Suffield Academy Communications Standards

Issued by the Suffield Academy Technology Department

Jason Healy, Director of Technology

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Screen Reader Edition. This version of the document is formatted for easier reading on mobile devices. **Page numbers will be different from the printed version.**

Introduction

This document describes the standards and requirements for the communications infrastructure at Suffield Academy. The school values its communications infrastructure as essential to delivering the school's mission, and therefore aims to maintain a consistent quality in its installed physical infrastructure. The standards in this document help the school achieve this quality.

This document is long due to the details discussed. However, such details help ensure our satisfaction with our installed infrastructure and lead to better project outcomes. We appreciate your taking the time to read it.

We have taken several steps to assist the reader, including detailed cross-referencing (with clickable text in the PDF version), topic-oriented layout, and a MasterFormat-style specification that follows industry practices.

This document does undergo periodic revisions, and we make every effort to distribute the most current version. The revision number and publication date is noted at the beginning of the document, and in the running footer on every page. The most recent version is available upon request by emailing `netadmin@suffieldacademy.org`.

The Suffield Academy Technology Department welcomes feedback regarding this document. Additionally, if any sections of the document require clarification, please do not hesitate to contact us so we may resolve ambiguities as quickly and efficiently as possible.

Where To Go From Here

This document addresses three major topics:

- Design Phase Considerations: This addresses basic requirements for the design phase of construction (sizing of rooms, types of equipment, number of cables, *etc.*). In some cases, these are general guidelines to help generate an initial set of plans for a project.
- Non-Communications Requirements: These are requirements that are outside the scope of Communications work, but that we wish to include in the formal project specification because it can affect the Communications work. Bidding requiements, notice to other trades, and clarification of scope for other contractors are discussed here.

- Communications Requirements: This is the largest and most detailed section, covering all our specifications and requirements for Communications work on campus. We expect that any master specification include the requirements of this section as part of the official project contract.

Please find a full table of contents immediately after this section. Additionally, the PDF version of this document includes a navigable table of contents (use the “bookmarks” feature in your PDF viewer), and all section references are hyperlinks that may be clicked to jump to the referenced section.

Contents

Chapter 1

Design Guidelines

This chapter last revised 2018-05-31 14:23:27 UTC (revision 3167)

1.1 Introduction and Audience

This chapter discusses design requirements for communications infrastructure at Suffield Academy. We provide these guidelines to assist the process of developing contract documents and building plans.

These requirements are intended for parties responsible for the design and specification of project elements: Architects and Engineers. Others may find them helpful as well.

Some items below are general guidelines, such as requested port counts in communications outlets. These guidelines should be followed using the designer's best judgment to produce a draft for further review. Others items are references to our formal Division 27 specification, such as requested room sizes and clearances. In this case, the design should incorporate these requirements as closely as possible in order to support the specification. Any inability to meet the requirements of Division 27 should be discussed with the Suffield Academy Technology Department (SATD) immediately.

1.2 Project Drawings

1.2.1 Specifications Shall Dictate

Drawings should contain a clear reference to the Division 27 specifications, explaining that detailed information is available, and that specific requirements may only be available there.

Notes should be included referencing communications items outside the drawing's scope (such as terminations in the Core Distribution Facility (CDF) that use existing equipment).

Summary drawings (*e.g.*, showing a key of symbols or overall riser diagrams) should include a general reference to the written specifications.

1.2.2 Visible Information

Provide dedicated drawings for Communications that do not include information from other trades (*e.g.*, electrical, plumbing, HVAC). A separate layer in the CAD drawings that can be displayed independently

from other drawing elements meets this requirement. In general, we need to see:

- Walls, doorways, and windows
- Room labels (name, number, and description)
- Communications outlet locations and labels (see below)
- Cable pathways and cable bundle counts
- Conduits
- Wireless Access Point locations

1.2.3 Outdoor Conduit

Plans should indicate a pull point in any section of conduit that has **any** of the following properties:

- Exceeds 200 linear feet (longer sections may be approved by the Suffield Academy Technology Department (SATD) in certain circumstances).
- Has bends totalling 180 degrees or more, regardless of number or direction of each bend.

1.2.4 Communications Outlets

Drawings should show the planned location of all outlets. To assist with planning, labelling, and "as-built" drawings, each outlet should be assigned an alphabetic designation that is unique in the room ("A", "B", "C", *etc.*). Additionally, the number of jacks in each outlet should be marked on the plans. See 271500.3.02 for detailed label requirements and 271500.3.07 for a sample floorplan depicting this information.

All outlets should have a *minimum* of two (2) jacks; jacks should be added in pairs so the number of jacks is always even.

1.2.5 Wireless Access Points (WAPs)

Specify Category 6_A/Class E_A ($Cat6_A$) wiring for all outlets servicing Wireless Access Points (WAPs).

Coordinate WAP locations with the SATD. General guidelines for initial placement:

- In classroom buildings, a WAP should be specified in every classroom.
- In dorm room spaces, a WAP should be specified in every room. The SATD will determine which locations will have a WAP installed during construction.
- For other spaces, signal from a WAP should not pass through more than two walls to reach the areas they serve.
- All WAPs should be on the ceiling unless there is a documented reason they cannot be placed there.
- For suspended ceilings, provide an outlet above ceiling level near the location of the WAP. The WAPs can be directly mounted to the suspended ceiling T-rail.
- For hard or unfinished ceilings, specify a 4"x4" box flush with the ceiling (unless no ceiling exists), with a single-gang mud ring. The jacks servicing the location will be coiled and stored in the box.

- Avoid “stacking” WAPs in a multistory building; WAPs should not be directly above or below another unit on a different floor.
- Place WAPs in rooms instead of hallways.

1.3 Pathways

For guidelines on sizing and maximum fill, see 271000.3.01.E.

Provide labels on drawings for all conduits, adhering to the guidelines in 271100.3.01.C.

Cables must be routed away from sources of interference or damage from other building components.

Cables must not be painted. If cables are routed through exposed areas that require painting, they must be run inside a conduit or raceway that can be painted.

1.4 Room Design Guidelines

1.4.1 Equipment Rooms (ERs)

All Equipment Rooms (ERs) must be sized to accommodate both the equipment and the persons responsible for servicing the equipment. See 271100.3.01 for requested clearances.

ERs should be dedicated rooms that can be secured for use only by authorized personnel.

ERs should have direct hallway access so staff do not need to pass through other rooms or spaces (offices, bathrooms, classrooms, storage) to reach the ER.

The door should open away from the room to prevent obstructing any space inside the room. If the door swings into the room, its path of travel must not overlap with any behind-rack clearances, nor block access to any equipment while open.

All ERs must have some type of cooling. A larger Main Distribution Frame (MDF) (three or more switches, or any server equipment) should have active cooling 365 days a year. If the building’s HVAC cannot provide adequate cooling to the room on a year-round basis, a separate system serving only the ER must be specified. For smaller Intermediate Distribution Frames (IDFs) (one or two switches), adequate ventilation and air exchange fulfill the cooling requirement.

Any active cooling system in a ER must be located far enough away from the equipment that an accidental coolant or condensate leak will not reach the equipment. Active cooling equipment should have a direct gravity-fed drain line (without electric pumps).

The ER must have a ceiling clearance of at least 8 feet. As the ER is not an inhabited space, a finished or false ceiling is not necessary. A finished ceiling may be omitted from construction plans.

Lighting in the ER should be arranged to provide light to both the front and back of the racks by being place parallel to the rack orientation and by avoiding lighting placement directly over the center of the racks.

Electrical service in the ER should be on dedicated circuits not shared by other equipment. Each rack should have a dedicated 20A quad-receptacle 120V outlet (NEMA 5-20R), and a 30A 120V outlet (NEMA L5-30R).

1.4.2 Classrooms

Provide at least one communications outlet on at least two walls of the classroom.

Provide one WAP in each classroom. The ceiling outlet co-located with the WAP should have a minimum of 4 jacks if it will be used to service the projector in addition to the WAP.

Specify a projector mount location, including mounting plate, pole, and flush-mounted NEMA 5-15 (or 5-20) duplex outlet.

Provide a communications outlet in the ceiling for the projector, unless the WAP outlet is near enough to service both pieces of equipment.

Provide a pathway from the projector to a AV wall box and faceplate. If pathway is not accessible, provide a minimum 1.5” conduit with pull string. Locate faceplate to the side of (not centered under) the projection surface. Place a communications outlet and an electrical outlet near the AV faceplate.

1.4.3 Offices

Provide communications outlets on a minimum of two walls of the office. Coordinate with furniture plan.

Provide one outlet in the ceiling for potential WAP use.

Coordinate with the SATD regarding WAP placement. Generally, every other office will have a WAP installed.

1.4.4 Dorm Rooms

Provide a communications outlet for each expected occupant of the room (*e.g.*, two for a double room, three for a triple).

Place outlets on different sides of the room. Set outlets at “desk” height (30” - 38” AFF) to reduce damage from moving furniture.

Provide one outlet in the ceiling for potential WAP use.

Coordinate with the SATD regarding WAP placement. Generally, every other bedroom will have a WAP installed.

1.4.5 Faculty Apartments

Provide at least one communications outlet in all rooms, including kitchen, but excluding bathrooms.

Provide ceiling outlets to support WAP placement. Exact locations should be coordinated with the SATD.

1.4.6 Common Areas

For dormitory common areas, provide a minimum of four (4) jacks, either in a single outlet or multiple outlets distributed through the room. Coordinate locations with anticipated devices such as televisions, wired phones, printers, and laptops.

Chapter 2

Non-Communications Requirements

This chapter last revised 2017-09-01 19:27:18 UTC (revision 2998)

2.1 Introduction and Audience

This chapter discusses requirements desired by the Suffield Academy Technology Department (SATD), but that do not strictly belong in the Division 27 (Communications) specification. We include them here so they can be incorporated into other sections of contract documents that are outside the scope of Division 27.

These requirements are intended for parties preparing contract documents or specifications for a project on behalf of Suffield Academy. Additionally, consulting engineers, project managers, and general contractors should review these requirements to convey our requirements to implementing parties.

2.2 Contract Requirements

2.2.1 Direct Contracting for Structured Cabling

To ensure fairness and transparency, Contractors furnishing products or services specified in Section 27 10 00 “Structured Cabling” (or its subsections) should be directly contracted, and not subcontracted by another trade (such as Electrical).

2.2.2 Notice of Division 27.20 Requirements to Other Trades

The SATD provides detailed specifications for equipment making use of (or attempting to duplicate) the school’s network infrastructure and shared radio spectrum. Though the section should be referenced by any subcontractor installing networked equipment, we request that these provisions be specifically incorporated by reference into the general provisions of the following sections. When a section number is provided, it also includes any dependent subsections. For example, Division 27, Section 40 also includes sections 41 and 42:

- **Division 11 Section 50** Education and Scientific Equipment
- **Division 11 Section 60** Entertainment and Recreation Equipment

- **Division 23 Section 09** Instrumentation and Control for HVAC
- **Division 14 All Sections** Conveying Equipment, notably Elevators
- **Division 25 All sections** Integrated Automation, building automation, HVAC automation, and others
- **Division 26 Section 09** Instrumentation and Control for Electrical Systems
- **Division 26 Section 50** Lighting
- **Division 27 Section 40** Audio-Video Communications
- **Division 27 Section 50** Distributed Communications and Monitoring Systems
- **Division 28 All sections** Access Control, Security, Video Surveillance
- **Division 28 Section 40** Life Safety (covered above but specifically called out for Fire Alarm monitoring)

Suggested wording for the reference:

Items furnished in this section may require communication via radio frequencies or communication networks. Attention is directed to Section 272000 — Data Communications, which is hereby made a part of this Section of the Specification and details the requirements for such equipment.

Additionally, we request that the General Contractor highlight Division 27.20 in any scope review meetings with subcontractors responsible for the sections listed above.

2.2.3 Outdoor Conduit

Affecting Division 26, Section 05.33:

All outdoor conduit runs should utilize **MaxCell** fabric innerduct (or equivalent) to allow for multiple independent cable pulls through the conduit.

Manholes, vaults, or handholes should be specified as appropriate, depending on the application.

In the absence of other design considerations, we request Quazite Polymer Concrete boxes, sized and rated appropriately for the application. Boxes should be labelled “Communications” or “Telecom” on their cover.

