CONNECTICUT STATE COLLEGES & UNIVERSITIES
BOARD OF REGENTS FOR HIGHER EDUCATION

Telecommunications Infrastructure Standards

Version: 3.2
Revision Date: April 12, 2012

The Telecommunications Infrastructure Standards contained here have been adopted and are to be applied to the system office and the colleges and universities that make up the Connecticut State Colleges and Universities.

Asnuntuck Community College
Capital Community College
Gateway Community College
Housatonic Community College
Manchester Community College
Middlesex Community College
Naugatuck Valley Community College
Northwestern Community College
Three Rivers Community College
Norwalk Community College
Quinebaug Valley Community College
Tunxis Community College
Central Connecticut State University
Eastern Connecticut State University
Southern Connecticut State University
Western Connecticut State University

Table of Contents

Page

1 Introduction

The Connecticut State Colleges & Universities (ConnSCU) has adopted the ANSI/TIA/EIA (American National Standards Institute, Telecommunications Industry Association and Electronic Industries Association) Standards and BICSI (Building Industry Consulting Service International) practices regarding the installation of structured cabling systems constructed with a minimum of Category 6 compliant components. Liberal reference to these standards and practices are made throughout this document, and the colleges/universities are encouraged to consult the original documents for more detailed information on wiring standards. This document is intended to summarize and highlight significant aspects of these standards and practices for the purpose of creating a simplified reference which colleges/universities may use in the planning, bid preparation, and implementation of a Structured Cabling System for their campus.

Each college/university is expected to adhere to the elements identified in this document for the implementation of any new wiring projects. Compliance with these standards will result in model installations which are easy to administer and modify when necessary, and which will in turn guarantee optimal performance from the network.

These standards are intended to allow ConnSCU to meet the telecommunications requirements of the colleges and universities for the next 20-30 years. It is essential that ConnSCU Network Management shall be consulted prior to and throughout the planning and design process to ensure that present and future voice and data service requirements can be met.

ConnSCU Information Technology (IT) Management **MUST** provide prior written approval for any deviations from these standards, or ConnSCU will not assume financial responsibility to upgrade the facility to performance expectations. Where ambiguity or questions arise to specific details not mentioned in these standards, appropriate TIA/EIA, NEC, and BICSI standards shall apply.

All applicable building codes must be strictly adhered to in regards to telecommunications services. ConnSCU cannot authorize variations to any building codes.

Construction specifications are a main ingredient of an Information Technology system. Information Technology systems shall adhere to these specifications in order to be functional in a wide variety of communications applications. This document does not allow or condone the avoidance of following any of the Laws, Standards, or Procedures of any, but not limited to the following:

Current National Electrical Code (NEC)
Connecticut Building Code
Connecticut Fire Code
Building Industry Consulting Services International (BICSI)

2 General

2.1 Introduction

The ConnSCU Wiring Distribution System (CWDS) is viewed as the most critical physical element of the long term telecommunications strategy. The Distribution System shall provide connectivity to all the other major subsystems including voice, data and video requirements. Any new systems installed shall be incorporated into the existing Distribution Systems and should combine copper and fiber optic technologies to provide enhanced communications services.

2.2 General Requirements

A. Any new systems installed shall be incorporated into the existing Distribution Systems and should combine copper and fiber optic technologies to provide enhanced communications services.

B. Installers for new construction or renovations shall be responsible for all cable, wire, hardware, labor, and materials for full installation of functioning Wiring Distribution System supporting the requirements of all systems including the Telephone Systems, Campus Data Network, Video Systems etc. This includes, but is not limited to, cross-connect fields, station cable, fiber and copper riser cable, protection, station jacks, raceways, wiring closet construction, outside facilities and all associated hardware and labor.

C. ConnSCU requires a secure distribution system while minimizing installation expense wherever possible. Installers shall consider the re-use of newly-installed wire and fiber optic cabling in those buildings where new wire has been installed. Already-installed wire and/or fiber optic cabling will be acceptable where it meets the Specifications in this document and ConnSCU IT Management.

D. ConnSCU requires fiber optic cables to be the media of choice for inter-building data and video cabling to minimize future congestion in new conduits and to be positioned to exploit emerging technologies that require fiber connectivity.

E. Installer shall coordinate the reconnection of facilities cabling systems to the backbone infrastructure with ConnSCU IT Management and campus facilities personnel. All alarms shall be fully tested upon completion. During installation, the Installer shall not disturb fire alarm or other critical alarm circuits. If any such circuit is found to be inoperative between the time work commences in a building, but prior to system acceptance, the Installer shall immediately repair the circuit at no additional cost to the Owner.

F. All installation work shall be done in a neat, highly qualified manner. It is the responsibility of the Installer to ensure that all state and local building codes are met. Any costs for changes to materials in order to meet code requirements shall be borne by the Installer.

G. Each building requires a Building Demarcation Point (BDP) for terminating Service Provider facilities and the inter-building cabling; a Main Equipment Room (MER) will serve as the central point for Wiring Distribution System. Telecommunications Rooms (TR) are required for the termination of workstation cables and the cross-connections to the backbone cables. The Installer shall provide all hardware (e.g., mounting brackets, vertical and horizontal troughs, cables trays) within the wiring closets.

H. Cross connection equipment used in the intra-building distribution system shall allow for direct termination of station and backbone cables on the blocks, and modular cross-connections between blocks.

I. All new construction or major renovation projects are required to have the design team either include or employ the services of a BICSI Registered Communications Distribution Designer (RCDD) to assist in planning and design of the telecommunications infrastructure.

J. All construction plans for BDP, MER and TRs shall be approved by the ConnSCU Telecommunications Department prior to construction. Approval shall also be obtained for the layout of the cross connect fields within the wiring closets before work starts.

K. All Telecommunications plans shall be reviewed and approved by the campus as well as the ConnSCU Telecommunication Department before work starts.

L. All aspects of the telecommunications distribution infrastructure shall conform to the requirements contained herein. Any deviation from this specification in regard to the design and sizing of telecommunications spaces, vertical or horizontal pathways shall be brought to the attention of the ConnSCU Telecommunications Department and approval prior to the release of the bid specification.

M. The Installer shall be knowledgeable of all applicable industry standards including but not limited to NEC, TIA/EIA and BICSI, and shall comply with all applicable regulations of the College/University, local, state, and federal governments. Any failure to pass inspections by any regulatory body shall be corrected wholly at the expense of the Installer and at no cost, whatsoever, to the Owner.

N. All work of this project shall conform to all applicable laws and ordinances and to the regulations of the local utility companies.

O. All components of the Installer's proposed systems shall meet the requirements of FCC Rules and Regulations Part 68 (Registration) and Part 15 (Emanation and Interference). All Proposals shall include all license, permit, and registration numbers obtained in compliance with FCC Rules and Regulations.

P. Any deviations to specifications must be submitted in writing with justifications and be approved by the campus facilities office and the ConnSCU Telecommunications Department.

2.3 Special Requirements

A. The ConnSCU Telecommunications Infrastructure Standards publication is intended to address standard installation practices for all of the Colleges and Universities, with safety and performance being the most important factors. While these standards are carefully monitored to ensure that the hardware and practices are technologically current, it is possible that some applications may require special consideration.

B. ConnSCU buildings frequently contain special purpose facilities and equipment with unique telecommunications requirements. Special telecommunications requirements may require deviation from these specifications. ConnSCU IT Management needs to be notified of these special requirements as early in the design process as possible.

C. The following is a short (but not all-inclusive) list of facilities and equipment that commonly have special telecommunications requirements:

- Data centers or computer rooms
- Computer labs or classrooms
- Video conferencing rooms
- Video equipment
- Laboratories
- Nursing simulation laboratories
- Scientific equipment
- Public telephones
- Internet kiosks
- Wireless networking

D. Installation designs and practices not specifically identified as standard in this document will require appropriate ConnSCU IT Management approval before connection to the campus voice or data network.

3 Conduit and Raceways

A. Galvanized rigid steel conduit shall be zinc-coated steel conforming to industry standards and specifications and as manufactured by Allied Tube & Conduit Corp., Republic Steel Corp., Wheatland Tube Co., or approved equal.

B. Intermediate Metal Conduit shall be zinc-coated steel conforming to industry standards and specifications and as manufactured by Allied Tube & Conduit Corp., Triangle/PWC, Inc., or approved equal.

C. Electrical Metallic Tubing shall be zinc coated steel conforming to industry standards and specifications and as manufactured by Allied Tube & Conduit Corp., Republic Steel Corp., Triangle/PWC, Inc., and Wheatland Tube Co.

D. Non-metallic conduit shall be composed of polyvinyl chloride, Schedule 40 suitable for 90 C conductors, conforming to industry standards and specifications and as manufactured by Carlon or approved equal. Provide sunlight resistant conduit where exposed.

1. Conduit, fittings and cement shall be produced by the same manufacturer, who must have had at least 5 years of experience in manufacturing the products.

2. Flexible conduit shall be galvanized, spiral wrapped metallic conduit or liquid-tight flexible metal conduit as herein specified.

3. All conduits are to be reamed and bushed.

E. Empty Raceways and Raceways installed for Telecommunications Systems including telephone, data, security, alarm, CATV, sound, video, low voltage conductors, etc. shall be installed as required by the Electrical Code, as required for raceways specified in this Section and as indicated herein.

F. Terminate conduits with bushings. Provide grounding bushings for backbone and riser conduits and for conduits entering equipment rooms or wiring closets. Ground conduits, cable trays and raceways to the local Telecommunications ground bus using braided hollow copper conductor equal to Belden #8669 (60A ampacity).

G. Provide pull boxes each time raceway installation exceeds a 100 foot (30M) section or a total of 180 degrees in bends and offsets between pull boxes. Do not install a pull box in lieu of a conduit bend. Align the corresponding conduits on opposite sides of pull box with each other.

H. Pull boxes shall be sized according to the following table:

Minimum Space Requirements in Pull Boxes Having One Conduit Each in Opposite Ends of the Box

MAXIMUM TRADE SIZE OF CONDUIT IN INCHES	Size of Box			**FOR EACH ADDITIONAL CONDUIT INCREASE WIDTH**
	Width	Length	Depth	
21mm (0.75 in.)	102 mm (4 in.)	305 mm (12 in.)	76 mm (3 in.)	51 mm (2 in.)
27 mm (1.0 in.)	102 mm (4 in.)	406 mm (16 in.)	76 mm (3 in.)	51 mm (2 in.)
35 mm (1.25 in.)	152 mm (6 in.)	508 mm (20 in.)	76 mm (3 in.)	76 mm (3 in.)
41 mm (1.5 in.)	203 mm (8 in.)	686 mm (27 in.)	102 mm (4 in.)	102 mm (4 in.)
53 mm (2.0 in.)	203 mm (8 in.)	914 mm (36 in.)	102 mm (4 in.)	127 mm (5 in.)
63 mm (2.5 in.)	254 mm (10 in.)	1067 mm (42 in.)	127 mm (5 in.)	152 mm (6 in.)
78 mm (3.0 in.)	305 mm (12 in.)	1219 mm (48 in.)	127 mm (5 in.)	152 mm (6 in.)
91 mm (3.5 in.)	305 mm (12 in.)	1372 mm (54 in.)	152 mm (6 in.)	152 mm (6 in.)
103 mm (4.0 in.)	381 mm (15 in.)	1524 mm (60 in.)	203 mm (8 in.)	203 mm (8 in.)

NOTE: Width is measured perpendicular to conduit orientation. Length is measured parallel to conduit orientation.

I. Pull boxes with covers over 20 inches (508 mm) shall have piano hinged covers with pad locking capability Covers over 20 inches (508 mm) wide shall be split bulkhead type with piano hinges located on the long sides. Provide doors where one door is able to be secured to the pull box while the other is able to swing free.

J. Locate pull box so it is accessible and covers can be opened at least to 90 degrees. Where above ceiling or behind access door center pull box in access door or ceiling tile opening

K. Pull boxes shall be securely mounted to building structure.

L. Grounding continuity shall be assured throughout raceway and pull box installation equal to electrical power raceway installation.

M. Bends shall be large radius, not exceeding 90 degrees and minimum size radius as follows:

1. 2 inch (53mm) trade size and less - 6 times conduit diameter.
2. 2-1/2 inch (63mm) trade size and larger - 10 times conduit diameter.
3. Conduits for fiber optics cabling - 10 times conduit diameter.

N. Junction boxes shall be constructed of code gauge galvanized sheet metal, of not less than minimum size required by the Electrical Code or other applicable Specification "Standards" and shall be furnished with screw fastened covers. Boxes exceeding 48 inches (1200mm) in any direction shall be properly reinforced with angle iron stiffeners.

O. Junction boxes to be installed in normally wet location areas shall be of the cast type with threaded hub and gasketed cover plate. The cast pull and junction boxes shall be manufactured by Crouse-Hinds, Appleton, Russell and Stoll, or approved equal.

P. Adequate expansion/compression fittings shall be used where crossing building expansion joints. Expansion fitting shall be multidirectional and have grounding jumpers, and shall be manufactured by O-Z Gedney, Crouse-Hinds or approved equal.

Q. Raceways shall have expansion fittings installed as recommended by the manufacturer. Provide a minimum of one expansion fitting per one hundred feet or fraction thereof for non-metallic raceways.

