

DIVISION 27 - COMMUNICATIONS

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OPERATION AND MAINTENANCE OF COMMUNICATIONS SYSTEMS

It is the responsibility of Information Technology Services (ITS) to insure that a fully compliant and efficient communication infrastructure is in place for the universities needs. These standards are in place to accomplish that goal. These standards are developed for the use of all campus departments as well as all Architects, Developers and Contractors involved in construction on NAU campus. Cost for materials and installation of all Telecomm related items should be part of the Project Budget. Coordination with NAU/ITS is required prior to actual construction and wiring placement. Elevator and emergency telephones shall be included in the project and installed by the contractor. Manufacturer shall be Ramtel and model number pre-approved by ITS.

Approved Contractor Requirements

- A. The Telecommunications Contractor shall be an approved Hubbell Certified Installer.
- B. A copy of the certification documents must be submitted with the quote.
- C. The System Installer must have an RCDD approve the project design
- D. A Hubbell System Performance Warranty covering all components, equipment and workmanship shall be submitted in writing with system documentation.
- E. Should the cabling system fail to perform its expected operation within the warranty period due to inferior or faulty material and/or workmanship, the contractor shall promptly make all required corrections without cost to Northern Arizona University.
- F. System shall be complete Hubbell connectivity system, this includes all copper and fiber connectivity.

Codes and Standards Compliance

- A. All materials shall comply with the most current applicable sections of the following Codes for installation of telecommunications cabling:
 - 1. International Building Code (IBC)
 - 2. National Electrical Code (NEC/NFPA 70)
 - 3. National Electrical Safety Code (NESC IEEE C 2)
 - 4. Local Codes, amendments, and ordinances.
- B. All materials and installation practices shall comply with the applicable sections of the following Telecommunications Industry Standards:
 - 1. ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements.
 - 2. ANSI/TIA/EIA-568-B.2, Commercial Building Telecommunications Cabling Standard, Part 2: Balanced Twisted-Pair Cabling Components.
 - 3. ANSI/TIA/EIA-568-B.3, Commercial Building Telecommunications Cabling Standard, Part 3: Optical Fiber Cabling Components Standard.
 - 4. ANSI/TIA/EIA-568-B.2-1: Transmission Performance Specification for 4-Pair 100 Ω Category 6 Cabling (Standard).
 - 5. ANSI/TIA/EIA-569-A (Including 5 addendums), Commercial Building Standards for Telecommunications Pathways and Spaces
 - 6. ANSI/EIA/TIA-570, Residential and Light Commercial Telecommunications Wiring Standard
 - 7. ANSI/TIA/EIA-606, The Administration Standard for the Telecommunications infrastructure of Commercial Building
 - 8. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications
 - 9. ANSI/TIA/EIA-758, Customer Owned Outside Plant Telecommunications Cabling Standard
- C. Installers shall have read the above documents and shall be familiar with the requirements that pertain to this installation. The documents may be obtained from:

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1.	Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, fax: 303-397-2740, http://global.his.com/
2.	IEEE-Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, NY, 10017-2394, 800-678-IEEE, fax: 732-981-9667, http://standards.ieee.org/

For any questions or further information on ITS cabling standards please contact Danny Henderson 928-523-7009, Daniel.Henderson@nau.edu

27 01 10 OPERATION AND MAINTENANCE OF STRUCTURED CABLING AND ENCLOSURES

The operation and maintenance of all structured cabling systems are the responsibility of NAU/ITS and any and all changes or modification shall be coordinated with NAU/ITS.

27 01 20 OPERATION AND MAINTENANCE OF DATA COMMUNICATIONS

The operation and maintenance of all data communications are the responsibility of NAU/ITS and any and all changes or modification shall be coordinated with NAU/ITS

27 01 30 OPERATION AND MAINTENANCE OF VOICE COMMUNICATIONS

The operation and maintenance of all voice communications are the responsibility of NAU/ITS and any and all changes or modification shall be coordinated with NAU/ITS

27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS

27 05 13 COMMUNICATION SERVICES

All Voice and Data Communication Services to be supplied by or coordinated with NAU/ITS. This includes dial tone services, T1 services, DSL services, Network services.

27 05 13.43 NAU – CATV SYSTEM

Cable Television Equipment and Signal

All distribution equipment "Line Powered" shall be a 60-90 volt AC Quasi-square wave signal or "premise" powered with 115VAC. The system shall meet or exceed all technical standards set forth in FCC Rules, Part 76. Forward bandwidth of all passive devices shall be a minimum of (1) GHz with full reverse (upstream) capacity. The ratio of visual signal levels to coherent disturbances such as intermodulation products, second and third order distortions or discrete-frequency interfering signals shall not be less than (-51dB). Carrier-to-noise ratio shall be 48dB minimum. System radiation (CLI) shall meet all FCC requirements of Part 76: Rules and Regulations. Isolation between any two outlets in the system shall be a minimum of 18dB. All room outlets in the system shall provide a minimum level of +3dBmv and a maximum level of +12dBmv. The RF level deference between any two adjacent channels shall be no greater than 3dB.

Drop Cable

RG-6 series with minimum 67% braid; 18 AWG 0.040" copper covered steel center conductor; gas expanded foam type dielectric (FEP); inner shield aluminum laminated tape with overlap bonded to dielectric; outer shield of 34 AWG bare aluminum braid wire; jacket of plenum rated material. CROSS

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REFERENCE: Belden #1530AP or CommScope #2276V. NOTE: Metal wall plates required for all housing projects.

Feeder Cable

500 P3 series copper clad aluminum center conductor; expanded polyethylene dielectric; solid aluminum sheath; outer jacketed of black high molecular weight polyethylene. CROSS REFERENCE: CommScope #P-3 Series.

Trunk Cable/Fiber

750 P3 series copper clad aluminum center conductor; expanded polyethylene dielectric; solid aluminum sheath; outer jacket of black high molecular weight polyethylene. CROSS: REFERENCE: CommScope #P-3 75-750 JCA. Fiber; single-mode.

Connectors

Drop; RG-6 compression type, Feeder; .500 pintype Gilbert #GRS 500CH-DU-03 Trunk; .750 pintype Gilbert #GRS 750CH-DU-03, Fiber; SC/APC or FC/APC (min.65dB return-loss).

Distribution Amplifiers/Nodes:

Distribution/Node amplifiers shall have a minimum forward bandwidth of 860MHz with full reverse (upstream) capacity. Manufacturer of CATV equipment and material shall be determined during preliminary project planning. Spare (standby) opto-electronic/electronics shall be provided at completion of project. All equipment shall be installed in equipment rooms on each floor of each wing, all cable drops shall be home runs to the equipment room on that floor and labeled with its corresponding room number.

Note: Design maps shall be included in project budget and provided prior to, during and at completion of project.

27 05 26 GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

All building and Communication grounding to conform to the following codes, standards, and practices: NFPA 70 of NEC, ANSI J-STD-607-A, IEEE, latest edition of BICII method manual and all applicable National, State and Local building codes.

A Telecommunications Main Grounding Bus bar (TMGB) connected to the Electrical Grounding System is required in all buildings. All communication equipment spaces require a Telecommunication Grounding Bus bar (TGB) connected to the TMGB and bonded to approved building ground. All connections bonded with a minimum 6 AWG conductor. All cable tray, equipment racks, and equipment cabinets bonded to TGB. All Telecommunication protectors and associated metallic cable sheaths to be grounded to selected TGB with a minimum 14 AWG insulated conductor. All copper pairs to be protected at building entrance facility with gas tube type 350VDC protector modules.