2.2.4 Fire Detection and Alarms

Affecting Division 28, Section 31:

Any fire alarm system (regardless of manufacturer) must include hardware to interface with the school’s existing campus-wide fire alarm system, a **Simplex 4120 Fire Alarm Network** over Multimode Fiber (MMF). The network uses a fiber-optic ring to communicate with a primary Network Display Unit in the school’s library, which in turn sends notifications to a central monitoring station. All systems must report through this network; direct communication via phone lines is not supported.

A minimum of six (6) strands of 62.5/125μm MMF must be run to the main fire alarm panel with ST terminations at the panel. Additionally, for non-Simplex systems, a **Simplex Network System Integrator** must be specified in order to tie the 3rd-party fire alarm into the Simplex network.

2.2.5 Elevator Signal Equipment, Emergency Communication System

Affecting Division 14, Section 21:

Suffield Academy does not provide copper wiring to newly-constructed buildings. Any emergency communication system must work without requiring hard-line telephone access. As an example, cellular dialers would provide voice communications without requiring wired infrastructure. Emergency communications over a data network are a possibility, provided that the building design includes provisions to maintain power to all necessary network equipment in the event of a power outage.

2.2.6 Structured Cabling Integrity

Schedule and supervise work performed by other trades to prevent damage to installed structured cabling. Consult with structured cabling contractor to ensure cables will not be moved, bundled, or otherwise disturbed after installation.

2.2.6.1 Painting of Structured Cable

Cables must not be painted at any time, unless the structured cabling installer and manufacturer expressly permit such treatment in writing, and verify that the system warranty will not be affected.

See the following documents for additional information:

http://www.belden.com/blog/datacenters/Dont-Paint-Yourself-Into-A-Corner.cfm

http://ecmweb.com/design/ins-and-outs-telecom-system-warranties

Chapter 3

Communications Requirements

This chapter describes our requirements for communications systems, including structured cabling, network equipment, data equipment, and voice equipment. **It should be incorporated into the project master specification.** Architects, general contractors, data/low-voltage contractors, audio-video contractors, and electrical contractors form the primary audience. Additionally, other contractors installing equipment that will connect to the school's network must adhere to the provisions of Section 27 20 00 "Data Communications".

The Suffield Academy Technology Department (SATD) is responsible for designing, specifying, deploying, and maintaining all devices related to networking and telephony on the Suffield Academy campus. This includes, but is not limited to, network devices such as switches, routers, wireless access points, phones, and computers. All other communications systems such as fire alarms, building access controls, audio-video systems, and building automation are designed, specified, deployed, and maintained by the system provider.

We have modeled this chapter after the MasterFormat Division 27 sectioning (April 2016 revision). Note that this chapter is *not* intended to be a full Division 27 specification (for example, we do not address electrical bonding in detail). Text appearing in a lighter color (this is an example) denotes requirements that we consider standard, but do not have specific requirements for. Parties incorporating this document into a specification may substitute equivalent text that conveys the same meaning or expands upon the meaning provided.

All other items (in the normal font) are specifically written and approved by the SATD and should be incorporated as written into any final specification unless otherwise agreed to by the SATD.

Section 27 00 00
Communications

This section last revised 2016-09-08 13:06:49 UTC (revision 2794)

PART 1 GENERAL

1.01 SUMMARY

A. This division identifies the requirements for designing and installing the communications infrastructure at Suffield Academy. Additionally, it contains requirements for equipment that connects to the communications infrastructure or uses radio frequency communications.

B. Specific requirements are organized by the subsections of this division.

C. Related Requirements:

1. Section 27 10 00 “Structured Cabling”
    a. Section 27 11 00 “Communications Equipment Room Fittings”
    b. Section 27 13 00 “Communications Backbone Cabling”
    c. Section 27 15 00 “Communications Horizontal Cabling”
2. Section 27 20 00 “Data Communications”

D. Subsections are bound by the definitions from the parent sections that enclose them; all parent sections must be consulted when implementing a specific section.

1.02 REFERENCES

A. Abbreviations, Acronyms, and Definitions

Every effort has been made to use industry standard terminology throughout this specification, but industry standard terminology is not used by all manufacturers and in many cases, industry standard terminology does not exist. Notify the SATD and the Engineer to define terminology used in specifications if any ambiguity exists.

8P8C

Eight Position Eight Conductor

Cat6

Category 6

Cat6$_A$

Category 6$_A$/Class E$_A$

Category 6

A standardized twisted pair cable supporting maximum frequency of 250MHz and suitable for 1000BASE-T Gigabit Ethernet applications.

Category 6_A/Class E_A

A standardized twisted pair cable that augments and improves on the Category 6 (Cat6) standard, supporting a maximum frequency of 500MHz and suitable for 10GBASE-T 10-Gigabit Ethernet applications. The specific variant used in this document is the ISO/IEC 11801 Edition 2 Amendments 1 and 2 standard, which differs from (and is more stringent than) the ANSI/TIA-568-B.2-10 standard.

CATV

Cable Television

CDF

Core Distribution Facility

Core Distribution Facility

A point on the network where connections from multiple buildings are combined together. Suffield Academy currently has a single CDF in its Library that hosts all core networking equipment and servers. The CDF may also act as an MDF and IDF.

Director of Technology

As of this writing, Jason Healy holds this position at Suffield Academy.

DoT

Director of Technology

Eight Position Eight Conductor

A plug (male) or jack (female) termination used with Category 6 wiring. Often referred to as RJ45.

Equipment Room

A generic name for an IDF, MDF, or CDF.

ER

Equipment Room

Ethernet

A local-area network protocol used worldwide by millions of devices. The IEEE 802.3 family of standards describe the protocol. Additionally, the 802.11 family of standards (Wireless LAN, or “Wi-Fi”) can be considered to implement wireless Ethernet. Thus, the term “Ethernet” may refer to either 802.3 or 802.11 unless qualified by “wired” or “wireless”.

IDF

Intermediate Distribution Frame

Inside Plant

Refers to cabling run entirely inside of a building. Typically has less protection against weather and damage, and is also cheaper and easier to work with.

Intermediate Distribution Frame

A secondary communications closet located inside a building. Used to connect premise equipment to the distribution portion of the network.

Internet of Things

Typically refers to embedded electronics that communicate automatically over the Internet to provide real-time data or control. Examples include thermostats, sensors, automation controls.

Internet Protocol

A networking protcol used worldwide by millions of communications devices. Two major versions exist: Internet Protocol, version 4 (IPv4) and Internet Protocol, version 6 (IPv6). Unless a specific version is noted, “IP” includes both versions.

Internet Protocol, version 4

The traditional version of Internet Protocol (IP). Addresses are represented as a 32-bit integer in “dotted quad” format with an optional slash and CIDR netmask. Example: `203.0.113.45/24`

Internet Protocol, version 6

The latest version of IP. Addresses are represented as a 128-bit integer in hexadecimal format, separated by colons, with an optional slash and netmask. Example: `2001:0db8:1234:abcd::/64`

IoT

Internet of Things

IP

Internet Protocol

IPv4

Internet Protocol, version 4

IPv6

Internet Protocol, version 6

ISP

Inside Plant

jack

Jack (Drop, Port);a single physical connection point to the network or phone system. Suffield Academy typically does *not* distinguish between network and phone connection jacks at the faceplate, so a particular jack may be patched to any available network in the MDF/IDF.

Light Interface Unit

An enclosure for breaking out and terminating optical fiber cabling. Also called Fiber Enclosures, Fiber Patch Panels, Fiber Cabinets, Fiber Distribution Panels.

LIU

Light Interface Unit

MAC address

Medium Access Control Address

Main Distribution Frame

The primary telecommunications closet in a building. Typically responsible for terminating connections from the outside plant to the inside plant equipment, either via an IDF or directly. In the latter case, the MDF acts as an IDF.

may

Indicates optional compliance for a requested action (or inaction if used with “not”). If provided in the context of a choice of possible actions, the implementor may select whichever action they prefer.

MDF

Main Distribution Frame

Medium Access Control Address

A 48-bit integer address uniquely identifying a station on an Ethernet network. Applies to both wired and wireless networks. Typically formated as a 12-digit hexadecimal number, separated by colons or dashes. Example: `fa:ca:de:01:23:45`

MMF

Multimode Fiber

Multimode Fiber

Fiber-optic cabling where light may take different paths through the same fiber. Typically used for short-length or lower-bandwidth communications. Suffield Academy uses 62.5/125 μm multimode fiber.

must

Indicates mandatory compliance for a requested action (or inaction if used with “not”). **Items marked “must” are mandatory unless an exception is granted in writing by the Director of Technology.**

OSP

Outside Plant

outlet

A single location consisting of one or more jacks. Typically a wall faceplate, but may also be a floor box, above-ceiling box, or a box for mounting a WAP.

Outside Plant

Refers to cabling run outside or between buildings. Typically has more protection from weather and damage than cabling intended for indoor use, but can be more expensive or difficult to work with.

Rack Unit

A unit of measure describing the height of equipment mounted in a standard 19-inch rack. Equivalent to 1.75 inches (44.45 mm). Sometimes abbreviated as “U”.

RU

Rack Unit

SATD

Suffield Academy Technology Department

should

Indicates a strong request for compliance for a requested action (or inaction if used with “not”). **Lack of compliance must be specific to a particular circumstance, and justifiable for reasons other than mere convenience. Implementors must provide written justification to the Director of Technology in cases of non-compliance.**

Single-Mode Fiber

Fiber-optic cabling where light only takes a single path through the fiber. Typically used for longer-haul and high-bandwidth communications.

SMF

Single-Mode Fiber

UPS

Uninterruptable Power Supply

Voice Over IP

Transmitting voice calls via an IP network instead of via a traditional analog phone line.

VoIP

Voice Over IP

WAP

Wireless Access Point

Wireless Access Point

A physical piece of equipment connected to the physical network that provides wireless services.

1.03 COORDINATION WITH OWNER

A. The SATD works directly with contractors as specified in the subsections that follow.

B. Provide at least one primary and one alternate contact to the SATD staff.

C. Owner shall provide contact names and information for SATD staff members for a given project. Additionally, the department staff may be reached by e-mailing `netadmin@suffieldacademy.org`.

D. Routine, scheduled, or anticipated requests must be scheduled at least three (3) business days in advance. Requests without this notice shall be dealt with on a best-effort basis.

E. In the event of an error, inconsistency, or ommission in this specification, contact the Engineer and SATD immediately for resolution and remediation. Failure to contact regarding a known error implies that the Contractor assumes responsibility for actions taken after discovery of the error.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION

Section 27 10 00
Structured Cabling

This section last revised 2018-01-03 19:30:41 UTC (revision 3065)

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the physical infrastructure requirements for the Suffield Academy communications network.

B. Section includes common requirements that apply to all related subsections listed below. Refer to Section 27 00 00 “Communications” for general requirements that also apply to this section (and those below it).

C. Related Requirements:

1. Section 27 11 00 “Communications Equipment Room Fittings”
2. Section 27 13 00 “Communications Backbone Cabling”
3. Section 27 15 00 “Communications Horizontal Cabling”

D. Scope of Work. Work includes, but is not limited to, the following:

1. Placement of and additions to ER hardware including equipment racks, cable routing hardware, copper and fiber termination equipment, patch cords, and grounding and bonding.
2. Placement of and additions to interior communications pathways including conduit, pull-boxes, and surface-mount raceway systems.
3. Installation and termination of backbone cabling including fiber optic cabling, voice backbone cable, and others as indicated on the drawings.
4. Installation and termination of horizontal cabling including Cat6 and Category 6_A/Class E_A ($Cat6_A$) copper cabling, and others as indicated on the drawings.
5. Testing, identification, documentation, configuration, and administration for the above communications systems.
6. Removal of existing horizontal cabling, terminations, and outlets as needed.

E. The work covered by this Section and subsections consists of furnishing all materials, accessories, connectors, supports, electrical protection, equipment, tools, setup, preparation, labor, supervision, incidentals, transportation, storage, and related items, and performing all operations necessary to complete the communications work as indicated in the project drawings and specified herein. It is the intent and purpose of this specification to have, upon completion of the project, a “turn-key” communications system designed, built, coordinated, and integrated with the existing communications system and complete and operable in all respects. Completely install, connect, and test all systems, equipment, devices, shown or noted or required to final connections and leave ready for satisfactory operation. Provide any minor items omitted from the design, but obviously necessary to accomplish the above intent.