R. Raceways and outlets shall be separated from sources of EMI and RFI such as transformers, ballasts and power lines. Do not install raceways parallel to power raceways unless four foot (1219mm) distance is maintained. Cross other raceways at 90 degrees. Maintain minimum 12 inch (305 mm) clearance in all directions from lighting fixtures and power wiring rated over 20 A. Maintain a minimum 6 inch (153 mm) clearance elsewhere from raceways and outlets. Maintain 48 inch (1220 mm) clearance from transformers. Clearances are measured all around raceway and outlets including through walls and floors.

S. Install raceways and outlets for power and telecommunications in separate stud wall or block cavities.

T. Provide a minimum of 4-4 inch conduits from the MER to each TR. If the MER and TR's are stacked, sleeves are acceptable. Provide 50% spare 4 inch conduit/sleeves. (This means that if four 4" conduits/sleeves are provisioned for

use, there must be an addition two 4" spare conduits/sleeves installed for future growth, for a total of six 4" conduit/sleeves.)

U. Provide a minimum of 4-4 inch conduits from the BDP to the MER. Provide 50% spare 4 inch conduits.

V. Align sleeves and conduits on opposite walls so there is a straight line between corresponding openings, parallel or perpendicular to Building Structure.

W. Provide a 200 lb test pull line in each raceway. Secure pull line at each end to prevent it from slipping back into raceway.

X. Non-metallic raceways or boxes are not allowed in interiors of buildings.

Y. Raceways shall have insulated throat fittings.

Z. Provide insulated bushings at all penetrations through steel studs.

AA. No cabling to an outlet is to be installed exposed. Provide surface metal raceway system to outlets where cabling would have to be installed exposed.

1. Surface mounted raceways shall be of sheet steel with matching covers, galvanized or painted to protect against corrosion conforming to industry standards and specifications. All necessary bends, couplings, connectors, etc., shall be provided.
2. Surface mounted raceways shall be suitable for lay in conductors with connector covers permanently attached so that removal is not necessary to utilize lay in feature.
3. Interior parts shall be smooth and free of sharp edges and burrs.
4. Surface mounted raceways shall be sized for adequate wire bending radius as required by code and TIA/EIA standards.
5. Surface mounted raceways shall be as manufactured by Wire Mold, Walker. or approved equal.

BB. Outlet shall be spaced 6 inches (150mm) minimum from an electrical outlet. Install outlet in separate stud cavity from power wiring

4 Spaces

3.2 Overview

This section defined the standards for Spaces, which are the areas used for housing telecommunications/computing equipment and cables. Discussed in this section are Building Demarcation Point, Main Equipment Rooms, and Telecommunications Rooms.

3.3 Building Demarcation Point

The Building Demarcation Point (BDP) consists of equipment (cables, connecting hardware, protective devices, etc.) and areas that terminate outside services into the premises (building, or campus) cabling. Here we would find protective devices that also serve as the demarcation point for outside carriers.

PROHIBITED: Using BDP room as a route for other facilities to pass through or above (such as water, drainage, electric, etc.)

PROHIBITED: Using boiler rooms, air exchange rooms, janitorial closets, electrical distribution closets or areas with water heaters and wet sinks to locate BDP

PROHIBITED: lay-in ceilings installed in BDP

3.3.1 Plan Area

Minimum size for small buildings - serving size of <20,000 sq. ft.: 4' X 5'

Minimum size for large buildings - serving area of <50,000 sq. ft.: 6' X 8'

If the BDP is co-located within the MER – follow Plan Area requirements for MER under section 3.3.1.

A. The BDP room shall be located on the basement or ground floor.

B. It is important to note that the BDP might not be located within the Main Equipment Room (MER) and, in these circumstances, the same number and size of the conduit as installed for the service entrance, must be installed between these two locations. It is not unusual for the demarcation point (BDP) to be located in the ground floor and the Main Equipment Room to be located on a higher floor.

C. If BDP and MER are in separate rooms, the following guidelines for the BDP room shall be met:

   1. Room should be near or at the point where the facilities enter the building.

   2. A maintenance clearance of 36 inches is required in front of all wiring or equipment panels.

3. Room shall be free of any storage material or other obstructions that could prevent technicians from performing their duties.

D. Door: Rooms shall have a fully opening, lockable door, which is at least 36" wide and 80" in height.

E. Interior Finishes: To minimize dust, floors should be vinyl composition tile and all exposed concrete, brick and gypsum board walls should be painted or sealed.

F. HVAC: Rooms shall have HVAC to control temperature and humidity. The heating, ventilating, and air conditioning (HVAC) system shall be designed to maintain an air temperature in the room of between 64°F - 72°F, with a humidity level of 55 - 30%. Design the system for the maximum amount of telecommunication equipment that the room could support. Estimated heat generated of electrical and electronics equipment is approximately 1,000 BTU for most rooms though an estimate would best be made based on the actual systems design.

G. Plumbing: Service Entrance Rooms cannot have any water pipes within the room's interior space, routing horizontally on the floor directly above the room or within the floor slab.

H. Grounding: Provide a building ground wire, with bus bar, to the room. Locate the bus bar at the lower left corner of the plywood backboard. The Owner will indicate on which backboard to place the bus bar. Refer to the Grounding section of these standards.

I. Lighting: Provide minimum lighting to be equivalent of 540 lux (50 foot-candles) measured 3 feet AFF.

J. Plywood Backboard Panels: Three interior walls, excluding the wall which contains the entrance door, in the room should be covered from 8" above finished floor 8 feet up, with ¾" plywood. Plywood should be fire-rated or treated with a minimum of two coats of fire retardant white paint on all sides.

1. The plywood shall reach from corner to corner. Install the plywood vertically at 6" AFF and anchor securely to wall substrate with a minimum of five (5) equally spaced fasteners along each vertical edge and down the centerline of each sheet of plywood.

2. Fasteners shall be of the appropriate type for each substrate.

3. Provide blocking or additional studs in framed walls to receive plywood backup panel fasteners.

4. The plywood shall be painted with two coats of fire retardant low-gloss, light-colored paint. In order to field verify the type of plywood installed, at least one of the legible grade stamps on each sheet of plywood shall be masked or covered prior to painting.

K. Electrical: On each wall, except the wall containing the door, install two 120 volt, 20-amp electrical four-plex outlets with a dedicated circuit to each receptacle, evenly spaced, at 102" AFF. Refer to Power section of these standards.

Note: Project plans may specify the need for additional electrical outlets to be installed, depending on the location of the electrical equipment.

Separate duplex 120V convenience electrical outlets shall be installed (for tools, field test instruments, etc.), which are:

1. Located at 18” AFF
2. Placed at 6 ft. intervals around perimeter walls
3. Isolated power and emergency receptacles shall have a finish color that is distinct from receptacles that are connected to normal power.
4. Floor Loads: Floors shall be designed to support 4.8 kPA (100 lb'/ft2) minimum.

L. All penetrations into fire walls, conduits, and sleeves through floors and cable trays that pass through a fire-rated wall must be properly fire-stopped in accordance with the National Fire Protection Association (NFPA), ANSI/NFPA-70 NEC, Article 300-21, and EIA/TIA-569B.

3.3.2 Plan Conduits

A. The installation of conduits for inter-building cabling may be required. This shall include, where appropriate, the required conduits as well as spare and empty conduits, all associated manholes, etc.

B. The acceptable means of service entrance to the building is an underground conduit system. All entrance conduits must be a minimum of four (4) inch conduit(s), buried at a minimum of thirty six (36) inches below grade. Building mounted boxes are not acceptable.

C. All outside plant conduit must be PVC, Type "C" or Schedule 40, four inch inner diameter (I.D.). Only non-metallic conduit shall be used, except where otherwise noted in this specification. One inch inner diameter (I.D.) may be used from an emergency phone station drop to a building or a manhole with the ConnSCU Information Technology department’s authorization only.

D. Entrance conduit begins at the designated manhole and ends when terminated in the BDP for that structure.

E. The cable routing for the CWDS must utilize the same campus conduits and trenches wherever possible.

F. The Installer shall be prudent in the design and installation of inter-building cabling to fully utilize already in-place individual conduits and to avoid the use of spare conduits. A fully utilized conduit is at its maximum when filled to 40% of capacity.

G. A minimum of two spare and empty four inch conduits must be provided for every new conduit bank.

H. All inter-building runs shall be well marked with a continuous marking strip buried in the same trench as the cable and/or conduit and placed 18" above the cable or conduit.

I. All bend radius will be at least 10 times the internal diameter of the conduit. Prefabricated fittings must be used. Pull boxes or joint boxes must not be used in place of bends.

J. Watertight joints between sections of conduits must be made using PVC solvent cement.

K. All conduits must be encased in concrete; PVC conduit separators must be placed at intervals of approximately three feet and fastened securely. The minimum depth of any conduit in the encasement to any exterior surface of concrete must be six inches.

L. Galvanized, rigid steel conduit must be used where conduit runs cross open ditches, attach to bridges or similar structures. All fittings must be suitable for connection to the PVC conduits. Proper grounding and bonding of these conduits is mandatory and must be specified in appropriate engineering installation plans.

M. All conduits crossing steam lines or running parallel within three feet of steam lines must be four inch fiberglass conduit for at least ten feet on either side of the steam line. All fittings must be suitable for connection to the PVC conduits.

N. Conduits shall be separated from other utilities for safety of personnel and for protection of equipment. There shall be 12 inches of earth between the telecommunications conduits and power or other foreign conduits. When crossing gas, oil, water or other pipes 6 inches of separation are required. Conduit runs parallel to pipes shall be separated by 12 inches of earth.

O. The conduit systems must be gradually sloped sufficient to permit penetrating water to drain towards the manholes. The highest point of each conduit must be at the center of each conduit run. The minimum depth of any conduit run to the ground surface is 24 inches unless otherwise specified and agreed to by the College or University.

P. All unused and spare conduits must be provided with removable conduit plugs for waterproofing and protection from earth and debris. All conduits, used and unused must be equipped with a minimum 200 pound strength pull cord.

Q. Four #4 reinforcing rods must be installed in all concrete encasements where entering buildings. Rods must extend six feet from the building. Tie to the building must be provided. The Vendor may install rigid galvanized steel conduit in place of the reinforced concrete. For either alternative the raceway should slope downward from the building and extend into undisturbed earth.

R. Service entrance conduits entering the building must extend to the BDF. These must be rigid conduits. If pull boxes are required, a #6 AWG ground wire must be pulled to the box from the common building/electrical ground.

3.3.3 Plan Manholes

A. Buildings identified to be a demarcation building for outside service providers (Comcast, AT&T, etc), the following apply:

   a. When a building is not on the property line, a minimum of four conduits from the BDP inside the building to the property line shall be provided. The conduits shall be terminated at a manhole, which shall be positioned as close as possible to the property line. However, the manhole shall be away from traffic conditions and be easily accessible for maintenance.

   b. Service providers (Telephone Company, cable company, etc.) will make the proper tie-in from the underground conduit to the building's conduits in the manhole. The location of the manhole must be coordinated with service provider engineers.

   c. For campuses with more than 1 building, a minimum of four additional conduits are required for the campus CWDS. The conduit shall be terminated in the designated manhole and routed to the BDP. If the same manhole is utilized for both the campus CWDS and the outside service providers, a minimum of eight conduits shall be installed.

B. All buildings shall have a minimum of four 4" conduits entering the building. Additional conduits may be required, determined by ConnCSU IT and/or campus IT, and will be included in the design. All Outside Plant (OSP) conduits shall terminate in the BDP and in designated manhole.

C. Fiber or copper splices must only occur in manholes or other protected and easily accessible locations.

D. All fiber optic cables shall be pulled through a corrugated innerduct in the conduits.

E. New manholes shall be reinforced concrete, cast in place or precast, and a minimum of 6 feet wide by 12 feet long and 6½ feet high. The concrete strength for manhole construction shall be 3600 P.S.I.

F. A PVC water barrier must be installed at each construction point.

G. The maximum distances between manholes must not exceed 600 feet for runs containing an aggregate of 45 degree bend, and must not exceed 400 feet for runs containing an aggregate of 90 degree bend. The Vendor must be responsible for the ability to pull cables in any conduit regardless of the distance limitations between manholes.

H. The manhole entrance, manhole roof, and manhole walls down to a level of at least 12 inches below the roof must be coated with one coat of cold asphalt tar and two coats of hot asphalt tar before backfilling around the manhole.

I. Manhole windows must be sealed watertight where conduits or laterals enter or leave.

J. A standard manhole collar and cover must be located in the exact center of the manhole roof, and flush with the finished grade of the ground, concrete, or asphalt surface.

K. Manholes must not be shared with power facilities. The covers must be physically designated as telecommunications manholes.

L. Joint boxes must be proposed only in cable routes having less than four conduits where no branches are required and must be approved by ConnSCU IT.

M. All splice connections in manholes must be in watertight enclosures and sealed according to industry standards. All splices must be re-enterable.

N. All copper cable sheaths must be bonded together at all splices with a #6 solid copper or equivalent.

O. Conduit entering service boxes and vaults shall be cut flush with the inside of the box. Voids around conduit, as well as the joints between box sections shall be mortared where appropriate. Terminators shall be used on all thermoplastic boxes. The boxes and vaults shall be free of mud, dirt, and debris.

P. All vaults and manholes furnished and installed shall be fully equipped with racking, pulling irons, steel ladders, grade rings, adjustable collars, vertical support brackets, frames and covers. Conduits shall be terminated in the lowest knockouts first. The frame and cover shall be adjusted to the final grade.

Q. Conduit terminations in service vaults and manholes shall not be brought into the neck, middle of any sidewall, or within 12" of the top or bottom. No conduits shall be terminated on the bottom of the vault. There should be a 2" separation between ducts as they terminate in the vault.