27 05 28 PATHWAYS FOR COMMUNICATIONS SYSTEMS

All communication cabling shall be routed in a designed and approved pathway system per ANSI/TIA/EIA-569-B, (Commercial Building Standard for Telecommunications Pathways and Spaces) and meet or exceed all National, State and Local codes and standards. Design shall be documented in floor plans and have built in flexibility for tenant movement and expansion and designed for maintenance and relocation of cables as easy as possible.

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27 05 28.29 HANGERS AND SUPPORT FOR COMMUNICATIONS SYSTEMS

All cable supports shall be located on maximum of 48" on center. All cable supports rated for Category 6 structured cabling system. In a ceiling distribution design a minimum of 3" clearance between ceiling tile and cable should be maintained. All hangers and supports must be suspended from or attached to the structural ceiling or walls with hardware designed to support their load bearing rating. Only Velcro type cable ties shall be used for dressing or securing Category 6 Cabling.

27 05 28.33 CONDUITS AND BACK BOXES FOR COMMUNICATION SYSTEMS

All conduits to be rigid, flexible conduit is not acceptable for any application. Design and installation of conduits should be run in most direct route possible with no more than two 90 degree bends and should not contain any electrical condulets (LB's). Conduit should not be placed over or adjacent to boilers, incinerators, hot water lines or steam lines. Conduits 2" or smaller require a bend radius of 6 times the internal conduit diameter, more than 2" require 10 times the internal conduit diameter. All conduit ends should be reamed and fitted with insulated bushing. Specify a minimum two 1" conduits to each office type room on opposite walls. All other rooms (labs, classrooms, etc.) require consultation with NAU/ITS. Conduit to terminate in a 4"x4" double gang box with 4" square single device cover and routed to communication cable tray or stubbed to accessible location. Equip all conduits with a pull cord that has a minimum test rating of 200 lb. All conduits dedicated to communication structured cabling system and shall not be shared with any other services.

27 05 28.36 CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

Type and design of cable tray distribution system shall be pre-approved by NAU/ITS. Cable tray installation must be installed to meet NEC article-392 and all state and local codes. Cable tray should be dedicated to telecommunication use only and not shared with electrical. Design should be such that all requirements for a certified Category 6 structured cabling system will be met i.e. bend radius, clearances and distances etc.

Cable tray to be sized so as not to exceed the allowable fill volume. All metallic cable trays must be grounded and clearly marked in accordance with ANSI/TIA/EIA-606-A and ANSI J-STD-607-A.

27 05 28.39 SURFACE RACEWAYS FOR COMMUNICATIONS SYSTEMS

Surface raceway should only be considered as last resort and with prior coordination with NAU/ITS. Raceway design should be of a type that conforms to category 6 certification for bend radius, interference and separation. Raceway must be capable of accepting Hubbell wiring products including jacks and faceplates. If electrical power and telecommunications services are both run in raceway separate compartments are required and must comply with applicable electrical codes. If a metallic barrier is provided, it must be bonded to ground. Raceway shall be sized so as not to exceed manufacturers fill rating.

27 05 28.40 FURNITURE RACEWAYS AND PATHWAYS

All furniture pathways to adhere to ANSI/TIA/EIA-569 current standards. Maximum pathway fill shall be 40%. Minimum size pathway shall not force the cable into a bend radius less than 1" under condition of maximum fill. Any parallel pathway to electrical must have proper separation. All furniture pathways must be capable of accepting Hubbell brand termination hardware.

27 05 43 UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATION SYSTEMS

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See section 33.81.26 for Site communications ducts, manholes. Under floor ducts systems shall be dedicated space for telecommunication cables and not shared with any other utility. The guideline for planning duct capacity is 1in² of cross section for each 100ft² of useable floor space. Junction boxes shall be placed at a maximum of 60 ft to allow access for cable placement. All distribution ducts must be physically linked to a telecommunication room directly or through no more than one feeder duct. Ducts entering the telecommunications room must terminate in either a slot or elbow.

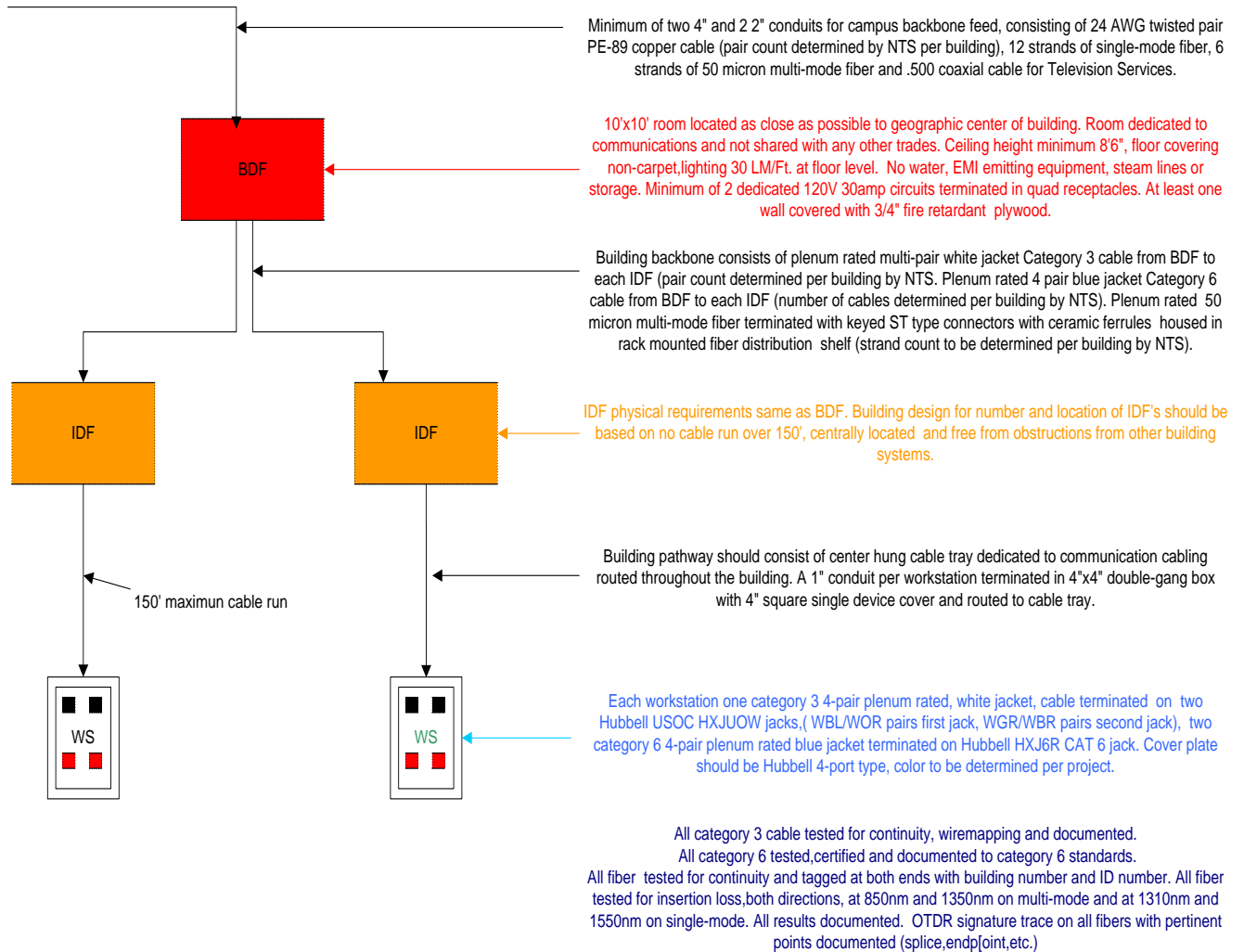
27 10 00 STRUCTURED CABLING

Complete structured cabling system to conform to all TIA/EIA Telecommunications Building Wiring Standards, latest edition of BICSI Telecommunications Method Manual and covered by Hubbell System Performance Warranty. All structured cabling tasks to be performed by Hubbell Certified Contractor. Hubbell System Performance Warranty shall be required.

