

Category 6A System
City of Port St Lucie IT Specification
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Preface

The specified system is an unshielded balanced twisted-pair cabling system designed for 10 Gb/s networking environments. Typical deployments include data centers, commercial buildings, and institutional sites (e.g., health care, education, military).

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Acronyms

AHJ	Authority having jurisdiction	lbf	Pound-force
ANEXT	Alien near-end crosstalk	LC	Limited combustible
ANSI	American National Standards Institute	LSOH	Low smoke zero halogen
ASTM	American Society for Testing and Materials	LSZH	Low smoke zero halogen
AWG	American wire gauge	m	Meter(s)
BICSI	Building Industry Consulting Service International	MHz	Megahertz
C	Celsius	mm	Millimeter(s)
CDT	Cable Design Technologies	N	Newton(s)
CMP	Communications plenum	NEXT	Near-end crosstalk
CMR	Communications riser	nF	Nanofarad(s)
CP	Consolidation point	ns	Nanosecond(s)
CSC	Construction Specifications Canada	NVP	Nominal velocity of propagation
CSI	The Construction Specifications Institute	OD	Outside diameter
CSV	Certified System Vendor	PCB	Printed circuit board
dB	Decibel(s)	PE	Professional Engineer
DC	Direct current	pF	Picofarad(s)
EF	Entrance facility	PSACRF	Power-sum attenuation-to-crosstalk ratio far-end
EIA	Electronic Industries Alliance	PSAACRF	Power-sum attenuation-to-alien crosstalk ratio far-end
ELFEXT	Equal level far-end crosstalk	PSANEXT	Power-sum alien near-end crosstalk
ER	Equipment room	PSELFEXT	Power-sum equal level far-end crosstalk
F	Fahrenheit	PSNEXT	Power-sum near-end crosstalk
ft	Foot/feet	RFQ	Request for quote
Gb/s	Gigabits per second	TBB	Telecommunications bonding backbone
IBDN	Integrated Building Distribution Network	TDR	Time domain reflectometer
IDC	Insulation displacement contact	TE	Telecommunications enclosure
IEC	International Electrotechnical Commission	TGB	Telecommunications grounding busbar
IEEE	Institute of Electrical and Electronics Engineers	TIA	Telecommunications Industry Association
in	Inch(es)	TMGB	Telecommunications main grounding busbar
ISO	International Organization for Standardization	TO	Telecommunications outlet/connector
kg	Kilogram(s)	TR	Telecommunications room
lb	Pound(s)	U	Rack unit [45 mm (1.75 in)]

UL

Underwriters Laboratories

WA

Work area

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DIVISION 27 – COMMUNICATIONS

27 00 00 Communications

27 05 00 Common Work Results for Communications

27 05 26 Grounding and Bonding for Communications Systems

NOTE: If grounding and bonding does not need to be specified, remove Section 27 05 26.

27 05 26.01 GENERAL

27 05 26.01.A The facility shall be equipped with a telecommunications bonding backbone (TBB). This backbone shall be used to ground all telecommunications cable shields, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current-carrying conductor. The TBB shall be installed independent of the building's electrical and building ground and shall be designed in accordance with the recommendations found in ANSI/TIA-607-C-2016, *Generic Telecommunications Bonding And Grounding (Earthing) For Customer Premises*.

27 05 26.01.B The main entrance facility/equipment room (EF/ER) in each building shall be equipped with a telecommunications main grounding busbar (TMGB). Each telecommunications enclosure (TE) and/or telecommunications room (TR) shall be provided with a telecommunications grounding busbar (TGB). The TMGB shall be connected to the building electrical entrance grounding facility. The intent is to provide a telecommunications grounding system that is equal in potential to the building electrical grounding system. This will minimize ground loop current potential between telecommunications equipment and the electrical system that supplies power to the equipment.

27 05 26.01.C All metal equipment racks, cabinets, backboards, cable shields, strength members, splice cases, cable trays, and the like entering or residing in TEs/TRs/ERs/EFs shall be grounded to the appropriate TGB/TMGB using a minimum 6 AWG stranded copper bonding conductor and compression connectors.

27 05 26.01.D All wires used for telecommunications grounding purposes shall be identified with green insulation or green tape. Non-insulated wires shall be identified at each termination point using green tape. All cables and busbars shall be identified and labeled in accordance with ANSI/TIA-606-C-2017.

27 05 26.02 GROUNDING AND BONDING SYSTEM INSTALLATION

27 05 26.02.A The TBB shall be designed and/or approved by a qualified Professional Engineer (PE), licensed in the jurisdiction where the work is to be performed. The TBB shall adhere to the recommendations found in ANSI/TIA-607-C-2016 and shall be installed in accordance with industry best practices.

27 05 26.02.B A licensed electrical contractor shall perform the installation and termination of the main bonding conductor to the building service entrance ground.

27 05 28 Pathways for Communications Systems

NOTE: If a design for pathways is to be specified, add appropriate wording to the following sections. Otherwise, delete Section 27 05 28.

27 05 28.29 HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

27 05 28.33 CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

27 05 28.36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

27 05 28.39 SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

27 05 53 Identification for Communications Systems

27 05 53.01 GENERAL

27 05 53.01.A Labeling shall be in accordance with the recommendations found in TIA/EIA-606-A, the manufacturer's recommendations/installation guides, and industry best practices.

27 08 00 Commissioning of Communications

27 08 01 System Documentation

27 08 01.01 GENERAL

27 08 01.01.A Upon completion of the installation, the successful bidder shall provide three comprehensive sets of documentation to the owner of the System for approval. Documentation shall include the items detailed below.