1.02 REFERENCES

A. Reference Standards: work must conform to all applicable national, state, and local standards:
   1. ANSI American National Standards Institute
   2. EIA Electronic Industries Association
   3. TIA Telecommunications Industries Association
      a. ANSI/TIA-568-C.0, *Generic Telecommunications Cabling for Customer Premises*
      b. ANSI/TIA-568-C.1, *Commercial Building Telecommunications Cabling Standard*
      c. ANSI/TIA-568-C.2, *Balanced Twisted-Pair Telecommunications Cabling and Components Standard*
      d. ANSI/TIA-568-C.3, *Optical Fiber Cabling Components Standard*
      e. ANSI/TIA-568-C.4, *Broadband Coaxial Cabling and Components Standard*
      f. ANSI/TIA-569-C, *Telecommunications Pathways and Spaces*
      g. ANSI/TIA-606-B, *Administration Standard for Telecommunications Infrastructure*
   4. ISO International Organization for Standardization
      a. ISO/IEC DIS 11801-1, *Information technology – Generic cabling for customer premises – Part 1: General requirements*
      b. ISO/IEC DIS 11801-2, *Information technology – Generic cabling for customer premises – Part 2: Office premises*
      c. ISO/IEC DIS 11801-3, *Information technology – Generic cabling for customer premises – Part 3: Industrial premises*
      d. ISO/IEC DIS 11801-4, *Information technology – Generic cabling for customer premises – Part 4: Homes*
      e. ISO/IEC DIS 11801-5, *Information technology – Generic cabling for customer premises – Part 5: Data centres*
      f. ISO/IEC DIS 11801-6, *Information technology – Generic cabling for customer premises – Part 6: Distributed Building Services*
   5. BICSI Building Industry Consulting Services International
      a. Building Industries Consulting Services International (BICSI) *Telecommunications Distribution Methods Manual* (TDMM)
   6. ASTM American Society for Testing and Materials
   7. FCC Federal Communications Commission
   8. ICEA Insulated Cable Engineers Association
   9. IEEE Institute of Electrical & Electronics Engineers
   10. NEC National Electrical Code
   11. NECA National Electrical Contractors Association
   12. NEMA National Electrical Manufacturers Association
   13. NESC National Electrical Safety Code
   14. NETA National Electrical Testing Association
   15. NFPA National Fire Protection Association

16. NIST National Institute of Standards & Technology
17. OSHA Occupational Safety and Health Administration
18. UL Underwriters Laboratories, Inc.

B. The contractor must determine and adhere to the most recent release of all applicable standards when developing the proposal for installation.

C. If the requirements of this document are in conflict with any governing codes or regulations, then the more stringent requirement applies. Nothing in this section shall be construed to permit work not conforming to all governing codes and regulations.

1.03 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings. Schedule a walk-through meeting with the SATD prior to beginning installation.

B. Sequencing with others. Other installations requiring communications network services depend on the work in this section. Before phone or network service can be provided, cabling must be:

1. Installed.
2. Terminated.
3. Tested.
4. Labelled.

This may affect services including (but not limited to):

1. Fire alarm dialers.
2. Elevator emergency phones.
3. Building automation and management.
4. Specialty lighting.
5. Audio-video components.

C. Sequencing with Owner. Sequence with work performed by the SATD at the following project milestones:

1. Re-routing existing network services prior to beginning work.
2. Owner delivery of equipment to be installed by Contractor.
3. Owner providing access to CDF or facilities not at the work site.
4. Contractor providing interim drawings to the SATD to configure network equipment (see 271500.1.03.A and 271500.1.03.C).
5. Owner providing instructions to Contractor for patching cables to equipment.

Additionally, request interim observations by the SATD staff throughout the course of the project to avoid costly corrections at the end of the project:

1. Walk-through prior to beginning installation.
2. Confirm locations of equipment in the ER before final placement.
3. Observe initial testing on installed cables.

1.04 INFORMATIONAL SUBMITTALS

A. Samples, labels and documentation. Provide a mock-up demonstrating documentation and labelling in a completed system:
   1. A section of the building plans showing a complete room, with all outlets labelled per 271000.1.05.A.
   2. A physical faceplate representing an outlet from the room shown on the sample plan, labelled per 271500.3.05.
   3. A physical patch panel, or a scale drawing of a patch panel, showing sample labels for the jacks on the sample outlet and plan, labelled per 271500.3.05.

   Sample drawings are provided as attachments in 271500.3.07.

B. Samples, cable. Provide a three (3) foot section of each type and color of horizontal cable showing all markings.

C. Parts list. Provide a detailed list of all parts required for installation, including manufacturer and part number.

1.05 CLOSEOUT SUBMITTALS

A. Record Documentation. Provide drawings reflecting the details of the installed system ("as-builts"). Drawings must meet the following minimum requirements:
   1. Computer-generated. Drawings must not be photographs, scans, or reproductions of handwritten information. All labels and cable information must be drawn using computer software and provided in electronic form. Drawings should be edits to the CAD files provided by the Architect (when such information is not already included on the drawings).
   2. Locations and labels. Depict outlet locations on a scale drawing of the building. In close proximity to the outlet location, show on the drawing the label information as recorded at the physical outlet location.
   3. Pathways. Depict cable routing and pathways from the ER to their termination points, along with bundle counts when cables servicing multiple locations are run together.
   4. Formats. Provide drawings in both Portable Document Format (PDF) and editable CAD format (DWG or DXF). Drawing elements must be computer-generated, and not scans of handwritten or paper-based drawings.

B. Warranty Documentation. Contractor must apply for all manufacturer's warranties on behalf of Owner and furnish proof of warranty prior to acceptance.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Tools. Any non-industry-standard tools required for the access, maintenance, or operation of the installed product must be furnished to the Owner, along with a written inventory of manufacturer name and part number for each tool. Examples include:
   1. Wrenches.
   2. Keys.
   3. Termination tools.
   4. Specific models of tools required by the manufacturer.

   Standard tools that are not specific to a manufacturer such as 110 punch-downs, Eight Position Eight Conductor (8P8C) crimpers, and wire strippers do not need to be submitted.

B. Training reference. Provide electronic copies of any training materials or sessions presented as described in 271000.3.03.A.

1.07 QUALITY ASSURANCE

A. Qualifications, Installers:
   1. Installer must have personnel certified by BICSI on staff.
   2. Installer must be normally employed in low-voltage cabling industry and been licensed for a minimum of five (5) years.
   3. Installer must be licensed, bonded, and insured in the State of Connecticut.
   4. Installer must furnish references for at least four (4) projects of similar size and scope completed in the last two (2) years.
   5. All technicians installing or testing cabling must be certified, through courses with hands-on training using actual tools and materials, in the type of cabling work they perform.
   6. All technicians must have up-to-date training or certifications required by the manufacturer to qualify work performed for all manufacturer's warranties.

1.08 WARRANTY

A. Manufacturer Warranty. All materials of the structured cabling system must be backed by a manufacturer's warranty of at least twenty-five (25) years from the date of Owner acceptance.

B. Special Warranty. Notwithstanding any manufacturer warranties, the Installer must warranty that the structured cabling system will be free from defects in workmanship for a period of two (2) years from the date of Owner acceptance.

C. During any warranty period, all defects developing through materials or workmanship must be corrected or replaced immediately without expense to the Owner, including labor, materials, and re-testing and re-certification of replaced components.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. New Products. The SATD furnishes all active electronic devices that provide network and IT-related functions unless otherwise specified:
   1. Wireless Access Points. Owner furnishes WAPs as well as accessories to mount each WAP to a standard electrical box or suspended ceiling T-rail. Contractor is responsible for mounting and connecting WAPs.
   2. Projectors. Owner furnishes audio-video projectors and speakers as well as accessories to mount to a wall or ceiling as appropriate. Contractor is responsible for mounting and connecting projectors.
   3. Active Electronics. Owner furnishes and installs all active electronic equipment such as network switches, Uninterruptable Power Supply (UPS) units, servers, and desktop computers. Contractor is responsible for providing patch cables and connecting them to the switching equipment per the instructions of the SATD.

2.02 EQUIPMENT

A. Cable bundling and support. Cables must be secured with reusable ties (such as hook-and-loop closures). Ties or fasteners that must be cut or that cannot be reused (such as zip ties or tie wraps) are not permitted.

B. Cable markings. All cabling must be factory-marked on the outside jacket with the type of cable, manufacturer of cable, and footage markings. Space between markings must not exceed 40 inches.

C. Equipment not specified. Furnish additional equipment as necessary to install a complete, functioning, and standards-compliant system. Examples of parts needed for a complete installation include (but are not limited to):

1. Backboxes, conduit, bushings, pull string.
2. Hooks, supports, fasteners, cable management.
3. Patch panels, keystone jacks, faceplates.
4. Patch cables, cross-connect wire, fiber jumpers.
5. Lightning protection, fuses, grounding.

PART 3 EXECUTION

3.01 INSTALLATION

A. General. Install cables and devices in accordance with industry and manufacturer standards. Install without damage to cable strands/fibers, cladding, or jacket. Install without violating recommended pulling tensions or bend radii.

B. Special Techniques, Cable Support. Cables, where not run in raceway, conduit, or cable tray, must be properly supported at recommended intervals through direct attachment to the structural building framing using J-hooks, cable slings, or other recognized supports. Cable must not be supported by ceilings, ceiling supports, mechanical piping, fire piping, or plumbing. Cable must be routed away from sources of EMI, heat, or environments that may cause damage to the cables or the signals carried in them.

C. Special Techniques, Service Loops. All cabling must have a minimum of sixteen (16) linear feet of slack in a service loop in the ER. Coil the cable neatly without violating any minimum bend radius for the cable and secure to the ladder rack or backboard. For cable runs between ERs, provide a service loop at each end.

D. Special Techniques, Cable Bundles. Bundle cables only with reusable ties or fasteners. Single-use tie-wraps or zip ties are not acceptable.

E. Pathway sizing. Conduit and supports must be sized to accommodate future growth. Pathways must not be filled more that 40% unless an additional empty pathway along the same route is available. If a pathway will be filled more than 40%, it must be sized larger.

F. Conduit, pull string. All conduits must contain pull string or rope after installation for future use. Each segment of conduit to an accessible pull point or box should have its own string.

G. Conduit, boxes. A segment of conduit must contain an accessible box or pull point if the segment contains one-hundred-eighty (180) total degrees or more of bend in the segment, regardless of direction or distance between each bend.

H. Conduit, outside plant boxes. In addition to the bend requirements above, a pull point must be provided every 200-250 feet to facilitate cable installation.

I. Conduit, termination. Each section of conduit must be terminated with a bushing to prevent damage to cables pulled through the conduit.

J. Conduit, labels. Label each conduit with a permanent, non-handwritten, weatherproof (if outdoors) label showing the near-end/far-end designation for the conduit (see 271100.3.01.C), along with a unique number distinguishing this conduit from all others having the same endpoints.

3.02 SITE QUALITY CONTROL

A. Site Tests and Inspections. Installed cabling must be certified to meet the performance characteristics appropriate for the type of cable installed. Subsections of this document define the specific tests for different types of cable.

B. Testing, Conditions. Final tests of cables must take place after cables are terminated and their connectors attached in their housings in their final positions (patch panels, wall outlets, *etc.*).

C. Testing, Notification. The SATD must be notified seven (7) calendar days prior to any testing so initial testing may be witnessed. Contractor must not replace or correct any cable deficiencies found through testing prior to the notified date.

D. Testing, Equipment. All testing equipment must have documentation showing factory or third-party calibration that is current at the time of testing. All testing equipment must have the latest software updates available.

E. Testing, Results Format. All test results must be stored and delivered electronically. Handwritten test results will not be accepted.

F. Testing, Failures. If any test failures are recorded, those results must be included along with any subsequent test results after the issue is fixed, along with a note explaining the corrective action taken.

G. Testing, Third-Party Verification. If completed test results are questionable in regard to failures (multiple failures, multiple “marginal” passes, or cables that do not pass visual inspection), a spot test on cables with problems may be done by a different independent contractor, with the cost of such spot-checks borne by the Installer.