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Building Overview

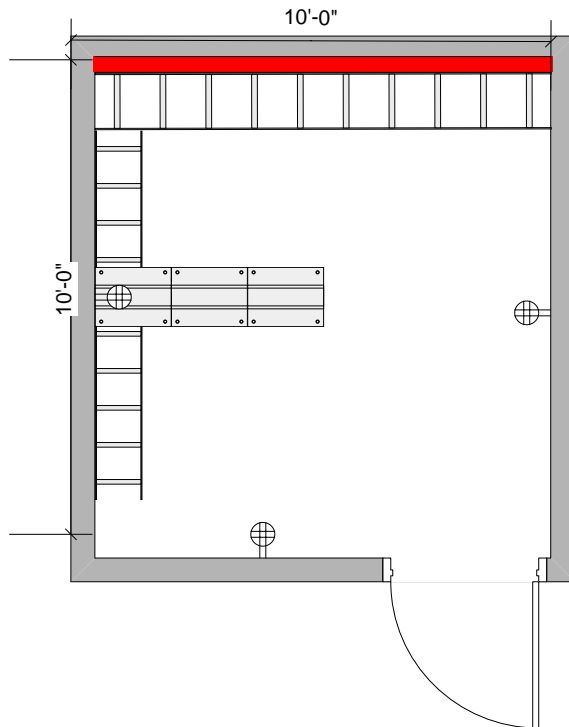


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COMMUNICATIONS EQUIPMENT ROOM FITTINGS

All buildings shall have at least one (depending on building size, footprint and design possibly more) Telecommunications room per floor. Building design shall be such that no horizontal cable run exceeds 150'. Design should be that Telecommunications rooms are as close to the core of the building as possible. Multiple story buildings should be designed so that Telecommunications rooms are stacked. A minimum of two 4" conduits from each room to main BDF is required. The space shall be dedicated to Telecommunications equipment and not shared with electrical or any other building system. Equipment not related to the support of telecommunications closet (e.g., piping, ductwork, etc.) shall not be installed in, pass through, or enter the telecommunications room. Minimum size shall be 10'X10' with a minimum of 8' 6" clearance height with solid ceiling. Wall finish shall be light in color. Lighting shall be a minimum of 500 lx measured 3ft. above finished floor. Room shall be environmentally controlled to maintain operating range of 65°F to 75° F 24/7. Flooring shall be static free, no carpeting. Power requirements are based on individual building design and need approval of NAU/ITS but a minimum of 2 20amp quad convenience outlets are required. Each Telecommunications room shall be equipped with a grounding bus bar connected to the building TGB. One complete wall shall be covered with 3/4" fire rated A-C plywood painted to match interior. Entrance door shall be minimum of 36" opening outward. Backbone and horizontal cable pathways shall terminate into room. Room cable management shall consist of ladder tray above all wall mount frames and all equipment racks.



3/4" fire retardent plywood entire wall

183B type blue metal backboard with
66M1-50 blocks mounted on plywood
for all category 3 backbone and
station cabling

Cable tray for all station and inter BDF cabling
7' 19" telco equipment rack for all fiber,
category 6 patch panel and electronic

Minimum ceiling height 8'6"

Dedicated 110v 20amp circuit per telco rack

Minimum 1 110v 20amp convenience outlet

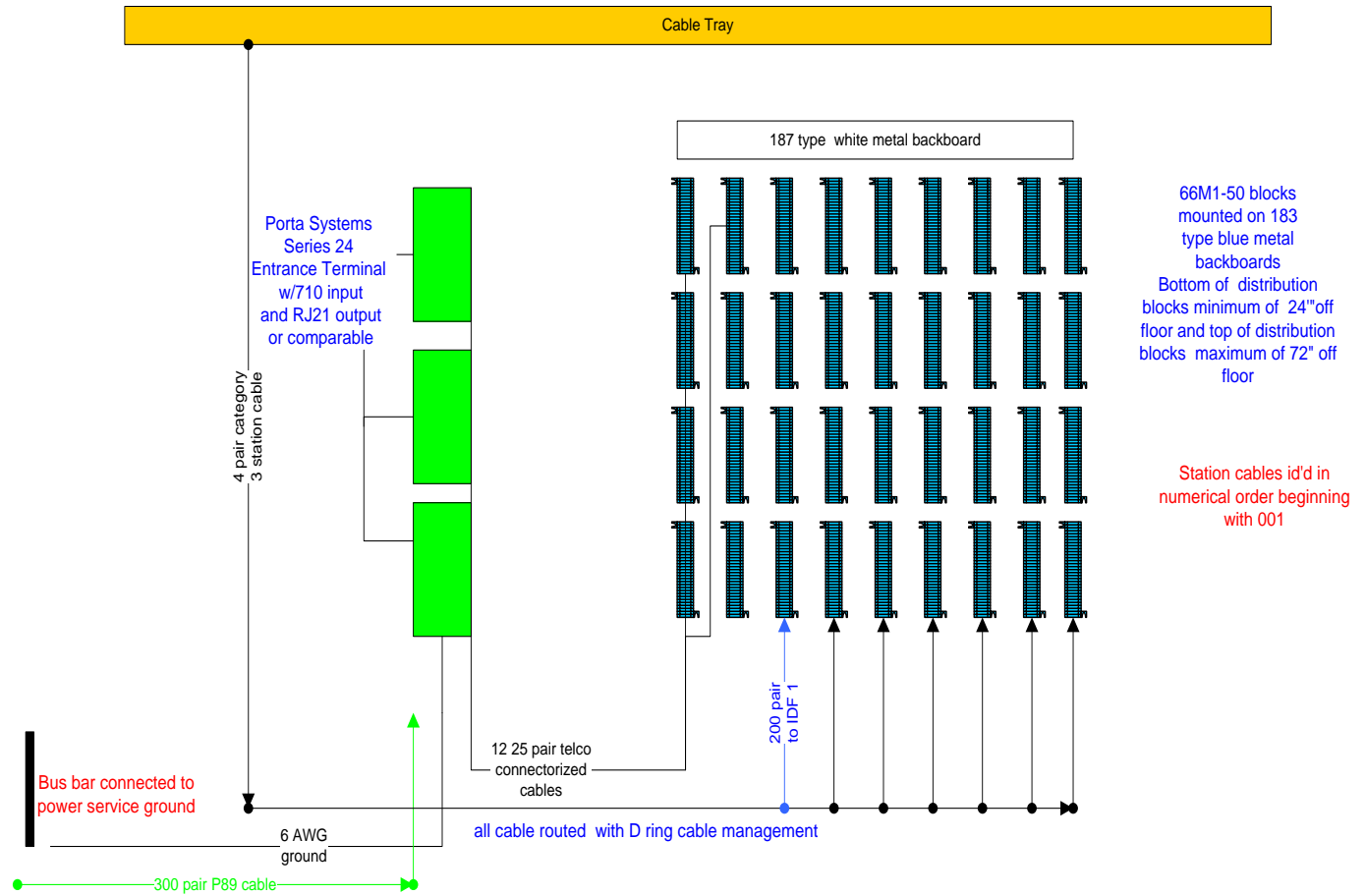
3' minimum doorway
open outward

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Typical BDF backboard with 300 pair feed, one additional IDF and 144 station drops

