture unless that unit of furniture is permanently secured to the building structure. MUTOAs must be located in an open work area so that each furniture cluster is served by at least one MUTOA. The MUTOA must be limited to serving a maximum of twelve work areas. Maximum work area cable length requirements must also be considered. MUTOAs must be labeled to include the maximum length of work area cables. MUTOA labeling is in addition to the labeling described in ANSI/TIA-606, or other applicable cabling administration standards. Work area cables extending from the MUTOA to the work area device must also be uniquely identified and labeled.

]3.6.2 Consolidation Point (CP)

Run horizontal cable in the ceiling or underneath the floor and terminate each cable on a CP in each individual zone. CPs located in ceiling spaces must remain accessible and not installed in an obstructed area. CPs must be labeled to include the maximum length of work area cables. CP labeling is in addition to the labeling in accordance with ANSI/TIA-606, section LABELING, and as designed. Work area cables and service outlet cables extending from the CP to the work area device must also be uniquely identified and labeled.

]3.7 TELECOMMUNICATIONS BONDING

**NOTE: Edit this subpart after Section 27 05 26
GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS is
issued.**

**Choose the bracketed option for Secondary bonding
busbars (SBB) when there are more than one
telecommunications room or telecommunications
equipment rooms included in the project.**

**Choose Telecommunications Bonding Conductors
bracketed option when more than one
telecommunication grounding busbar is installed as
part of the project.**

**Choose or edit the requirement for a
Telecommunication Bonding Backbone (TBB) and
Backbone Bonding Conductor (BBC) in accordance with
ANSI/TIA-607.**

Clean the busbar prior to fastening the conductors to the busbar and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance.[No. 2 AWG bare copper wire throughout cable tray system, and bond to each section, except use No. 1/0 aluminum wire if cable tray is aluminum.][Provide cable tray connecting hardware listed for bonding per the manufacture literature and from the same manufacturer.] Provide in accordance with ANSI/TIA-607, NFPA 70[and section BONDING PRODUCTS][and as specified in Section 27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS].

3.7.1 Telecommunications Bonding Busbars

Install a Primary bonding busbar (PBB) in the telecommunications entrance facility in accordance with ANSI/TIA-607. Install the PBB as close to the electrical service entrance grounding connection as practicable. Where a panelboard for telecommunications equipment is not installed in the entrance facility room, locate the PBB near the backbone cabling and associated terminations. In addition, locate the PBB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a PBB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the PBB.[Bond the PBB to building steel using[irreversible exothermic weld][2 lugs connect rated for bonding].][Install a Secondary bonding busbar (SBB) in all other telecommunications rooms and telecommunications equipment rooms. Install the SBB as close to the telecommunications room panelboard as practicable, when equipped. Where a panelboard for telecommunications equipment is not installed in the telecommunications room, locate the SBB near the backbone cabling and associated terminations. In addition, locate the SBB to provide for the shortest and straightest routing of the grounding conductors. Where a panelboard for telecommunications equipment is located within the same room or space as a SBB, bond that panelboard's alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure to the SBB.] Install bonding busbars to maintain clearances as required by NFPA 70 and insulated from its support. A minimum of 50 mm 2 in separation from the wall is recommended to allow access to the rear of the busbar and adjust the mounting height to accommodate overhead or underfloor cable routing.

3.7.2 Telecommunications Bonding Conductors (TBC)

Install a TBC service equipment bond consisting of separate bonding conductor between the PBB and readily accessible grounding connection of the electrical service in accordance with ANSI/TIA-607. Bonding conductors should not be placed in ferrous metallic conduit unless required per NFPA 70 for protection from physical and mechanical damage. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 1 m 3 ft in length, bond the conductors to each end of the conduit using a grounding bushing and No. 6 AWG conductor, minimum.