H. Inspections, Workmanship. Good workmanship and appearance are of equal importance with communications operation. Lack of quality workmanship provides sufficient reason for rejection of a system in part or in its entirety, even if it passes performance testing. Carefully lay out all work in advance and install in a neat and workmanlike manner in accordance with recognized good practices and standards. Provide workmen who are skilled in their craft and a competent Project Manager who will oversee all work.

I. Work Spaces, Cleanliness. Work in finished spaces must be in “broom clean” condition at the end of each work day. Remove trash from all work areas by the end of each work day.

3.03 CLOSEOUT ACTIVITIES

A. Training. If special tools or operating skills are required for the maintenance or operation of installed equipment, provide in-person training directly to members of the SATD staff. Additionally, provide electronic copies of training materials or sessions for future reference.

3.04 PROTECTION

A. In unfinished spaces, protect installed cabling and equipment from dust, paint, or other hazards that may diminish the quality or performance of the installed product.

B. The Contractor must report any conditions or practices at the site that may impact the performance or warranty of the installed communications system, including those caused by other trades or called for in the project plans. Examples include (but are not limited to) excess dust, moisture, painting of cables, or routing of cables near potential sources of interference. Failure to report such conditions implies that the Contractor accepts responsibility for any issues with performance that may arise as a result of such conditions when the system is complete.

END OF SECTION

Section 27 11 00
Communications Equipment Room Fittings

This section last revised 2017-01-17 02:33:55 UTC (revision 2849)

PART 1 GENERAL

1.01 SUMMARY

A. This section describes standards for Equipment Rooms (ERs), including the Main Distribution Frame (MDF) and any Intermediate Distribution Frames (IDFs) in a building.

B. Products dealt with in this section include equipment placement, communications racks, and associated cable management.

C. This section subsumes the specifications for the following subsections:

1. 27 11 16 Communications Cabinets, Racks, Frames, and Enclosures
2. 27 11 19 Communications Termination Blocks and Patch Panels
3. 27 11 23 Communications Cable Management and Ladder Rack
4. 27 11 26 Communications Rack Mounted Power Protection and Power Strips

Other subsections of this section not mentioned above are not used.

D. Refer to Section 27 00 00 “Communications” and Section 27 10 00 “Structured Cabling” for common requirements that also apply to this section.

1.02 ADMINISTRATIVE REQUIREMENTS

A. Coordination with Owner. Prior to attaching or anchoring any equipment in the ER (*e.g.*, racks, backboards, HVAC), request a meeting with the SATD to confirm final placement.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Suffield Academy will furnish and install any required UPS units for the communications racks.

2.02 EQUIPMENT

A. Description. The ER contains racks to house network equipment, cross-connects, patch panels, and cable management. Additionally, some equipment is wall-mounted.

B. All ERs will contain at least one (1) communications rack and a backboard for mounting non-rack equipment or securing service loops.

C. Design Criteria, Communications Racks.

1. Provide at least one (1) 4-post open-frame rack for each MDF, unless a 2-post rack is deemed sufficient by the SATD.

2. Provide at least one (1) 19-inch 2-post racks for each IDF unless the SATD specifically requests a 4-post rack.
3. All racks must have at least 42Rack Units (RUs) of usable vertical space; 45RUs should be provided.
4. All racks must have pre-drilled threaded holes accepting 10-32 rack screws.
5. All racks must be black with numbered RU markings permanently stamped on the front (and, if applicable, back) rails.
6. Include horizontal and vertical cable management for all racks.
7. Include a ladder or other support system for each rack to support and route horizontal cabling.
8. Provide a wall-mounted backboard, unless there will be no Cable Television (CATV) or other utility distribution that requires it **and** there exists a means for securing cable service loops (ladder rack, wall hooks, etc).

D. Design Criteria, Termination Blocks and Patch Panels. Refer to the specific sections for each cable type:
1. Section 27 13 00 “Communications Backbone Cabling”
2. Section 27 15 00 “Communications Horizontal Cabling”

PART 3 EXECUTION

3.01 INSTALLATION

A. Special Techniques, Communications Racks.
1. Provide a minimum 48” clearance in front of the rack, measured from the front rail.
2. Provide a minimum 38” clearance behind the rack, measured from the back rail.
3. Provide a minimum 30” clearance between one side of the rack and any other obstructions. The other side of the rack may be flush against a wall or another rack.
4. Provide a minimum 30” clearance (free of hinges, latches, or any other obstruction) horizontally through the doorway of the ER.
5. Equipment not in racks (such as fuse panels, cross-connection boxes, or CATV distribution) must have 30” of clearance in front of them to allow for service. This clearance may overlap with side-of-rack clearances, but must not overlap with front-of-rack or behind-rack clearances.
6. Racks must be properly anchored to the floor and connected to any other cable management.
7. Racks must be properly grounded.

B. Special Techniques, Electrical Outlets. Label each electrical outlet in the ER with:
1. Circuit breaker panel designation.
2. Circuit breaker number.
3. Voltage and Phase.
4. Current limit.

C. Labels. Label racks in accordance with TIA-606-B:
1. Coordinate with SATD to determine an identifier for the building containing the ERs. Typically, the first part of the name of the building is used.

2. Coordinate with SATD to determine an identifier for each ER in the building. Typically, a room number (*e.g.*, `112`) is used.
3. Coordinate with SATD to determine an identifier for each rack and wall cabinet space per TIA-606-B using non-grid coordinates. Typically, each rack will receive a sequential number.
4. Label each rack or cabinet with the full building, ER and rack designation. Example: `BREWSTER-112.01` for the first rack (01) in the ER located in room 112 of Brewster Hall.

END OF SECTION

Section 27 13 00
Communications Backbone Cabling

This section last revised 2021-02-11 03:03:08 UTC (revision 3815)

PART 1 GENERAL

1.01 SUMMARY

A. This section describes backbone cabling used to connect a building to other buildings, services, or facilities. It also discusses cabling from one ER to another within the same building.

B. Products described in this section include:

1. Optical fiber cabling
2. Coaxial backbone cabling (for CATV applications)
3. Termination blocks for cabling
4. Transition blocks for Outside Plant (OSP) to Inside Plant (ISP) cabling
5. Innerduct for ISP riser cabling

C. This section subsumes the specifications for the following subsections:

1. 27 13 13 Communications Copper Backbone Cabling
2. 27 13 23 Communications Optical Fiber Backbone Cabling
3. 27 13 33 Communications Coaxial Backbone Cabling

Other subsections of this section not mentioned above are not used.

D. Refer to Section 27 00 00 “Communications” and Section 27 10 00 “Structured Cabling” for common requirements that also apply to this section.

1.02 REFERENCES

A. Definitions

1. Multimode Fiber (MMF), when used in this section, refers to 62.5/125μm OM1/A1b multimode optical fiber.
2. Single-Mode Fiber (SMF), when used in this section, refers to 8-9/125μm OS1/OS2 single-mode optical fiber.

B. Reference Standards:

1. NECA National Electrical Contractors Association
   a. NECA/FOA 301, *Standard for Installing and Testing Fiber Optic Cables*
2. TIA Telecommunications Industries Association
   a. TIA 492AAAA-A, *Detail Specification for 62.5 um Core Diameter/125 um Cladding Diameter Class Ia Multimode Graded-Index Optical Waveguide Fibers*
   b. TIA 492CAAA, *Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers*

c. TIA-526-7 (OFSTP-7), *Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant*

d. TIA-526-14-B (OFSTP-14), *Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant*

3. ISO International Organization for Standardization

a. IEC-60793-2-10, *Optical fibres – Part 2-10: Product specifications – Sectional specification for category A1 multimode fibres*

b. IEC 60793-2-50, *Optical fibres – Part 2-50: Product specifications – Sectional specification for class B single-mode fibres*

c. IEC 61280-4-1, *Fibre-optic communication subsystem test procedures – Part 4-1: Installed cable plant – Multimode attenuation measurement*

d. IEC 61280-4-2, *Fibre-optic communication subsystem test procedures – Part 4-2: Installed cable plant – Single-mode attenuation and optical return loss measurement*

1.03 ADMINISTRATIVE REQUIREMENTS

A. Sequencing with Owner. Coordinate with the SATD to provide access to CDF or facilities not at the work site.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. For renovation of buildings where existing backbone cabling and terminations can be re-used, Owner may furnish:

1. Light Interface Units (LIUs) in the CDF.

B. Verify that existing equipment is acceptable for re-use prior to specifying equipment for the project.

2.02 EQUIPMENT

A. Design Criteria, All Cabling. Cables must meet all applicable codes and environmental requirements for the type of installation (OSP, riser, plenum, *etc.*).

B. Design Criteria, Multimode Fiber (MMF) and Single-Mode Fiber (SMF) Cabling:

1. OSP cable must be suitable for that purpose, possessing weather- and water-proofing features. Cable must be of loose-tube type and armored.

2. Cable for ISP use must be tight-buffered, and designed for use in metal conduit, plastic conduit, or innerduct.

3. Cable must follow standard TIA color scheme for individual strands.

4. MMF must have transmission windows of 850nm and 1300nm. Target applications include 1000BASE-SX, 1000BASE-LX, 10GBASE-S, and 10GBASE-LRM. Terminate all strands with LC duplex connectors.

5. Single-Mode Fiber (SMF) must have transmission windows of 1310nm and 1550nm. Target applications include 1000BASE-LX and 10GBASE-L, but may include future standards requiring different wavelengths. Terminate all strands with LC duplex connectors.
6. For new installations, provide a *minimum* of twelve (12) strands of MMF and twelve (12) strands of SMF from the CDF to the MDF. Provide terminations and LIU in both the MDF and CDF, unless prior arrangments are made to re-use existing equipment in the CDF.
7. Inside the building, provide a *minimum* of twelve (12) strands of SMF from the MDF to each IDF.
8. Terminations/connectors must :
    a. be factory-polished and pre-terminated.
    b. be mated to their fiber strand using a fusion splice method.
    c. be Ultra-Physical Contact (UPC) polished.

C. Design Criteria, LIU:
1. LIUs in the CDF are Corning CCH-04U. Fiber terminations in the Library must use cassettes compatible with this enclosure. If no available space exists in the existing enclosures, specify a new CCH-04U.
2. In buildings other than the CDF, the LIU must be rack-mounted. Corning CCH-02U for MDF, and CCH-02U or CCH-01U (as appropriate for the number of connections) in each IDF.
3. A single LIU may terminate multiple types of fiber, but each type must be terminated in its own contiguous region of the panel (all MMF together, all SMF together, all ISP together, *etc.*).

D. Design Criteria, Coaxial Cabling. Cable must meet the standards of the Cable TV utility provider for transmission of CATV signals. Provide documentation of coordination with Cable TV utility provider and agreed upon specifications.

PART 3 EXECUTION

3.01 EXAMINATION

A. Prior to receiving optical fiber cabling, ensure work area is relatively free of dust and debris. Optical fiber terminations should be performed only when they are unlikely to be disturbed or dirtied by additional work at the site.

3.02 INSTALLATION

A. Optical Fibers:
1. No splices are allowed except to terminate cable with connectors. Cable runs must be continuous.
2. Strands should be terminated in order in the LIU.
3. If multiple cables are terminated in the LIU, group them logically by:
    a. Source (building or ER).
    b. Type (MMF or SMF).

c. Cable or bundle.

B. Labels

1. Label all cables, panels, and ports per TIA-606-B:
   a. Assign each panel a name composed of the rack identifier followed by a hyphen, followed by alphabetic character uniquely identifying it in the rack. Rack identifiers are defined in Section 27 11 00 “Communications Equipment Room Fittings”. Example: `PANEL 112.02-C` describes, from left to right, the ER (room 112), second rack (02), and third panel (C). Panel identifiers are assigned from top to bottom, with “A” at the top of the rack.
   b. On each panel, label the ports sequentially. Do not use subpanel labelling. If subpanels are present, label the start and end ranges of each subpanel (*e.g.*, 1-6, 7-12, 13-18).
   c. On the cover of each panel, provide the building, panel name and description of the panel, followed by the near-end/far-end designation for each group of ports. Example:

```
BREWSTER-112.02-C OSP Fiber Termination
Ports 1-6 MMF to LIB-1A.02-D Ports 24-30
Ports 7-12 SMF to LIB-1A.02-E Ports 1-6
```

   d. Label each cable with a near-end/far-end designation matching those defined above. Labels should be placed to facilitate identification of the cable, near entrances to rooms, enclosures, or after splitting from a bundle of cables.