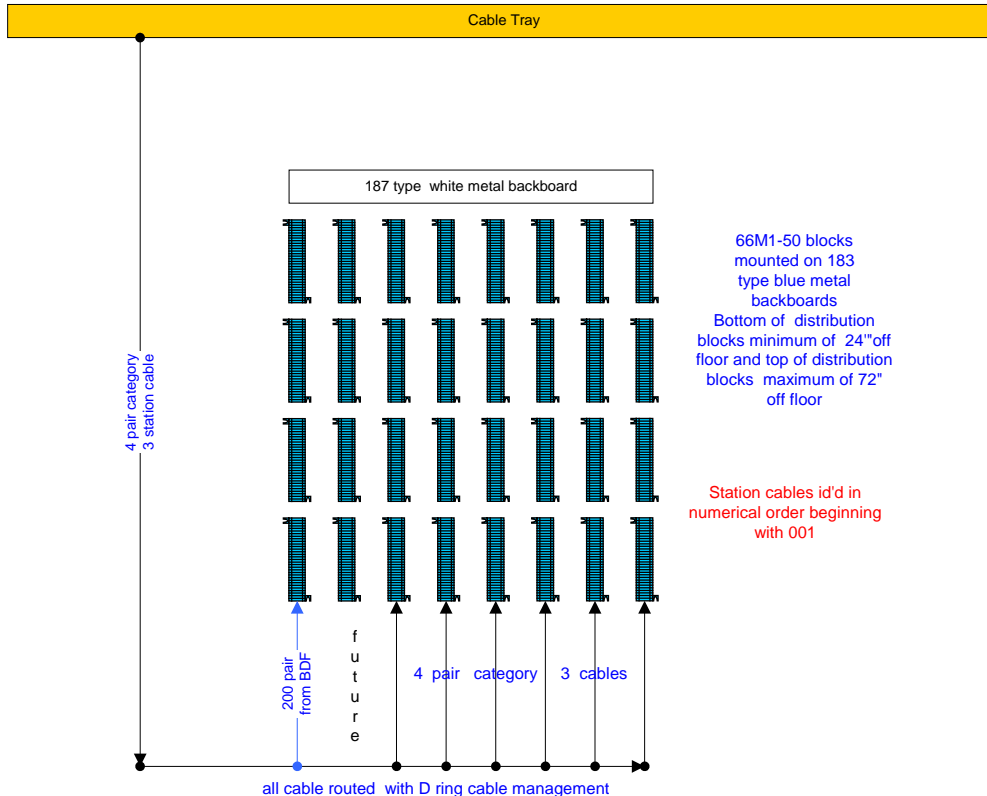


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Typical IDF backboard with 200 pair feed, and 144 station drops



27 11 13 COMMUNICATIONS ENTRANCE PROTECTION

All copper entrance cable to be terminated in Porta-System series 24 building entrance terminal, (710 input/RJ21 output) or a comparable substitute pre approved by NAU/ITS and protected by gas tube type modules capable of handling surges higher than 300 volts and incorporates a positive temperature coefficient self-resetting current limiter as is UL497 listed.

27 11 16 COMMUNICATIONS CABINETS, RACKS, FRAMES, AND ENCLOSURES

All network and telecommunication equipment will be housed in 7' 19" equipment racks, any other enclosure type requires pre approval of NAU/ITS. Equipment rack shall meet ANSI/EIA-310-D standard. Rack secured and grounded per manufacturers and all applicable codes. Rack positioned at least 3' from any wall. Rack equipped with horizontal cable management between all patch panels and active equipment. Vertical cable management required if design dictates or if multiple racks are involved. Rack equipped with rack mount 19" power strip 20A/120v with minimum of 8 NEMA5 -20R receptacles. Rack configuration requires pre-approval of NAU/ITS.

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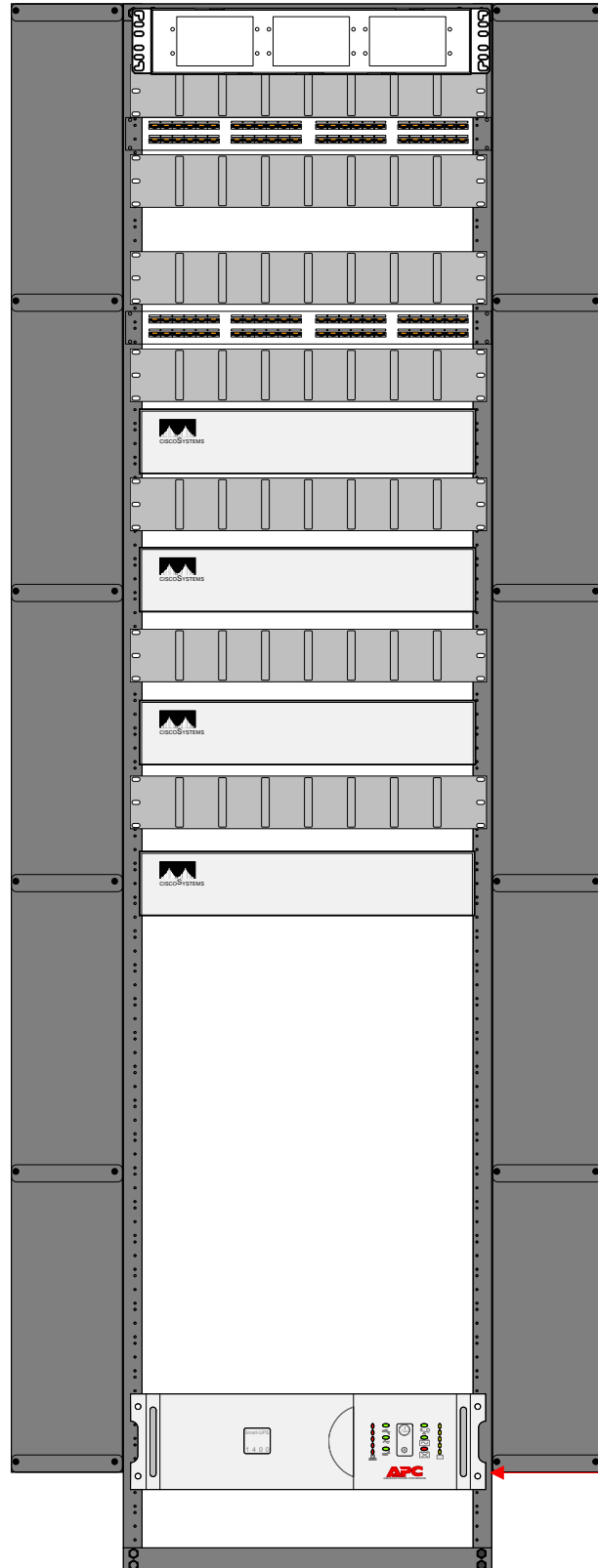
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Typical BDF/IDF equipment rack

CPI 46053703 w/ Vertical management or comparable

Cable tray from top of rack to wall, rack anchored to floor



Fiber distribution panel with keyed ST type connectors, for campus and building backbone size determined per building design

cable manager

Category 6 rated patch panel (568A wiring) for building backbone size dependent on building design

2" cable manager

48 port category 6 patch panel, T568A wiring

cable management

48 port category 6 patch panel, T568A wiring

cable management

Cisco switch, model number determined by NTS

cable management

Cisco switch, model number determined by NTS

cable management

Cisco switch, model number determined by NTS

cable management

Cisco switch, model number determined by NTS

Technical Standards Revised 12/15/2012

APC UPS, model number determined per #2012 needs

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27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

All OSP twisted pair to be terminated in Porta-System series 24 with 710 input and RJ21 output (or comparable) type building Entrance terminal.