27 08 01.01.B Documentation shall be submitted within 10 working days of the completion of each testing phase (e.g., subsystem, area, floor). This includes all test results and draft as-built drawings. Draft drawings may include hand-written annotations. Printer-generated (final) copies of all drawings shall be submitted within 30 working days of the completion of each testing phase. At the request of the owner of the System, the successful bidder shall provide copies of the original test results in electronic format, for example a Fluke Networks (*.flw) Linkware file or a Microsoft Excel (*.xls) file.

27 08 01.01.C The owner of the System may request a 10% random field re-test of the installed cabling system (at no additional cost) to verify documented findings. If the re-test findings contradict the documentation submitted by the successful bidder, additional testing can be requested to the extent deemed necessary by the owner of the System, including a 100% re-test. This testing shall be at no additional cost to the owner of the System.

27 08 02 Test Results Documentation

27 08 02.01 GENERAL

27 08 02.01.A The test equipment shall meet the requirements found in ANSI/TIA-568.2-D-2018 – *Balanced Twisted-Pair Telecommunications Cabling And Components Standard* .

- 27 08 02.01.B Test documentation shall be provided on permanent media within three weeks after the completion of the project. The media shall be clearly marked on the outside front cover with the words "Project Test Documentation", the project name, and the date of completion (month and year). The results shall include a record of test frequencies, cable type, conductor pair and cable (or connector) ID, measurement direction, reference setup, and technician name(s). The test equipment name, manufacturer, model number, serial number, software version, and last calibration date will also be provided. Unless the manufacturer specifies a more frequent calibration cycle, proof of annual calibration must be documented for all test equipment used in this installation.
- 27 08 02.01.C Printouts generated for each cable by the test equipment shall be submitted as part of the documentation package. Alternately, the successful bidder may furnish this information in electronic format on permanent media. The media shall contain the electronic equivalent of the test results as defined by the bid specification, in a file format compatible with Microsoft Word (version 6.0) or Microsoft Excel (2002 or later version).
- 27 08 02.01.D When repairs and re-tests are performed, the problem(s) found and the corrective action(s) taken shall be noted. Both the failed and passed test results shall be documented including test data at all frequency points and graphs.

27 08 03 As-Built Drawings

- 27 08 03.01 GENERAL
- 27 08 03.01.A Drawings must include cable routes and telecommunications outlet/connector (TO) locations. Each TO location shall be referenced by its unique identifier. Numbering, icons, and drawing conventions used shall be consistent throughout all documentation provided. The owner of the System will provide floor plans in paper and electronic (DWG, AutoCAD Release 14) formats, to which as-built construction information can be added. These documents will be modified accordingly by the successful bidder to denote as-built information as defined above and returned to the owner of the System.
- 27 08 03.01.B The successful bidder shall annotate the base drawings and provide both print (same plot size as originals) and electronic (AutoCAD Release 14) versions of the modified files.

27 10 00 Structured Cabling

27 10 01 Scope

27 10 01.01 GENERAL

27 10 01.01.A This document describes the requirements for furnishing and installing a telecommunications cabling infrastructure for the City of Port St Lucie. A balanced twisted-pair cabling system capable of supporting 10 Gb/s networking is described.

27 10 01.01.B All cables and related support, termination, and grounding hardware shall be furnished, installed, tested, labeled, and documented by the successful bidder as detailed in this document.

27 10 01.01.C General product specifications, design considerations, and installation guidelines are provided in this document. Specific site-related requirements are provided as an attachment to this document. In case of conflict, this document shall take precedence. The successful bidder shall meet or exceed all requirements for the cabling system described in this document.

27 10 02 Regulatory References

27 10 02.01 GENERAL

27 10 02.01.A All workmanship and materials shall be in full conformance with applicable building, electrical, and other codes, as determined by the authority having jurisdiction (AHJ).

27 10 02.01.B All cabling system components shall be Underwriters Laboratories (UL) Listed and shall be marked as such. In cases where UL has no published standards for a component, any equivalent national independent testing standard shall apply and the item shall be appropriately marked. Where UL has an applicable system listing and label, the entire system shall be labeled.

27 10 02.02 REFERENCE LIST

27 10 02.02.A The product specifications, design considerations, and installation guidelines provided in this document are in part derived from recommendations found in recognized telecommunications industry standards. The following are used as reference:

ANSI/TIA-568.0-D-2015	Generic Telecommunications Cabling for Customer Premises
ANSI/TIA-568.1-D-2015	Commercial Building Telecommunications Cabling Standard
ANSI/TIA-568.2-D-2018	Balanced Twisted-Pair Telecommunications Cabling And Components Standard
ANSI/TIA-568-C.2-1-2016	Balanced Twisted-Pair Telecommunications Cabling and Components Standard, Addendum 1: Specifications for 100 Ω Category 8 Cabling
ANSI/TIA-568.3-D-2016	Optical Fiber Cabling and Components Standard
ANSI/TIA-568.4-D-2017	Broadband Coaxial Cabling And Components Standard
ANSI/TIA-569-D-2015	Telecommunications Pathways and Spaces
ANSI/TIA-569-D-1-2016	Telecommunications Pathways and Spaces: Addendum 1- Revised Temperature and Humidity Requirements for Telecommunications Spaces
ANSI/TIA-570-D-2018	Residential Telecommunications Infrastructure Standard
ANSI/TIA-606-C-2017	Administration Standard for Telecommunications Infrastructure
ANSI/TIA-607-C-2016	Generic Telecommunications Bonding And Grounding (Earthing) For Customer Premises
ANSI/TIA-607-C-1-2017	Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises – Addendum to TIA-607-C
ANSI/TIA-758-B-2012	Customer-Owned Outside Plant Telecommunications Infrastructure Standard
ANSI/TIA-862-B-2016	Intelligent Building Systems Cabling Standard
ANSI/TIA-862-B-1-2017	Structured Cabling Infrastructure Standard for Intelligent Building Systems Addendum 1: Updated References, Accommodation of New Media Types
ANSI/TIA-942-B-2017	Telecommunications Infrastructure Standard for Data Centers
ANSI/TIA-1005-A-2012	Telecommunications Infrastructure Standard for Industrial Premises
ANSI/TIA-1005-A-1-2015	Telecommunications Infrastructure Standard for Industrial Premises Addendum 1- M12-8 X-Coding Connector - Addendum to TIA-1005-A
ANSI/TIA-1152-A-2016	Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
ANSI/TIA-1179-A-2017	Healthcare Facility Telecommunications Infrastructure Standard
ANSI/TIA-4966-2014	Telecommunications Infrastructure Standard for Educational Facilities
ANSI/TIA-4966-1-2017	Telecommunications Infrastructure Standard for Educational Facilities Addendum 1: Updated References, Accommodation of New Media Types
ANSI/TIA-4994-2015	Standard for Sustainable Information Communications Technology
ANSI/TIA-5017-2016	Telecommunications Physical Network Security Standard
TIA TSB-155-A-2010	Guidelines for the Assessment and Mitigation of Installed Category 6 Cabling to Support 10GBASE-T
TIA TSB-162-A-2013	Telecommunications Cabling Guidelines for Wireless Access Points
TIA TSB-184-A-2017	Guidelines for Supporting Power Delivery Over Balanced Twisted-Pair Cabling

