

DIVISION 27 - COMMUNICATIONS

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27 01 00	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 university's 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. *All SOW and project proposals/designs shall be in accordance to BICSI recommended installation practices, standards, and codes stated below.* 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 have an RCDD with OSP Design Certification on staff and shall be an approved Hubbell Certified Installer or **Belden** Certified Installer
- B. A copy of the certification documents must be submitted with the quote.
- C. All quotes with the specified warranty solution submitted to NAU for approval must have all the part numbers and documents pertaining to the specifications of the materials being used for the project being quoted along with as-builts pertaining to BDF/IDF layouts.
- D. The System Installer shall have an RCDD/ OSP approve the project design. Overall project management/ installation oversight shall be by a BICSI certified RCDD/ OSP on a weekly basis.
- E. The System Installer shall have a certified BICSI Technician Lead *employed on staff and on-site* during project construction at all times. The Lead Technician shall be OSHA 30 Certified.
- F. All installers/ Technicians shall be BICSI certified or enrolled in a State authorized Apprenticeship program. New members added to the installation team must be approved by NAU/ ITS. All members of the installation team shall be OSHA 10 certified. A copy of current certifications of all members of the installation team shall be submitted with the quote.
- G. A Hubbell Mission Critical Warranty for 25 years covering all components, equipment and workmanship shall be submitted in writing with system documentation.
- H. A SureBit or ChannelMate System Warranty for 25 years covering all components, equipment and workmanship shall be submitted in writing with system documentation.
- I. 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.
- J. *Copper System shall be complete Hubbell Mission Critical Solution System or Belden/Hubbell ChannelMATE Solution System. One warranty solution per job, no mixing of warranty solutions will be allowed. Verify with NAU/ITS for intended warranty on a per job basis.***
- K. *Fiber optics may be Belden or Hubbell.***
- L. *No portion of the Telecommunications cabling contract/ project may be subbed out to another entity unless prior approval is granted by NAU/ ITS.***
- M. *No contractor may bid on an NAU Telecommunications project without meeting the above contractor requirements or without NAU/ITS approval only.***
- N. *All subcontractors/contractors shall wear in plain sight a photo ID at all times during project construction stating company name, employee name and current BICSI credential.***

Note: Design maps shall be included in project budget and provided prior to, during and at completion of project. Prior to sign off of completion and release of payments: NAU/ITS shall reserve



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the right to test and verify compliance of all fiber and copper cables installed under contract prior to sign off of completion.

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-569-C.0-2009+A1:2010+A2:2012, Generic Telecommunications Cabling for Customer Premise Standard***
2. ***ANSI/TIA/EIA-568-C.1-2009+A1:2012, Commercial Building Telecommunications Cabling Standard,***
3. ***ANSI/TIA/EIA-568-C.2-2009+A1:2010, Balanced Twisted Pair Telecommunications Cabling and Components Standard***
4. ***ANSI/TIA/EIA-568-C.3-2009+A1:2010, Optical Fiber Telecommunications Cabling Systems Standard***
5. ***ANSI/TIA/EIA-568-C.3-2009+A1:2011, Optical Fiber Cabling and Components Standard***
6. ***ANSI/TIA/EIA-568-B.2-1: Transmission Performance Specification for 4-Pair 100 Ω Category 6 Cabling (Standard).***
7. ***ANSI/TIA/EIA-569-C-2012, Commercial Building Standards for Telecommunications Pathways and Spaces***
8. ***ANSI/TIA/EIA-570-C-2012, Residential Telecommunications Infrastructure Standard***
9. ***ANSI/TIA/EIA-606-B-2012, The Administration Standard for Commercial Telecommunications***
10. ***ANSI/TIA/EIA-607-B-2013, Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications***
11. ***ANSI/TIA/EIA-758-B-2012, Customer Owned Outside Plant Telecommunications Infrastructure Standard***
12. ***TIA/EIA-1005-A-2012 Telecommunications Infrastructure Standard for Industrial Premises***
13. ***BICSI/NECA-607 Telecommunications Bonding and Grounding, Planning and Installation Methods for Commercial Buildings***
14. ***TIA/EIA-942-A-2012 Telecommunications Infrastructure Standard for Data Centers***
15. ***TIA-TSB-190, 2011 Guidelines on Shared Pathways and Shared Sheath***
16. ***NFPA 780- Standard for Installation of Lightning Protection Systems, latest issue***
17. ***Telecommunications Designers/ Contractors and Installers shall have read the above documents and must be familiar with the requirements that pertain to this installation. The documents may be obtained from:***
18. ***Global Engineering Documents, 15 Inverness Way East, Englewood, CO, 80112-5776, 800-854-7179, fax: 303-397-2740, <http://global.his.com/>***



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19. ***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, designs and layouts, please contact **Ralph Sedillo at 523-2185 ralph.sedillo@nau.edu or Paul Trujillo at 523-2905 paul.trujillo@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:

The system shall meet or exceed ALL technical standards set forth in FCC Rules & Regulations Part 76; http://www.ecfr.gov/cgi-bin/text-idx?c=ecfr&sid=3100d6c36aa8d24cb14d0de0e94df597&tpl=/ecfrbrowse/Title47/47cfr76_main_02.tpl

*Band width of ALL active and passive devices shall have a minimum of 54 MHz to 860 MHz (forward/downstream) and 5 MHz to 42 MHz (reverse/upstream).