3.3.4 Construction

A. The Installer shall provide storage and work facilities for all equipment and personnel used on the project. The University can furnish raw acreage but cannot supply finished facilities for use by the installer.

B. All construction, excavation, and restoration plans for new conduit, ducts, and manholes shall be submitted to and approved by the appropriate ConnSCU Telecommunications Department, College/University and State of Connecticut departments prior to commencement of work.

C. The Installer shall protect, replace, or restore to original or better condition any architectural or landscape features of the campus disturbed or altered by any construction.

D. The Installer shall protect all above and below grade existing utilities. Any damages to existing utilities must be corrected by the Vendor on an immediate, emergency basis. Established cutover dates will not be modified as the direct result of damages, delays or other circumstances. All damages are the sole responsibility of the Installer and the repair thereof shall be at vendor expense.

E. The Installer shall immediately remove from the site any debris, including earth, resulting from construction.

F. The Installer shall do any pumping necessary to remove any water from construction areas.

G. The Installer shall repair all damage to building exterior and interior walls, ceilings, foundations, or floors

3.3.5 Terminating Conduit Inside a Building

H. Design conduits entering from below grade point to extend 4 inches above the finished floor.

I. Conduits shall be provided with a bushing at cable exit point.

J. If the conduits enter the building below the finished floor, this is best accomplished by creating a trench for the conduits to enter. The trench must be a minimum of three (3) feet deep and two (2) feet wide.

K. It is imperative that slope and grade be considered in the design and installation of entrance conduits, ensuring that conduits are sloping away from the building toward the hand hole, thus eliminating drainage problems.

L. All entrance conduits shall be securely fastened to the building so they can withstand the typical placing procedures by the service provider.

M. Rubber conduit plugs, a water plug, or duct sealer (depending upon the conditions) shall be used to seal inside-the-building end of a conduit to prevent rodents, water, or gases from entering the building.

N. A contractor to reseal conduits after cable is placed in them.

3.3.6 Outside Plant Cabling

A. Copper Backbone Cabling

1. The Copper Backbone cable shall meet or exceed the EIA/TIA Category 3 performance requirements.

2. A minimum of 200 pairs of copper cable are to be installed from the Campus Node Room to the BDP. ConnSCU will identify the Campus Node Room. Additional pairs may be required based on the needs of the College/University and will be identified during the design phase of the project.

3. OSP Copper Backbone Cable shall incorporate 24 AWG solid copper conductors insulated with a polyvinyl chloride skin over expanded polyethylene with a gel-based (ETPR) filling compound. Conductors shall be twisted to form pairs and fully color-coded. Copper backbone cables shall be terminated on wall mounted 188 type lightning protector blocks at BDP and on rack mounted Category 5 patch panels at TRs and MER.

B. Fiber Optic Backbone Cabling

1. OSP Fiber optic backbone cable shall be stranded loose tube cable consisting of a minimum 96 strands of Singlemode OM3 rated cable. The cable shall be OFNP rated. All fiber strands will be terminated with LC connectors. No fiber will be daisy chained for use on the ConnSCU network.

2. All OSP fiber shall be installed in PE constructed corrugated inner duct when placed in underground conduits. The underground 4" conduits will house a minimum of three 1-1/4" innerducts per conduit.

3.4 Main Equipment Room (MER)

PROHIBITED: Using MER room as a route for other facilities to pass through

PROHIBITED: Locating other non-IT resources in telecommunications rooms

PROHIBITED: lay-in ceilings installed in MER

A. The MER is the primary communications room for a building or facility. Other common terms or abbreviations used to describe this room are Building Equipment Room (BER), Main Distribution Frame (MDF), or simply Equipment Room (ER).

B. The MER is used to distribute communication services to all of the Floor Communication Rooms (TR) within the building and, as such, it can be viewed as the center of the star for wiring and cable distribution. The room contains

the necessary wiring cross connects, punch down blocks, fiber patching equipment, and other components to connect to each TR within the building.

C. Items included in a typical MER are the network racks, file servers, video surveillance cabinet and servers, CATV termination hardware, PA system cabinet, PA termination field, 110 blocks for voice, video communication cabinet, UPS's, conduit sleeve receiving services from outside campus for CATV, WAN fiber, and voice circuits.

3.4.1 Plan Area

A. Main Equipment Rooms should be sized to meet the requirements of the current and planned communications equipment. When the designer/engineer does not know the specific equipment that may be used in an equipment room, the EIA/TIA 569B standard recommends that there be a minimum of 0.35 square feet of space for every 100 square feet of workspace. (A minimum of 280 square feet is recommended.)

B. The actual size of the MER shall be determined during the design phase of the project when more information, pertinent to the size and application of the building, is available.

C. When designing equipment rooms, consider incorporating building information systems other than traditional voice and data communications systems (e.g., CATV distribution systems, alarm and security systems, and audio/paging systems). In some instances, the MER (equipment room) may also serve as the entrance facility for the building communications.

D. It is important to note that the MER must be a secure room and that disaster backup and continuity plans must be in place for this facility.

E. The design of a new equipment room should begin with an assessment that considers each of the factors listed below. The information gathered from this assessment must be considered by the engineers/designers at all stages of the project design, along with guidelines and requirements of applicable local, state, federal standards and this design document.

F. The following design factors shall be considered:

1. College/University requirements
2. ConnSCU System requirements
3. Telecommunications pathway locations
4. Service provider (Local Exchange Carrier [LEC]) requirements
5. Environment/Facility conditions and resources

3.4.2 Locating the Equipment Room

A. Every building shall have one Main Equipment Room, and the room should be centrally located in the basement or ground floor.

B. The location of the MER can have significant impact on all other aspects of communications system distribution design. In selecting a location, awareness of the spaces immediately adjacent to (i.e., beside, below, and above) the equipment room must be addressed. When designing equipment rooms, the following factors shall be considered:

1. Services to be terminated
2. Access and proximity to distribution cable pathways
3. Building facilities and access to the equipment room
4. Telecommunications provider requirements
5. Proximity to electrical service and electro magnetic interference (EMI) sources
6. Space required for equipment
7. Provisions for future expansion
8. HVAC issues

C. Do not locate equipment rooms in places that are subject to the following conditions:

1. Water infiltration
2. Steam infiltration
3. High humidity from nearby sources
4. Heat (e.g., direct sunlight)
5. Any other corrosive atmospheric or environmental conditions
6. Adjacency requiring access through other secure areas

D. Shared use of equipment room space with other building facilities must be avoided. Locations which are unsatisfactory for equipment rooms include space in or adjacent to:

1. Electrical closets
2. Boiler rooms
3. Washrooms
4. Janitor closets

5. Space that contain:

    a. Sources of excessive EMI (i.e. transformers, ballasts, motors, machinery or fan units)

    b. Hydraulic equipment or other heavy machinery that may cause excessive vibration

    c. Steam pipes

    d. Drains

    e. Cleanouts

E. Avoid locations that are below the water level unless preventive measures against water infiltration are employed. The room must be free of plumbing and electrical utilities that are not directly required to support the Equipment Room function. A floor drain is required if there is any risk of water entering the facility.

3.4.3 Space Allocation & Layout

A. The layout of major communications equipment in the MER must facilitate the effective routing of power and communications cabling. The Main Equipment Room must prove adequate space for:

1. Server rack(s)

2. Network equipment rack(s)

3. Cable rack(s)

4. Video surveillance equipment rack(s)

B. The designer shall make provisions for access to equipment for maintenance and administration as well as for future growth. NEC Section 11016 requires three (3) feet of clear working space around equipment with exposed live parts. This applies to communication equipment rooms.

C. MER shall have a ground bus and meet all requirements of NECA/BICSI 607-2011 Standard for Bonding and Grounding Planning for commercial Buildings. Refer to paragraph 7 of this standard for Bonding and Grounding Requirements.

D. A Fire suppression system for the MER is required if the MER houses production Servers, Video surveillance/security systems, Health Safety systems.

E. Fire suppression systems for the MER shall be designed per Section 5 of this specification. Pipes must be insulated to prevent water condensation from forming and possibly damaging telecommunications equipment. Fire suppression system pipes shall not be installed directly over equipment, but

rather they shall be placed near the walls with the manifold pipes in ceiling corners.

F. All penetrations into fire walls, conduits, and sleeves through floors and cable trays that pass through a fire-rated wall must be properly fire-stopped in accordance with the National Fire Protection Association (NFPA), ANSI/NFPA-70, the NEC, TIA-569 B, and Chapter 8 of BICSI TDMM (12th edition or subsequent releases). The manufacturer's recommended installation practices must be followed. Each installation of fire-stopping material must only be used in applications as specified by the fire-stop manufacturer. When installing additional cabling/wiring, the fire-stop system must be reevaluated, and if necessary, a new fire-stop system must be installed to restore the firewall integrity with the appropriate UL-classified system. Only use of UL-classified fire-stop systems is acceptable.

G. In addition to space for communications requirements, an equipment room also shall include space for necessary environmental control equipment, power distribution/conditioners, and UPS systems that may be installed.

3.4.4 Wall Requirements

A. A minimum of three interior walls in the room should be covered from 6" above finished floor 8 feet up, with ¾" plywood. Plywood should be fire-rated or treated with a minimum of two coats of fire retardant white paint on all sides. In order to field verify the type of plywood installed, at least one of the legible grade stamps on each sheet of plywood shall be masked or covered prior to painting.

B. The plywood shall reach from corner to corner. Install the plywood vertically and anchor securely to wall substrate with a minimum of five (5) equally spaced fasteners along each vertical edge and down the centerline of each sheet of plywood.

C. Fasteners shall be of the appropriate type for each substrate.

D. Provide blocking or additional studs in framed walls to receive plywood backup panel fasteners.

E. If the Building Demarcation Point (BDP) is located within the room, wall space with backboards must be provided for terminations and related equipment. Due to equipment mounted on the walls and workspace requirements, this need may have an effect on the three-foot workspace.

3.4.5 Ceiling Requirements

A minimum ceiling height of 10'-0" must be maintained. MER rooms shall not have a lay-in or drop ceiling. Ceilings open to the structure shall be painted white to match interior walls.

3.4.6 Floor Requirements

A. Flooring should be tile or other finished surface to keep dust at a minimum. Anti-static protection should be taken as required by equipment.

B. The floor rating under distributed loading must be greater than 12 Kpa (250 lb./ft.2).

C. The floor loading may be concentrated and therefore must be greater than 4.4 M (1000 lbs.) in areas where support for communications equipment, racks, and cabinets is required.

3.4.7 Door Requirements

A. The door shall be at least three feet (3') wide and swing open out of the room wherever possible. If door swing out is not possible, then the room must be enlarged to accommodate the swing.

B. The door should lock from outside access.

C. The door to the MER shall not be located at the center of the front wall. Place the door at the outermost end of the corridor side of the MER.

3.4.8 Mechanical System Requirements

A. The MER heating, ventilating, and air conditioning (HVAC) system shall be designed to maintain an air temperature in the room of between 64°F - 72°F, with a humidity level of 55 - 30%.

B. Design the system for the maximum amount of telecommunication equipment that the MER could support. Estimated heat generated of electrical and electronics equipment is approximately 30,000 BTU for most rooms though an estimate would best be made based on the actual systems design.

C. Cooling in the MER is critical to the operation of the network electronics and shall be maintained continuously 24x7x365.

D. The cooling system within the MER shall remain independent of the building automated systems and/or building automatic shutdown system, if any, and shall not be subjected to building power-saving shutdowns (evenings, weekends, and holidays).

E. The temperature display for the MER shall be mounted above lighting switches next to the entry door. Temperature will be controlled digitally through the building automation system.

F. Where water-based HVAC systems are utilized, water lines and coils shall not be located over planned communications equipment locations.

G. Condensate liners shall drain to building exterior, or sanitary drain line, without use of condensate pump. Evaporator unit shall include secondary safe pan with float switch designed to shut off unit in the event of overflow.

3.4.9 Electrical System Requirements

A All new construction and major renovations shall include both a UPS system and backup generator to support the Telecommunications rooms/closets.

1. Each MER shall be wired for a UPS system with transient voltage surge suppression (TVSS) protection device. The size of the UPS system will be determined on a project by project basis. A transfer switch will provide a feed to the UPS system and will receive its feed from two sources: the building's main power distribution panel; and a backup telecommunications generator. The UPS system will feed an electrical distribution panel in each telecommunications room/closet (MER/TR). The distribution panels will be sized on a project by project basis with a minimum size to accommodate four dedicated 30 amp 2 pole circuits with 100% expansion space.

   Each Active Equipment Cabinet/Rack (housing servers, network equipment, video surveillance, etc.) shall be equipped with a minimum of one 20 Amp, 120V circuit equipped with one quad outlet; one L5-20-R twist-lock; and two 208V-L6-30-R twist-lock. Electrical Engineer shall coordinate with Structural Cable System Designer, ConnSCU IT and Owner for quantity and location, and mounting height of receptacles for each specific telecommunication room layout.

2. Coverplates for surface mounted boxes in Telecommunication Room spaces shall be raised cover galvanized steel manufactured for the purpose.

3. Coverplates shall be identified with panelboard designation on top and circuit number below engraved or silk screened.

4. Environmental alarms must meet state, federal, codes and be interfaced to the College/University card access/alarm panels. Panel inputs include all UPS alarms; generator active alarms; fire, temperature, humidity, A/C unit transition switch; floor water detection; battery damper; and door breech.