TIA TSB-185-2009	Environmental Classification (MICE) Tutorial
TIA TSB-190-2011	Guidelines on Shared Pathways and Shared Sheaths
TIA TSB-5018-2016	Structured Cabling Infrastructure Guidelines to Support Distributed Antenna Systems

27 10 02.02.B In cases where product specifications, design considerations, and installation guidelines provided in this document are in conflict with the references listed above, the more stringent requirements shall apply. All references listed above were current during development of this publication. The bidder is responsible for referencing to the most recent releases when developing bid proposals.

27 10 02.02.C This document does not take precedence over any code, either partially or wholly.

27 10 03 General Condition – Approved Vendor

27 10 03.01 GENERAL

27 10 03.01.A The bidder must be an authorized reseller/installer of the System. The bidder must have successfully completed all design and installation training provided by the manufacturer of the System.

27 10 03.01.B The bidder shall demonstrate proven expertise in the implementation of network cabling. Expertise can be illustrated through the inclusion of details of at least three projects involving the design and installation of a Category 6, or Augmented Category 6 (Category 6A) balanced twisted-pair cabling system within the past two-year period. Names and contact information for each of the three projects shall be included.

27 10 03.01.C The successful bidder shall hereinafter be referred to as the Vendor.

27 10 03.01.D The Vendor shall accept complete responsibility for the design, installation, acceptance testing, and certification of the System.

27 10 03.01.E The Vendor shall provide proof of its current authorized reseller/installer status and shall deliver the final warranty for the installed System.

27 10 04 General Condition – Approved Installer

27 10 04.01 GENERAL

- 27 10 04.01.A The installation of the System shall be performed by direct employees of the Vendor.
- 27 10 04.01.B All installation and testing shall be performed by an authorized reseller/installer and supervised by individuals qualified to install and test the System, in accordance with the manufacturer requirements. The supervisor(s) shall have successfully completed installation training provided by the manufacturer.

27 10 05 General Condition – Approved Products

- 27 10 05.01 APPROVED PRODUCTS: ALL CONDITIONS MUST BE MET FOR APPROVAL
- 27 10 05.01.A Approved balanced twisted-pair cable: TIA Category 6A/ISO Class rated, 23awg., Solid bare copper conductors, polyolefin insulation or FEP insulation, 4 twisted pairs, H-Spline center member, ripcord, PVC or Flamarrest Jacket. Conductor pairs are of bonded-pair construction.
- 27 10 05.01.B.1 Approved connectors – 110-style:
TIA Category 6A/ISO Class rated, RJ45, Keystone footprint, 110-style IDC pair terminations, IDCs are at 90-degree orientation to each other to control alien crosstalk, X-Bar termination fixture to ensure proper pair positioning, flexible PCB as signal-carrying internal path.
- 27 10 05.01.B.2 Approved connectors – universal-gender:
TIA Category 6A/ISO Class EA rated, RJ45, Keystone footprint, Plenum rated. Universal-gender connector core can be fitted with either modular jack or modular plug..
- 27 10 05.01.C Approved patch panels: TIA Category 6A/ISO Class rated, Titanium, Rear termination, RJ45, Keystone footprint, 110-style IDC pair terminations, IDCs are at 90-degree orientation to each other to control alien crosstalk, X-Bar termination fixture to ensure proper pair positioning, flexible PCB as signal-carrying internal path.
- 27 10 05.01.D Approved cordage: TIA Category 6A/ISO Class rated, 4-pair 23 AWG UTP, bonded-pair, transmission performance up to 625 MHz
- 27 10 05.02 EQUIVALENT PRODUCTS

27 10 05.02.A To qualify for final System warranty, only products meeting all details of this specification shall be used to ensure the end-to-end performance of the System.

27 10 07 Work Included

27 10 07.01 GENERAL

27 10 07.01.A The work included consists of all labor, equipment, products, and supplies required to design, install, test, and certify the System in compliance with project specifications.

27 10 07.01.B The work included consists of (but is not limited to) the following:

1. Pre-registration of project with the manufacturer of the System as necessary.
2. Furnishing and installation of a complete balanced twisted-pair telecommunications cabling infrastructure capable of supporting Gigabit networking.
3. Furnishing, installation of, and termination of all cabling runs.
4. Furnishing and installation of all TOs, patch panels, and cordage.
5. Furnishing and installation of all required cabinets and/or racks in TEs, TRs, and/or ERs.
6. Furnishing of any other material required to implement a complete system.
7. Testing all installed cabling runs and furnishing a summary report confirming the Pass status of each run.
8. Furnishing all test and labeling information in both electronic and paper formats.
9. Providing training and complete documentation, including the End User Manual, Application Guidelines, and as-built drawings.

