

Standard: Data Network Wiring Standards

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Revision History

Standard	Effective Date	Email	Version	Contact	Phone
OIT-DNWS		strevena@csustan.edu	1.0	Stan Trevena	209.667.3137

Part 1: General

1.01 Section Includes

- A. Fiber Optic Cable
- B. Fiber Optic Distribution Cabinets
- C. Interbuilding Fiber Optic Cabling/Patch Cords
- D. Fiber Optic Connectors
- E. Interbuilding Distribution Copper Cable
- F. Interbuilding Copper Cable Patch Cords
- G. Network Transceivers, Switches and Hubs
- H. Equipment Racks
- I. Standard Equipment Rack Accessories
- J. Data Modular Jacks K. Cable Runways
- L. Cable Supports M. Faceplates and Wall Boxes
- N. Innerduct
- O. Cable Pull Ropes
- P. Interbuilding Horizontal Distribution Coaxial Cable and Connector Cords
- Q. Coaxial Cable Connectors
- R. Broadband Distribution Fiber Optic Equipment
- S. Broadband Distribution Amplifiers
- T. RF Signal Splitters, Taps and Combiners Introduction and Purpose

1.02 Publications and Standards

A. Electronics Industry Associations/Telecommunications Industry Association (EIA/TIA) publications:

1. EIA/TIA 568B - Commercial Building Telecommunications Wiring Standards
2. EIA/TIA 569 - Commercial Building Standard for Telecommunications Pathways and Spaces
3. EIA/TIA TSB 72 - Centralized Optical Fiber Cabling Guidelines
4. EIA/TIA 606 - Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
5. EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications
6. EIA 310-D - Cabinets, Racks, Panels, and Associated Equipment
7. EIA/TIA 455-57A - Optical Fiber End Preparation and Examination
8. EIA/TIA 455-59 - Measurement of Fiber Point Defects Using an OTDR
9. EIA/TIA 455-60 - Measurement of Fiber Cable Length Using an OTDR
10. EIA/TIA 455-61- Measurement of Fiber Cable Attenuation Using an OTDR
11. EIA/TIA 455-95 - Absolute Optical Power Test for Optical Fibers and Cables
12. EIA/TIA 526-14 - Optical Power Loss Measurements of Installed Multimode Fiber Cable

B. IEEE 802.3 - Ethernet Specification.

C. ANSI/ICEA S-83-596-1994 - Fiber Optic Premise Distribution Cable Technical Requirements.

D. NCTA - Recommended Practices for Measurements on Cable Television Systems.

E. SCTE - Broadband System Communications Certification, Installer

F. FCC Part 15 and Part 68.

G. Installation shall be performed in accordance with the following applicable standards:

1. Applicable codes and regulations of the Government of the State of California, Stanislaus County, and the City of Turlock.
2. Building Officials and Code Administration National Code (BOCA)
3. Electronic Industries Association (EIA)

4. Federal Communications Commission (FCC)
5. Institute of Electrical and Electronic Engineers (IEEE)
6. National Electrical Code (NEC)
7. National Fire Protection Association (NFPA)
8. National Electrical Manufacturers Associations (NEMA)
9. Occupational Safety and Health Administration (OSHA)
10. Telecommunications Industries Association (TIA)
11. Underwriters Laboratories (UL)
12. Building Industry Construction Standards Institute (BICSI) 13. Stanislaus State OIT Guidelines and Specifications

1.03 Submittals

A. See Division 1 for general submittal procedures.

B. Installer Certification: Provide proof of satisfactory completion of installation training and certification, for the staff approved to undertake the following tasks:

1. Fiber optic installation and test procedures
2. UTP Cat 5 and Cat 6 copper cable installation and test procedures
3. Coaxial cable installation and test procedures
4. Grounding installation and test procedures.

C. Within thirty (30) days following the date of issuance of the Notice to Proceed, the Contractor shall provide the following to the Engineer for review:

1. Manufacturer's cutsheets for all of the itemized products in Part 2 - Products of this Specification. Samples of each product may be requested at the discretion of the Telecommunications Facilities Planner at any time.
2. Mounting and attachment details illustrating the connection of equipment racks to the structure, and the connection of the specified equipment to the equipment racks.
3. Equipment rack elevations illustrating the vertical locations of the terminal equipment (i.e. fiber boxes, patch panels, etc.).
4. Wall elevations illustrating the vertical routing of all cabling into the destination terminal points and the manner in which the cabling shall be dressed and terminated.