[3.7.3 Backbone Bonding Conductor (BBC)

Install a BBC between the topmost SBB's that extends across the building, using the telecommunications backbone pathways shortest paths, and connects to the SBBs in all telecommunications rooms and equipment rooms in accordance with ANSI/TIA-607. Each BBC must be continuous to the

farthest SBB. Bonding conductors should not be placed in ferrous metallic conduit unless required per NFPA 70 for protection from physical and mechanical damage. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 1 m 3 ft in length, bond the conductors to each end of the conduit using a grounding bushing and No. 6 AWG.

]3.7.4 Telecommunications Bonding Backbone (TBB)

Install a TBB that originates at the PBB, extends throughout the building using the telecommunications backbone pathways shortest paths, and connects to the SBBs in all telecommunications rooms and equipment rooms in accordance with ANSI/TIA-607. Each TBB must be continuous to the farthest SBB. Bonding conductors should not be placed in ferrous metallic conduit unless required per NFPA 70 for protection from physical and mechanical damage. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 1 m 3 ft in length, bond the conductors to each end of the conduit using a grounding bushing and No. 6 AWG conductor, minimum.[In a metal frame (structural steel) building, where the steel framework is readily accessible within the room, or external to the room but readily accessible; bond each PBB[and SBB] to the vertical steel metal frame using conductors sized per ANSI/TIA-607 based on length but no less than No. 6 AWG conductor.]

- a. The TBC[and TBB][BBC] conductor must be installed without splices and routed in the shortest possible straight-line path to the greatest extent possible. Make the bonding conductor between a TBB and SBB continuous. Where splices are unavoidable, the number of splices should be a minimum. Make the splices accessible and located in telecommunications spaces. Connect joined segments of a TBB using exothermic welding, irreversible compression-type connectors, or equivalent. Install all joints to be adequately supported and protected from damage. Whenever two or more TBBs are used within a multistory building, bond the TBBs together with a backbone bonding conductor (BBC) at the top floor and at a minimum of every third floor in between. Do not connect the TBB or BBC to the pathway ground.
- b. Telecommunications Bonding Connections (TEBC): Telecommunications bonding connections to the PBB[or SBB]: utilize listed compression, two-hole lugs, exothermic welding, suitable and equivalent, or other irreversible compression type connections. Bond all metallic pathways, cabinets, and racks for telecommunications cabling and interconnecting hardware located within the same room or space as the PBB[or SBB] to the PBB[or SBB respectively]. In a metal frame (structural steel) building, where the steel framework is readily accessible within the room; bond each PBB[and SBB] to the vertical steel metal frame using a minimum No. 6 AWG conductor. Where the metal frame is external to the room and readily accessible, bond the metal frame to the SBB or PBB with a minimum No. 6 AWG conductor. When practicable because of shorter distances and, where horizontal steel members are permanently electrically bonded to vertical column members, the SBB may be bonded to these horizontal members in lieu of the vertical column members. All connectors used for bonding to the metal frame of a building must be listed for the intended purpose.
- c. Rack Bonding Busbar (RBB): Install[horizontal][vertical] busbars in each equipment frame provided. Bond all appliances and supporting hardware that have a manufacturer bonding connection available. Unless otherwise approved by the Telecommunications Manager to not

bond equipment frames using example "A" in ANSI/TIA-607. Utilize listed compression, two-hole lugs, suitable and equivalent one-hole compression.

- d. Telecommunications Equipment Frames and Supporting Structures; Bond all telecommunications equipment frames and supporting metallic structures (cable trays, ladder rack, conduits, bonding conductor of nonmetallic sheathed cables, foiled, or shielded cable) in accordance with ANSI/TIA-607 and NFPA 70.[Bond access flooring supports systems.] Utilize listed compression two-hole lugs, bonding ribbons, or other irreversible compression type connections. Where ground fault protection is employed, ensure that connection of ground and neutral does not interfere with correct operation of fault protection. Label all bonding conductors in accordance with ANSI/TIA-606, paragraph LABELING of this section, and as designed. Test all bonding in accordance with ANSI/TIA-607 and as provided in paragraph TESTING.