All CATV/TV locations shall consist of one (1) station cable and one (1) drop cable as listed below.

Station Location:

All Category 6 cables to TV locations shall consist of a minimum one (1) Category 6 100ohm White cable terminated in the BDF on its own Category 6 Patch Panel. If distance is an issue than the cable will terminate in the closest IDF/ TR within the distance limitation.



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Drop Cable;

*RG-6 series with a minimum 60% braid (minimum SCTE standard); 18 AWG copper covered steel center conductor; foam dielectric material (FEP); inner shield aluminum-poly, bonded – 100% aluminum laminated tape with overlap bonded to dielectric; outer shield of 34 AWG bare aluminum braid wire; jacket of polyvinyl chloride (PVC) plenum rated material. CROSS REFERENCE: CommScope #2276V/2275V; Belden#633938

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;

.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

Connectors;

*Drop cable; RG-6 compression type. CROSS REFERENCE: ICM F-CONN#FS6PL2/Corning-Gilbert#GF-UR-6-PL.
*Feeder cable; .500 pin type Gilbert #GRS 500CH-DU-01 *Trunk cable; .750 pin type Gilbert #GRS 750CH-DU-01. *Fiber (singlemode); “APC” type SC/FC (min.-60dB return-loss).

Distribution, fiber nodes, RF Amplifiers;

All equipment shall be installed & labeled in appropriate equipment rooms as designated by project/design. All cable drops shall be home runs to the designated equipment rooms and labeled with its corresponding room number. Fiber nodes/RX's and RF amplifiers shall be premise power type (115VAC). It is recommended that these active components be of the same manufacturer/model type currently being utilized throughout the campus CATV system. CROSS REFERENCE: Scientific Atlanta mod. #90090 (fiber Rx/amplifier), Blonder Tongue mod. #FRDA/FRRA (wall/rack mount fiber Rx/amplifier), Blonder Tongue mod. #BIDA (RF distribution amplifier). Back-up/spare “active” equipment shall be provided by the project/contractor. *Note; ALL active/passive components as well as any other equipment or specifications outlined in this standards sheet should be discussed with NAU/CATV personnel prior to any design, purchase and/ or implementation. Contact; Terry Draper 928.523.9621 Terry.Draper@nau.edu

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-B, IEEE, latest edition of any BICSI Design 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



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a minimum 6 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. Pathways shall run parallel to the building design. 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. **Any and all pathway sleeves shall be rigidly secured on both sides of the wall. ISP fiber optic cables shall be placed inside inner-duct unless an armored cable is used for safety, identification and protection of the fiber. Pathways shall not exceed 40% initial fill volume when installed. When necessary additional sleeves and pathways shall be installed to meet the standard to not exceed 40% initial fill volume. A free and clear pull-line with minimum 200lb pull rating will be available for future use will be left in all main pathways and conduits.** All cable colors to be bundled separately in the ceiling and in all BDF's/ IDF's or TR's. When cables enter the closets they will be packed neatly ie:(cigarette packing). **OSP pathways refer to Division 33 for standard pathways.**

Fire Wall penetrations shall be installed in accordance to the current Division 21 Fire Code guidelines. No exceptions will be taken unless otherwise approved prior to installation by the NAU Fire Marshal. Acceptable manufacturers for pre-fabricated fire stop solutions are 3M, Hilti and STI (Specified Technologies, Inc.).

27 05 28.29 HANGERS AND SUPPORT FOR COMMUNICATIONS SYSTEMS

All cable supports shall be located on maximum of 48" on center attached to both sides of cable tray. All cable supports rated for **Fiber Optic**, Category 6 and 6a structured cabling system. In a ceiling distribution design a minimum of 3" clearance between ceiling tile and cable or the lowest point of the support system in a tray design 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 straps shall be used for dressing or securing **Fiber Optic**, Category 6 and 6a Cabling. J-Hook or straps for the support system shall be installed no greater than 48" on center and in accordance to **all** BICSI design standards and best practices.

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, electrical convertors/rectifiers/panels 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 **and stubbed out to accessible location in the same room.** All other rooms (labs, classrooms, etc.) require consultation with NAU/ITS. Conduit to terminate in a **5"x5"** double gang box with single **gang** device cover and routed to communication cable tray or stubbed to accessible location **within the same room.** 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. **Underground conduits that contain OSP telecommunications cables shall terminate with conduit end bells inside the BDF, vault or manhole and sealed when not in use. Type of seal shall be approved by NAU/ITS. No rigid foams permitted.**



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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. A/V (Audio/ Video) and Security may reside in the same pathway as Telecommunications ONLY with prior approval through NAU/ ITS. Physical separation shall be required when multiple applications other than telecommunications reside in the same tray. Design should be such that all requirements for a maximum 40% initial fill volume and a certified Category 6 and 6a 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 initial maximum fill volume of 40% for all services residing in the cable tray or support system. All metallic cable trays shall be grounded and clearly marked in accordance with ANSI/TIA/EIA-606-A and ANSI J-STD-607-B-2013.