All Category 3 cabling shall be terminated on 66M1-50 connecting blocks mounted on 183 type blue metal backboards. All Category 6 cables shall be terminated on rack mounted Hubbell Category 6 patch panel.

27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

All cable management to conform to industry standards and comply with a Hubbell certified Category 6 system. All active and passive rack mount equipment to be separated by horizontal cable management. Vertical cable management required in multiple rack design. Ladder rack required to all racks and for cable entrance into all telecommunication rooms. All wall mount Category 3 cable termination fields require 187 type white metal backboards for cross connect field.

27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

Minimum of one horizontal power strip 20A/120V with 8 NEMA5-20R receptacles.

27 13 00 COMMUNICATIONS BACKBONE CABLING

See section 33 82 00 for site communications distribution and outside plant requirements All campus buildings will be fed with twisted pair copper, 8.3 micron single-mode fiber, and 50 micron Laser optimized multi-mode fiber. Number of conductors to be determined by NAU/ITS on a per project basis.

27 13 13 COMMUNICATIONS COPPER BACKBONE CABLING

27 13 13.01 BUILDING COPPER BACKBONE

Building voice backbone cabling will consist of multi-pair (100 pair minimum) plenum rated inside cable between BDF and all IDF's. All cable will be homerun and terminated at both ends on 66M1-50 connecting blocks mounted on blue metal 183 type mounting boards. All pairs tested for continuity, shorts grounds and wire map. Building data backbone will consist of multiple (number to be determined per project by ITS) 4-pair plenum rated blue jacket category 6 cables terminated on Hubbell category 6 patch panel. All cables certified at Category 6 specifications and be a registered partner of Hubbell for system performance warranty.

27 13 13.02 INTER BUILDING COPPER CABLE BACKBONE

Copper cable shall be PE 39 type and meet the following requirements:

24 AWG pair count determined by NAU/ITS per project

Cable shall meet the requirements of ANSI/CEA S-84-608

Buried service wire to conform to ANSI/CEA S-86-634.

The transmission requirements of connecting hardware used in the OSP shall comply with the connecting hardware requirements of ANSI/TIA/EIA 568-A.

27 13 13.13 COMMUNICATIONS COPPER CABLE SPLICING

All splicing and splice closures to conform to TIA/EIA-758. All splicing completed with 710 type multiple pair connectors. No bridge-taps and 25-pair binder groups shall not be split between termination points. All splices housed in a closure compatible with all materials used in the construction of cable, filling compounds, bonding and grounding devices, chemicals, and sealants that the closure would come in

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contact under normal conditions. Closure construction shall be reusable and re-enterable without factory refurbishing. All closures to be filled with filling compound. Replacement parts shall be readily available.

27 13 13.14 COPPER CABLE TESTING

All twisted pair cable to be tested with complete wire map and 100 % pass rate for following:

- DC loop resistance
- Wire map
- Continuity to remote end
- Shorts between two or more conductors
- Crossed pairs
- Reversed pairs
- Split pairs
- Any other miss-wiring

27 13 23 COMMUNICATIONS OPTICAL FIBER BACKBONE CABLING

Fiber- SM

A germania-doped silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD). Each optical fiber refractive index profile shall be step index.

Each fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²). The fiber shall be coated with a dual acrylate protective coating and the coating shall be in physical contact with the cladding surface. The single-mode fiber shall meet EIA/TIA-492CAAB, "Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak," and ITU-T G.652.C, "Characteristics of Single-Mode Optical Fiber Cable." Fiber shall have a mode field diameter of 9.20 ± 0.40 μm at 1310 nm and 10.40 ± 0.50 μm at 1550 nm. Fiber core-clad concentricity shall be $= 0.5$ μm . Fiber cladding diameter shall be 125.0 ± 0.7 μm . Fiber cladding non-circularity shall be $= 0.7\%$. Fiber coating diameter shall be 245 ± 5 μm .

The attenuation specification shall be a maximum value for each cabled fiber at $23 \pm 5^\circ\text{C}$ on the original shipping reel. The cabled fiber attenuation for Loose Tube and Ribbon cable constructions shall be < 0.4 dB/km at 1310 nm and < 0.3 dB/km at 1550 nm. For Tight Buffered constructions the cabled fiber attenuation shall be < 1.0 dB/km at 1310 nm and < 0.75 dB/km at 1550 nm. The attenuation at the water peak (1383 nm) shall not exceed the 1310 nm attenuation value. The cabled fiber shall be capable of operating in the 1360 nm to 1480 nm water peak region.

The attenuation due to 100 turns of fiber around a 50 ± 2 mm diameter mandrel shall not exceed 0.05 dB at 1310 nm and 0.10 dB at 1550 nm. The attenuation due to 100 turns of fiber around a 75 ± 2 mm diameter mandrel shall not exceed 0.10 dB at 1625 nm. There shall be no point discontinuities greater than 0.10 dB at 1310 nm and 1550 nm.

The maximum dispersion shall be $= 3.2$ ps/(nm•km) from 1285 nm to 1330 nm and shall be $= 18$ ps/(nm•km) at 1550 nm. The cabled fiber shall support Gigabit Ethernet (GbE) operation according to the 1000BASE-LX (1310 nm) specifications up to 5000 m in accordance with the GbE standard. The cabled fiber shall support laser-based 10 Gigabit Ethernet (10GbE) operation according to the 10GBASE-LX4 (1300 nm region), 10GBASE-L (1310 nm) and 10GBASE-E (1550 nm) specifications for distances of 10 km, 10 km and 40 km, respectively.

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The cabled optical fiber shall support industry-standard multi-gigabit Fiber Channel physical interface specifications.

Fiber MM 50um Laser Optimized

Each fiber in the cable must be usable and meet required specifications. Each optical fiber shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical and environmental requirements of this specification. A germania-doped silica core surrounded by a concentric silica glass cladding shall comprise each optical fiber. The fiber shall be a matched clad design manufactured by the outside vapor deposition process (OVD). Each optical fiber shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi (0.7 GN/m²). The fiber shall be coated with a dual-layer acrylate protective coating. The coating shall be in physical contact with the cladding surface. The attenuation specification shall be a maximum value for each cabled fiber at 23 ± 5°C on the original shipping reel. The multimode fiber shall meet TIA-492AAAC, "Detail Specification for 850-nm Laser-Optimized, 50-µm Core Diameter/125-µm Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers."

The core diameter shall be 50.0 ± 2.5 µm. The cladding diameter shall be 125.0 ± 2.0 µm. The cladding non-circularity shall be = 1.0%. The core-clad concentricity shall be = 1.5 µm. The coating diameter shall be 245 ± 5 µm. The optical fiber refractive index profile shall be graded. The numerical aperture of the fiber shall be 0.200 ± 0.015.