27 10 08 Drawings Specifications

27 10 08.01 GENERAL

- 27 10 08.01.A All drawings and plans provided with this document are diagrammatic. They are included to show the scope of the project in order to assist in the development of bid documents. The Vendor shall make allowances in the bid proposals to cover the work required to comply with the intent of the drawings and plans.
- 27 10 08.01.B The Vendor shall verify all dimensions at the site and is responsible for their accuracy.
- 27 10 08.01.C Prior to submitting a bid, the Vendor shall indicate:
1. Any specified materials the Vendor believes to be inadequate.
 2. Any necessary items of work omitted from the bid specification.

27 10 09 Pre-Project Submittals

- 27 10 09.01 GENERAL
- 27 10 09.01.A Under the provisions of this document and prior to the start of work, the Vendor shall:
1. Submit proof of authorized reseller/installer status of their company with the System manufacturer and the names of all individuals that will be performing the installation and testing to the owner of the System.
 2. Submit details of all cabling system products to be used to the owner of the System.
- 27 10 09.01.B Work shall not be performed without the written approval of the submitted items by the owner of the System.
- 27 10 09.01.C The Vendor must obtain approval from the manufacturer and from the owner of the System for any substitution of submitted products. No substituted items shall be installed without written approval.

27 10 10 Delivery, Storage, and Handling

- 27 10 10.01 GENERAL
- 27 10 10.01.A Delivery and receipt of project materials shall be determined for each project.

- 27 10 10.01.B All cable to be used in the project shall be stored according to manufacturer's recommendations. In addition, all cable must be stored in a protected area. If cable is stored outside, it must be covered with opaque plastic or canvas for protection from the elements, with adequate ventilation to prevent condensation. If air temperature at the cable storage location will be below 4.4 °C (40 °F), the cable shall be moved to a heated location [minimum 10 °C (50 °F)]. If necessary, cable shall be stored off-site at the Vendor's expense.
- 27 10 10.01.C If the Vendor intends to provide a trailer on-site for the storage of project materials, prior approval must be obtained from the owner of the System.

27 10 11 Structured Cabling Overview

27 10 11.01 GENERAL

27 10 11.01.A The system chosen shall meet the following specifications:

1. The balanced twisted-pair cabling system shall be of bonded pair configuration.
2. The balanced twisted-pair cabling system shall support 10 Gb/s networking and shall provide guaranteed performance up to 625 MHz for a worst-case 4-connector, 100 m (328 ft) channel.

NOTE: 4-connector refers to one TO, one consolidation point (CP), and two cross-connect panels in a TE/TR/ER (one for horizontal cables and one for equipment pigtails).

27 10 11.01.B At a minimum, the balanced twisted-pair cabling system will exceed the key performance parameters for Augmented Category 6A found in ANSI/TIA-568.2-D-2018 – *Balanced Twisted-Pair Telecommunications Cabling And Components Standard* over the specified frequency ranges by the values listed below.

Parameter	Worst Case Margin (1 – 500 MHz)	Worst Case Margin (500 – 625 MHz)
Insertion loss	3%	Beyond Standard (*)
Return loss	2.0 dB	Beyond Standard (*)
NEXT	2.5 dB	Beyond Standard (*)

PSNEXT	3.5 dB	1.5 dB(*)
PSANEXT	2.0 dB	2.0 dB(*)
PSACRF	10.0 dB	8.0 dB(*)
PSAACRF	Beyond Standard	Beyond Standard (*)

Note: The **Margin** is the additional headroom (in dB or %) compared to the minimum specified value for Category 6A at each frequency point over the specified frequency range. The **Worst Case Margin** is determined at the frequency where the measured data point is closest to the limit line. The Category 6A limit line equations are used to determine the **Worst Case Margin** over the frequency range from 500 MHz to 625 MHz.

NEXT = Near-end crosstalk

PSACRF = Power-sum attenuation-to-crosstalk ratio far-end

PSAACRF = Power-sum alien attenuation-to-crosstalk ratio far-end

PSANEXT = Power-sum alien near-end crosstalk

PSNEXT = Power-sum near-end crosstalk

NOTE: The values listed above are characterized as "Margin" or "Guaranteed Headroom" beyond the performance specified in standards, and serve as additional assurance of the cabling system's performance after installation and over its operational lifespan.

(*) Value proposed or statement represent guaranteed margin against ANSI/TIA-568.2-D-2018 – *Balanced Twisted-Pair Telecommunications Cabling And Components Standard* extrapolated to 625MHz.

27 10 12 TESTING AND ACCEPTANCE

27 10 12.01 GENERAL

27 10 12.01.A All terminated cabling runs shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements found in the TIA/EIA-568 series of standards. All pairs in each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation, including (but not limited to) cables, connectors, patch panels, and cordage shall be repaired or replaced in order to ensure 100% usability of all installed runs.