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 and 6a 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. ***All raceway shall be secured to surfaces via anchors of the appropriate type for the wall being attached to. Color of raceway shall match the wall being attached to.***

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

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 Hubbell **or ChannelMate** solution **for the** structured cabling system to conform to all TIA/EIA Telecommunications Building Wiring Standards, latest edition of BICSI Telecommunications Method Manual and covered by the Hubbell Mission Critical **or** ChannelMate System Performance Warranty. All structured cabling tasks to be performed by Hubbell Mission Critical **or** ChannelMate Certified Contractor. Hubbell System Performance Warranty **or** ChannelMate System Solution Warranty shall be required. **Warranty Solutions shall be determined on a per job basis.**



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Current structured cabling color codes:

Hubbell Mission Critical 25yr Warranty Recommended Part#'s.

App	Color	Hubbell Cable Part#	Hubbell Jack Part#
Voice	Yellow	Cat 6 Part # C6RPEY	HXJ6Y
Data	Blue	Cat 6 Part # C6RPEB	HXJ6B
Wireless	Gray	Cat 6a Part # C6ASPGY	HJ6AGY
Security, Card Reader	Green	Category 6 Part # C6RPEG	HXJ6GN
Attendance Reader	Green		
CATV, A/V	White	Category 6 Part # C6RPEW	HXJ6W

Hubbell Wire Management, Panels and Racking: (Black finish only unless otherwise specified)

19" Rack		HPW84RR19D
Vertical Management		VS76 (Black Finish)
(Vertical Management shall run the entire length of both sides of the rack) (Doors and door hinges and spools for a complete solution shall be included)		
Horizontal Management		HC119ME6N and HC219ME6N
Ladder Rack		HLS10xB (Sized accordingly)
Elevation Kits		Included
(All hardware kits for connectivity and support shall be included for a complete install)		
Radius Drops		HLCDxx
Patch Panels	Cat6	HP624 and HP648 (Rear cable management shall be included)
	Cat6a	HP6A24 and HP6A48 (Rear cable management shall be included)
Rack Mount 110 Kits w/ Cable Management		110RM15 and 110RM25

Alternate Warranty Solution

ChannelMate 25yr Warranty Recommended Part #'s.

App	Color	Belden Cable Part#
Voice	Yellow	Category 6 Part #2413 004A1000
Data	Blue	Category 6 Part #2413 D15A1000
Wireless	Gray	Category 6a Part #10GX13 0081000
Security, Card Reader	Green	Category 6 Part #2413 005A1000
Attendance Reader	Green	
CATV, A/V	White	Category 6 Part #2413 009A1000

Cooper B-Line Wire Management, and Racking: (Black finish only unless otherwise specified)

19" Rack	SB55608419U6FB
Vertical Management	SB86086D084FB (Used for the outside management in a multiple rack design)
	SB860810D084FB (Used in between racks in a multiple rack design)
(Vertical Management shall run the entire length of the rack)	



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(Doors, spools and hinges for a complete solution shall be included)

Horizontal Management SB87019S1FB and SB87019S2FB

Ladder Rack SB13AL12FB and SB13AL18FB

Elevation Kits SB227R6FB

Radius Drops SB13ALDO12FB and SB13ALDO18FB

(All hardware kits for connectivity and support shall be included for a complete install)

Patch Panels Cat6 **HP624 and HP648 (Rear cable management shall be included)**

Cat6a **HP6A24 and HP6A48 (Rear cable management shall be included)**

Rack Mount 110 Kits w/ Cable Management

110RM15 and 110RM25

Category 6 cabling shall be the minimum category cable recommended for all communication designs and plenum in type.

Networks with higher bandwidth needs, NAU/ITS recommends Category 6A structured cabling solutions.

Star Topology recommended for all building layouts. Consult with NAU/ITS before following any format that is not a star topology for a building overview with recommendations.

27 11 00 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 permanent link horizontal cable run exceeds 90 meters'. 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'X12' with no 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 **(4) 20amp quad convenience outlets are required (2) of these (4) outlets shall be NEMA5 20R receptacles.** Each Telecommunications room shall be equipped with a grounding bus bar connected to the building TMGB. **All walls shall be covered with 3/4" fire rated A-C plywood painted with two (2) coats of white fire retardant paint on all 6 sides.** 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 racks above all wall mount frames and all equipment racks.

Recommended BDF/ IDF Layout

Rack Mount 110 Blocks for CAT 3 backbone cabling. Cable bundles to the patch panel shall be no greater than 24 cables.