The maximum cabled fiber attenuation shall be 3.0 dB/km at 850 nm and 1.0 dB/km at 1300 nm for all cable types. The cabled optical fiber shall have a minimum effective modal bandwidth (EMB) of 2000 MHz•km at 850 nm in accordance with FOTP-220 for 10 Gigabit Ethernet. The cabled optical fiber shall have a minimum over-filled launch (OFL) bandwidth of 1500/600 MHz•km at 850/1300 nm. The cabled optical fiber shall have a minimum restricted mode launch (RML) bandwidth of 1400 MHz•km at 850 nm in accordance with FOTP-204 for Gigabit Ethernet.

The cabled optical fiber shall support industry-standard IEEE 802.3 10GBASE-S (10 Gigabit Ethernet at 850 nm) physical layer specifications for 300 m. The cabled optical fiber shall support industry-standard IEEE 802.3 1000BASE-SX (Gigabit Ethernet at 850 nm) physical layer specifications for 1000 m and 1000BASE-LX (Gigabit Ethernet at 1300 nm) for 600 m. The cabled optical fiber shall support industry-standard multi-gigabit Fibre Channel physical interface specifications.

There shall be no point discontinuity greater than 0.2 dB. The attenuation coefficient at 1380 nm shall not exceed the attenuation coefficient at 1300 nm by more than 3.0 dB/km. The attenuation due to 100 turns of fiber around a 75 mm diameter mandrel shall not exceed 0.5 dB at 850 nm and 1300 nm.

27 13 23.01 BUILDING OPTICAL FIBER CABLE BACKBONE

Single-Mode and 50 Micron Laser optimized Multi-mode fiber optic backbone required between BDF and all IDF locations. All cable to be homerun with no splices and installed in 1" plenum rated innerduct. Strand count to be determined by NAU/ITS on a per project basis.

ISP Cable- MIC 2-24 fibers plenum

Cable shall be plenum-rated, all-dielectric, with two to twenty-four 900 ± 50 µm tight-buffered fibers. TBI® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low-friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low-friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded together around jacketed or non-jacketed dielectric strength members via reverse oscillation and surrounded with dielectric strength members and a ripcord. Cables containing 12 to 24 fibers shall have a

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dual-layer stranded design. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 μm , 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 μm , 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Unique color identification of all fibers within the hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. Cable shall be listed OFNP/FT-6 and be fully compliant with ICEA S 83-596. The outer jacket shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet (e.g., "CORNING OPTICAL CABLE - 01/00 – 12 SM – TB2 - OFNP (ETL) OFN FT6 (CSA) 0001 marking shall be in contrasting color to the cable jacket. FEET"). The

Cable shall have a storage temperature range of -40° to 70°C on the original shipping reel, installation temperature range of 0° to 60°C , and an operating temperature range of 0° to 70°C . Cable manufacturer shall be ISO 9001 registered.

-- -29.

ISP Cable- UMIC 24-144 fibers plenum

Cable shall be all-dielectric and contain 36 to 144 $900 \pm 50 \mu\text{m}$ tight-buffered fibers. TBII® Tight-Buffered Fiber shall be made of a PVC material and shall have a UV-cured acrylate coating (low friction slip layer) between the acrylate coating of the optical fiber and the PVC buffer. The fiber coating, low friction slip layer and PVC buffer shall be removable with commercially available stripping tools in a single pass for termination or splicing. The individual fibers shall be color-coded for identification. The optical fiber color coding shall be in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." Fibers shall be stranded via reverse oscillation with dielectric strength members and a ripcord in either 6-fiber or 12 fiber subunits. Cable with < 60 fibers shall contain 6-fiber subunits, otherwise cable shall contain 12-fiber subunits. Subunits shall be stranded together in a planetary configuration around a jacketed or bare glass reinforced plastic (GRP) dielectric central member. Cable shall contain a ripcord underneath outer cable jacket to facilitate jacket removal. Each subunit jacket shall be made of a PVC material and shall be identified with a unique number at periodic intervals. Subunit color containing multimode fiber shall be orange. Subunit color containing 50/125 μm , 850 nm laser optimized fiber shall be aqua. Subunit color containing single-mode fiber shall be yellow. A dual-layer subunit design shall be used for cables containing 108 to 144 fibers. The cable jacket color shall be orange for cables containing all multimode fiber, except for cables containing 50/125 μm , 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. The cable jacket color shall be yellow for cables containing all single mode fiber. Hybrid cables (containing more than one type of fiber) shall have an outer jacket with the color corresponding to the greatest percentage of total fibers within the cable, except for hybrid cables containing 50/125 μm , 850 nm laser optimized fiber, which shall have an aqua colored outer jacket. Cable shall be listed OFNP/FT-6 and be fully compliant with ICEA S-83-596. Cable outer jacket shall be marked with the manufacturer's name or ETL file number, date of manufacture, fiber count, fiber type, flame rating, listing symbol, and sequential length markings every two feet (e.g., "CORNING OPTICAL CABLE - 01/00 – 72 SM– TB2 - OFNP (ETL) OFN FT6 (CSA) 0001 FEET"). The marking shall be in contrasting color to the cable jacket.

Cable shall have a storage temperature range of -40°C to $+70^{\circ}\text{C}$, installation temperature range of 0°C to $+60^{\circ}\text{C}$, and an operating temperature range of 0°C to $+70^{\circ}\text{C}$. Cable manufacturer shall be ISO 9001 registered.

27 13 23.02 INTER BUILDING OPTICAL FIBER CABLE

Fiber Optic cable shall meet following requirements:



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Cable shall be all-dielectric, stranded loose-tube design with dry water blocking for outdoor duct and aerial installations in fiber counts from two to 288. Each fiber shall be distinguishable by means of color coding in accordance with TIA/EIA-598-B, "Optical Fiber Cable Color Coding." The fibers shall be colored with ultraviolet (UV) curable inks. Buffer tubes shall be made from polypropylene. Each buffer tube shall contain a water swellable yarn for water blocking protection. The water-swellable yarn shall be non-nutritive to fungus, electrically non-conductive, and homogeneous. It shall also be free from dirt or foreign matter. This yarn will preclude the need for other water blocking material; the buffer tube shall be gel free. The optical fibers shall not require cleaning before placement into a splice tray or fan out kit. The buffer tube shall be manufactured to a standard 3.0 mm in size, regardless of fiber count, to reduce the number of required installation and termination tools. Buffer tubes containing fibers shall be color coded with distinct and recognizable colors in accordance with TIA/EIA-598-B. Buffer tube colored stripes shall be inlaid in the tube by means of co extrusion when required. The nominal stripe width shall be 1 mm. Buffer tubes in a hybrid cable (cable containing more than one type of fiber) shall contain only one fiber type. Identification of fiber types in a hybrid cable shall correspond to fiber core diameter (or mode field diameter) from smallest to largest in accordance with TIA/EIA-598-B. Buffer tubes shall be stranded around the dielectric central member using the reverse oscillation stranding process. Two polyester yarn binders shall be applied contra helically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking, and dielectric with low shrinkage. Water swellable yarn(s) shall be applied longitudinally along the central member during stranding. For dual-layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two-layer core. A water swellable tape shall be applied longitudinally over both the inner and outer layer. The water-swellable tape shall be non-nutritive to fungus, electrically non-conductive, and homogenous. It shall also be free from dirt and foreign matter. Cable shall be comprised of water-swellable yarns and/or tapes, dielectric strength members (as required), ripcord(s) and an MDPE jacket containing carbon black to provide ultraviolet light protection while inhibiting the growth of fungus. Cable jacket shall be marked with the manufacturer's name, month and year of manufacture, sequential meter or foot markings, a telecommunication handset symbol as required by Section 350G of the National Electrical Safety Code® (NESC®), fiber count, and fiber type. The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes, which shall be printed in light blue. The height of the marking shall be approximately 2.5 mm. Cable shall contain reverse oscillation lay (ROL) markings as needed. Cable shall have a storage temperature range of -40° to 70°C, an installation temperature range of -30° to 70°C, and an operating temperature range of -40° to 70°C. Cable shall have a short-term tensile rating of 2700 N. No fiber strain shall occur over the service life of the cable when subjected to a maximum, long-term tensile rating of

890 N. Cable shall meet the functional requirements of Rural Utilities Service (RUS) 7 CFR 1755.900 and be fully compliant with ICEA S-87-640. Manufacturer shall be ISO 9001 and TL 9000 registered.