3.03 SITE QUALITY CONTROL

A. Perform tests and inspections. See 271000.3.02.

B. Testing, Existing Cabling. When new backbone cabling is connected to existing plant cabling, or when existing cabling is re-terminated by the installer, the installer must test the complete cabling path back to the CDF. Notify the SATD immediately if any failures are detected in existing cables.

C. Testing, Optical Fiber.

1. Compute a loss budget for each cable type and length prior to testing using NECA/FOA 301 (Annex A). Use the loss per unit length specified for the cable type along with an average attenuation of 0.5dB for each connector. An example is shown below:

Cable ID	(Length km x Loss dB/km) + (Connectors x 0.5dB) = To
MM-MDF/IDF1-01	(0.07 km x 1.0 dB/km) + (2 x 0.5dB) =
SM-LIBRARY/BARNES-01	(0.2 km x 0.5 dB/km) + (2 x 0.5dB) =
	(km x dB/km) + (x 0.5dB) =

   Loss budgets will be compared with actual measured results.

2. Perform OTLS bi-directional insertion loss (“Tier 1”) tests per NECA/FOA 301 (Annex B.2). Test MMF at both 850nm and 1300nm. Test SMF at both 1310nm and 1550nm. Test must be performed using the “1 Jumper Reference Method”, with reference-quality connectors per ISO/IEC 14763-3. Record details of all tests, including:
   a. Name of person performing the test.

b. Date and time of test.
c. Project name.
d. Test equipment model (Tx and Rx).
e. Test equipment serial number (Tx and Rx).
f. Test equipment software version (Tx and Rx).
g. Test equipment calibration date (Tx and Rx).
h. Parameters of test (loss of reference cables or connectors, 0dB reference or calculated, *etc.*).
i. Direction of test (list source and destination endpoints).
j. Wavelength used for test.
k. Cable ID and strand number under test.
l. Length of cable under test.
m. Measured attenuation (dB) of cable under test.

3. Strands with a loss of more than 10% (0.5dB) from the average of other strands of the same type along the same path must either be remediated, or brought to the immediate attention of the SATD for further discussion.
4. Strands must not show reflectance worse than the documented values for the factory-polished connector used on the strand. Reflectance peaks from the OTDR trace must not show saturation. In all cases, strands must have a reflectance better than -35dB.
5. Strands showing impossibly low levels of loss must be re-tested to confirm results. Keep and present all results, even if invalidated by later tests.
6. 100% of all strands under test must pass testing. Any failed strands must be remediated through normal means or replaced at no cost to the Owner.

D. Testing, Coaxial. Test with 100% sweep and certify to meet CATV standards. Coordinate with Cable TV utility provider for applicable testing standards.

END OF SECTION

Section 27 15 00
Communications Horizontal Cabling

This section last revised 2022-03-24 13:20:08 UTC (revision 4366)

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Pathways.
   2. Twisted Pair cabling.
   3. Cable connecting hardware, patch panels, and cross-connects.
   4. Communications outlets and connectors.
   5. Cabling system identification products.
   6. Cable management system.
   7. Patch cables.
   8. Wireless Access Points (WAPs).

B. This section discusses products necessary for a permanent link between an ER and outlet. Provide all components necessary for an industry-standard and code-compliant installation.

C. This section subsumes the specifications for the following subsections:
   1. 27 15 13 Communications Copper Horizontal Cabling
   2. 27 15 23 Communications Optical Fiber Horizontal Cabling
   3. 27 15 33 Communications Coaxial Horizontal Cabling
   4. 27 15 43 Communications Faceplates and Connectors
   5. 27 16 00 Communications Connecting Cords, Devices, and Adapters

   Other subsections of this section not mentioned above are not used.

D. Refer to Section 27 00 00 “Communications” and Section 27 10 00 “Structured Cabling” for common requirements that also apply to this section.

1.02 REFERENCES

A. Definitions
   1. Category 6 (Cat6), when used in this section, refers to Class E / Category 6 wiring as defined in ISO/IEC 11801:2002.
   2. Category 6_A/Class E_A ($Cat6_A$), when used in this section, refers to the augmented (500MHz) twisted pair wiring standard **as defined by ISO/IEC 11801 Edition 2 Amendment 2:2010**. Note that this standard is more stringent than the corresponding TIA-568-B.2-10 standard, and **the more stringent standard must be used**.

1.03 SCHEDULING

A. Interim Drawings:

1. In order to coordinate the connection of equipment to cabling, the SATD must be provided with a set of "as-built" drawings by the **earlier** of:
    a. Five (5) calendar days *prior* to the Contractor patching the Owner-furnished equipment in the ER to the installed cabling.
    b. Seven (7) calendar days *prior* to the expected certificate of occupancy.
    c. Seven (7) calendar days *after* completing termination and labeling of the cabling.
2. The format of the drawings is described in 271500.1.04.A.

B. Patch Cable Instructions:
1. The Contractor provides and installs patch cables in the ER. Patch cables connect panels to each other, or to Owner-provided equipment in the ER.
2. The SATD shall provide a written set of instructions for patching the equipment to the patch panels based on the interim drawings described above.
3. Schedule final patch-panel connections *at least* five (5) calendar days after drawings are delivered to the SATD to allow the SATD to produce patch instructions.

C. WAP Drawings:
1. The SATD furnishes all WAPs for installation by the Contractor. Once installed, the SATD must be provided with a set of drawings by the **earlier** of:
    a. Seven (7) calendar days *prior* to the expected certificate of occupancy.
    b. Seven (7) calendar days *after* completing installation of the WAPs.
2. The format of the drawings is described in 271500.1.04.B.

1.04 SUBMITTALS

A. Interim Drawings:
1. Provide, per the schedule in 271500.1.03.A, a set of "as-built" drawings showing:
    a. The locations of all network outlets in the physical building.
    b. The labels assigned to each outlet.
    c. The labels assigned to each patch panel port, along with the outlet and jack the patch panel port is connected to.
2. To facilitate quicker production of the interim drawings, drafts should be produced before the start of work and regularly updated throughout the project. Drawings that do not meet the full specifications of 271000.1.05.A may be used in approved circumstances (for example, they may be handwritten or furnished in non-electronic form). However, such drawings do not qualify as final submittals.

B. WAP Drawings:
1. Provide, per the schedule in 271500.1.03.C, a set of drawings showing:
    a. The location of each WAP.
    b. The serial number of each WAP.
    c. The outlet and jack designation where each WAP is connected.
2. Provide a computer-readable spreadsheet in comma-separated value (CSV) format with the following columns:

a. The serial number of the WAP
b. The MAC address of the WAP.
c. The room number of the WAP.
d. The designation of the outlet the WAP is connected to.
e. The designation of the jack the WAP is connected to.

C. Warranty Documentation. Provide documentation per 271000.1.08.

D. Record Documentation. Provide final “as-built” drawings per 271000.1.05.A.

E. Spare Parts. Provide an additional five (5) of each color and length of patch cable used in each ER.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. See 271000.2.01.

2.02 EQUIPMENT

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the communications outlets and the horizontal cross-connect located in the ER. This cabling and its connecting hardware are called “permanent link”, per the TIA and IEC standards.

B. Patch cables connect equipment in the ER to the patch panels.

C. Station Cords connect equipment in the work area to the jacks in outlets nearby.

D. Design Criteria, Horizontal Cabling:

1. Performance. Cables must meet all criteria for the cable type specified on project drawings. Typically, cable type will be noted at the outlet; provide a permanent link to the outlet at the category specified, either:
   a. Category 6 (Cat6), or
   b. Category 6_A/Class E_A ($Cat6_A$)
2. Colors. Cable colors must be uniform throughout a building, and should be one of the following (in order of preference):
   a. Blue
   b. White
   c. Black

   Specific project requirements may influence color selection (*e.g.*, cables run in exposed areas may need to be a certain color). Notify the SATD and coordinate with Architect if other colors are used.

E. Design Criteria, Patch Panels:

1. Suffield Academy does not distinguish between voice and data cabling at the outlet locations; all cabling is either Cat6 or $Cat6_A$ and may be used for voice or data.
2. All cabling must terminate on 8P8C patch panels to retain maximum flexibility for later use.

3. Suffield Academy does not use 66- or 110-style terminations for cross-connecting voice cables.
4. Patch panel connectors must be individual keystone type, with ratings meeting or exceeding the class and category of the cabling it terminates (Cat6 or Cat6_A). Keystone colors must match those of the outlet jacks they connect to.
5. Patch panels must have space available to label:
    a. The port number (unless permanent numbers are stamped or etched into the panel).
    b. The room, outlet, and jack count for each group of connectors.
6. Patch panels must have 48 ports, arranged in two even horizontal rows in 1RU or 2RU of rack space as indicated on rack elevation drawings. Numbering must begin at at the top-left of the panel (when facing the front), then proceed in a top-to-bottom, left-to-right orientation, creating a row of odd numbers and a row of even numbers. See 271500.3.07 for a sample diagram.
7. To facilitate easier labelling and grouping of jacks, specify enough panels to leave an average of 4 ports empty on each panel.

F. Design Criteria, Jacks:
1. Performance. Jacks must be standard keystone inserts and meet or exceed the class and category noted on the project drawings (Cat6 or Cat6_A).
2. Colors. Jacks must be available in the following colors:
    a. Blue (used for odd-numbered jacks; see 271500.3.02).
    b. White (used for even-numbered jacks; see 271500.3.02).
    c. Yellow (used for Cat6_A jacks).

G. Design Criteria, Faceplates. All outlet locations have an even number of jacks. Select faceplates capable of holding the required number of jacks at each outlet. Faceplates must hold an even number of jacks in each vertical column. If an exact match for the required number is not available, provide blanks for extra spaces. Coordinate color and finish with Architect.

H. Design Criteria, Patch Cables:
1. Performance. Patch cables must meet or exceed the class and category for the jacks they connect to (Cat6 or Cat6_A).
2. Design. Provide cables with “slim-boot” snagless connectors.
3. Length. Select cables long enough to provide clean routing between patch panels and connected equipment, without leaving unnecessary amounts of slack. This may require several lengths of cable for different panels.
4. Colors. Cables must be available in the following colors:
    a. Blue (used for odd-numbered jacks; see 271500.3.02).
    b. White (used for even-numbered jacks; see 271500.3.02).
    c. Yellow (used for all Cat6_A jacks).
    d. Orange (used for voice connections).
5. Quantity. Provide enough cables to connect all patch panels to equipment. Coordinate with the SATD regarding the expected number of voice patches. Exact quantities of each length of cable will not be known until patching is complete; provide enough of each length to complete patching and provide requested spares; return unused cable at no cost to Owner.

I. Design Criteria, Station Cords:

1. Performance. Cables must meet or exceed the class and category requested (Cat6 or $Cat6_A$).
2. Colors. Cables must be available in the following colors:
   a. White (Cat6).
   b. Yellow ($Cat6_A$).
3. Quantities:
   a. Provide one (1) $Cat6_A$ cable for each WAP.
   b. Provide one (1) Cat6 cable for each projector.
   c. For occupied offices, coordinate with the SATD; typically two (2) Cat6 cables are needed in each office.
4. Lengths:
   a. WAPs. As short as possible to connect WAP to the outlet. Typically twelve (12) inches or less when jacks are available in the box where the WAP is mounted.
   b. Projectors. As short as possible to connect projector to outlet.
   c. Occupied offices. Coordinate with the SATD; typical length is ten (10) feet.

PART 3 EXECUTION

3.01 INSTALLATION OF CABLES

A. Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters. Conceal raceway and cables except in unfinished spaces.

B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

D. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

3.02 INSTALLATION OF OUTLETS

A. All outlets must have an even number of jacks, with a minimum of two (2) jacks at any location.

B. Visually divide the jacks in half horizontally. The top row are the odd-numbered (blue) jacks and the bottom row are the even-numbered (white) jacks. If the outlet does not follow the requested arrangement (*e.g.*, has no faceplate, is a surface-mount box, or is of a different approved design), alternate between odd/even (blue/white) jacks for each connector.

C. See 271500.3.07 for a sample diagram.

3.03 INSTALLATION OF PATCH PANELS

A. Use keystone inserts to terminate horizontal cabling from outlet jacks. Colors must match the colors of the jacks terminated on the far end (blue, white, yellow).