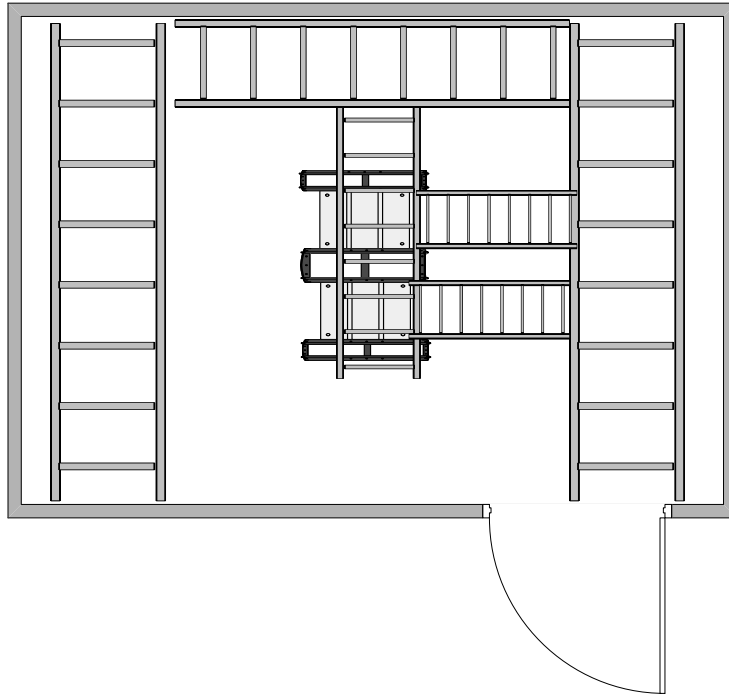
All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly ie:(cigarette packing).



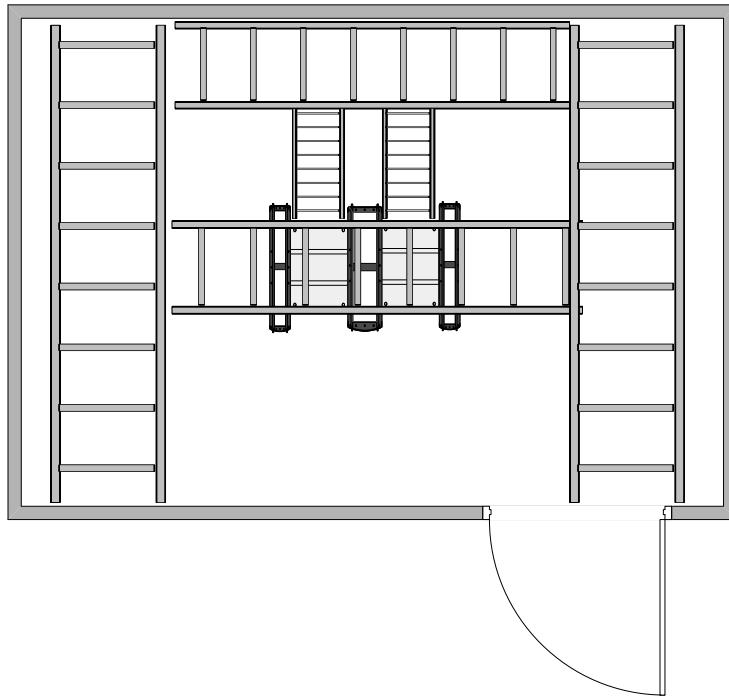
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Typical BDF/ IDF Rm. for
VoIP Layout.
Cat3 OSP/ ISP Riser and
Voice Panels (Yellow
Cables) in the Left Rack.
Fiber/ Data Back Bone,
WAPs and Data Panels
(Blue Cables) in the
Right Rack.
Ladder Racking within
the Telco Rms shall be
18" wide
Layout is Diagrammatical
only.