27 10 12.02 COPPER PERMANENT LINK TESTING

- 27 10 12.02.A All balanced twisted-pair cable links shall be tested to verify compliance with Category 6A performance for the parameters listed in Section 27 10 11.01.B of this document. The extent of testing shall be in accordance with the end-customer's testing requirements, with 100% testing of permanent links for Insertion Loss, Return Loss, NEXT, PSNEXT and PSACRF. These tests are performed at the same time as the Continuity test using an automated tester, such as the Fluke DSX8000.
- 27 10 12.02.B Continuity – Each pair in every installed cabling run shall be tested using a test set that detects and identifies opens, shorts, polarity and pair reversals, crossed pairs, and split pairs. The results shall be recorded as Pass/Fail (as indicated by the test set) and referenced to the appropriate cable identification number and circuit/pair number. Any fault shall be corrected and the run re-tested prior to final acceptance.
- 27 10 12.02.C Length – Every installed cabling run shall be tested for installed length using a time domain reflectometer (TDR) device. The cable length shall not exceed 90 m (295 ft). The cable length shall be recorded, referencing the cable identification number and circuit/pair number.
- 27 10 12.03 CATEGORY 6A PERFORMANCE TESTING
- 27 10 12.03.A Category 6A performance testing shall be done according to the requirements of ANSI/TIA-568.2-D-2018 and ANSI/TIA-1152-A-2016.
- 27 10 12.03.B Additional testing parameters to verify compliance with System are listed in Section 27 10 11.01.B of this document.
- 27 10 12.03.C Of the parameters referenced in Section 27 10 12.01.A, 27 10 12.03.A and 27 10 12.03.B, it is understood that alien crosstalk parameters cannot be 100% tested using current field test equipment. Alien crosstalk of Category 6A permanent links or channels are intended to be met by design. For verification purposes, the number of permanent links or channels to be tested as “disturbed” or “victim” is 1% of the total number of permanent links or channels in the installation or 5, whichever is greater.

27 10 13 Warranty and Services

- 27 10 13.01 QUALIFICATION OF SYSTEM
- 27 10 13.01.A The installed System shall be covered by a certification and warranty, issued by the manufacturer and delivered by the Vendor.

- 27 10 13.01.B Telecommunications spaces and pathways in new buildings or in those buildings having undergone major renovations in the preceding three years should conform to the recommendations outlined in ANSI/TIA-569-D-2015. In cases of installation in restrictive spaces and pathways (where it is not possible to implement the standards-based recommendations), no cabling run shall exceed 90 m (295 ft) in length nor be installed in any manner that limits the performance of the System.
- 27 10 13.01.C The installed System shall conform to all applicable local building and electrical codes.
- 27 10 13.02 CERTIFICATION
- 27 10 13.02.A To qualify for System Certification, the System shall be designed, installed, and tested by an authorized reseller/installer partner of the manufacturer of the system.
- 27 10 13.02.B To qualify for System Certification, the installed cabling system shall fully comply with all relevant manufacturer design and applications guidelines, including any pre-approved deviations.
- 27 10 13.02.C To qualify for System Certification, only products made or approved by the System manufacturer shall be used to ensure the end-to-end performance of the System.
- 27 10 13.03 25-YEAR COMPONENT WARRANTY
- 27 10 13.03.A The System Certification shall provide a twenty-five (25) year warranty for all Manufacturer-built passive components used in the installed System. Defective and/or improperly installed products shall be replaced and/or reinstalled at no cost to the owner of the System.
- 27 10 13.04 LIFETIME APPLICATION ASSURANCE
- 27 10 13.04.A The System Certification shall provide the assurance that all present and future commercially available applications engineered for the performance level of the installed cabling system in accordance published standards will work for the lifetime of the certified System.
- 27 10 13.04.B Should the certified System fail to support the networking technologies designed to operate over it—at the time of cutover, during subsequent use, or after upgrading active network devices (e.g., migrating to Gigabit Ethernet switches from 100 Mb/s Ethernet switches)— the manufacturer and the Vendor shall take prompt corrective action.
- 27 10 13.05 OWNER RESPONSIBILITY

- 27 10 13.05.A The Vendor shall provide a User Manual to the owner of the System. This document describes essential system elements and specifies the owner's responsibilities for maintaining the integrity of the installed cabling system over time. The User Manual contains guidelines for cabling system modifications (e.g., relocations, additions, changes to services), in addition to labeling and record-keeping maintenance requirements.
- 27 10 13.05.B The owner of the System accepts that the benefits offered by System Certification are revoked if non-approved products are introduced to the installed System. To regain System Certification in such cases, a Vendor must apply and validate all corrective modifications deemed necessary by the Manufacturer.

27 11 00 Communications Equipment Room Fittings

27 11 13 Communications Entrance Protection

NOTE: If entrance protection does not need to be specified, remove Section 27 11 13.

27 11 13.01 COPPER CABLE PROTECTION UNITS

- 27 11 13.01.A All copper circuits shall be provided with an entrance cable protector panel for electrical protection. All building-to-building circuits shall be routed through this protector. The protector shall be equipped with a 6 AWG copper bonding conductor between the protector ground lug and the approved ground point.

27 11 16 Communications Cabinets, Racks, Frames, and Enclosures

NOTE: If cabinets, racks, frames, and enclosures do not need to be specified, remove Section 27 11 16.

27 11 16.01 RACKS

- 27 11 16.01.A All racks shall provide cable management and support elements for cordage at the front of the rack. They shall also provide cable management, support, and protection elements for the cables and/or equipment pigtails placed along the legs of the rack.

- 27 11 16.01.B Any free-standing rack shall be a knock-down rack assembly equipped with two vertical and two universal channels.

27 11 16.02 RACK INSTALLATION

- 27 11 16.02.A Racks shall be securely attached to the concrete floor using a minimum 9.5 mm (0.375 in) hardware or as required by local codes.

- 27 11 16.02.B Racks shall be placed with a minimum of 914 mm (36 in) clearance from the walls on all sides of the rack. When mounted in a row, there shall be a minimum of 914 mm (36 in) clearance from the wall behind the racks, in front of the row of racks, and from the walls at the ends of the row.

- 27 11 16.02.C All racks shall be grounded to the TGB in accordance with Section 27 05 26 of this document.