B. Patch panel ports must be arranged and numbered per 271500.2.02.E.

C. If an outlet has an odd number of jacks (*i.e.*, a blue without a white), leave a blank space in the panel where the missing jack would go so as to preserve the arrangement of jacks.

D. Terminate jacks sequentially in the patch panel in a logical order corresponding to their physical location:

1. Locate jacks belonging to the same outlet sequentially on the panel in the order they appear in the outlet.
2. Locate outlet groups of jacks sequentially with other outlet groups in the same room by their outlet number.
3. Do not split jacks belonging to the same outlet between different panels in the same rack, or between different racks.
4. When practical, locate outlets from adjacent rooms in adjacent portions of the patch panel.
5. Terminate Cat6 and Cat6_A on the same panel, using keystone inserts appropriate for the type of cable being terminated. Notify SATD if connectors with different ratings cannot share panels.

3.04 INSTALLATION OF PATCH CABLES

A. The contractor is responsible for providing and connecting patch cables in the ER. The SATD provides a written set of instructions for connecting patch cables to equipment or other patch panels. These instructions will be produced after the SATD has received the interim drawings described in 271500.1.04.A.

B. Use cable colors corresponding to the jack being connected (blue, white, Cat6_A, orange).

C. Use cable length appropriate for routing the cable through horizontal and vertical cable management without unnecessary slack.

D. Arrange cables neatly, using horizontal and vertical cable management. After patching, the rack should have a neat and orderly appearance.

3.05 LABELLING

A. Label all patch panels, outlets, and faceplates with the following scheme (a modified version of TIA-606-B). Project Drawings should show all designations; if not, use the scheme to generate designations and coordinate with SATD.

B. Outlets in work areas.

1. Use a unique designation for each outlet in a room, using a letter, starting with the letter “A”. Letters that may be confused with numbers must not be used: “I”, “O”, “Q”, “S”, “X”, or “Z”. In the event of more than 20 outlets in a single room (exhausting all available letters), add an extra letter, yielding a sequence of “AA”, “AB”, ... “AY”, “BA”, “BB”, ... “BY”.
2. Label each outlet with the room number where the outlet is physically located, and the unique letter code for that outlet. Example: `319.E` would be the fifth outlet in room 319.

3. Label each outlet with the patch panel designation where the jacks of the outlets are terminated. See 271100.3.01.C for designations. Example: `209.01D` would be the fourth panel (D) in the first rack (01) of the ER in room 209.
4. Label each jack in the outlet with a two-digit number corresponding to the port number on the patch panel that it is horizontally connected to. Begin the numeric sequence with the jack in the top-left corner, then proceed top-to-bottom, left-to-right.
5. See 271500.3.07 for a sample diagram.

C. Patch Panels.

1. Label each panel with its designation, as described in 271100.3.01.C.
2. Label each group of jacks with the room number and outlet designation, as determined above.
3. See 271500.3.07 for a sample diagram.

3.06 SITE QUALITY CONTROL

A. Perform tests and inspections. See 271000.3.02 for general guidelines.

B. Site Tests and Inspections:

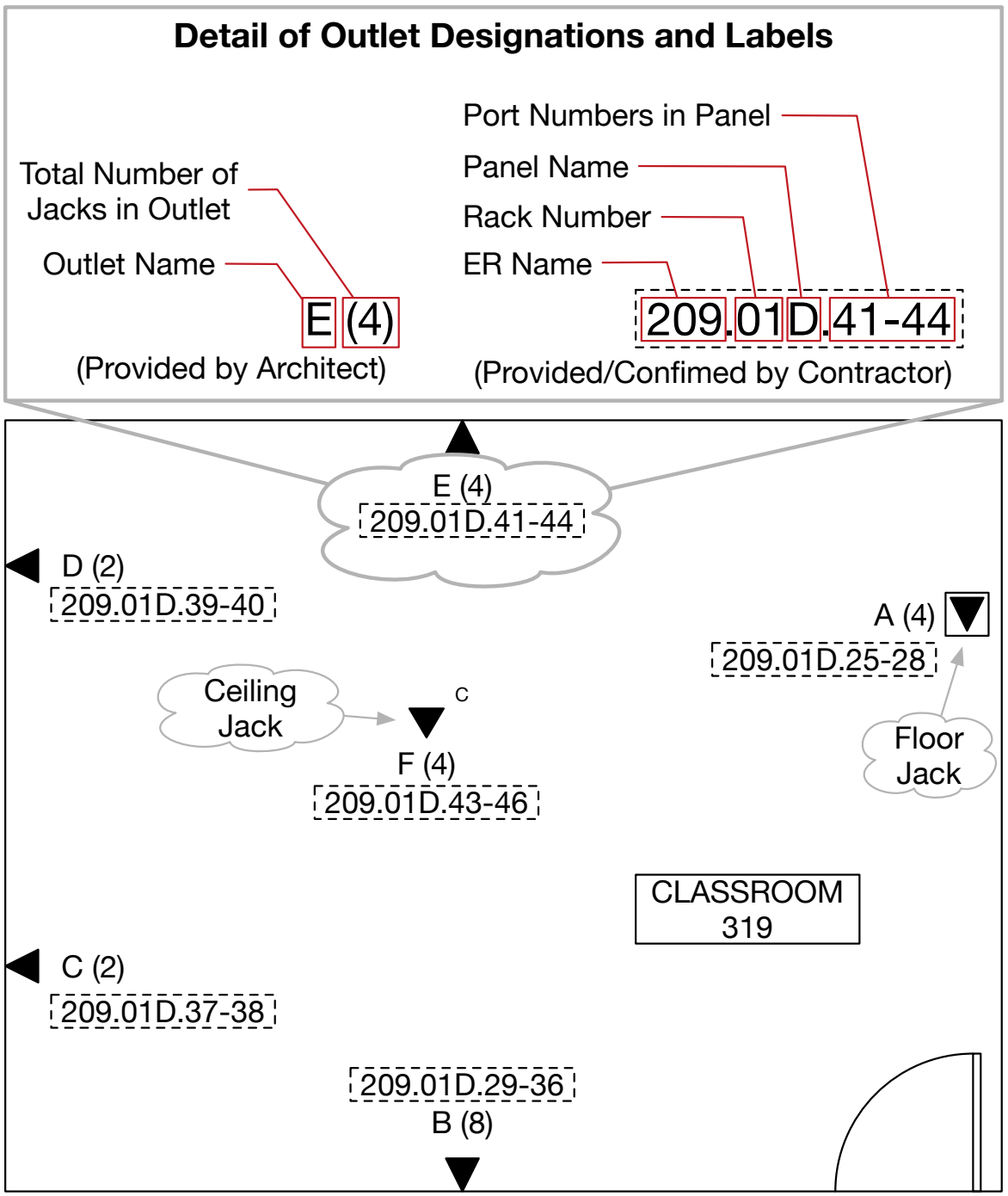
1. Visually inspect cable jacket materials for NRTL certification markings. Inspect cabling terminations in ERs for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with applicable standards.
2. Visually confirm Cat6 and $Cat6_A$ markings (as appropriate) on outlets, cover plates, jacks, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Performance Tests: for each outlet, perform all required tests as defined in ISO/IEC 11801 (including Edition 2 Amendment 2:2010 as applicable to $Cat6_A$). Record details of all tests, including:
    a. Name of person performing the test
    b. Date and time of test
    c. Project name
    d. Test equipment model (Tx and Rx)
    e. Test equipment serial number (Tx and Rx)
    f. Test equipment software version (Tx and Rx)
    g. Test equipment calibration date (Tx and Rx)
    h. Cable ID under test
    i. Length of cable under test
    j. Measured transmission parameters (return loss, insertion loss, NEXT, PSNEXT, *etc.*, as mandated by standards)

3.07 ATTACHMENTS

A. Sample diagram and labelling. Attached at the end of this section are the following:

1. Sample Floorplan Layout, Outlet Designation, and Labels. This diagram shows a sample room with floor, ceiling, and wall outlets. Drawings must depict the outlet name, jack count, and patch panel connections. The information in this diagram corresponds to the Sample Faceplate and Sample Patch Panel diagrams in this section.
2. Sample Outlet Faceplate Layout and Labels. This diagram shows outlet layouts, colors, and labels. The information in this diagram corresponds to the Sample Floorplan and Sample Patch Panel diagrams in this section.
3. Sample Patch Panel Layout and Labels. This diagram shows patch panel port ordering, numbering, layout, and labelling. The information in this diagram corresponds to the Sample Floorplan and sample Faceplate diagrams in this section.
4. Sample Workmanship. These photos are from an existing campus ER and demonstrate correctly installed cabling. Note that cables are dressed neatly, supported using cable management, and secured with reusable ties.
5. WAP Boxes. These photos show desired installation of WAP back boxes and cable termination. Box covers/rings are also shown.

Sample Plan Drawing Showing Outlets



Sample Outlet Labels and Configurations

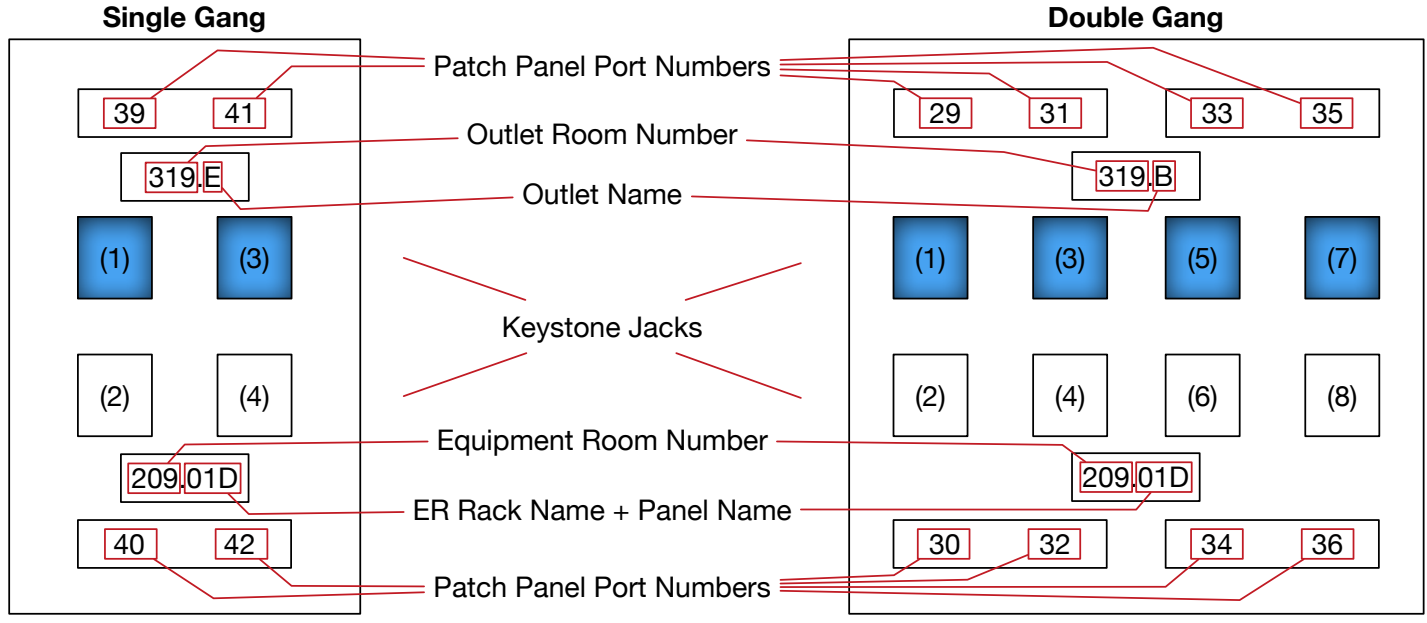
Shaded box represents blue keystone insert

(#)