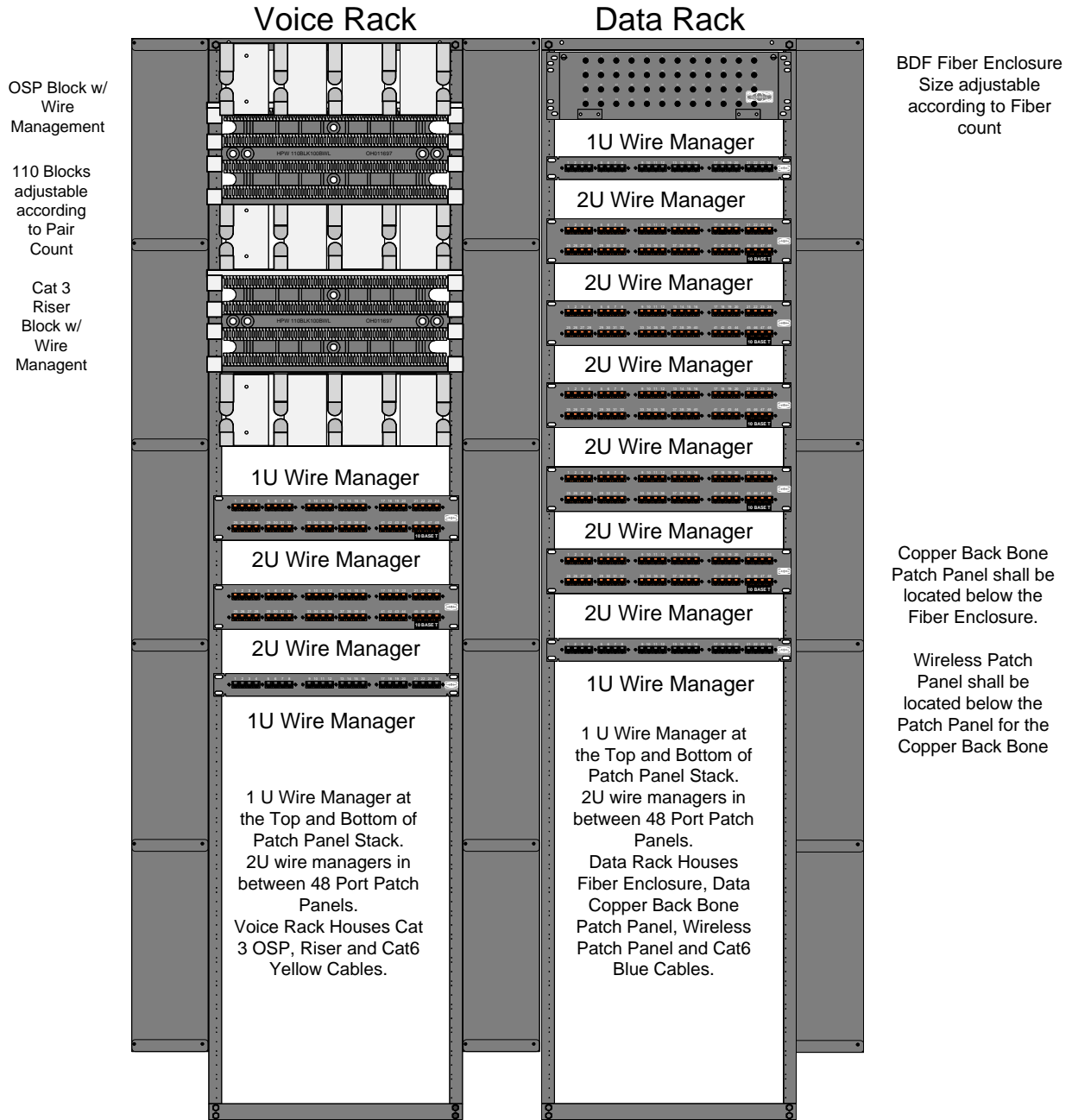


Typical BDF/ IDF Rm. for
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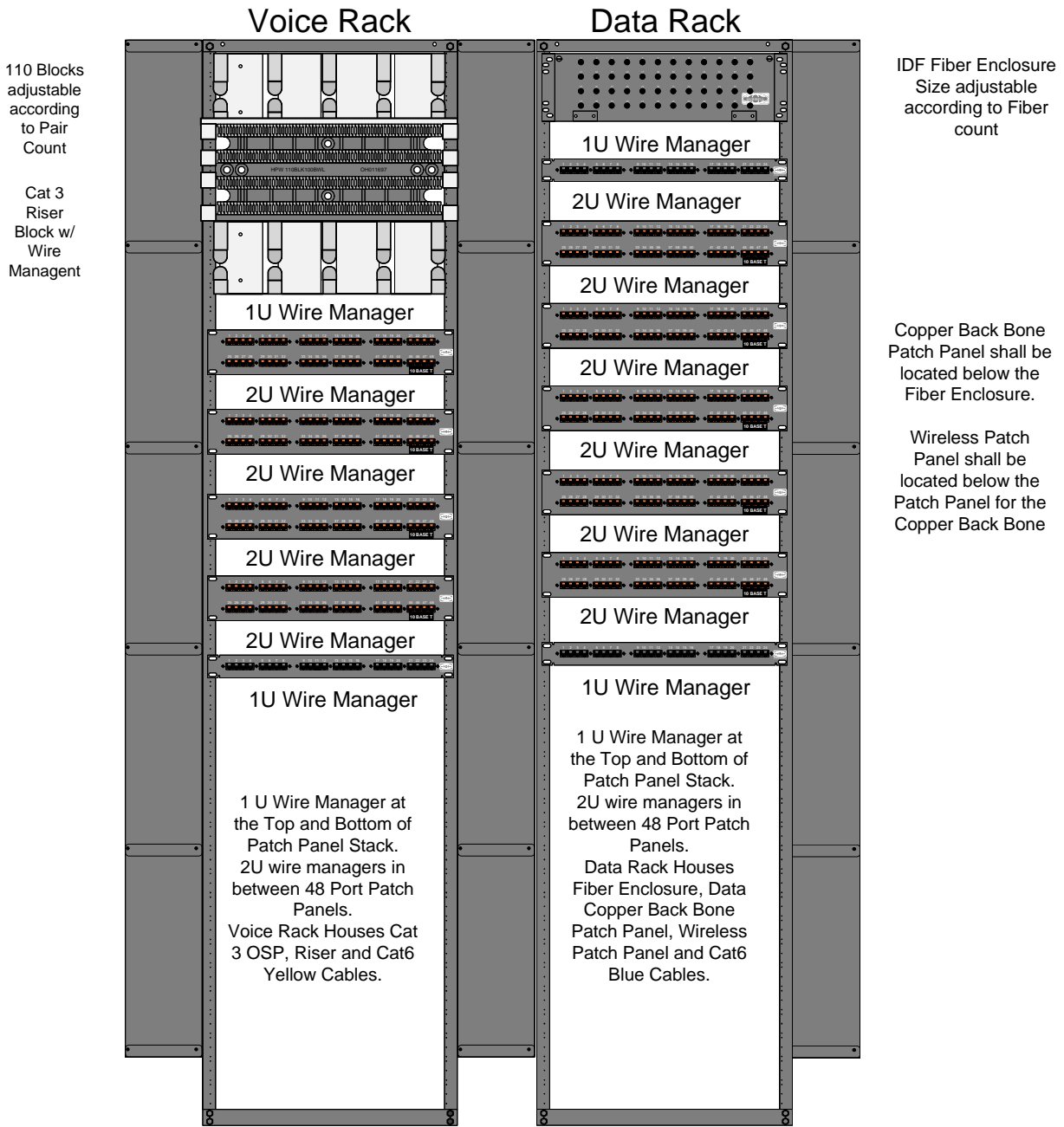