NOTE: If grounding and bonding does not need to be specified, remove Section 27 11 16.02.C.

- 27 11 16.02.D Rack-mount fasteners not used for installing patch panels and other hardware shall be bagged and left with the rack upon completion of the installation.
- 27 11 16.02.E Rack-mount termination equipment shall be installed in accordance with the manufacturer's recommendations and installation guides.
- 27 11 16.02.F Wall-mount termination equipment shall be installed on 1.2 m x 2.4 m x 19 mm (4 ft x 8 ft x 0.75 in) void-free plywood. The plywood shall be mounted 0.3 m (1 ft) above the finished floor. The plywood shall be painted with two coats of white, fire-retardant paint.
- 27 11 16.02.G Wall-mount termination equipment shall be installed in accordance with the manufacturer's recommendations and installation guides.

27 11 19 Communications Termination Blocks and Patch Panels

27 11 19.03 PATCH PANELS

- 27 11 19.03.A The patch panel system shall provide a centralized termination, identification, and service assignment point for Category 6A cabling and cordage in TEs/TRs/ERs.
- 27 11 19.03.B The patch panels used to terminate the 4-pair balanced twisted-pair cable shall have the following characteristics:
1. The patch panels shall be available in 24-port 1U, 48-port 1U, 48-port 2U, and 72-port 2U configurations.
 2. The cord management system for the patch panel shall not occupy additional rack space [i.e., zero (0) U].
 3. The patch panels shall be equipped with 24, 48, or 72 connectors. The connectors shall have the characteristics described in Section 27 15 43 03 of this document.
 4. The transmission characteristics of the patch panels will be guaranteed to 625 MHz for all ports.

27 11 19.05 COPPER TERMINATION HARDWARE INSTALLATION

- 27 11 19.05.A Cables shall be dressed and terminated in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 11 19.05.B The twisted pairs shall be guided, positioned and secured at the connector termination point using a termination bar that locks the pairs in place to prevent untwisting of pairs into the cable when terminating the conductors.
- 27 11 19.05.C The termination bar holding the wires in place at the IDC termination shall withstand a tensile force of 20 lbs minimum applied to the cable without dislodging the IDC connection
- 27 11 19.05.D Cables shall be neatly bundled, dressed, and routed to their respective termination connectors. Each patch panel shall terminate a cable bundle separated and dressed back to the point of cable entrance into the equipment cabinet or rack.
- 27 11 19.05.E Each cable shall be clearly labeled on the cable jacket behind the patch panel at a location that can be viewed without removing the bundle support element(s). Labels obscured from view shall not be acceptable.

27 13 00 Communications Backbone Cabling

27 13 13 Communications Copper Backbone Cabling

27 13 13.01 BACKBONE CABLES

27 13 13.01.A The backbone cabling is the portion of the cabling system that links the termination fields in different TEs/TRs/ERs within a building (and between buildings in a campus environment). It is commonly installed between floors in a vertical orientation.

27 13 13.02 BACKBONE CABLE INSTALLATION

27 13 13.02.A Backbone cables shall be installed in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.

27 13 13.02.B A plastic or nylon pull cord with a minimum test rating of 90 kg (200 lb) shall be co-installed with the cable in any conduit.

27 13 13.02.C Where cables are routed using conduits, the backbone and horizontal cables shall be installed in separate conduits.

27 13 13.02.D Where cables are installed in an air return plenum, any non-plenum cable shall be installed in metallic conduit.

27 13 13.02.E Where backbone cables and horizontal cables are installed in a cable tray or wireway, backbone cables shall be installed first and segregated from the horizontal cables.

27 13 13.02.F All backbone cables shall be securely fastened to a wall of the TE/TR/ER served.

27 13 13.02.G Backbone cables spanning more than three floors shall be securely attached at the top of the cable run with a wire mesh grip as well as on alternating floors or as required by local codes.

27 13 13.02.H Vertical cable runs shall be supported by messenger strand, cable ladder, or any other method that provides adequate support for the weight of the cable.

27 13 13.02.I Large bundles of backbone cables and/or heavy cables shall be attached to support elements using metal clamps and/or metal banding.

27 15 00 Communications Horizontal Cabling

27 15 13 Communications Copper Horizontal Cabling

27 15 13.01 TOPOLOGY

27 15 13.01.A The horizontal cabling shall be installed using a star topology, typically extending from centralized TRs to individual TOs in work areas (WAs).

27 15 13.01.B The cabling system shall provide (*A MINIMUM OF TWO*) cabling runs to the TO in each WA. All runs will terminate in designated TEs/TRs/ERs. No run shall exceed 90 m (295 ft), as measured from the cable termination point at each end. An additional 10 m (33 ft) is allowed for cordage at both ends, for a maximum allowable end-to-end or channel length of 100 m (328 ft).

27 15 13.02 HORIZONTAL CABLES

27 15 13.02.A The 4-pair balanced twisted-pair cables shall be available in Bonded pair configuration with the characteristics below.

27 15 13.02.B The cables will be available in plenum (CMP), non-plenum (CMR), low smoke zero halogen (LSOH/LSZH). The minimum recommended installation temperature shall be 5 °C (40 °F). The temperature rating shall be 60 °C (140 °F).

27 15 13.02.C The cables shall include a cross-web filler. .

27 15 13.02.D The cable conductors shall be 23 AWG solid copper.

27 15 13.02.E The effective cable OD shall be 6.0 mm (0.24 in) for CMR-rated cable and CMP-rated cable. The effective cable OD is the diameter of a six-around-one cable bundle divided by 3.

27 15 13.02.F The minimum bend radius shall be 25 mm (1 in) for CMR-rated cable and CMP-rated cable.