27 13 23.13 OPTICAL FIBER SPLICING AND TERMINATIONS AND TESTING

Rackmount Housings:

Housing shall be Hubbell brand. Housings shall be mountable in an EIA-310 compatible 465- or 592 mm rack. Housings shall be available in both 1U, 2U and 4U sizes. One EIA rack space or panel height (denoted as 1U) is defined as being 44.45 mm in height. The unit shall meet all applicable design requirements listed in ANSI/TIA/EIA-568, ANSI/TIA/EIA-942, and the polymer compounds flammability requirements of UL 94 V-0. Manufacturer shall be ISO 9001 and TL 9000 registered. Housings shall be manufactured using 16-gauge aluminum or equivalent for structural integrity and shall be finished with a rustic gun-metal grey powder coat for durability. All joints shall be welded and finished in a workman-like manner. Installation fasteners shall be included and shall match the housing color. The unit shall include a clamshell-type cable clamping mechanism to provide cable strain-relief.

The front and rear doors shall be lockable when used with an optional key lock kit. The Connector Housings

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shall have a labeling scheme that complies with ANSI/TIA/EIA-606. The housings shall be available with factory-installed connectorized cable stubs in multiple cable and connector types. The housing shall have the ability to accommodate fusion splicing with additional hardware. The housing shall be 16 inches deep for extra cable routing.

Connectors ST SM

Connectors shall be Hubbell brand. Connector shall be compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with the TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA-604-2. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 μm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall be installable upon single-mode optical fiber. Ferrule material shall be ceramic. The connector crimp on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171. Connector reflectance shall be measured after manufacture to be less than or equal to -40/-55 dB for super physical contact (SPC)/ultra physical contact (UPC). Manufacturer shall be ISO 9001 and TL 9000 registered. The manufacturer shall have an in-depth knowledge, and more than 10-year history, of manufacturing and supporting connector technology that does not require epoxy or polishing in the field.

Connectors ST MM 50um

Connector shall be compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA-604-2. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 μm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall be installable upon 50/125 μm multimode optical fiber. Ferrule material shall be ceramic. The connector crimp on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171. Connector reflectance shall be less than or equal to -20 dB. Manufacturer shall be ISO 9001 and TL 9000 registered.

Connectors ST MM 50um Laser Optimized

Connector shall be compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with TIA/EIA Fiber Optic Connector Intermateability Standard (FOCIS) document, TIA/EIA-604-2. The connector installation shall not require the use of epoxies, adhesives or ovens. The connector shall be installable upon 900 μm buffered fiber in one minute or less and upon 2.9 mm jacketed cable in three minutes or less total time. The connector shall be installable upon 850-nm laser-optimized 50 μm multimode optical fiber. Ferrule material shall be ceramic. The connector crimp on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants. Connector shall be consistently capable of insertion losses of 0.3 dB (typical) and shall be 0.75 dB (maximum) when installed in accordance with the manufacturer's recommended procedure and tested in accordance with FOTP-171. Connector reflectance shall be less than or equal to -20 dB. Manufacturer shall be ISO 9001 and TL 9000 registered.

Splice cases:

The SCF splice closures shall be available in canister (butt) and in-line styles to fit most applications. All end-caps feature two express ports for uncut feeder cables.

The Splice Closure Housing shall be non-metallic. It shall be resistant to solvents, stress cracking and creep. The housing materials shall also be compatible with chemicals and other materials to which they might be exposed in normal applications. The optical fiber closure shall be capable of accepting any optical fiber cable commonly used in interoffice, outside plant and building entrance facilities. As an option, the

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ability to double the cable capacity of an installed canister splice closure by use of a kit shall be available. Such a conversion shall not disturb existing cables or splices. Encapsulation shall not be required to resist water penetration. The splice closure shall be re-enterable. The closure end-cap shall be capable of accepting additional cables without removal of the sheath retention or strength-member-clamping hardware on previously installed cables or disturbing existing splices. The optical fiber splice closure shall provide a clamping mechanism to prevent pistoning of the central member or strength members and to prevent cable sheath slip or pullout. The splice closure shall have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and the armored cable sheath. The cable bonding hardware shall be able to accommodate a copper conductor equal to or larger than 6 AWG.

Aerial splice closures shall have available the necessary hardware to attach and secure the closure to an aerial strand. The closure shall accommodate splice trays suitable for single- fiber, single fiber heat-shrink, mechanical or ribbon heat-shrink splices. The small splice closure shall accommodate up to 72 single- fiber splices or 144 ribbon fiber splices using 12-fiber ribbons. The medium-sized closure shall accommodate up to 288 single-fiber splices or 432 ribbon-fiber splices. The large closure shall accommodate up to 480 single-fiber splices or 864 ribbon-fiber splices. The installation of the splice closure shall not require specialized tools or equipment, other than those normally carried by installation crews.

All fibers (inter and intra building) tested for continuity and tagged at both ends with building number and ID number. All fibers tested for insertion loss, both directions, at 850nm and 1350nm on multi-mode, and at 1310nm and 1550nm on single-mode. All results documented. OTDR signature trace on all fibers with pertinent points documented (splice, endpoints, etc.) Only test results with University personnel present will be accepted.

27 15 00 COMMUNICATIONS HORIZONTAL CABLING

27 15 00.16 VOICE COMMUNICATIONS HORIZONTAL CABLING

All workstations shall be fed by one 4-pair 100 ohm balanced Category 3 plenum rated with white jacket cable. Manufacturer of cable must be partner with Hubbell and registered for System Performance Guarantee. No cable run shall exceed 150'. Cable shall be terminated at the work station on two Hubbell USOC HXJU type jacks (w-bl/w-or pairs on one and w-gr/w-br pairs on the other) and terminated at the BDF/IDF on 66M1-50 connecting blocks mounted on blue metal 183 type backboards.

27 15 00.19 DATA COMMUNICATIONS HORIZONTAL CABLING

All workstations shall be fed by two 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cables. All buildings shall be designed for wireless communication with access point coverage of 50 foot diameter. Each wireless point shall consist of one 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cable. Manufacture of cable must be partner with Hubbell and registered for Hubbell System Performance Guarantee. No cable run shall exceed 150'. Cable be terminated at workstation on Hubbell category 6 jack and terminated at the BDF/IDF on Hubbell Category 6 patch panel. All cables tested and certified to Category 6 standard. Computer labs, classrooms, and all other special applications require the input of NAU/ITS on number and location of drops. Only Velcro type cable ties shall be used with Category 6 cabling.