Typical BDF Layout. Diagrams are for Layout Purposes only, Refer to Part Numbers related to warranty being installed

Bottom Wire Manager shall not drop below the #16 RU Marking. Space below this RU is reserved for Switches, Rack Mount Power Strips and UPS's. If Necessary install a Third rack for Network Equipment

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Typical IDF Layout. Diagrams are for Layout Purposes only, Refer to Part Numbers related to warranty being installed

Bottom Wire Manager shall not drop below the #16 RU Marking. Space below this RU is reserved for Switches, Rack Mount Power Strips and UPS's. If Necessary install a Third rack for Network Equipment



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27 11 13 COMMUNICATIONS ENTRANCE PROTECTION

All copper entrance cable shall have a service loop and be terminated on a stub-in and stub-out building entrance terminal, (710 Splicing Only for Stubs In and Out) or a comparable substitute pre-approved by NAU/ITS and protected by gas tube type modules capable of handling surges higher than 300 volts sneak currents and incorporates a positive temperature coefficient self-resetting current limiter as is UL497 listed.

*Circa 1900-100K series Stub In/ Out 100 pair BETs with covers recommended
Consult with NAU/ITS for recommendations and approval on B.E.T.'s.*

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

All network and telecommunication equipment will be housed in 7' 19" Black 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 a minimum 4' from any wall in front of or behind it. Rack equipped with horizontal cable management above and below all patch panels and active equipment. Vertical cable management required on both sides of the rack and on all rack designs. Racks shall be equipped with rack mount 19" power strip 20A/120v with minimum of 8 NEMA5 -20R receptacles. Rack configuration requires pre- approval of NAU/ITS.

27 11 19 COMMUNICATIONS TERMINATION BLOCKS AND PATCH PANELS

All OSP twisted pair to be terminated on a stub-in and stub-out building entrance terminal with the stub in and out spliced with 710 modules. Building Entrance Terminal. (B.E.T) type must be pre-approved before installation.

All Category 3 OSP cabling shall be terminated on B.E.T.'s with stub in and stub out tails then transitioned to or directly terminated on Hubbell Brand Rack Mount 110 blocks. Cat 6 and 6a cabling to terminate on the same category type Patch Panels. Any analog or dial tone services shall terminate on 110 blocks in the Telco closets. No 66 Blocks

27 11 23 COMMUNICATIONS CABLE MANAGEMENT AND LADDER RACK

All cable management to conform to industry standards and comply with the specified warranty solution for Category 6 and 6a systems. All active and passive rack mount equipment to be separated by horizontal cable management. Vertical cable management required in all rack designs. Ladder rack required to all racks and for cable entrance into all telecommunication rooms (**18" wide Ladder Rack in the BDF/ IDF's**). All Category 3 OSP cable termination fields require **transitioning to** Hubbell brand Rack Mount 110 blocks for a cross connect field and horizontal management above and below.

27 11 26 COMMUNICATIONS RACK MOUNTED POWER PROTECTION AND POWER STRIPS

Minimum of one horizontal power strip 20A/120V with 8 NEMA5-20R receptacles. Power cord length shall be a minimum 8' with NEMA5-20R plugs.

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 **OS2**, and 50 micron Laser optimized multi-mode fiber **OM4**. Number of conductors to be determined by NAU/ITS on a per project basis. **20' Service loops shall be placed in all vaults and manholes. Minimum size service loops shall be 8' and not to exceed minimum bend radius.**

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27 13 13 COMMUNICATIONS COPPER BACKBONE CABLING

27 13 13.01 BUILDING COPPER BACKBONE

Building CAT 3 voice backbone cabling will consist of multi-pair (**25** pair minimum) **suitable** rated inside cable between BDF and all IDF's. All cable will be homerun and terminated at both ends on Hubbell Brand Rack Mount 110 blocks. All pairs tested for continuity, shorts grounds and wire map.

Building Data backbone will consist of White Category 6a cables certified at Category 6a specifications and be compliant for system performance warranty specified for that job **along with** 8.3 micron single-mode fiber **OS2**, and 50 micron Laser optimized multi-mode fiber **OM4** for data inter building backbone cabling.

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 **and be of the water tight and re-enterable type unless otherwise approved by NAU/ITS**. All splicing **shall be** completed with 710 type multiple pair connectors only. 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 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 Category 3 OSP 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

All Voice and Data Category 6 and 6a twisted pair cables will be tested with a 100% pass rate to the cable categories applicable standard for the following in accordance to Amendment 10 of the TIA/EIA-568-B.2 document:

- Insertion Loss (IL)
- Near End Crosstalk (NEXT)
- Power Sum Near End Crosstalk (PSNEXT)
- Attenuation to Crosstalk Ratio (ACR)
- Power Sum Attenuation to crosstalk Ratio (PSACR)



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- Far End Crosstalk (FEXT)
- Equal Level Far End Crosstalk (ELFEXT)
- Power Sum Equal Level Far End Crosstalk (PSELFEXT)
- Return Loss (RL)
- Wire Map
- Propagation Delay
- Delay Skew
- Length

No Hybrid cables allowed unless approved by NAU/ITS.