27 15 13.02.G The transmission characteristics of the cable must meet or exceed .Augmented Category 6 requirements as per ANSI/TIA-568.2-D-2018.

27 15 13.03 HORIZONTAL CABLE INSTALLATION

- 27 15 13.03.A Horizontal cables shall be installed in accordance with standards-based recommendations, the manufacturer's recommendations/installation guides, and industry best practices.
- 27 15 13.03.B A plastic or nylon pull cord with a minimum test rating of 90 kg (200 lb) shall be co-installed with the cable in any conduit.
- 27 15 13.03.C Cable raceways shall not be filled greater than the ANSI/TIA-569-D-2015 recommended maximum fill for the particular raceway type, or 40%.
- 27 15 13.03.D Cables shall be installed in continuous lengths from origin to destination. An exception is made for one CP in any cabling run.
- 27 15 13.03.E Where cables are installed in an air return plenum, any non-plenum cable shall be installed in metallic conduit.
- 27 15 13.03.F If CPs are used, they shall be placed in accessible locations and housed in suitable enclosures intended for that purpose.
- 27 15 13.03.G If a J-hook or trapeze system is used to support cable bundles, all horizontal cables shall be supported at every 1.2 m to 1.5 m (48 in to 60 in) intervals. It is recommended that the support surface is rounded without any sharp edges and at least 2 inches wide. At no point shall cable(s) rest on acoustic ceiling grids or panels.
- 27 15 13.03.H Horizontal cables shall be bundled in groups of no more than 50 cables. Cable bundle quantities in excess of 50 cables may cause deformation of the bottom cables within the bundles, which will degrade the performance of those cables.
- 27 15 13.03.I Cable shall be installed above fire-sprinkler systems and shall not be attached to such systems or any associated ancillary equipment or hardware. The cabling system and its associated pathways shall be installed so that they do not obscure any valves, fire alarm conduit(s), boxes, or other control devices.
- 27 15 13.03.J Cables shall not be attached to ceiling grid or lighting fixture wires. Where support for horizontal cable is required, the Vendor shall install appropriate carriers to support the cabling.
- 27 15 13.03.K Any cable damaged or exceeding recommended installation parameters during installation shall be replaced by the Vendor prior to final acceptance at no cost to the owner of the System.

- 27 15 13.03.L Cables shall be identified by a self-adhesive label in accordance with Section 27 05 53 of this document and ANSI/TIA-606-C-2017. The cable label shall be applied to the cable behind the faceplate, on a section of cable that can be accessed by removing the cover plate.
- 27 15 13.03.M Balanced twisted-pair cable shall be installed so that there are no bends smaller than 4 times the OD of the cable at any point in the run or at the termination points.
- 27 15 13.03.N The pulling tension on any 4-pair balanced twisted-pair cable shall not exceed 110 N (25 lbf).
- 27 15 13.04 Cat 6A Pre-Terminated Cabling System
- 27 15 13.04.A Category 6A cabling shall be available as a factory-terminated solution to save time when deploying 10G cabling in data center applications.
- 27 15 13.04.B The Category 6A pre-terminated cabling system shall be easy to install in standard patch panels using the same port-count configurations (ideally retrofitable inside the same panels).
- 27 15 13.04.C The Category 6A cabling system shall be easy to repair without disrupting service on the other cables in the group.
- 27 15 13.04.D The Pre-terminated cable assemblies shall be well protected within a polymer sleeve to withstand abuse and be equipped with a pulling eye to facilitate cabling deployment.
- 27 15 13.04.E The connectors at the ends of the cable assemblies shall not exceed 1.4 inches in diameter (over pulling-eye) to facilitate fishing through cabinet openings.
- 27 15 13.04.F The cable assemblies shall be available only in a *bonded-pairs* configuration.

27 15 43 Communications Faceplates and Connectors

- 27 15 43.01 GENERAL
- 27 15 43.01.A Each horizontal cable shall be terminated at its designated WA in a modular connector assembly using a keystone footprint module designed to snap into a faceplate.
- 27 15 43.01.B The WA modular connector assembly/faceplate shall accommodate:

1. A minimum of two cabling runs.
 2. Blank fillers, to be installed in any outlet port in the faceplate that is not occupied by a modular connector assembly.
- 27 15 43.01.C Multiple WA outlets that are in close proximity on drawings (and not separated by physical barriers) may be combined in a single faceplate. The Vendor shall be responsible for determining the optimum compliant configuration.
- 27 15 43.01.D The same orientation and positioning of modular connector assemblies on faceplates shall be used throughout the project. Prior to installation, the Vendor shall submit the proposed configuration(s) for WA modular connector assemblies/faceplates for approval by the owner of the System.
- 27 15 43.01.E All WA outlets shall accommodate printed label strips for outlet identification purposes. Printed labels shall be permanent and shall comply with ANSI/TIA-606-C-2017. Handwritten labels shall not be accepted.
- 27 15 43.02 FACEPLATES
- 27 15 43.02.A The faceplate housing the modular connector assemblies shall provide a symmetrically centered appearance for the modules.
- 27 15 43.02.B The faceplate housing the modular connector assemblies shall have no visible mounting screws.
- 27 15 43.02.C The faceplate housing the modular connector assemblies shall have built-in labeling windows to facilitate outlet identification.
- 27 15 43.03 CONNECTORS
- 27 15 43.03.A The modular connector assemblies using keystone footprint modules to terminate the 4-pair balanced twisted-pair cable shall have the characteristics listed below.
- 27 15 43.03.B The connectors shall be modular in form, with available mounting options for TOs, CPs, rack-mount panels, and wall-mount panels.
- 27 15 43.03.C.1 110-style connectors: TIA Category 6A/ISO Class rated, RJ45, Keystone footprint, 110-style IDC pair terminations, IDCs are at 90-degree orientation to each other to control alien crosstalk, X-Bar termination fixture to ensure proper pair positioning, flexible PCB as signal-carrying internal path.