Empty box represents white keystone insert

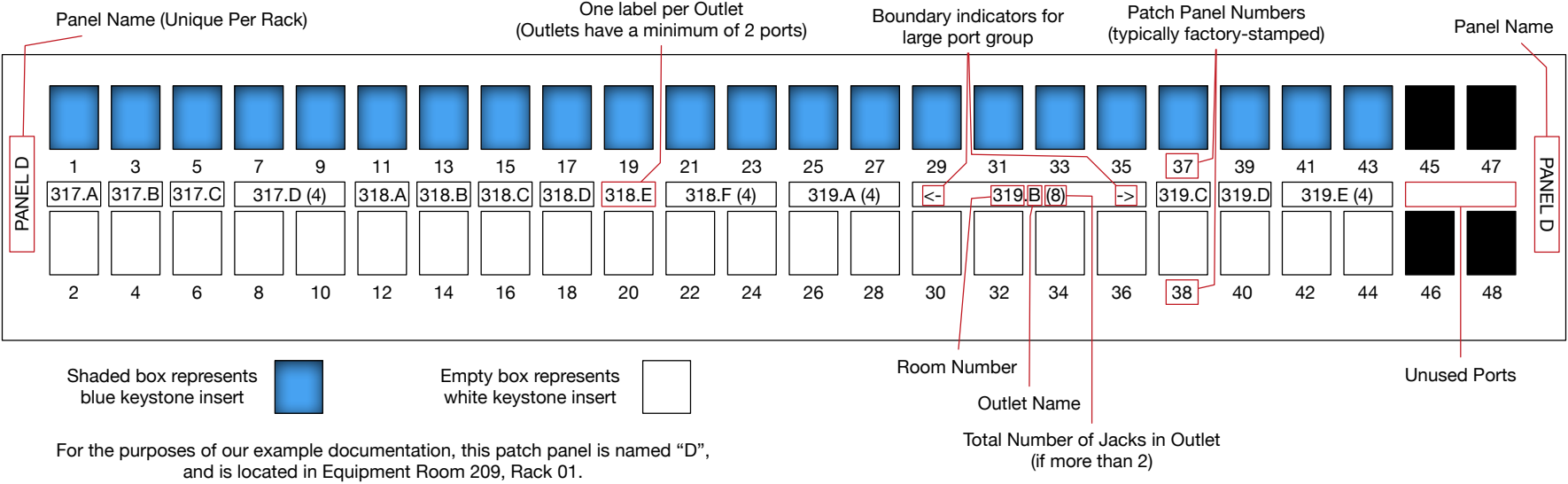
(#)

(#) represents port order for jacks in this outlet (not marked on installed product)



Both sample outlets are located in room 319, and their jacks are horizontally connected to Equipment Room 209, Rack 01, Patch Panel “D”.

Sample Patch Panel Layout and Labels

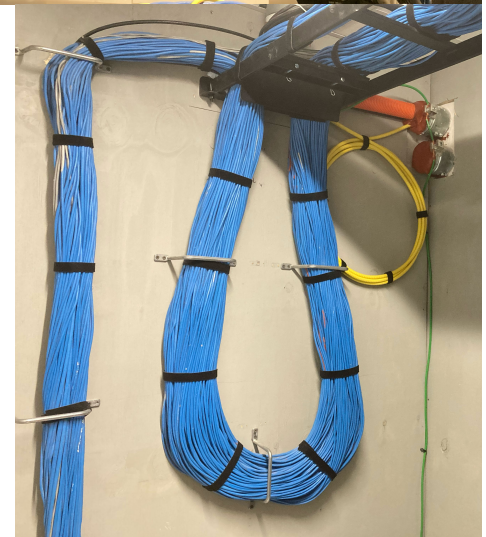


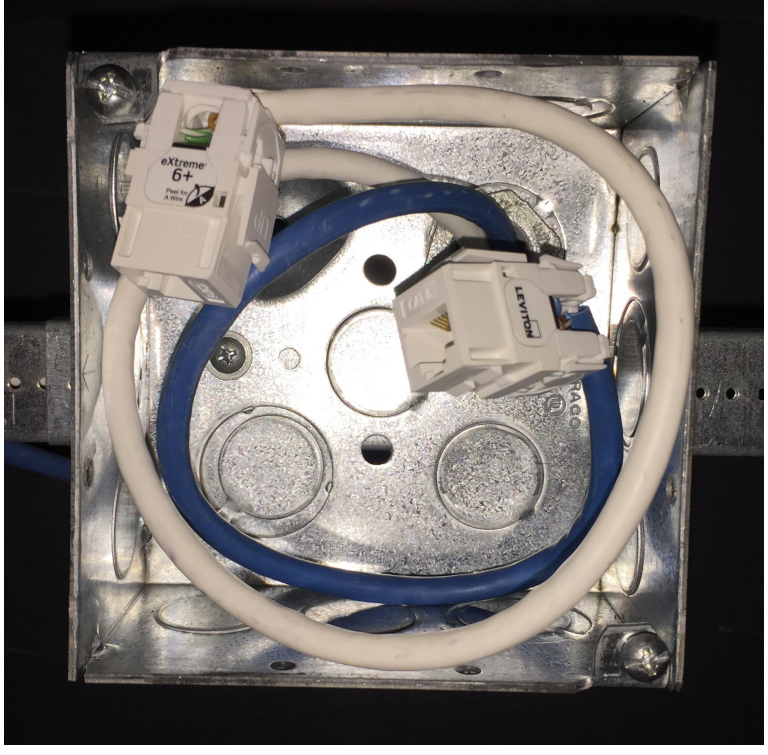
For the purposes of our example documentation, this patch panel is named “D”, and is located in Equipment Room 209, Rack 01.

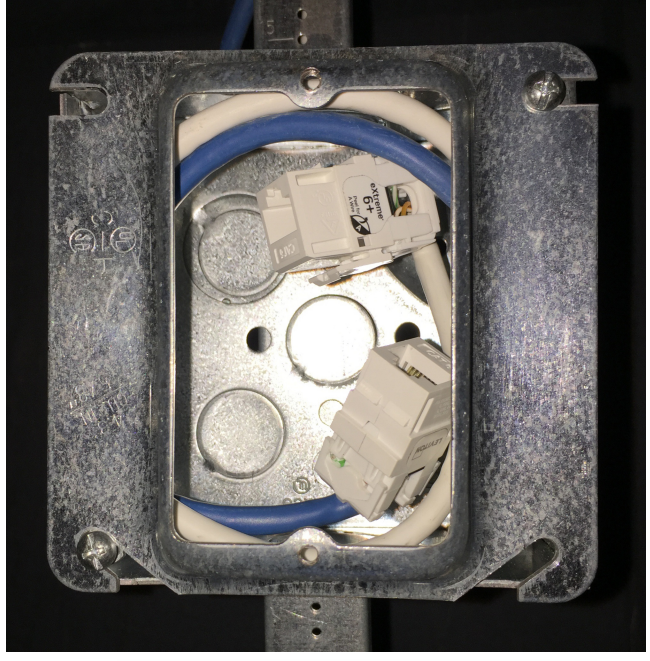
Example of Workmanship

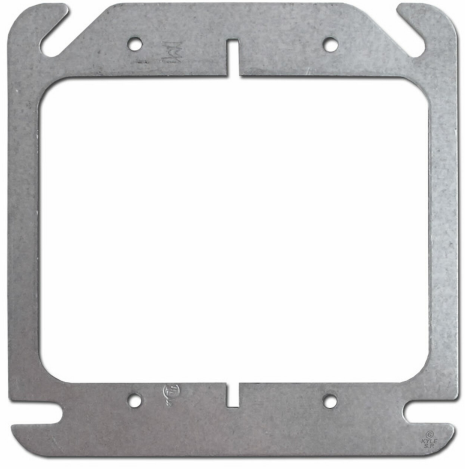
Clockwise from left:

1. Dressed rack from front
2. Patch panel from rear
3. Copper and fiber service loops









WAP back boxes

Top left: box with terminated jacks for WAP

Top right: box with single-gang mud ring installed, ready for WAP mount installation

Right: single-gang ring may be substituted with 2-gang shown here; consult with SATD to confirm exact WAP mounting type.

END OF SECTION

Section 27 20 00
Data Communications

This section last revised 2022-03-24 13:20:08 UTC (revision 4366)

PART 1 GENERAL

1.01 SUMMARY

A. This section discusses requirements for any equipment that relies on the Suffield Academy communications infrastructure or shared frequency spectrum. Examples include (but are not limited to):
   1. Equipment using radio frequencies to communicate wirelessly:
      a. Any equipment operating in an unlicensed radio band, such as the ISM bands; examples include **but are not limited to**:
         1) 902 to 928 MHz
         2) 2.400 to 2.4835 GHz
         3) 5.725 to 5.875 GHz
         4) 5.925 to 7.125 GHz
      b. Any equipment using the IEEE 802.11 wireless protocols (“Wi-Fi”, “Zigbee”, “Bluetooth”, *etc.*) to communicate.
      c. Audio-Video equipment, controls, microphones.
      d. Scoreboards, clocks, and signage.
      e. Building automation, lighting controls, sensors.
   2. Equipment that uses data networking to communicate using Suffield Academy’s communications network:
      a. Any equipment relying on the Ethernet (IEEE 802.3) or Internet Protocols to communicate.
      b. Building automation, lighting controls, sensors.
      c. Audio-Video equipment or controls.
      d. Internet of Things (IoT) devices.
      e. Cameras.
      f. Physical access control mechanisms.
   3. Equipment that uses a phone line to communicate:
      a. Fire alarm dialers.
      b. Elevator emergency phones.
      c. Utility meter dialers.

B. This section subsumes the specifications for the following subsections:
   1. 27 20 21 Data Communications Network Equipment
   2. 27 20 22 Data Communications Hardware
   3. 27 20 24 Data Communications Peripheral Data Equipment
   4. 27 20 25 Data Communications Software
   5. 27 20 26 Data Communications Programming and Integration Services

Other subsections of this section not mentioned above are not used.

C. Refer to Section 27 00 00 “Communications” and Section 27 10 00 “Structured Cabling” for common requirements that also apply to this section.

D. Products Installed But Not Furnished Under This Section. WAPs maintained by Suffield Academy are not discussed in this section; see Section 27 15 00 “Communications Horizontal Cabling” for requirements and procedures. **No WAPs other than those provided by Suffield Academy may be installed.**

1.02 REFERENCES

A. Definitions

1. Ethernet, when used in this section, refers to both “wired” Ethernet (IEEE 802.3) and “wireless” Ethernet (WLAN/Wi-Fi, IEEE 802.11a/b/g/n/ac/ax and later standards).
2. Internet Protocol (IP), when used in this section, refers to all versions of IP unless a specific version is named (IPv4 or IPv6).
3. “Owner-maintained” refers to electronic equipment that is installed, updated, or otherwise maintained by the Owner. Examples include commodity servers, desktop computers, laptops, or tablets. The expectation is that the SATD is responsible for keeping the equipment in working order.
4. “Vendor-maintained” refers to electronic equipment that should not be installed, updated, or maintained by the Owner. Examples include proprietary equipment or equipment that requires specialized software, tools, or training to configure and maintain.

B. Reference Standards

1. Internet Engineering Task Force (IETF)
   a. RFC 791, *Internet Protocol*
   b. RFC 2460, *Internet Protocol, Version 6 (IPv6) Specification*
   c. RFC 2131, *Dynamic Host Configuration Protocol*
   d. RFC 3315, *Dynamic Host Configuration Protocol for IPv6 (DHCPv6)*
   e. RFC 4862, *IPv6 Stateless Address Autoconfiguration*
   f. RFC 5321, *Simple Mail Transfer Protocol*
   g. RFC 1034 and RFC 1035, plus references and updates (Domain Name System)
   h. RFCs 3411 – 3418 (Simple Network Management Protocol)
2. Institute of Electrical and Electronics Engineers (IEEE)
   a. All 802.3 Working Group standards (Ethernet)
   b. All 802.11 Working Group standards (Wireless LAN / Wi-Fi)
   c. 802.11i-2004: Amendment 6, *Medium Access Control (MAC) Security Enhancements* (defines Wi-Fi Protected Access II)
   d. 802.1X-2010, *Port Based Network Access Control*
3. United States Federal Government (various agencies)
   a. Office of Management and Budget Memorandum *M-21-07: Completing the Transition to Internet Protocol Version 6 (IPv6)* (https://www.whitehouse.gov/wp-content/uploads/2020/11/M-21-07.pdf)

b. NIST *USGv6 Capabilities Table* (https://doi.org/10.6028/NIST.SP.500-267Br1s)

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination. Voice and Data communications are generally unavailable until structured cabling installation is complete. Early availability of communication services must be coordinated with structure cabling installers and the SATD.