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 $9.20 \pm 0.40 \mu\text{m}$ at 1310 nm and $10.40 \pm 0.50 \mu\text{m}$ at 1550 nm. Fiber core-clad concentricity shall be $= 0.5 \mu\text{m}$. Fiber cladding diameter shall be $125.0 \pm 0.7 \mu\text{m}$. Fiber cladding non-circularity shall be $= 0.7\%$. Fiber coating diameter shall be $245 \pm 5 \mu\text{m}$.

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 $< 0.4 \text{ dB/km}$ at 1310 nm and $< 0.3 \text{ dB/km}$ at 1550 nm. For Tight Buffered constructions the cabled fiber attenuation shall be $< 1.0 \text{ dB/km}$ at 1310 nm and $< 0.75 \text{ dB/km}$ 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 $50 \pm 2 \text{ mm}$ 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 $75 \pm 2 \text{ mm}$ 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 $= 3.2 \text{ ps}/(\text{nm}\cdot\text{km})$ from 1285 nm to 1330 nm and shall be $= 18 \text{ ps}/(\text{nm}\cdot\text{km})$ 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.

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



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Fiber MM 50um Laser Optimized OM4

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 **OS2** and 50 Micron **Laser optimized multi-mode OM4** fiber optic backbone required between BDF and all IDF locations. **All cable to be homerun with no splices and installed in a 1" plenum or riser rated (depending on the application) suitable inner duct. 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. 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 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.

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. 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 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:

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



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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

Rack mount 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 black 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 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 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.

All fiber optic terminations/splices shall be fusion spliced.

Connectors LC SM

Connector shall be compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with the TIA/EIA Fiber Optic Connector Inter-mate ability Standard (FOCIS) document, TIA/EIA-604-2. The



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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. 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 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 APC SM

Connector shall be compliant with industry standard ANSI/TIA/EIA-568-B.3. The connector shall comply with TIA/EIA Fiber Optic Connector Inter-mate ability 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 LC MM 50um OM4 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 Inter-mate ability 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.

Splice case 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 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.

All Fiber/ Copper Splice Enclosures shall be water resistant. 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

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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 **office** workstations shall be fed by one (1) 4-pair 100 ohm balanced Category 6 plenum rated with yellow jacket cable with matching color jacks. **Manufacturer of cable must be accepted by the proposed warranty.** No Horizontal permanent link cable run shall exceed 90 meters. Cable shall be terminated at the work station on one (1) Category 6 yellow jack capable of Gigabit Ethernet (GbE). All Voice jacks should have Gigabit Ethernet (GbE) capability. ***Voice only locations shall consist of a Cat6 yellow cable and jacket on an appropriate type mounting plate.***

All Terminations shall be 568-A.

All office work stations shall consist of one (1) yellow Cat6 and two (2) blue Cat6 cables with matching color jacks. All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly ie:(cigarette packing)

27 15 00.19 DATA COMMUNICATIONS HORIZONTAL CABLING

All **office** workstations shall be fed by two (2) 4-pair 100 ohm balanced Category 6 plenum rated with blue jacket cables with matching color jacks. Manufacturer of cable must be accepted by the proposed warranty. No Horizontal cable run shall exceed 90 meters. 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. All Data jacks should have a Gigabit Ethernet (GbE) capability. 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 and 6a cabling. ***Data only locations shall have the colors split. (i.e. 2 Data only shall consist of 1 yellow and 1 blue jack with matching color cables, 4 Data only shall consist of 2 yellow and 2 blue jacks with matching color cables and so on.)***

All Terminations shall be 568-A

All office work Stations shall consist of one (1) yellow Cat6 and two (2) blue Cat6 cables with matching color jacks. All cable colors to be bundled separately in the ceiling and all closets. When cables enter the closets they will be packed neatly ie:(cigarette packing)

27 15 00.20 WIRELESS DATA COMMUNICATION HORIZONTAL CABLING

NAU wireless solution is Cisco 3602I or 3602E w/ external antennae (Cisco Aironet 2.4-GHz/5-GHz MIMO 4-Element Patch Antenna (AIR-ANT2566P4W-R)) 802.11n access points utilizing WISM 2 Controllers.



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Horizontal cabling shall be designed to meet minimum -61db signal strength in all areas. This is generally achieved with AP locations placement at a 35' radius. NAU/ITS shall use the planning mode of the Cisco Prime Infrastructure (PI) or other comparable software to generate the locations that meet 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. All WAP locations shall consist of (2) Cat 6a gray cables with matching color jacks. **No permanent link run shall exceed 80 meters (242') including the 30' service loop at the device end. All installations shall be installed in accordance to current TIA TSB-162-A. Wireless Cables shall be terminated 568-A on Hubbell Cat6a Patch Panels separate from the station cable Patch Panels.** All wireless cabling shall terminate in the BDF unless distance is an issue. **Telecommunications contractor is responsible for the mounting of all WAP's on projects.**

Any further question/ details shall be referred to NAU/ NOC.