3.4.10 Lighting

A. MER shall have adequate and uniform lighting with a minimum of 50-foot-candles (540 lux) at 3 feet (910 mm) above floor level. (Take into account the light loss due to the full cable tray and light that may be blocked by equipment cabinets when performing the lighting calculations.)

B. Coordinate positions of the light fixture with the equipment layout, particularly overhead cable trays and equipment cabinets, to ensure the light is not obstructed.

C. Use four-lamp fixtures with high-efficiency electronic ballasts and RFI filters. Light fixtures shall be properly secured to the ceiling.

D. Put two lamps on one switched circuit, and the other two lamps on another switched circuit.

E. Provide emergency lighting in the MER consistent with the emergency lighting system for the building.

3.4.11 Cable Management

A. Overhead cable management must be given careful consideration during planning stages of construction.

B. At a minimum, all communication spaces should have cable wireway installed at a height of ninety-six (96) inches off the floor, with minimum dimensions of (4"d x 12"w).

C. Locate the cable tray on the perimeter walls of the MER with the cable tray providing access to equipment racks.

D. All cable wireways shall be UL approved for use with communication cabling.

3.4.12 Grounding System

A. A grounding system must be designed. The system must provide a short, low-resistance path to ground from all conductive surfaces. Follow Grounding and Bonding outlined in Section 7 of this document.

3.4.13 Conduits and Sleeves

A. Riser and distribution cables leaving the room to building TRs should be via cable tray, four-inch (4") conduits or sleeved cores.

B. The exact number of conduits required or size of the cable wireway should be determined based upon the amount of fiber and copper cable that must be supported in each closet and each computer or communications room.

C. Additional conduits or sleeved cores must be included in the design to provide for future growth.

D. If the Building Demarcation Point (BDP) is not located within the MER, sufficient conduit must be run between these two locations. Additional cores/conduits must be provided for future growth.

E. All conduits/coring should be kept six inches (6") or less from walls whenever construction permits.

F. All penetrations must be sealed with a smoke and flame stops, which meet applicable code.

G. Pull cable must be installed in all conduits.

3.5 Floor Communications Room (TR)

PROHIBITED: Using TR room as a route for other facilities to pass through

PROHIBITED: Locating other non-IT resources in telecommunications rooms

PROHIBITED: Lay-in ceilings installed in TR

PROHIBITED: Using boiler rooms, air exchange rooms, janitorial closets, electrical distribution closets or areas with water heaters and wet sinks for TR

A. The TR is set aside on each floor of a building for the exclusive purpose of housing the communications equipment and related wiring that serves that specific area of the building. Other common terms or abbreviations to describe this space are Satellite Equipment Room (SER), Intermediate Distribution Frame (IDF), or simply wiring closet.

B. The equipment in the TR includes wiring cross connects and patch panels, punch down blocks, fiber patching equipment, etc. The TR also contains communications equipment such as routers and switches where applicable.

C. While the MER serves as the communications hub for the entire building, the TR serves as the center of the star for wiring and cable distribution for that floor (or portion of the floor). Wiring from the TR is distributed to each work space served by that TR; this wiring can be distributed via a number of methods depending upon building and electrical codes, fire safety codes, etc. The most common methods are cable tray systems, cable suspension (above a dropped ceiling), conduits and various under floor systems.

D. The cable distance between the TR and any workspace must be less than 295 feet of measured cable length.

E. Design and engineering standards for the MER as specified previously in this document detailing specifications on: Power/UPS, HVAC, Fire Alarm, Security, Cable Management, and Electrical Systems, apply to TR design as well.

F. There will be one or more TRs depending on the size and layout of a floor. The TRs should be located so that it is easy and straightforward to run cable to each location served by that TR without having to penetrate or pass around architectural barriers. It is common to have four TRs on each floor, each TR serving a quarter of the floor.

3.5.1 Plan Area

TRs vary in size depending on their function, concentration of telecommunication outlets and the size of the floor area they serve. The actual size of TR will depend on the building and therefore will require input from ConnSCU during the design phase of the project. However, the room must be rectangular in shape, and the minimum size of a TR should not be less than 9' x 10'.

3.5.2 Locating TRs

A. TRs should be located so that it is easy and straightforward to run cable to each location served by that TR without having to penetrate floors or pass around architectural barriers.

B. It is imperative that TRs be located so as to minimize cable lengths for both horizontal and vertical cable runs.

C. Vertical Distribution - When designing closets for vertical distribution, it is preferable to "stack" closets so that the telecommunication closet on level one is located directly below the telecommunications closet on level two, etc. Closets should be connected to one another via four (4) inch conduits. Conduits should penetrate the floor in the closet on the far left corner of the closet, and extend no less than six (6) inches above the floor.

D. Horizontal Distribution - Telecommunication closets must be located to maintain a distance no greater than 295 feet (cable length) from the furthest termination point (communication outlet) served by that closet. Ensure that conduits and cable trays feeding the telecommunication closet terminate completely inside the closet.

3.5.3 Structural Guidelines

A. A minimum of three (3) walls in telecommunications closets should be equipped with plywood, floor to ceiling. Plywood should be fire-rated or treated with a minimum of two coats of fire retardant paint on all sides.

B. The door should be minimally three feet (3') wide and should swing open out of the room. Doors should lock from outside access.

C. Floor loading must be at least 100 lb. per square foot.

3.5.4 Working Clearances

NEC Section 110-16 requires three (3) feet of clear working space around equipment with exposed live parts. This applies to communication telecommunication closets.

3.5.5 Conduit Accessibility

It is essential that clear, unobstructed access to cable tray and conduits be provided within the TR. When possible, entrance conduit and distribution conduit/cable tray should enter and exit on the same wall; if this is not possible, cable tray inside the room should be provided for distribution from wall to wall.

3.5.6 Lighting

TRs must have adequate and uniform lighting. An intensity of 50 foot candles (LM/ft2) at 3 feet above floor level is recommended. Coordinate the light fixture positions with the equipment layout, especially overhead cable trays, to ensure the light is not obstructed.

3.5.7 HVAC Requirements

A. Telecommunications equipment requires heating, ventilating and air conditioning equipment to function properly at all times. If the building’s HVAC system cannot ensure continuous operation (including weekends and holidays), stand-alone systems with independent controls will be required.

B. Typical room requirements are as follows:

1. Temperature range 64 degrees to 75 degrees F.
2. Humidity range 30 percent to 55 percent relative.
3. Heat dissipation 4000 to 5,000 BTUs per hour per rack (number of racks to be determined by the designer).

3.5.8 Electrical Requirements

A. When designing electrical system for TRs, an engineer shall assume that the Owner will install in the room a Power over Ethernet (PoE) data switch. Electrical system for each telecommunication room shall be sized to accommodate a minimum of 200 switch ports with the maximum output of 15.4 watts per port. The Electrical Engineer shall coordinate with the Structural Cable System Designer for the quantity of data cables required for all telecommunication rooms in project scope and verify all power requirements and components. Access shall be made to the main building ground bus bar.

B. The TR UPS distribution panel fed from the MER UPS system will be sized on a based on the requirements of the TR with a minimum size to accommodate a minimum of four dedicated 30 amp 2 pole circuits with 100% expansion space.

C. Each Active Equipment Cabinet/Rack (housing network equipment, video surveillance, etc.) shall be equipped with a minimum of one 20 Amp, 120V circuit equipped with one quad outlet; one L5-20-R twist-lock; and two 208V-L6-30-R twist-lock. Electrical Engineer shall coordinate with Structural Cable System Designer, ConnSCU IT and Owner for quantity and location, and mounting height of receptacles for each specific telecommunication room layout.

D. Coverplates for surface mounted boxes in Telecommunication Room spaces shall be raised cover galvanized steel manufactured for the purpose.

E. Coverplates shall be identified with panelboard designation on top and circuit number below engraved or silk screened.

4 Fire Protection Systems

A. The Telecommunications Rooms are critical elements of the communication and emergency system of the College/University. It is essential to protect both the facility and the equipment delivering communication services.

B. Fire protection for the telecommunications room(s) containing equipment in addition to network switches and routers (e.g. computer servers, security systems, network storage devices, etc.) shall be achieved by a combination of a pre-action sprinkler system and a clean agent fire suppression system. Notwithstanding the foregoing, rooms containing only network switches and routers need not comply with the above.

C. Where more than one telecommunication space is involved that requires a clean agent fire suppression system as identified above, each telecommunication space shall be protected by an individual system. Multiple areas remote from each other shall not be served by a single pre-action / clean agent system.

D. The fire protection systems shall comply with the requirements of the Connecticut State Building Code and Fire Code and the referenced editions of NFPA 13, NFPA 70, NFPA 72 and NFPA 2001.

E. The pre-action / clean agent system shall both be controlled by a single control panel with dual release capability. System release shall be activated by a combination of cross zoned ionization and photoelectric smoke detectors in alarm or by a high sensitivity smoke detection system as determined most appropriate by the consultant. System control shall also include manual release, system abort and service by-pass functions.

F. The pre-action / clean agent control panel(s) shall be interfaced with the building fire alarm system to relay system trouble and alarm conditions to the building fire alarm system.

G. Smoke detection shall be provided within all areas served by the protection systems including any plenum spaces within the telecommunications room protection envelope.

H. The consultant shall coordinate location of storage tanks, control panels and pipe routing with the telecommunication equipment layout in order to minimize interference with room equipment. Coordinate the location of fire protection system components with room ductwork and lighting. Route system pipes over foot traffic areas and avoid installing piping directly over telecommunication equipment.

I. The consultant shall specify that the installer shall provide a shop drawing submittal indicating, but not limited to, the following:

    a. The sequence of operation of the detection and release equipment

b. The internal control panel wiring diagram

c. Scaled installation drawings at not less than 1/8" scale showing: storage tanks, control panels, agent nozzles, sprinklers, piping, smoke detectors, manual pull stations, abort switches, and audible/visual alarms

d. Manufacturer's literature on all specified equipment

e. Hydraulic calculation data

J. Where existing telecommunication spaces are to be modified, any existing wet sprinkler piping shall be removed and replaced with a pre-action sprinkler system.

K. The clean agent system shall be a total flood system utilizing Novec1230, commonly known by the trade name Sapphire. The system shall be designed to provide the required agent discharge in 10 seconds or less and maintain the required design concentration within the protected space for a minimum of 10 minutes.

L. Sizing of the clean agent system piping system shall be performed by the installer utilizing clean agent manufacturer's UL listed software.

M. The design concentration of the clean agent within the protected space shall equal or exceed the manufacturer's current recommendation for a Class C electrical fire. The design concentration shall not exceed the NOAEL value stated in NFPA 2001.

N. The consultant shall coordinate electrical power shutdown of equipment within the protected space with the electrical engineer.

O. The consultant shall coordinate with the architect the required sealing of the room to properly maintain the required clean agent discharge concentration. Spaces protected by the clean agent system shall be properly sealed by the appropriate use of door sweeps, self-closing doors, painting of porous walls; and sealing of all holes, cracks, and penetrations. Where possible, walls for the protected space are to extend up to deck.

P. All ductwork within the space shall be properly sealed. Ducts with inlets or outlets to the protected space shall be provided with dampers to provide a 100% duct closure to the space prior to clean agent system discharge. Consultant shall coordinate with the HVAC engineer to ensure such function is provided.

Q. The design specifications shall require the installing contractor to provide a room fan test as described in NFPA 2001, Annex C to verify the proper sealing of the protected space.

5 Communication Distribution Systems (Pathways & Spaces)

Communications Pathways and Spaces are facilities used to distribute and support cable and connecting hardware between MER and between TR and the work area outlet. These spaces may include conduit, cable tray, "J"-hooks, sleeves, etc.

5.2.1 Backbone Communication Pathways

A. Backbone Communication Pathways may consist of conduits and floor penetrations (i.e., sleeves or slots), which provide routing space for communication cables.

B. Vertically aligned closets with connecting sleeves are the most common type of backbone pathway.

C. Designer shall position cable sleeves adjacent to a wall, which can support backbone cables. Sleeves must not obstruct wall-terminating space. All sleeves must be constructed in accordance with the National Electrical Code (NEC) and local fire codes and has a minimum of 2-inch high curb from the finished floor.

D. Design sleeves with a 4-inch diameter unless a smaller size is required by the structural engineer.

E. Designer shall follow guidelines of EIA/TIA 569A for determining the number of 4-inch sleeves required.

5.2.2 Horizontal Communication Pathways

A. Horizontal Distribution Systems (horizontal pathways and spaces) consist of structures that conceal, protect, and support horizontal cables between the communications workstation outlet and the horizontal cross connect in the serving telecommunications room.

B. Horizontal communications pathways are used to distribute and support horizontal cable and connecting hardware between the workstation outlet and the telecommunications room. These pathways and spaces are the "container" for the horizontal cabling.

C. **NOTE:** It is the responsibility of the Architect/Engineering Firm to review all proposed Horizontal Distribution Systems with ConnSCU to ensure the system design:

1. Makes optimum use of the ability of the horizontal cabling system to accommodate change
2. Is as unconstrained as possible by vendor dependence
3. Compliance with this document, Local, State, and Federal Codes
4. Compliance with ANSI/EIATIA569-B

5.2.3 Pathway Design

The Architect shall coordinate with the other design disciplines (i.e. mechanical, structural, etc to provide adequate telecommunications pathways designed for accessibility and growth. The Architect shall bear in mind that mechanical, structural and electrical facilities tend to be static systems while the telecommunications systems are dynamic in nature, subject to adds, move and changes over the life of the facility.