27 15 00.20 WIRELESS DATA COMMUNICATION HORIZONTAL CABLING

NAU wireless solution is Cisco 3602I 802.11n access points utilizing WISM 2 Controllers. Horizontal cabling shall be designed to meet minimum -67db signal strength in all areas. This is generally achieved with AP locations placement at a 35' radius. NAU/ITS shall review and amend any proposed wifi design to meet

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these parameters as well as any user requirements such as increased client density loads found in classroom and large capacity spaces. WAP locations should be located so that horizontal mounting will be allowed.

27 15 43 COMMUNICATIONS FACEPLATES AND CONNECTORS

Quad telephone faceplates shall be standard at all workstation locations fed by one category three 4-pair and two category 6 4-pairs, (color and material to match electrical plates) with two Hubbell category 6 modular jacks (category 6 cable, T568A wiring) and two Hubbell USOC HXJU type jacks (w-bl/w-or pairs of category three cable terminated on one and w-gr/w-br pairs of category three cable terminated on the other.

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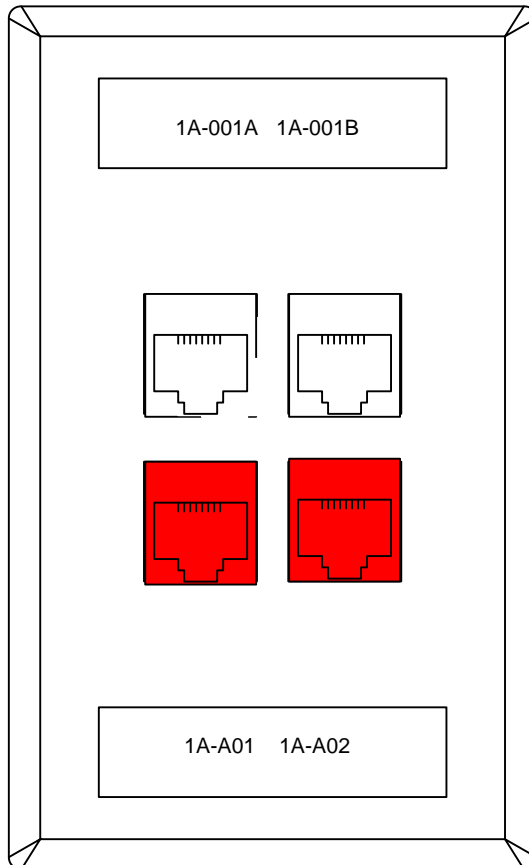
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Workstation Detail

Voice jacks labeled with IDF and cable number

Hubbell USOC HXJU
type jack
Terminate
W,BL/W,OR of category 3
station cable

Hubbell HXJ6 Red
Category 6 modular jack



Hubbell USOC HXJU type
jack
Terminate
W,BL/W,OR of category 3
station cable

Hubbell HXJ6 Red
Category 6 modular jack

Category 6 labeled with
IDF and patch panel
number and port

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27 16 00 COMMUNICATIONS CONNECTING CORDS, DEVICES, AND ADAPTERS

27 16 13 COMMUNICATIONS CUSTOM CABLE ASSEMBLIES

All custom built cable assemblies tested and certified to appropriate category level and meet performance level of all applicable codes and standards.

27 16 16 COMMUNICATIONS MEDIA CONVERTERS, ADAPTERS, AND TRANSCEIVERS

Furnished by NAU/ITS

27 16 19 COMMUNICATIONS PATCH CORDS, STATIONS CORDS, AND CROSS CONNECT WIRE

Patch cords, equipment cords, and work area cords must meet the applicable performance requirements in ANSI/TIA/EIA-568-B.2. All cords associated with the data horizontal cable system must be 4-pair Category 6 rated and factory terminated and shall be included in Hubbell System Warranty. All patch cords sized to provide a neat appearance.

27 21 00 DATA COMMUNICATIONS NETWORK EQUIPMENT

All Data Communication Equipment furnished by NAU/ITS

27 31 00 VOICE COMMUNICATIONS SWITCHING AND ROUTING EQUIPMENT

All equipment furnished by NAU/ITS.

27 32 00 VOICE COMMUNICATIONS TELEPHONE SETS, FACSIMILES, AND MODEMS

All telephone sets and ancillary equipment furnished by NAU/ITS except Elevator and Emergency Telephones

27 32 23 ELEVATOR TELEPHONES

Manufacturer shall be RamTel all models shall be ACA capable. Model must be pre approved by NAU/ITS

27 32 26 RING-DOWN EMERGENCY TELEPHONES

Manufacturer shall be RamTel all models shall be ACA capable. must be pre approved by NAU/ITS All site located Emergency phones to be fed by buried service wire meeting ANSI/CEA S-86-634 standard with station protection and routed to the closest Telecommunications equipment room.

27 33 00 VOICE COMMUNICATIONS MESSAGING

All services provided and maintained by NAU/ITS

27 34 00 CALL ACCOUNTING

All services provided and maintained by NAU/ITS

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27 35 00 CALL MANAGEMENT

All services provided and maintained by NAU/ITS

27 40 00 AUDIO-VIDEO COMMUNICATIONS

Cable Television Equipment and Signal

All distribution equipment shall be "Line Powered" with a 60 volt AC Quasi-square wave signal. The system shall meet or exceed all technical standards set forth in FCC Rules, Part 76. Band width of all passive and active devices in the forward feed shall be 54 MHz to 750 MHz and 5MHz to 30 MHz in the reverse feed.

Amplifiers shall be "Push-Pull " design. The system shall be designed to -57dB or better cross modulation and a carrier-to-noise ratio shall be 46dB minimum. System radiation (CLI) shall meet all FCC requirements of Part 76: Rules and Regulations. Isolation between any two outlets in the system shall be a minimum of 28dB. All room outlets in the system shall provide a minimum level of +3dBmv and a maximum level of +12dBmv. The RF level deference between any two adjacent channels shall be no greater than 2dB.

Drop Cable

RG59/u Type, 95% braid coverage 10 AWG:NOM 0.032" copper covered steel center conductor; gas expanded polyethelene dielectric; inner shield aluminum-polypropylene - aluminum laminated tape with

overlap bonded to dielectric; outer shield of 34 AWG bare aluminum braid wire; jack of black polyvinylchloride or polyethelene. CROSS REFERENCE: Belden #9108 or comm/scope #F5995BVV

Feeder Cable

500 P3 series copper clad aluminum center conductor: expanded polyethylene dielectric; solid aluminum sheath; outer jacked of black high molecular weight polyethylene. CROSS REFERENCE: Comm/scope #P-3 Series.

Trunk Cable

750 P3 series copper clad aluminum center conductor; expanded polyethylene dielectric; solid aluminum sheath; outer jacket of black high molecular weight polyethelene. CROSS: REFERENCE: comm/scope #P-3 75-750 JCA

Connectors

RG59 F-Type Gilbert #GF/59-AHS, Feed .500 pintype Gilbert #GRS 500CH-DU-01 Trunk .750 pintype Gilbert #GRS 750CH-DU-01

Distribution Amplifiers:

Trunk will be Scientific Alanta series 6500 750MHz sub-split truck station with reverse module. Feeder will be Scientific Alanta 6501/6502 distribution amplifier with reverse module. All 2-port, 4-port, 8-port taps and directional couplers will be Scientific Atlanta. All equipment shall be installed in equipment rooms on each floor of each wing all cable drops shall be home runs to the equipment room on that floor and labeled with its corresponding room number.