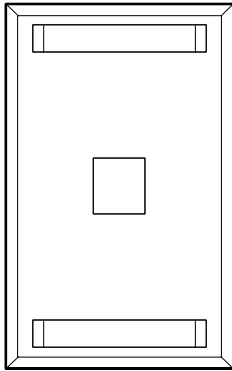
27 15 43 COMMUNICATIONS FACEPLATES AND CONNECTORS

Consult with NAU/ ITS for specified port openings per faceplate. Workstation locations fed by three (3) Category 6 4-pair cables. (color and material of the face plate to be determined by NAU/ITS) with three (3) Hubbell Category 6 modular jacks and one blank with matching color to the face plate if necessary. **(Category 6 and Category 6a cables and jacks terminated T568A).**

NAU/ ITS recommended face plate is white with modular jack colors matching the cable jacket colors. All work Stations shall consist of one (1) yellow Cat6 and two (2) blue Cat6 cables for all office locations, data only location colors shall be split between yellow and blue with matching color jacks terminated 568-A. (i.e., (2) data only locations shall consist of (1) yellow and (1) blue cable, (4) data only locations shall consist of (2) yellow and (2) blue cables and so on.

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1 Port Jack Color
Layout
Yellow

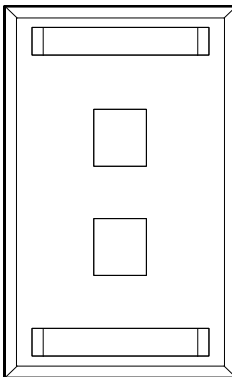
All Work Stations shall consist of:

(1) Double Gang Outlet box with Reducing Plate/ No Reducing plate for Double Gang Face Plates

(1) Yellow Cat6 Jack 1Gig Capable

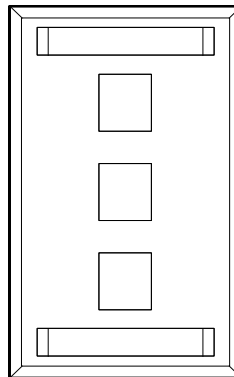
(2) Blue Cat6 Jacks 1Gig Capable

All data only location drops shall have the colors split
(ie. 2 data only shall consist of one yellow and one blue cable
4 data only shall consist of 2 yellow and 2 blue cables)



2 Port Jack
Color Layout
Yellow

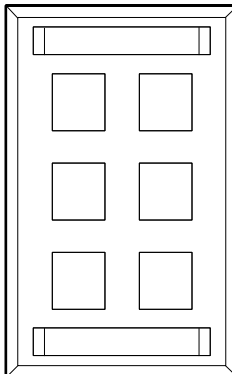
Blue



3 Port Jack Color
Layout
Yellow

Blue

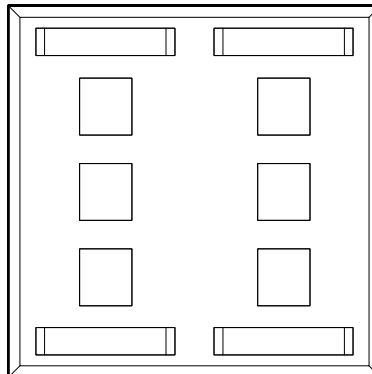
Blue



6 Port FP Jack Color
Layout
Station 1 Station 2
Yellow Yellow

Blue Blue

Blue Blue



DIVISION 27 - COMMUNICATIONS

Section Title
Number

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 be manufactured by Hubbell and 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 or Category 6a rated, factory terminated, meet horizontal cable specifications and shall be included in the System Warranty. All patch cords sized to provide a neat appearance. Patch cord colors shall match the designated application it is being used for.

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. 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. Enclosure shall have electrical ground, preferably within 20 feet and the use of a gas discharge type lightning arrestor is recommended. The response time should be 1ns or less. If additional surge protection is needed, Surge Arrestor, Pt 800-1018 is recommended. Housing associated with elevator phones shall be grounded

27 32 26 RING-DOWN EMERGENCY TELEPHONES

Phones

Manufacturer shall be Ramtel all models shall be ACA capable Ramtel PLC-8 or Ramtel PLC-7 column unit or the Ramtel PLW-6 wall unit. The critical feature is the All Campus Alert compatible components including the strobe, siren and speakers. Column units have 4 speakers and wall mounted units have 2 speakers per unit. The required unit color is safety blue. If warranted, shielding may be required to prevent interfering with the NAU observatory activity.



DIVISION 27 - COMMUNICATIONS

Section Title
Number
Phone locations

Phones will be placed in locations within walking distance of 200 feet of the closest emergency phone and the location light (blue) must be visible from at least one adjacent emergency unit. Phones must be ADA accessible and may not interfere with the NAU observatory.

Design professionals are required to include NAU /ITS, NAU PD, and the Dark Skies coalition in the siting of all emergency phones.

Submittals

Submittals for Ring-Down Emergency Phones to be provided to NAU PD and NAU/ITS for approval.

Installation

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. Enclosure and columns shall have electrical ground, preferably within 20 feet and the use of a gas discharge type lightning arrestor is recommended. The response time should be 1ns or less. If additional surge protection is needed, Surge Arrestor, Pt 800-1018 is recommended

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

27 35 00 CALL MANAGEMENT

All services provided and maintained by NAU/ITS