3.8 LABELING

3.8.1 Labels

NOTE: Install and label medical facilities in accordance with Defense Health Agency LAN/WLAN Installation Manual. Label other projects in accordance with ANSI/TIA-606 using a mechanical device for printing. Labeling schemes are required to be detailed in design drawings and approved by the telecommunications manager. Labeling must be IAW the architectural wayfinding and not construction space number/naming conventions.

Provide labeling in accordance with ANSI/TIA-606, UFC 3-580-01, and as submitted and approved on T4 shop drawings. Handwritten labeling is unacceptable. Stenciled lettering for voice and data circuits must be provided using[thermal ink transfer process][laser printer] [_____]. Labeling of cabling must be provided on all telecommunication outlet boxes.

3.8.2 Cable

Cables must be labeled using labels with To/From information on opposing end with identifiers in accordance with ANSI/TIA-606 and as submitted and approved on T4 shop drawings.

3.8.3 Termination Hardware

Equipment frames, workstation outlets, service outlets, and patch panel connections must be labeled using coded labels with identifiers in accordance with ANSI/TIA-606 and as submitted and approved on T4 shop drawings.

3.9 FIELD APPLIED PAINTING

NOTE: Use and coordinate paint and coating requirements with Section 09 90 00 PAINTS AND COATINGS when provided in the job. When

requirements are beyond what is specified in Section
09 90 00, specify the requirements in this paragraph.

Painting must be as specified in Section 09 90 00 PAINTS AND COATINGS.

3.9.1 Painting Backboards

If backboards are required to be painted, then the manufactured fire-retardant backboard must be painted with fire retardant paint, so as not to increase flame spread and smoke density and must be appropriately labeled. Label and fire rating stamp must be unpainted and placed in a location not anticipated to be covered by equipment.

3.10 FIELD FABRICATED NAMEPLATE MOUNTING

Provide number, location, and letter designation of nameplates as indicated. Fasten nameplates to the device with a minimum of two sheet-metal screws or two rivets. Nameplates must be installed plumb, level, and center to the device.

3.11 TESTING AND INSPECTIONS

3.11.1 Telecommunications Cabling Testing

Perform telecommunications cabling inspection, verification, and performance tests in accordance with ANSI/TIA-568 Series, ISO/IEC 14763-2, ISO/IEC 14763-3 based on media. Test equipment must conform to ANSI/TIA-1152. Provide results with coordinated as built record plans for labeling in accordance with ANSI/TIA-606 and approved label scheme as a single complete package. Remove failed cable reels from project site upon attenuation test failure. Copper tests are required to be performed with Certification Test Equipment level IIIe at 500 MHz for class [6][6A][_____] with the results furnished in the native format of the tester and in PDF format. For service outlets and other cables that are not workstation outlets use the most applicable test for the class of cable per ANSI/TIA-568 Series standard. To test links with an MPTL run the test Permanent Link Adapter and a Patch Cord Adapter (PCA) on the other end following manufacturer recommendations.

Level	Frequency	Cable Category
IIE	100 MHz	5e and class D
III	250 MHz	6 and class E
IIIe	500 MHz	6A and class EA
IV	1000 MHz	8 and class F/FA*

3.11.1.1 Inspection

Visually inspect UTP and optical fiber jacket materials for UL or third-party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for T568A or T568B pin assignments and inspect cabling connections to confirm compliance with ANSI/TIA-568.1, ANSI/TIA-568.2,[ANSI/TIA-568.3,][ANSI/TIA-568.4][ANSI/TIA-568.5][and][ANSI/TIA-570 for residential

cabling]. Visually confirm [Category 6a][_____] marking of outlets, cover plates, outlet/connectors, and patch panels ensuring the entire channel is composed of components of the same marking. Visually inspect cabling jacket for deformation and discoloration. Cables may be required to be replaced, regardless of test results, if cabling jacket damage is deemed by the telecommunications manager or COR to be excessive.