27 15 43.03.C.2 Universal-gender connectors: If using universal-gender connectors the modular plug or jack can be “*gender-changed*” such that a modular plug can be exchanged at any time during or after installation for a modular jack, or vice versa; all without re-termination of the cable. The terminated piece of the connector, (the “core”) can be assembled to *either* a modular plug or modular jack with the addition of a snap-on housing to the core. The connector termination method shall involve no single conductor handling making bonded-pair cable quick and easy to terminate. The modular plug/jack shall be plenum-rated, such that a NEMA-rated enclosure will NOT be required in order to utilize the plug or jack in an area requiring plenum-rated materials.

27 15 43.03.D The transmission characteristics of a mated plug/jack connection shall meet the following performance parameters:

PSANEXT	70 dB @ 100 MHz
Insertion Loss	0.2 dB @ 100 MHz
	0.45 dB @ 100 MHz
Return loss	28 dB @ 100 MHz
TCL	34 dB @ 100 MHz
NEXT	54 dB @ 100 MHz
	40 dB @ 500 MHz

27 15 43.04 WORK AREA INSTALLATION

27 15 43.04.A Work area TOs shall be installed in accordance with standards-based recommendations, the manufacturer’s recommendations/installation guides, and industry best practices.

27 15 43.04.B Cables shall be dressed and terminated in accordance with standards-based recommendations, the manufacturer’s recommendations/installation guides, and industry best practices.

- 27 15 43.04.C Slack cable shall be coiled in flush or surface-mount TOs if adequate space is provided to house the cable coil without exceeding the manufacturer's bend radius limitations. In hollow-wall installations where box eliminators are used, cable slack can be stored in the wall. No more than 300 mm (12 in) of slack shall be stored in a TO, modular furniture raceway, or insulated wall. Excess slack may be loosely coiled and stored in the ceiling above each WA.
- 27 15 43.04.D Bend radius of the cable in the termination area shall not be less than 4 times the OD of the cable.
- 27 15 43.04.E Data outlets (unless otherwise noted in drawings) shall occupy the bottom positions on faceplates. Data outlets in horizontally oriented faceplates shall occupy the right-most positions.
- 27 15 43.04.F Voice outlets (unless otherwise noted in drawings) shall occupy the top positions on faceplates. Voice outlets in horizontally oriented faceplates shall occupy the left-most positions.

27 16 00 Communications Connecting Cords, Devices, and Adapters

27 16 19 Communications Patch Cords, Station Cords, and Cross-Connect Wire

27 16 19.01 CORDAGE

27 16 19.01.A The work area cords, patch cords, and equipment cords/pigtails shall meet ANSI/TIA-568.2-D-2018 Category 6A standard and ISO/IEC 11801:2007 Class E standard for component compliance. *The modular cords shall also meet reliability requirements of TIA/EIA-568-B.2, Normative Annex F.4.3.1 with a minimum Return Loss margin of 3 dB throughout each step of the mechanical stress test procedure.*

27 16 19.01.B The cord cable shall use 24 AWG solid copper conductors *in a bonded pair configuration* for reliable long-term channel performance to 625 MHz. A crossweb randomization element shall be used for consistent pair separation and minimal ANEXT coupling.

27 16 19.01.C The modular shall be built with a flexible boot and strain relief for optimum protection in high-density installations

27 16 19.01.D The modular cords shall be available in standard colors (Brown, Red, Orange, Yellow, Green, Blue, Purple, Gray, White, Black) and also TIA 606-A Pantone colors (Red, Orange, Yellow, Green, Blue, Purple).

27 16 19.01.E The transmission characteristics of a mated plug/jack connection shall meet the performance parameters described in 27 15 43.03.F.

27 16 19.01.F The transmission characteristics of individual cords and their corresponding channels shall comply with the requirements for Category 6A performance when tested in a:

1. Stand-alone configuration.
2. Worst-case "bundled" configuration, where 6 other cords surround the cord being tested.

ANNEX A: ADDITIONAL INFORMATION

NOTE: Firestop installation is a critical safety element. If penetrations must be introduced to one or more fire-rated barriers for the purpose of installing pathways or cabling, include this section.

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 80 00 Fire and Smoke Protection

07 84 00 Firestopping

07 84 13 Penetration Firestopping

07 84 13.01 FIRESTOP SYSTEM

07 84 13.01.A A firestop system consists of the item or items penetrating the fire-rated barrier, the opening in the barrier, and the materials used to seal and restore the fire integrity of the penetrated barrier. Firestop systems serve as an effective block against fire, smoke, heat, vapor, and pressurized water streams.

07 84 13.01.B All penetrations through fire-rated building structures (e.g., walls, floors) shall be sealed with an appropriate firestop system. This requirement applies to “through” penetrations (complete penetration) as well as “membrane” penetrations (through one side of a hollow structure). Any penetrating items (e.g., riser slots and sleeves, cables, conduits, cable trays, raceways) shall be properly firestopped.

07 84 13.01.C Firestop systems shall be UL Classified to ASTM E814 – *Standard Test Method for Fire Tests of Through-Penetration Fire Stops* (UL 1479) and shall be approved by a qualified PE licensed in the jurisdiction where the work is to be performed. One or more drawings illustrating the deployment of the proposed firestop system(s), stamped or embossed by the PE, shall be provided to the owner of the System prior to installing the firestop system(s).

07 84 13.02 FIRESTOP SYSTEM INSTALLATION

07 84 13.02.A All firestop systems shall be installed in accordance with the manufacturer's recommendations/installation guides and shall be available for inspection by the local AHJ prior to acceptance.