A. Horizontal Distribution Systems must be designed to accommodate diverse user applications including:

    1. Data Communications

    2. Cable TV

Note: The designer should also consider that other building information systems (e.g., building alarms and security, audio visual and audio PA system) may require area/space in the Horizontal Distribution System and should plan with these facilities accordingly.

B. Space and pathway design shall accommodate and facilitate continuing changes and allow for a minimum of 100% growth.

C. Telecommunication spaces and pathway shall not be located in enclosed stairways, elevator shafts or elevator equipment rooms.

D. An open ceiling distributions system is the preferred cable distribution system. An open ceiling distributions system shall not be installed above inaccessible ceiling areas such as lock-in type tiles, drywall or plaster. Suspended ceiling tiles shall be of the removable or lay-in type and located a maximum of 11’0” above the floor whenever possible.

E. Adequate and suitable space shall be available in the ceiling area for the distribution system. Mechanical systems (i.e. HVAC, sprinkler, etc.) shall be located as high as possible above the ceiling to provide space for the data/telecommunications spaces and pathways.

F. A minimum of 6” of clear space all around the cabling spaces and pathways shall be clear accessible space not required for the removal of tile, light fixtures or service and access to other systems.

G. An effective design of a building’s Horizontal Distribution System should meet the following criteria:

    1. Comply with all applicable local, state, and federal codes.

    2. Comply with all applicable BICSI, EIA/TIA, UL, NEC, FCC standards and codes.

    3. Provide flexible cable distribution to workstation locations.

    4. Facilitate ongoing maintenance.

5. Easily accommodate future changes in equipment and services.

6. Minimize occupant disruption when horizontal pathways and spaces are accessed.

H. The horizontal distribution system must be designed to handle all types of communications cabling (i.e., UTP, Coax, and Fiber Optic). When determining the type and size of the cable pathway, consider the quantity and size of the cables that the pathway is intended to house, and allow for growth of the area served over the planning cycle.

I. When designing the horizontal distribution system it is important to consider adds, moves, and changes, and minimal disruption to immediate occupants.

5.2.4 Electromagnetic Interference (EMI)

A. Because EMI causes severe problems with electronic equipment, and telecommunications and data communications, primary consideration must be given when designing a horizontal distribution system to avoid all potential sources of electromagnetic interference. To avoid electromagnetic interference, all distribution pathways should provide clearances of at least:

1. Four (4) ft. (1.2 m) from large motors and/or transformers

2. One (1) ft. (0.3 m) from conduit and cables used for electrical power distribution

3. Five (5) in. (12 cm) from fluorescent lighting

B. Note: Horizontal Distribution Pathways should cross perpendicular to fluorescent lighting and electrical power cables or conduits.

C. For additional clearance requirements, see ANSI/EIATIA569-B and ANSI/NFPA 70.

5.2.5 Grounding & Bonding

Horizontal Pathways must be grounded and bonded in accordance with the requirements specified in ANSI/NFPA 70 and Section 7 of this document, except where other codes or local authorities impose more stringent requirements.

5.2.6 Firestopping

All horizontal pathways that penetrate fire rated barriers must be stopped in accordance with applicable codes.

5.2.7 Cable Tray Systems

A. Properly installed and coordinated cable trays in the primary cable paths for Category 6 and Category 6A data cabling are critical for cable and network performance.

B. In the Design Development and Construction Document Phase, the Architect and the MEP engineers shall carefully design and coordinate the cable tray paths and clearances to avoid elevation changes and transitions of the continuous path. Careful consideration in the Design and Construction Document Phases must be given to the vertical real estate zones above ceiling so that HVAC ducts, piping, and equipment do not interfere with the cable tray paths.

C. In the Contract Documents, the Architect shall require a coordination submittal to insure that plan and section drawings are submitted and reviewed to insure a continuous uninterrupted cable tray installation fully coordinated with HVAC systems, ducts, sprinklers, piping, and electrical work. The Architect shall provide a copy of this reviewed submittal to the Owner representative along with a letter verifying that this submittal has been approved and coordinated and furnished to the Contractor for coordination during the Contract Administration Phase of the work.

D. Cable tray systems are used primarily as main corridor distribution apparatus. Cable tray system recommended for use in plenum areas above dropped ceilings in corridors of newly constructed and renovated buildings.

E. Cable wireway system is not required in all corridors. It is left to ConnSCU discretion to decide if application warrants the cost of the cable tray system.

F. Cable wireway systems should be designed as equipped to support only telecommunications and data communications cable.

G. Shared systems with power are not acceptable under the guidelines listed in avoiding EMI.

5.2.7.1 Suitable Cable Tray Systems

A. The tray shall be wire basket style.

B. A wire basket tray shall be U shaped and constructed of round wire mesh. The basket tray shall be hung via the trapeze style or wall-mounted.

C. Cable tray system must not be center hung.

5.2.7.2 Cable Tray Runs

A. Cable tray systems should be installed with a minimum of bends. If more than three 15 degree turns are installed in a contiguous length, then de-rate the effective capacity of the cable tray by twenty five (25) percent.

B. Delineations in a level cable tray installation are often unavoidable; however, these delineations should be kept at a minimum, with each delineation not exceeding 30 degrees and 24 inches offset. The total delineation for the tray span should not exceed 180 degrees.

C. The cable tray system shall support unbalanced load without tilting.

D. Use end-of-tray cable waterfalls where wire drops down to prevent abrasions and cuts from metal tray edges.

5.2.7.3 Cable Tray Size and Capacity

A. Cable tray size and capacity shall be determined by the amount and type of cable, the static load capacity of the tray, and the length of the support span.

B. Cable tray systems should be designed to accommodate 100 percent future growth.

5.2.7.4 Cable Tray Installation Clearance

A. Cable trays containing telecommunication cables shall not contain any pipes, tube or equal for steam, water, air, gas, drainage or any service other than telecommunication.

B. It is recommended that the cable tray system be installed with as much clearance as possible from other building facilities, and installed in the lowest most location below all other building facilities but above the ceiling grid, in accordance with EIA/TIA standards and meeting the following criteria:

1. 6 in. clearance from obstructions on both sides
2. 6 in. clearance from obstructions to the top

C. Installation of cable tray pulley systems installed in a solid ceiling environment should provide access points at 20 ft. centers and at any directional deviation greater than 15 degrees and/or 90 degree turns.

5.2.7.5 Cable Tray Entering Telecommunications Closets

It is recommended that Cable trays **NOT** be used as a method of passing through walls into the Telecommunications Closets. The recommended method is to stop the cable trays at the wall and provide the appropriate number of 4" sleeves through the wall, continuing the pathway in the Telecommunications Closet with Ladder Racks to the terminating rack or wall. However, if a Cable tray is to be used to enter a telecommunications closet through a wall, the cable tray should be terminated as close as possible to the terminating rack or wall.

5.2.8 Cable Wrap System

A. In the areas along the corridors, where the cable tray cannot be used, and cables are required to be run "free-air", flexible cable wrap systems shall be used.

B. Cable support loops shall be attached to 3/8" threaded rod. The rods shall be secured to the building structure and be spaced a minimum of 4' apart. The cable support loops shall be flexible and shall hold up to 100 four-pair UTP cables.

C. The cable support loops shall feature a simple locking and unlocking to allow the additions of cables pull easily through.

D. Cable support system shall be suitable for air handling spaces (Plenum).

E. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568B & 569A, NFPA 70 (National Electrical Code), and applicable local codes.

F. Cable support system shall be Caddy CAT425.

5.2.9 Cable Hook Systems

A. In the areas where the cables are to be branched out from the main corridors to the workstations or classrooms, cable hook systems shall be used.

B. Cable hooks shall be capable of supporting a minimum of 30 lbs. with a safety factor of 3.

C. No more than 24 cables allowed per "J"-hook.

D. Installation and configuration shall conform to the requirements of the ANSI/ EIA/TIA Standards 568B & 569 B, NFPA 70 (National Electrical Code), and applicable local codes.

E. Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653 G90. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3.

F. Cable hooks for corrosive areas shall be stainless steel, AISI type 304.

G. Cable hooks shall be B-Line series BCH21, BCH32, BCH64, or other manufacture that meets these specifications.

5.2.10 Conduit Distribution

A. Horizontal conduit system consists of conduits radiating from the accessible ceiling in rooms or corridors to the workstation outlets in the floor, walls, and columns of a building.

B. Telecommunication outlets shall be with a minimum 1-inch ID continuous Electrical Metal Tubing (EMT) conduit provided to the accessible ceiling.

C. Conduits shall be provided with a bushing at cable exit point.

D. Conduits shall be placed in the straightest run possible with no more than the equivalent of two 90° bends per run. Refer to BICSI TDMM, 12 edition, Chapter 5 or subsequent releases for information on conduit sizing and routing.

E. All conduits shall be equipped with a contiguous length of plastic or nylon pull string with a minimum rating of 200 lbs. (90 Kg) or a 12 AWG wire.

5.2.10.1 Conduit Runs

A. Conduit runs should be designed in the most direct route, parallel to building lines, with no more than two (2), 90 degree bends between pull points or pull

boxes, and contain no continuous sections longer than one hundred feet (100') without pull points or pull boxes installed.

B. It is recommended that conduit runs be kept to no more than 150 ft. in total length including sections through pull boxes.

5.2.10.2 Conduit Bend Radii

A. The radius of a conduit bend must be at least 6 to 10 times the diameter of the conduit (See section 2.4 of this document).

B. Conduits designated for Futureflex tubing must be installed with a minimum bend radius of 12 times the diameter of the conduit.

5.2.10.3 Conduit Entering Telecommunications Closets

A. Horizontal distribution conduits entering a telecommunications closet should terminate near the corners and allow for proper cable racking. If conduits are entering through the floor, they must terminate four (4) inches above the finished floor.

B. If conduits are entering through a wall, the conduits must be reamed and bushed, and terminated as close as possible to the terminating rack or wall.

5.2.11 Outlet Boxes

A. Exposed, surface mounted outlet boxes or outlet boxes installed in normally wet locations shall be of the cast metal type with threaded hubs.

B. Recessed outlet boxes for dry locations shall be of the pressed sheet steel, zinc coated type.

C. Telecommunications outlet boxes installed in drywall, plaster, or concrete block wall must be 4-inch by 4-inch by 2-1/2 inch boxes.

D. Telecommunications outlet boxes should be mounted at least 18"AFF (Above Finished Floor) or even with adjacent electrical duplex services.

E. Telecommunications outlet boxes shall be located at least 150 mm (6 in) from any electrical service.

F. Outlet boxes for general use, flush mounted in concrete work and walls in normally dry locations, shall be manufactured by Steel City, Appleton, Raco or approved equal.

G. All conduits are to be reamed and bushed.

H. Where telecommunications outlet boxes are designated for the video monitors, the boxes should be mounted at 84 inches AFF.

I. Outlet boxes should not be placed back to back.

5.2.11.1 Mounting Outlet Boxes, Above Counters

A. Outlet boxes installed above a counter will meet the following criteria:

1. Counter with backsplash at least 6 inches above the top of the counter to the center of the outlet.

2. Counter without a backsplash at least 12 inches above the top of the counter to the center of the outlet.

5.2.11.2 Outlet Boxes for Wall Telephones

A. Telecommunications outlet boxes for wall phones shall be 4-inch by 2-inch by 2-1/2 inch boxes.

B. Telecommunications outlet boxes designated for wall telephones should be mounted per ADA.

6 Inside Building Cabling

PROHIBITED: Daisy chaining of conduit

PROHIBITED: Splitting copper pairs between jacks. TIA/EIA-568-B-1 states: "Each 4-pair cable shall be terminated in an eight-position modular jack at the work area outlet."

PROHIBITED: Sharing the outlet and conduit pathway

PROHIBITED: Using traditional nylon synch style tie wraps to bundle cables. Only Velcro style tie wraps are acceptable.

A. Telecommunications outlets shall be wired with unshielded, twisted pair 23 AWG wire (UTP) with suitable insulation and sheath material to meet or exceed EIA/TIA 568C.0 or equivalent. The wire shall be type communications riser cable (CMR) or communications plenum cable (CMR) (UL) with rating dependent or NEC Section 800-15.

B. Structure cabling distribution system shall be designed and installed in a “star” topology configuration with the MER being the central “hub.”

C. The sum total cable length between each Workstation Outlet (WA) to Telecommunication Room (TR) shall not exceed 295 ft.

D. NO SPLICES or TAPS are allowed. Each run from outlet to panel must be a single continuous cable.

E. Each WA shall be supplied by no less than two (2) separate communication cables.

F. Cables shall, at a minimum, adhere to the Category 6 specifications (higher categories when approved).

G. UTP cables shall be terminated on an eight conductor eight position (commonly referred to as “RJ45”) jack. The wiring scheme shall be the same as the scheme used throughout the campus (T568A or T568B wiring scheme). When an entire campus is being wired, the T568B wiring scheme shall be used.

6.2 ConnSCU Infrastructure Cabling Requirements

A. The primary objective for the proposed backbone cable infrastructure system is to implement a telecommunications distribution design that allows the cable plant to be flexible, manageable, and expandable. The system should provide the ability to adapt to changing user and technology environments without re-cabling the building to meet demands for increased bandwidth or services and to facilitate ongoing moves, adds or changes. Designed to support true

ubiquitous connectivity to an intelligent transport network capable of spanning both the nation and the globe, the distribution design will recognize that building communications systems and media are dynamic and shall be able to support a variety of applications and services. The distribution design should be able to accommodate voice, video, data, public address systems, CATV, security and environmental control.