3.11.1.2 Verification Tests

- a. Technicians who have successfully completed a training program for the test equipment and hold a current certificate as proof thereof must execute the tests.
- b. The COR must be notified of the start date of the testing phase 5[_____] business days before testing commences and must be invited to witness [and][or] review field-testing. Cable acceptance testing must only be performed after cabling is in place, both ends are terminated, and faceplates are installed.
- c. Bonding system testing is required to determine if an acceptable level of resistance is provided between the telecommunications bonding system and the building's electrical grounding electrode system. Prior to performing testing a visual inspection must be performed to verify all components are installed in accordance with ANSI/TIA-607 recommendations. Perform bonding testing on all segments of the bonding system using a two-point test in accordance with ANSI/TIA-607. Testing must be performed prior to the installation of any telecommunications equipment. Maximum value of resistance between any two points in the telecommunications bonding system and to the buildings electrical grounding electrode system must be less than 100 milliohms. Document and submit test results in accordance with paragraph SUBMITTALS.
- d. UTP backbone copper cabling must be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks. Test cables after termination but prior to being cross-connected.

NOTE: Two methods for measuring the installed optical fiber cable plant loss are described in TIA/EIA-526-7 (single-mode cable). Tier 1 uses optical power measurement equipment. Tier 2 uses an Optical Time Domain Reflectometer (OTDR). Tier 2 is now recognized as a recommended test by TIA and BICSI. Method B is not recommended for existing cable plants containing branching devices and/or isolators. Tier 2 testing is required when certifying PON or FTTx to document the performance of splitters.

[For multi-mode optical fiber, perform 100 percent of optical fiber end-to-end attenuation tests in accordance with ANSI/TIA-568.3 and ANSI/TIA-526-14 using[Tier 1, Optical Power Meter and LED Light Source][and][Tier 2, OTDR] for multi-mode optical fiber.][For single-mode optical fiber, perform 100 percent of optical fiber end-to-end attenuation tests in accordance with ANSI/TIA-568.3 and ANSI/TIA-526-7 using[Tier 1,

Optical Power Meter and Light Source][and][Tier 2, OTDR] for single-mode optical fiber.]Test the link at both standard frequencies bidirectionally for[multi-mode][and][single-mode]. Reference grade connectors with an attenuation value equal to or less than[.10dB for multimode][and][0.20dB for single-mode] must be used. The testing method must comply with ANSI/TIA-526-7 using the single jumper method. Fiber connector loss must be .5dB or less and splice loss must be 0.3dB or less for cable acceptance.

An optical time domain reflectometer (OTDR) is required for all inside plant lengths more than 90 m 295 ft[when requested by the Telecommunications Manager] [_____] using the launch cables and exit cables of the required length for the fiber type. This does not relieve the requirement for the OLTS above.

Final labeling must be verified as part of testing and certified as accurate per record documentation.

3.11.1.3 Performance Tests

Perform testing for each outlet[CP][and][MUTOA] as follows:

- a. Perform 100 percent of Category [6a][_____] cables using link tests in accordance with ANSI/TIA-568.1 and ANSI/TIA-568.2[ANSI/TIA-568.5]. Tests for pass/fail must include Wire Map, DC Loop Resistance, Length, Propagation Delay, Delay Skew, Insertion Loss, Return Loss, NEXT, ACR-F, PS ACR-F, PSNEXT, PSAACR-F, DC Resistance Unbalance, DC Resistance Unbalance between pairs.

Testing of no less than 10 percent of cabling installed for Average PS ANEXT, PS AACR-F, Average PS AACR-F.

Test reports must be recorded for information only for the following tests: ACR-N, PS ACR-N, TCL, and ELTCTL.

- b. Optical fiber Links. Perform optical fiber end-to-end[Tier 1][Tier 2], bidirectional, link tests in accordance with ANSI/TIA-568.3.

3.12 COMMISSIONING

Commissioning of the telecommunications system must be accomplished for projects where more than passive equipment is provided as further defined in Section 01 91 00.15 BUILDING COMMISSIONING.

-- End of Section --