B. Preinstallation Meetings. Prior to configuration or installation of equipment, schedule a meeting with the SATD to discuss equipment installation and requirements.

C. Radio frequencies. Both licensed and unlicensed spectrum use must be coordinated with the SATD and other installers to prevent interference.

1.04 SUBMITTALS

A. Record Documentation, networked equipment. Provide a spreadsheet of all installed equipment electronically in comma-separated value (CSV) format. At a minimum, include the following data for each device:

1. Brief description of the device.
2. Physical location where the device was installed.
3. Manufacturer of the device.
4. Model of the device.
5. Serial number of the device.
6. Medium Access Control Address (MAC address) of the device.
7. Protocols and (if proprietary or non-standard) port numbers used by the device. Example: `HTTPS, SSH, TCP 8888, UDP 1234`.
8. Usernames and passwords for the device (may be provided in a separate spreadsheet if there are multiple entries per device).
9. License key information required for the operation of the equipment.
10. DNS hostname of the device (supplied by the SATD).
11. IP address of the device (supplied by the SATD).

B. A version of the spreadsheet must be provided to the SATD prior to installation so addresses and hostnames can be generated and added to the documentation. This version must contain the description, manufacturer, model, serial number, and MAC address fields. Other fields may be omitted until final submittal.

C. Software. Provide electronic copies of any software required to configure, install, or operate a piece of equipment. The software must be organized by the model or name of device given in the documentation defined in 272000.1.04.A. Software may be withheld only if the equipment is vendor-maintained and if the Owner is forbidden by the manufacturer to receive a copy of the software (e.g., use of the software requires a partnership with the manufacturer). Examples of such software items include, but are not limited to:

1. Installation packages.
2. Firmware images.
3. Drivers.

4. Configuration utilities.
5. Updates or service packs not included in the installation packages.

D. Configuration Settings and Source Code. For all equipment, provide:

1. An electronic copy of all configuration settings necessary to convert the equipment from its factory-default state to the operational state at the time of acceptance. Settings must be human-readable unless the equipment has a documented process for restoring a backup of settings in binary form.
2. "Source code" necessary to operate, configure, or make changes to the programming of the equipment. Examples include, but are not limited to:
    a. Design or Layout files, including those for proprietary software specific to the equipment.
    b. Configuration settings.
    c. Graphics.
    d. Scripts.
    e. Computer code.
    f. Programming language instructions.
    g. Mockups, Wireframes, or other Documentation.
3. At no cost to Owner, grant Owner full and unrestricted rights to all files provided under this section, including the rights to use, copy, modify, merge, publish, distribute, and sublicense.

All files must be organized by the model or name of device given in the documentation defined in 272000.1.04.A.

The intent is that the Owner (for owner-maintained equipment) or any authorized vendor (for vendor-maintained equipment) should be able to restore the equipment from its factory defaults, configure the equipment with the correct settings, and make changes to those settings to implement new functionality without requiring the services of the original installer.

E. Radio Frequency Usage. Any equipment using wireless radio communications, but not using Suffield Academy's 802.11 wireless infrastructure, must provide an electronic spreadsheet in comma-separated value (CSV) format containing the following:

1. Brief description of the device.
2. Physical location where the device was installed.
3. Manufacturer of the device.
4. Model of the device.
5. Serial number of the device.
6. Radio frequency band(s) used by the device. Example: `2.4GHz ISM` or `G50 470-536MHz`.
7. Specific frequency and channel assigned to the device. Example: `498.700MHz, Channel 32`.
8. License number for the spectrum, or "unlicensed" for bands that do not require a license from the FCC.

F. Radio Frequency Licenses. Apply for all necessary frequency licenses on behalf of Owner and furnish proof of licenses prior to acceptance.

PART 2 PRODUCTS

2.01 OWNER-FURNISHED PRODUCTS

A. Network Electronics. Owner furnishes and installs all non-station network equipment. Examples include, but are not limited to: network switches, WAPs, routers, and firewalls. **Network electronics must not be provided by others unless authorized by the SATD.**

2.02 EQUIPMENT DESIGN CRITERIA

A. Radio frequencies. Equipment that communicates wirelessly must not use the 2.4GHz, 5GHz, and 6GHz ISM bands for communications other than 802.11. Equipment using 802.11 must use Suffield Academy's wireless infrastructure and must not provide their own WAPs.

B. Analog phone lines. Suffield Academy has transitioned away from analog phone service to Voice Over IP (VoIP). New equipment must be specified to use other means of communication (VoIP, SIP, wireless, IP, or others) instead of phone lines, unless authorized by the SATD.

C. Network hardware. The SATD furnishes all network equipment (switches, WAPs, routers, *etc*.). To ensure interoperability and ongoing management, all other network equipment not furnished by the owner must be authorized in writing by the SATD prior to specification, procurement, or installation. Hardware specified without prior authorization that fails to meet SATD requirements must be replaced with approved hardware at no cost to the Owner. Credit Owner any funds recovered from returned or unused equipment.

D. If project requires commodity hardware (laptops, personal computers, tablets, servers), the installer must coordinate with the SATD in advance of any final specification, procurement, or installation. System requirements should be specified without recommending a specific brand or style of hardware, unless such requirements are mandatory for the correct functioning of the installation.

E. Supported operating systems. The following requirements apply when commodity hardware is used with general-purpose operating systems as part of an installed system:
   1. Owner-maintained systems. The following operating systems are supported:
      a. Debian GNU/Linux, current stable release (version 11, "Bullseye", as of this writing).
      b. macOS, latest available version at the time of installation (version 12, "Monterey", as of this writing). The most recent patch release must be installed.
   2. Vendor-maintained systems. Operating systems must meet at least one (1) of the following requirements:
      a. Be one of the supported Owner-maintained operating systems listed above.
      b. Be the manufacturer's latest stable version of the operating system.
      c. Have at least five (5) years of included updates and patches remaining in the product lifecycle at the time of acceptance.

F. IP version support. Suffield Academy is transitioning away from IPv4; the protocol is now deprecated and is not supported on new equipment. **New equipment that uses IP to communicate must support operating using only IPv6**. It must be possible to deploy, configure, and operate the equipment fully using only IPv6. Some critical requirements are

provided below; vendors wishing to familiarize themselves with IPv6-only requirements are directed to the US OMB Memorandum M-21-07 as a starting point.

Suffield Academy will provide legacy connectivity to external IPv4-only hosts via a NAT64/DNS64 gateway.

G. Automatic address assignment and configuration. Static IP assignment is supported at the discretion of the SATD, and usually reserved for servers and equipment that require a direct connection from users. In addition to static assignment, equipment must be able to obtain an IP address, subnet/prefix, and router address via **all** of the following protocols:

1. All "core" items listed in NIST USGv6 Capabilities Table (some items duplicated below).
2. IPv6 stateless address autoconfiguration (RFC 4862 plus updates).
3. Neighbor Discovery for IP version 6 (IPv6) (RFC 4861 plus updates).

Note that Suffield Academy does **not** provide assignment via Stateful DHCPv6 at this time. Automatic configuration must be supported via SLAAC. If stable addresses are necessary, EUI-64, cryptographically-derived or another statically-derived fixed address algorithm should be used.

To support correct functions of the network, recursive DNS servers provided by Suffield Academy must be used by all equipment. Equipment must be able to obtain recursive DNS server address(es) via either (or both) of the following methods:

1. IPv6 Router Advertisement Options for DNS Configuration (RFC 8106 plus updates).
2. Stateless DHCPv6; Dynamic Host Configuration Protocol for IPv6 (DHCPv6) (RFC 8415 plus updates).

H. IP address selection. All IP addresses or prefixes are provisioned and assigned by the SATD, including those from the private (*e.g.*, RFCs 1918 or 4193 or IPv6 ULA) ranges. Equipment must not require use of a specific address range.

I. Routable communications for IP. All equipment using IP for communication must support routed unicast connections from non-local subnets for discovery, configuration, and communication. **Equipment must not require any of the following for proper operation**:

1. Multicast service announcement, discovery, or communication (*e.g.*, mDNS, Zeroconf, Bonjour, uPNP, DLNA, SAP).
2. Broadcast service announcement, discovery, or communication (this does not apply to the standard IPv6 discovery protocols such as neighbor discovery, router discovery, or DHCPv6).
3. A requirement that other devices must reside on the same subnet in order to communicate with the equipment.

J. Configuration methods, networked equipment. Equipment without a local means of configuration (touchscreen, buttons, switches) must be configurable from remote computers using vendor-independent protocols. Equipment that requires a specific platform (*e.g.*, Microsoft Windows) for interaction are not acceptable. Approved protocols include:

1. HTTP or HTTPS (without reliance on specific browser versions or plug-ins).
2. SSH.
3. RS-232.
4. DHCP vendor options.

5. TFTP.
6. DMX.
7. Others authorized in writing by the SATD.

K. Wireless Authentication. Any equipment using 802.11 wireless must support authentication via Wi-Fi Protected Access II (WPA2) using AES encryption. Equipment should support authentication via 802.1X EAP-TLS, as this mechanism is preferred over the less-secure WPA2 protocol.

L. WAN Access. Most devices on the Suffield Academy are firewalled from receiving connections initiated from outside the campus network. Equipment may initiate outbound connections freely; provide a list of WAN resources required by the equipment. If inbound access to the equipment is necessary from off-campus, it must be approved by the SATD prior to specification.

M. Infrastructure services. Equipment must not attempt to provide critical network services already configured on the network. Examples include (but are not limited to):
1. DHCP server or DHCPv6 server.
2. Spanning-tree root bridge.
3. Router advertisements.
4. DNS server.

N. Ethernet standards. Equipment interfacing with the Owner's wired network must support 1000BASE-T Gigabit Ethernet (IEEE 802.3ab). Very old standards (such as 10 Megabit or half-duplex operation) may not be supported by Owner's equipment.

O. Power over Ethernet (PoE). Most buildings have PoE (802.3af or 802.3at) available for use by networked equipment, and so networked power is preferred over separate mains power for small devices. Coordinate with the SATD to confirm availability and design limits.

P. Time representation format. Systems must represent dates and times in a manner that allows proper functioning during the potential lifetime of the component. A test example is the "Year 2038" issue, where time values are stored as a 32-bit signed integer representing the number of seconds since January 1 1970, resulting in errors for any date after 2038. Systems that work with absolute dates and times (such as scheduled events or calculations) must correctly interpret dates in the foreseeable future.

2.03 ACCESSORIES

A. Provide power cords, network patch cables, phone cables, and any accessories necessary to connect to the building's installed horizontal cabling.

PART 3 EXECUTION

3.01 INSTALLATION

A. Address assignment. Configure each device to receive or automatically determine its IP address. Static addressing may be used when coordinated with the SATD. Perform address assignment via Stateless Address Autoconfiguration (SLAAC), using either stable, randomized, or hardware-derived addresses as appropriate for the application. For example, if the device must be reachable at the same address over a long period of time, consider using a hardware-derived address.

B. Inter-device communication. Use DNS hostnames for communications. Hard-coded IP addresses should not be used.

C. Default passwords. All passwords must be changed from their factory defaults to randomly-generated values. Consult with the SATD for password generation and complexity requirements. Record all passwords in submittal documentation.

D. Labels. Label each network-capable device with a machine-generated label. The label must contain the short canonical hostname (without domain name) as submitted in the record documentation. Additionally, include the MAC address of the device unless it is already clearly marked on the device's factory-installed label.

E. Accessory Labels. Label any detachable accessories unique to the equipment with a machine-generated label containing the associated device's name and serial number. Examples of accessories include (but are not limited to):

1. Power cords with transformers ("wall warts")
2. Antennas
3. Remote controls

3.02 SITE QUALITY CONTROL

A. Notification Testing. Prior to acceptance, send test notifications from all equipment that sends automatic notifications as part of its operation. Include the SATD and any recipients who will normally receive such notifications as part of the test.

3.03 CLOSEOUT ACTIVITIES

A. Training and Demonstration. For each unique model of equipment, provide a demonstration to the SATD or Owner's staff as appropriate. Demonstrate connecting, authenticating, operating, and configuring the equipment.

B. Backup procedure. For Owner-maintained equipment, demonstrate and verify the procedure to back up and restore device settings with the SATD or Owner's staff as appropriate.

END OF SECTION