B. The building backbone infrastructure systems will consist of cable pathways, telecommunications closets, equipment rooms, telecommunications entrance facilities, transmission media, and support facilities that meet the requirements of the Connecticut State Colleges and Universities. The proposed backbone system for data networking is a high bandwidth, low attenuation, fiber optic design that provides a universal transport system for voice, data, video and facilities systems. Coaxial cable for CATV and broadband applications will also be provided where applicable. The proposed telecommunications building backbone infrastructure shall meet code and comply with industry and Connecticut State University System standards.

C. All products and installation procedures used as part of the horizontal and backbone cabling systems must be free from defects and support any current or future application ratified by IEEE, ANSI and ISO that is developed for an ANSI/TIA/EIA-568C.0 compliant structured cabling system for a period of 25 years as spelled out in Hubbell's "Mission Critical 25" Warranty.

D. The standards set forth in this document are basic standards for system wiring and components. These are minimal requirements only; a detailed system specification and design is required for each installation.

E. These standards and specifications shall be updated periodically to reflect the most current EIA/TIA and BICSI standards. All wiring systems that are being upgraded shall meet these guidelines. To achieve a successful long-term cabling solution, ConnSCU established the following performance goals based on emerging technology:

1. Cabling system shall operate the application(s), which the system was designed to support. Applications may include, but are not limited to: 10/100/1000 Mbps Ethernet (IEEE 802.3), and other network services and applications.

2. Provide a cable system with adequate bandwidth to deliver the network existing and future applications.

3. Provide a strong network foundation and physical connectivity for each campus to build upon to support the instructional and administrative data needs.

4. Provide a cable system than supports the majority of workstations upon implementation, and that can be easily expanded in the areas to meet the individual campus instructional needs.

5. Provide a cable system that has high integrity, performance, and usability based on the current Commercial Building Telecommunications Cabling Standard, BICSI, and future EIA/TIA & IEEE standards technology.

F. Cabling System must meet the EIA/TIA-568C.0 standards for Category 6 or better wiring as stated above. Any deviations from standards from this document will require the prior approval of ConnSCU.

6.3 Backbone Cabling

The function of the backbone wiring is to provide the interconnection between each telecommunications room (TR), building demarcation point (BDP), and Main Equipment Room (MER) in the telecommunications system-wiring structure.

6.3.1 Voice Backbone Cabling

B. The Voice Backbone cable shall meet or exceed the EIA/TIA Category 3 performance requirements.

C. Voice Backbone Cable shall incorporate 24 AWG solid copper conductors insulated with a polyvinyl chloride skin over expanded polyethylene. Conductors shall be twisted to form pairs and fully color-coded.

D. Voice backbone cables shall be terminated on wall mounted 110 type blocks at BDP, MER & TRs.

E. A minimum of one 24-port CAT 6 patch panel shall be installed in each MER and TR for special circuits and/or analog phones. The ConnSCU Telecommunications department will designate the equipment rack that will house this patch panel. CAT 6 cable will be installed from the patch panel to a wall mounted 110 type block on an adjacent wall (location to be designated by ConnSCU).

6.3.2 **Fiber Optic Backbone** Cabling

A. Fiber optic backbone cable shall be tight buffer cable consisting of a minimum 24 strand of OM3 rated 50/125 micron multimode fibers and 24 strands of Single Mode OM3 rated cable. The cables shall be OFNP rated.

B. The indoor fiber optic backbone cable shall have inter-locking armor made of aluminum.

C. All fiber strands will be terminated with LC connectors.

D. No fiber will be daisy chained for use on the ConnSCU network.

6.4 Horizontal Copper Cables

A. All horizontal data cables shall be Category 6. Cables shall terminate on modular Patch Panels in the Telecommunications Rooms.

B. The maximum permitted horizontal distance is 295 feet with 33 feet allowed as the total cumulative length for patch cables, jumpers cords, etc. (total maximum length not to exceed 328 feet).

C. Category 6 cables shall be suitable for installation free-air, in building risers, in conduit and/or in cable tray and carry CMP or CMR rating dependent or NEC Section 800-15.

D. Transmission characteristics of the cable shall meet or exceed the following specifications

HORIZONTAL																	
FREQ	SRL (dB)			RL (dB)			INSERTION LOSS (Attenuation) (dB)			PS-NEXT (dB)			NEXT (dB)			ACR (dB)	
MHz	min.	typical	patch	min.	typical	patch	max.	typical	patch	min.	typical	patch	min.	typical	patch	min.	typical
1	26.0	44.1	(26.0)	20.0	32.0	(20.0)	1.7	1.5	(2.4)	78.3	98.4	(78.3)	80.3	100.4	(80.3)	78.6	93.9
4	26.0	47.4	(26.0)	23.6	32.0	(23.6)	3.5	3.1	(4.6)	69.3	88.8	(69.3)	71.3	90.8	(71.3)	67.8	82.4
10	26.0	45.9	(26.0)	26.0	36.2	(26.0)	5.5	4.9	(7.1)	63.3	80.2	(63.3)	65.3	82.2	(65.3)	59.8	72.2
16	26.0	43.4	(26.0)	26.0	39.7	(26.0)	7.0	6.3	(9.0)	60.3	77.5	(60.3)	62.3	79.5	(62.3)	55.3	68.5
20	26.0	42.7	(26.0)	26.0	39.9	(26.0)	7.8	7.1	(10.1)	58.8	75.7	(58.8)	60.8	77.7	(60.8)	53.0	65.9
31.25	25.0	41.4	(25.0)	25.0	41.0	(25.0)	9.8	9.0	(12.7)	55.9	72.8	(55.9)	57.9	74.8	(57.9)	48.1	61.6
62.5	23.5	39.5	(23.5)	23.5	37.7	(23.5)	14.1	13.0	(18.4)	51.4	68.3	(51.4)	53.4	70.3	(53.4)	39.2	51.5
100	22.5	39.9	(22.5)	22.5	37.4	(22.5)	18.0	16.8	(23.6)	48.3	64.5	(48.3)	50.3	66.5	(50.3)	32.3	45.1
155	21.6	38.9	(21.6)	21.6	37.3	(21.6)	23.2	21.4	(30.0)	45.4	62.0	(45.4)	47.4	64.0	(47.5)	24.2	38.1
200	21.0	38.0	(21.0)	21.0	36.0	(21.0)	29.1	24.7	(34.6)	43.8	59.5	(43.8)	45.8	61.5	(45.8)	16.7	32.0
250	20.5	37.4	(20.5)	20.5	35.2	(20.5)	30.9	27.9	(39.1)	42.3	58.1	(42.3)	44.3	60.1	(44.3)	13.4	27.6
350	19.8	34.1	(19.8)	19.8	32.0	(19.8)	38.1	34.0	(47.4)	40.2	54.8	(40.2)	42.2	56.8	(42.2)	4.1	19.2
500	19.0	33.2	(19.0)	19.0	31.3	(19.0)	47.7	42.0	(58.3)	37.8	53.5	(37.8)	39.8	55.5	(39.8)	—	9.0

E. The jacket color for data cables shall be coordinated with the Owner.

6.4.1 Category 6 Jacks

A. Horizontal cables shall each be terminated at their designated workstation location on modular Category 6 jacks. The jacks shall snap into a modular faceplate.

B. Each jack shall be labeled with TR #, panel # and jack ID numbers.

C. Jacks colors shall be coordinated with the Owner.

D. Additional modules for copper shall include the following:

1. F-Type coax coupler module, male-male threaded
2. RCA path through modules with red (CMRPR), yellow (CMRPY), and white (CMRPW) inserts
3. Female to female coupler to use in SVGA applications
4. S-Video patch through modules

E. IMPORTANT: Cable and Termination Components (Jack, Patch Panel, and Wiring Blocks) shall be designed and installed to function as a System. The compatibility of the cable to be installed with the proposed termination

components shall be recognized and documented by the Termination Component Manufacturer.

6.4.2 Category 6 Patch Panels

A. Data horizontal cables shall be terminated at the Telecommunication Rooms on high-density angled modular patch panels.

B. Data Patch Panels shall be designed and installed in a fashion as to allow future station cabling to be terminated on the panel without disruption to existing connections.

C. Data Patch panels shall be sized to accommodate a minimum of 20% growth in the quantity of stations relative to the initial installation.

D. The patch panels shall contain labels on a front for easy port edification.

6.4.3 Faceplates

A. Faceplates shall be plastic and incorporate recessed designation strips at the top and bottom of the frame for identifying labels. Designation strips shall be fitted with clear plastic covers.

B. Any unused jack positions shall be fitted with a removable blank inserted into the opening.

C. Single gang faceplate shall be installed, where a standard single gang mod ring mount over dual gang outlet box.

D. Dual gang faceplates shall be installed where a dual gang outlet box used for the telecommunications outlet.

E. Wall-mounted "Wall Phone" outlets shall be installed where identified on the Floor plan Drawings to accommodate wall-mounted telephone sets. The Wall Plate shall be a single gang faceplate to accommodate two (2) data jacks, mounted on a standard single gang outlet box or bracket.

6.5 Cable Management System

A. The Cable Management System shall be used to provide a neat and efficient means for routing and protecting fiber and copper cables and patch cords on telecommunication racks and enclosures.

B. The system shall be a complete cable management system comprised of floor mount racks, vertical and horizontal cable managers to manage cables on both the front and rear of the rack.

C. The system shall protect network investment by maintaining system performance, controlling cable bend radius and providing cable strain relief.

6.5.1 Equipment Rack

A. At the Telecommunication Rooms, passive equipment racks shall house Cable Termination components (e.g. Copper Data and Fiber Optic) and active equipment racks shall house Network Electronics (by others).

B. All Racks shall be [84"] in height and shall be self-supporting.

C. All Racks shall be standard [19”] wide.

D. Channel uprights shall be spaced to accommodate Industry standard 19” mounting.

E. 4 post active equipment racks may be required to accommodate active equipment. The design engineer must consult with ConnSCU Telecommunication and Campus IT.

F. A passive equipment rack shall not have more than six 48-port patch panels (288 copper cable terminations) for terminating cables. If more than 200 cables are designed for a TR, a second passive equipment rack shall be installed. (If more then 400, then a third must be installed, and so on)

G. For each passive equipment rack installed, a minimum of one active equipment rack shall be installed. Additional active equipment racks may be required, consult with ConnSCU Telecommunications and Campus IT.

6.5.2 Vertical Cable Management

A. At the Telecommunication Rooms, vertical cable management shall be furnished and installed on both sides of racks to organize cables on front and rear of telecommunication racks.

B. Vertical cable management shall be 6” wide as a minimum.

C. Vertical cable managers shall include components that aid in routing, managing and organizing cable to and from equipment. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief.

D. Open cabling section on the rear shall provide easy access and routes cable bundles feeding into the back of patch panels and 1 RMU cable guides on the front shall enable fanning and managing patch cords.

E. Door/Cover (front only) shall be able to open from the right or left and still be easily removed to allow for quick moves, adds, and changes.

6.5.3 Horizontal Cable Management

A. Horizontal cable managers shall include components that aid in routing, managing, and organizing cable to and from equipment.

B. Panels shall protect network equipment by controlling cable bend radius and providing cable strain relief.

C. The duct fingers shall include retaining tabs to retain the cables in place during cover removal.

D. The covers shall be able to hinge from either side yet still be easily removed to allow for quick moves, adds, and changes.

NOTE: Where Cable Termination Hardware is wall mounted, the cable pathway shall be established for jumpers routed from the Equipment Rack(s) to the wall. This shall be in the form of slotted ducts, troughs or other means.

6.6 Fiber Optic Patch Panels

A. Separate patch panels shall be installed for each type (single mode and multimode) of fiber optic cable and shall be labeled accordingly.

B. All terminated fibers shall be mated to duplex LC couplings mounted on enclosed patch panels. Couplers shall be mounted on a panel that, in turn, snaps into the enclosure.

C. The patch panel enclosure shall be sized to accommodate the total fiber count to be installed at each location plus 20% for expansion.

D. Patch panels shall be designed for easy installation, front removal and expansion of snap-in adapter panels.

E. Patch panels shall be enclosed assemblies affording protection to the cable subassemblies and to the terminated ends. The enclosures shall incorporate a hinged or retractable front cover designed to protect the connector couplings and fiber optic jumpers.

F. The patch panel's enclosure shall provide for strain relief of incoming cables and shall incorporate radius control mechanisms to limit bending of the fiber to the manufacturer's recommended minimums or 1.2", whichever is larger.

G. Access to the inside of the patch panel enclosure during installation shall be from the front and rear. Panels that require any disassembly of the cabinet to gain entry shall not be accepted.

H. All patch panels shall provide protection to both the "facilities" and "user" side of the coupling. The patch panel enclosure shall be configured to require front access only when patching. The incoming cables (e.g., backbone, riser) shall not be accessible from the patching area of the panel. The enclosure shall provide a physical barrier to access of such cables.

I. Fibers shall be terminated either by (1) splicing of factory-terminated cable assemblies ("pigtails") or (2) the use of a "fan-out" kit. In the latter approach, individual fibers are to be secured in a protective covering – such as an Aramid reinforced tube for example - with connectors mated to the resulting assembly. In both instances, the termination hardware shall incorporate a mechanism by which

cable and sub-assemblies are secured to prevent damage. Splicing shall be by the "fusion" method. Individual splice loss shall not exceed 0.2 dB.

6.7 Fiber Optic Connector

A. Fiber optic connector shall be small factor connector "LC" style.

A. The connector shall meet or exceed a Fiber Optic Connector Intermateability Standard (FOCIS) document (TIA/EIA-604-10).

B. The LC connector must meet the mechanical and environmental performance requirements set forth in Annex A of TIA 568-B.3. The basic minimum requirements for an optical connector are maximum loss of 0.75 dB for multimode or singlemode fibers and a minimum return loss of 20 dB for multimode and 26 dB for singlemode fiber.

C. Connectors shall sustain a minimum of 200 mating cycles per EIA/TIA-455-21 without violating specifications.

7 Grounding and Bonding

7.2 *Overview*

A. ANSI/TIA/EIA-607 Commercial Building Bonding and Grounding Requirements for Telecommunications define bonding as the physical joining of conductive materials bringing them to the same electrical potential. Grounding is the physical connection of conductive materials to ground or an electrical potential of zero. If both the transmitting and receiving stations are not referencing the same zero potential, data errors will occur. In order for network communications systems to perform properly, all components of the system must be bonded and grounded per ANSI/TIA/EIA specifications. In addition, grounding is essential for the protection of life and property. Properly bonded and grounded systems will conduct electrical energy (static, lightning, short circuit, etc.) away from sensitive equipment as well as living creatures and either trip protective devices or dissipate this energy safely to ground. The goal of a proper grounding and bonding system is to have no more than 5 ohms impedance between any two-grounded points in the building. A good rule of thumb is, if it's metal, ground it.

B. The grounding system must be intentional, visually verifiable, and adequately sized to handle expected currents safely. The grounding system shall be designed and installed in accordance with the NECA/BICSI 607-2011 Standard for Bonding and Grounding Planning for commercial buildings.

7.3 TMGB – Telecommunications Main Grounding Busbar

A. All telecommunications grounding and bonding systems begin at the Telecommunications Main Grounding Busbar or TMGB, which is usually located in the building electrical entrance facility or MER.

B. The length of this bar is determined by the amount of connections that will be made to it, but the minimum thickness is ¼ inch. The TMGB shall be 4 inches high, a minimum of 20 inches long, and of variable length to accommodate the expected number of lugs and allow for future growth.

C. TMGBs shall be electotin plated for reduced contact resistance.

D. The TMGB shall be mounted using minimum 2-inch insulated standoffs.

E. The TMGB is connected to the building's main electrical panel ground by a licensed/certified electrical contractor.

F. When connecting the TMGB to a buried ground rod or field, only exothermic connections shall be used.

G. TMGBs shall be assigned a unique identification and permanently labeled.

7.4 TGB – Telecommunications Grounding Busbar

A. Telecommunications Grounding Busbars or TGBs are located in Telecommunications Closets (TR) to provide grounding for racks, enclosures, and equipment in these spaces.

B. The length of this bar is determined by the amount of connections that will be made to it, but the minimum thickness is ¼ inch and the minimum width is two inches.

C. TGBs shall be electotin plated for reduced contact resistance.

D. The TGB shall be mounted using minimum 2-inch insulated standoffs.

E. When there is an electrical panel present in these rooms, it shall be bonded to the TGB by a licensed/certified electrical contractor.

F. All metal racks, enclosures, equipment and cable pathways entering these spaces shall be bonded to the TGB using minimum #6 AWG wire and crimp or weld-on lugs.

G. All exposed/accessible building steel within these spaces shall be bonded to the TGB using minimum #6 AWG wire and crimp or weld-on lugs.

H. TGBs shall be assigned a unique identification and permanently labeled.

7.5 TBB – Telecommunications Bonding Backbone

A. The Telecommunications Bonding Backbone or TBB is used to connect all TGBs throughout a building to the TMGB.

The busbars on each floor shall be bonded to the Telecommunications Bonding Backbone (TBB). The TBB shall be routed in as straight a line as possible and be continuous, with no splices, from the TMGB to the top floor TGB. It shall be sized in accordance with J-STD-607-A (See Table 1). The bend radius on any necessary bends in this cable should be greater than 8 inches.

Table 1: Sizing of the TBB

TBB Length in Linear meters (feet)	**TBB Size (AWG)**
Less than 4 (13)	6
4-6 (14-20)	4
6-8 (21-26)	3
8-10 (27-33)	2
10-13 (34-41)	1
13-16 (42-52)	1/0
16-20 (53-66)	2/0
Greater than 20 (66)	3/0

B. The TMGB shall be bonded to an approved grounding electrode and to the building's main electrical ground system. This grounding electrode conductor shall be no smaller than the TBB. Connections to the TGBs at every floor except the top floor shall be made via copper compression H-Tap (see section 6.9) and a conductor no smaller than the TBB. In the event that more than one TBB exists in a building, the TGBs shall be connected at the top floor and at a minimum of every third floor below by a Grounding Equalizer (GE), which is equal in size to the TBB

C. The TBB shall be an insulated copper conductor sized to allow no more than 25 ohms resistance between any two points in the grounding system. The minimum conductor size is #6 AWG.

D. When two or more TBBs are run vertically in a multi-story building, they shall be bonded together using a TBB Intermediate Bonding Conductor or TBBIBC. TBBIBCs shall be installed at the top floor and a minimum of every third floor in between.

E. TBB/TBBIBCs shall be installed and protected from physical and mechanical damage.

F. Any metallic conduit used to protect grounding or bonding conductors shall be bonded to that conductor.

G. TBBs shall be assigned a unique identification and permanently labeled

7.6 Rack Grounding

A. Electrical continuity throughout each rack or cabinet is required to minimize safety risks. The racks shall be assembled using paint-piercing grounding washers (Panduit Part no. RGW, or ConnSCU-approved substitute) and antioxidant (per the recommendations of the manufacturer). An electrostatic discharge port kit (Panduit RGESD, or ConnSCU-approved substitute) shall be placed on the rack (on the right side when facing the rack) at 40 inches above the floor. All bonding connections to the rack shall be made with thread-forming screws (Panduit Part no. RGTS, or ConnSCU-approved substitute), or the threads must be cleaned of all paint or residue (per the NEC).

B. In locations with multiple racks, the rack shall be connected to the common bonding network with a #6 AWG conductor and a copper compression HTAP. In locations with single racks, a #6 AWG conductor to the busbar is sufficient. The common bonding network is a 2 AWG continuous conductor placed below or above the racks. Refer to NECA/BICSI 607-2011 for design recommendations.

7.7 Pathway Grounding

A. Any metallic component, including equipment, ladder racks, enclosures, cable trays, etc. must be bonded to the grounding system. Provisions must be made to bond individual segments of ladder rack and basket tray together in order to make them electrically continuous. Any metallic conduit that carries a grounding conductor and is greater than 3 feet long must have both ends bonded to the conductor with a bonding jumper no longer than 12 inches and fastened with a compression HTAP to the conductor on one side and to the conduit on the other.

7.8 Equipment Grounding

A. Although AC-powered equipment typically has a power cord that contains a ground wire, the integrity of this path cannot be easily verified. Thus, many equipment manufacturers require grounding above and beyond that which is specified by local electrical codes, such as the NEC. Always follow the grounding recommendations of the manufacturer when installing equipment.

7.9 Electrical Service

A. When an electrical panelboard is located in a telecommunications room, a 6 AWG bonding conductor shall be run from the busbar to the electrical service ground. When an electrical panelboard is not located in the room, a 6 AWG bonding conductor should be run from the busbar to the nearest electrical panelboard (where feasible).

7.10 Compression Fittings

A. Lugs and HTAPs must be manufactured of tin plated copper and fastened via irreversible compression (crimped). Lugs shall have spacing to fit Panduit GB series predrilled busbars and a window to allow for inspection of the crimp. HTAPs shall be contained in clear covers that allow inspection of the die marks to ensure that the proper die was used.

B. Approved lugs:

1. Panduit LCC or LCCX series
2. Burndy YAZ series
3. CPI
4. Electric Motion Company CCL Series

C. Approved HTAPS:

1. Panduit HTWC series
2. Burndy YH series (when used with clear covers) or a ConnSCU-approved substitute.

7.11 Testing and Documentation

A. The grounding system shall be documented by means of a diagram showing the locations of the busbars and the size of the conductors, indicating all connections between conductors from the busbars or TBB back to the building electrical grounding system. This includes: connections to building AC panelboards, building steel, the building electrical service ground, connections between the busbar(s) and the TBB. If not connected with a two-hole lug, the connection type of any bonding connection(HTAP, clamp, etc) between the busbar and the building ground point should be specified on the drawing.

B. To ensure that bonding connections from the busbar to infrastructure within the telecommunications spaces are of low resistance and that the impedance to ground is as low as possible, the following checks shall be performed.

    1. Lugs: Visually check that the conductor is visible in the window of the lug to ensure that it was fully inserted, and that the lug is properly crimped. Check that the lug is fastened through both mounting holes, that the connection is tight and that antioxidant was used (if necessary).

    2. HTAPs: Ensure that the mark left on the HTAP indicates that the appropriate manufacturer-recommended die was used for that HTAP, and that the connection is protected by a clear cover that allows visual inspection.

    3. Racks: Visually check that the racks have been assembled with paint-piercing washers or are constructed so as to make such measures unnecessary (i.e. welded).

    4. Conduits: If a bonding conductor is routed through a metallic conduit more than three feet long, ensure that both ends of the conduit are bonded to the conductor with a suitable method, avoiding sharp bends in the cable. Looping the conductor itself through the conduit bonding collar is prohibited.

C. Measurements: Ensure that the resistance of the following connections is less than 0.1 ohms:

    1. Lug to HTAP for any connections to Common Bonding Network

    2. Rack bonding lug to any rack section (the paint-piercing washers make good test points)

    3. Bonding lugs to busbar, cable tray, and cable bond

8 Installation Practices

8.2 Overview

All services provided for installation of structure cabling system shall be professional and conform to the highest standards for industry practices. ConnSCU Telecommunications Department reserves the right to halt any installation due to poor workmanship. All work shall be defect free and the installer will replace, at their expense, any work found to be defective.

8.3 Station Cabling

A. All new telecommunication outlets shall contain a minimum of two Category 6 rated cables.

B. This configuration will support current applications and present an additional growth capability.

C. All CAT 6 cables shall be terminated in compliance with Category 6 specifications to two RJ45 jacks and labeled with the MER/TR #and Panel # (where applicable) and jack ID numbers.

D. Locations and quantities of telecommunication outlets shall comply with the ConnSCU specification.

E. Station cables shall be run in conduit, free-air, above drop ceiling, or in cable tray from the Telecommunications Room to the WA serving each area.

F. Contractor shall be responsible for installing station cabling in such a manner as to avoid unnecessarily long runs. Any area that cannot be reached within the above constraints shall be identified and reported to the architect prior to installation, so that the architect may discuss changes to the plan with ConnSCU.

G. Contractor shall avoid abrasion and other damage to cables during installation.

H. All cable shall be free of tension at both ends.

I. Where installed free-air, installation shall consider the following:

1. Cable shall run at right angles and be kept clear of other trades work.
2. Cables shall be supported according to code utilizing “J-“ hooks or cable wraps anchored to ceiling concrete, walls, piping supports or structural steel beams.
3. Those devises shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
4. Supports should be spaced at a maximum of 4-foot intervals unless limited by building construction. If cable “sag” at mid-span exceeds six (6) inches, another support shall be used.
5. Cable shall never be laid directly on the ceiling grid.
6. Cables shall not be attached to existing cabling, plumbing or steam piping, ductwork, ceiling supports or electrical or communications conduit.

J. Manufacturers minimum bend radius specifications shall be observed in all instances.

K. Use of loop-and-hook (Velcro) type fasteners is the preferred method to bundle cables together. If plastic tie wraps are needed to attach cable bundles to anchors, then the tie wraps should be left loose fitting. No sharp burrs should remain where excess length of the cable tie has been cut. Also, tie wraps must not be used on cable bundles exceeding 24 cables, J-Hooks or Cable Tray is the appropriate method of supporting cables.

L. Cable sheaths shall be protected against damage from sharp edges. A bushing or grommet shall be used to protect the cable wherever it passes over a sharp edge.

M. A one (1) foot coil of each cable shall be placed in the ceiling at the last support (e.g. J-Hook, Bridal Ring, etc.) before the cables enter a fishable wall, conduit, surface raceway or box. At any location where cables are installed into movable partition walls, via a service Pole, approximately 15-feet of slack shall be left in each station cable under 250-feet in length to allow for change in the office layout without re-cabling. These "service loops" shall be secured at the last cable support before the cable leaves the ceiling, and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.

N. To reduce or eliminate EMI, the following minimum separation distances from ≤480V Power lines shall be adhered to:

   1. A minimum separation distance of twelve (12) inches shall be maintained from power lines of <5-kVa.
   2. A minimum separation distance of eighteen (18) inches shall be maintained from high voltage lighting (including fluorescent).
   3. A minimum separation distance of thirty-nine (39) inches shall be maintained from power lines of 5-kVa or greater.
   4. A minimum separation distance of thirty-nine (39) inches shall be maintained from transformers and motors.

8.3.1 Aesthetics

A. All cables terminating at the patch panels shall be vertically straight, with no cables crossing each other, from twelve inches inside the ceiling area to the termination block.

B. All MER/TR tie and station cable bundles shall be combed and bundled to accommodate individual termination block rows and patch panels. Each tie cable or cable bundle shall be secured to both the distribution frame and the structure to which the frame is attached with anchor points, placed a maximum of nine inches apart, starting at the center of the top of the termination block. Anchor points will extend up each cable or cable bundle to a point a maximum of two inches below the false ceiling or from under the raised floor.

C. Cable bundles for station cables should not exceed 24 cables per bundle.

D. For any given MER/TR, a horizontal and vertical alignment for all mounting hardware will be maintained to provide a symmetrical and uniform appearance to the distribution frame.

E. All surface-mounted devices shall be firmly secured, including station cable termination plates/jacks.

8.4 Work Area Outlet

A. Work Area Outlets shall be flush-mounted on wall-mounted boxes, in floor-mounted boxes, and on modular furniture.

B. Any outlets to be added where these conditions are not met shall be positioned at a height matching that of existing services or as directed otherwise by the Site Coordinator and the Architect. Nominal height (from finished floor to center line of Outlet) in new installation shall be as follows:

1. Standard Work Area Outlet (WA): refer to Details & Drawings
2. Wall-Mounted Telephone Outlet (WA-W): refer to Details & Drawings
3. Ceiling-Mounted Wireless Access Point Outlet (WA-P): refer to Details & Drawings

8.4.1 Cable Termination

A. Termination Hardware (Blocks and Patch Panels) Positioning and Layout must be reviewed and approved by ConnSCU Telecommunications Department prior to construction. The review does not exempt Contractor from meeting any of the requirements stated in this document.

8.4.2 Cable Termination – Data UTP

A. At Work Area Outlets and Patch Panels, the installer shall insure that the twists in each cable pair are preserved to within 0.5-inch of the termination for the cables. The cable jacket shall be removed only to the extent required to make the termination.

8.4.3 Cable Termination - Fiber Optic

A. ALL fibers shall be terminated using LC connector type.

B. All terminated fibers at the Telecommunication Rooms shall be mated to couplings mounted on patch panels. Couplings shall be mounted on a panel that, snaps into the housing assembly. Any unused panel positions shall be fitted with a blank panel inhibiting access to the fiber optic cable from the front of the housing.

C. Couplings shall be color coded. Single mode couplings shall be yellow and Multimode shall be orange.

D. All couplings shall be fitted with a dust cap.

E. Fibers from multiple locations may share a common enclosure but must be segregated on the connector panels and clearly identified. Fibers from multiple destinations may be secured in a common enclosure, provided that they are clearly identified as such. Fibers from different locations shall not share a common connector panel (e.g. "insert").

F. Slack in each fiber shall be provided as to allow for future re-termination in the event of connector or fiber end-face damage. Adequate slack shall be retained to allow termination at a 30" high workbench positioned adjacent to the termination enclosure(s). A minimum of 1-meter (~39") of slack shall be retained regardless of panel position relative to the potential work area.

G. Insertion loss of two mated connectors shall be less than or equal to 0.75dB.

8.5 Equipment Rack

A. Equipment racks shall be bolted to the floor as recommended by the manufacturer. Multiple racks shall be joined and the ground made common on each. Racks shall also be stabilized by extending the support bracket to the overhead cable tray.

B. The rear of the rack should be approximately 40" from the wall to allow for access by maintenance personnel. In all cases, a minimum of 36" workspace in front of the rack is also required. Locations where these guidelines cannot be followed should be brought to the attention of ConnSCU Telecommunications Department for resolution prior to installation.

C. Positioning of hardware should be reviewed and approved by ConnSCU and Site Coordinator(s) prior to installation.

D. Equipment Rack shall be equipped with cable management hardware as to allow an orderly and secure routing of twisted pair cabling to the data patch panels. At minimum, one such Horizontal Jumper Management Panel shall be placed below each Fiber Optic and Category 6 Patch Panel. Additional Jumper Management panels may be required pending installation of other cable types on the rack.

E. The rack shall be equipped with ground bus bar, grounded to the Telecommunications Ground (TGB) using a #6 AWG (or larger) insulated stranded copper conductor (GREEN jacket).

F. Each rack shall be equipped with a horizontal rack-mount power strip, including a 12-foot cord for standard household 110V/15A power, On/Off switch, circuit breaker, and a minimum of six (6) standard AC outlets.

9 Testing, Acceptance, Documentation and Labeling

9.2 Test Requirements for Copper Horizontal Cables

A. Horizontal cabling testing shall be conducted from the jack at the outlet in the Work Area to the Termination Block on which the cables are terminated at the MER or TR.

B. Baseline accuracy of the test equipment must exceed TIA Level III, as indicated by independent laboratory testing. Test adapter cable must be approved by the manufacturer of the test equipment.

C. All horizontal copper cables must be tested with a Level 3 Fluke DTX Networks Cable Tester.

D. Testing of the Permanent Link shall be performed. However, Contractor shall warrant performance based on channel performance and provide patch cords that meet channel performance criteria. All cabling not tested strictly in accordance with these procedures shall be retested at no cost to the Owner.

E. Horizontal "Station" cables shall be free of shorts within the pairs, and be verified for continuity, pair validity and polarity, and Wire Map (Conductor Position on the Modular Jack). Any defective, split or miss-positioned pairs must be identified and corrected.

F. Testing of the Cabling Systems rated at TIA Category 6 and above shall be performed to confirm proper functioning and performance.

G. Testing of the Transmission Performance of station cables (Category 6 shall include:

1. Length;
2. Attenuation;
3. Pair to Pair NEXT;
4. ACR;
5. PSNEXT Loss;
6. Return Loss;
7. Pair to Pair ELFEXT Loss (Equal Level Far End Cross-talk);
8. PSEFEXT Loss;
9. Propagation Delay;
10. Delay Skew;
11. Return Loss.

H. The maximum length of station cable shall not exceed 90 meters, which allows 10 meters for equipment and patch cables.

I. Cables shall be tested to the maximum frequency defined by the EIA/TIA 568 B standards covering that performance category. Test records shall verify a "PASS" on each cable and display the specified parameters—comparing test values with standards based "templates" integral to the unit.

J. Any "Pass∗" or "Warning" test results shall be considered a "FAIL" for the channel or permanent link under test. In order to achieve an overall "Pass Condition", the test result for each individual test parameter must be "PASS"

K. All data shall indicate the worst-case result, the frequency at which it occurs, the limit at that point, and the margin. These tests shall be performed in a swept frequency manner from 1MHz to the highest relevant frequency, using a swept frequency interval consistent with TIA and ISO requirements. Information shall be provided for all pairs or pair combinations, and in both directions when required by the appropriate standards.

9.3 Test Requirements for Fiber Optic Cabling System

9.3.1 Tests After Installation

A. Upon completion of cable installation and termination, the Fiber Optic cabling shall be tested to include Optical Attenuation ("Insertion Loss" Method).

9.3.2 Optical Attenuation Testing

A. Optical Attenuation shall be measured on all terminated optical fibers, in both directions of transmission, using the "Insertion Loss" method. Measurement shall be inclusive of the optical connectors and couplings installed at the system endpoints. Access jumpers shall be used at both transmit and receive ends to ensure an accurate measurement of connector losses.

B. Field test instruments for multimode fiber cabling shall meet the requirements of ANSI/TIA/EIA-526-14A. The light source shall meet the launch requirements of ANSI/EIA/TIA-455-50-B.3, Method A. This launch condition shall be achieved either within the field test equipment or by use of an external mandrel wrap (as described in clause 11 of ANSI/TIA/EIA-568-B.1) with a Category 1 light source.

C. Field test instruments for single mode fiber cabling shall meet the requirements of ANSI/EIA/TIA-526-7.

D. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.

E. The fiber optic launch cables and adapters must be of high quality and the cables shall not show excessive wear resulting from repetitive coiling and storing of the tester interface adapters.

F. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests detailed in the following table.

9.3.2.1 Performance Test Parameters

A. The link attenuation shall be calculated by the following formulas specified in ANSI/TIA/EIA standard 568-B.1

B. Link Attenuation = Cable_Attn + Connector_Attn + Splice_Attn

C. Cable_Attn (dB) = Attenuation_Coefficient (dB/km) * Length (Km)

D. The values for the Attenuation_Coefficient are listed in the table below:

Type of Optical Fiber	Wavelength (nm)	Attenuation_Coefficient (dB/km)
Single-mode Outside Plant	1310	0.5
	1550	0.5
Single-mode Inside Plant	1310	1.0
	1550	1.0
Multimode Inside Plant	850	3.5
	1300	1.5

E. Connector_Attn (dB) = number_of_connector_pairs * connector_loss (dB)

F. Maximum allowable mated connectors_loss = 0.70 dB

G. Splice_Attn (dB) = number of splices (S) * splice_loss (dB)

H. Maximum allowable splice_loss = 0.2 dB

I. Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.

J. Test equipment shall measure the link length and automatically calculates the link loss based on the above formulas is preferred.

K. The above link test limits attenuation are based on the use of the One Reference Jumper Method specified by ANSI/TIA/EIA-526-14A, Method B and ANSI/TIA/EIA-526-7, Method A.1. The user shall follow the procedures established by these standards or application notes to accurately conduct performance testing.

L. The backbone link (multimode) shall be tested in two directions at both operating wavelengths to account for attenuation deltas associated with wavelength.

M. Multimode backbone links shall be tested at 850 nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A.

N. Because backbone length and the potential number of splices vary depending upon site conditions, the link attenuation equation shall be used to determine limit (acceptance) values.

O. Single mode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ANSI/TIA/EIA-526-7. All single mode links shall be certified with test tools using laser light sources

9.4 Labeling

9.4.1 Labeling of Cabling and Termination Components

A. Backboard and Equipment Racks

1. Backboards and Equipment Racks shall be labeled by the Contractor identifying the Telecommunication Room. Additionally, Equipment Racks shall have an alpha character after the room number unique to that particular communications closet. For example, TR1-A would be the first rack in TR1.
2. Character height shall be 1-inch (minimum).

9.4.2 Fiber Optic Backbone, Riser Cables, and Termination Components

A. All fiber optic backbone and copper (inter-building, riser and tie) cables shall be identified AT BOTH ENDS with a designation that identifies where the opposite end of the same cable terminates (e.g. Equipment Room or Telecommunications Room I.D.). In addition, labeling of all fiber optic cables shall include the number of fibers in the cable.

B. Each fiber optic termination panel shall be clearly labeled indicating the destination of the cable(s) and the fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

9.4.3 Standard Work Outlet Faceplates

A. All faceplates shall be clearly labeled indicating the destination of the cable(s) [Telecommunication Room Number], the Data Patch Panel(s) letter designation, and the Data Port number(s) on the Data Patch Panel(s).

B. Telecommunications Outlets are to be labeled (1) on the cover of the assembly and (2) on each cable terminated at that location.

C. Station cables shall be labeled within 2-inches of the cable end.

9.4.4 Data Patch Panels

A. All Data Patch Panels shall be clearly labeled indicating the Telecommunication Room Number, The Data Patch Panel letter designation and the Data Port Number on the Data Patch Panel [Ports 1 through 48]. Each Telecommunication Room shall start with Data Patch Panel ‘A’ and continue through the Alphabet. The Data Patch Panels shall be installed to allow for growth of 20% within each Telecommunication Room.

B. Station cables at the patch panels shall be labeled within 2-inches of the cable end.

C. A Data Port Schedule for each Telecommunication Room shall be created in spreadsheet format (Excel) with the Telecommunication Room Number, Data Patch Panel Letter Designations, Data Port Numbers and Room Numbers identified in the spreadsheet. In addition for each Data Patch Panel Port a Fields shall be provided in the spreadsheet for the Owner to manage the cabling infrastructure by recording the Device and any special Notes pertaining to the Room utilizing the Data Cable terminated to the port.

9.4.5 Fiber Optic Cables and Termination Components

D. All Fiber Optic Cables, Termination Enclosure and Connector Panel, shall be clearly labeled.

E. In addition, labeling of all Fiber Optic Cables shall include the number of fibers in the cable.

F. Each Fiber Optic Termination Panel shall be clearly labeled indicating (1) the destination(s) of the cable(s) and (2) fiber number of each fiber position. The cable identifiers are to be secured to (1) the side and (2) the front cover of the panel enclosure.

9.4.6 Ground System Labeling

A. All Grounds should be labeled as close as practicable (i.e. for ease of access to read the label) to the point of termination. Labels shall be nonmetallic and include the following statement "WARNING: If this connector or cable is loose or must be removed, please call the building telecommunications manager."

9.5 Documentation

A. Upon completion of the installation, Contractor shall provide full documentation sets to ConnSCU for approval. All documentation shall become the property of the Owner.

B. Documentation shall include the items detailed in the sub-sections below:

1. Campus plans showing:
    a. Conduit and manhole locations.
    b. Cable identifiers, counts, and routes.
    c. Any other outside facilities installed.
2. Floor prints showing:
    a. Office, building, or campus layout.
    b. Location of all station jacks with identifying numbers.
    c. Location and size of all communications raceways.
    d. Cable identifiers, pair counts and routes for all station and backbone cables.
3. BDP, MER and TR layouts.
4. Cross-connect field, equipment rack and frame layouts.
5. Cross-connects installed by the vendor as part of their installation.
6. Telephone locations and types (if installed by the vendor).
7. Certified test and inspection results both electronically and paper copy.

C. All documentation shall be consistent with the labeling used by the college/university on previous projects. The Vendor is responsible for entering appropriate data into College/University's cable management system. The College/University may also request that the information be provided in a format compatible with its electronic cable management system.

D. One hard copy of each updated cabling location table will be posted in the location-wiring closet (TR/MER), attached to or inside the rack or enclosure.

E. Contractor shall provide accurate as-built Construction Drawings. The drawings are to include cable routes and outlet locations. Outlet locations shall be identified by their sequential number as defined elsewhere in this document. Numbering, icons and drawing conventions used shall be consistent throughout all documentation provided.