5. Detailed elevations of all CATV backboards illustrating vertical locations of CATV equipment to be installed.

1.04 Quality Assurance

A. Installer Qualifications: Company specializing in installing voice and data and video premises wiring with minimum three years documented experience.

B. The Contractor shall ensure that all design, workmanship, materials employed, required equipment, and the manner and method of installation conforms to accepted practices. The Contractor shall also ensure that each piece of equipment is in satisfactory working condition.

C. In completing the Work, the Contractor shall adhere to all applicable professional practices, including but not limited to the standards set forth herein, governing the installation of Fiber Optic Systems, Network wiring and associated components.

1.05 Work included

A. Trenching and backfilling for all underground conduit systems installed shall be the responsibility of the Contractor. Joint trenching should be utilized where practical. Sand shall be used as backfill material and shall be compacted in accordance with and coordinated with the grading and site preparation requirements. Locations of existing underground systems shall be determined by hiring an underground utility service company (at the Contractor's expense) or, for applicable areas or utilities, by calling Underground Service Alert (USA) at least 48 hours prior to any excavation. All underground work shall be performed as directed by the serving utility companies. The Facilities Planner must also be notified prior to the commencement of work.

B. No work shall be concealed until after inspection and approval by proper authorities. If work is concealed without inspection and approval, the party that concealed said work shall be responsible for all work required for opening and restoring the concealed areas, in addition to all required modifications.

1.06 Clean Up and Repair

A. Upon completion of an installation task, the relevant areas and equipment shall be left clean and in an operational state.

B. The Contractor shall be responsible for debris removal and repairing any damage caused to the premises by the Contractor's installation activities, at no cost to the Owner or any other contractor working on the project.

Part 2: Products

2.01 Fiber Optic Cable

A. Fiber optic cable shall be used for data communications and broadband video. All buildings will have one run from the Stanislaus State Data Center on the Main Campus to the appropriate equipment room and one run from a redundant core to the same equipment room.

B. Outside plant fiber optic cabling shall be composite design, fiber optic cabling with multimode and single mode strands.

C. Indoor Multimode Plenum Building Cable and Indoor Singlemode Plenum Rated Building Cable shall be installed indoors with the sizes per individual building specifications.

2.02 Fiber Optic Distribution Cabinets

A. A fiber optic distribution shelf shall be used for terminating and/or splicing fiber optic cables for fiber interconnects up to 144 ports. The shelf shall be rack mountable (on standard 19" rack frames), for acceptance of fiber optic connections.

B. Distribution shelf shall be fiber optic modular shelf.

2.03 Interbuilding Fiber Optic Cabling/Patch Cords

A. Multimode Fiber:

1. Physical Specifications

a. Fiber Dimension

- i. Core: 62.5 microns
- ii. Cladding: 125 microns
- iii. Coating: 250 microns
- iv. Buffering: 900 microns

b. Cable Minimum Bending Radius

- i. During Installation: 20 times the outside cable diameter
- ii. After Installation: 10 times the outside cable diameter

c. Buffered Fiber Minimum Bend Radius: 0.75 in.

d. Operating Temperature Range: -40 to 185 degrees F

e. Storage Temperature Range: -40 to 158 degrees F

2. Optical Specifications a. Maximum Fiber Loss

- i. 3.4 dB/km at 850 nm (Typical range 2.8-3.2 dB/km)
- ii. vi. 1.0 dB/km at 1,300 nm (Typical range 0.5-0.8 dB/km)

b. Minimum Bandwidth

- i. 200 MHz-km at 850 nm (Typical range 200-400 MHz-km)
- ii. 500 MHz-km at 1,300 nm (Typical range 700-1,000 MHz-km)

c. Numerical Aperture: 0.275

3. Number of fiber strands as required for service.

4. Indoor composite.

B. Single-Mode Fiber:

1. Physical Specifications

a. Fiber Dimension

- i. Core: 8.3 microns
- ii. Cladding: 125 microns
- iii. Coating: 250 microns
- iv. Buffering: 900 microns

b. Cable Minimum Bending Radius

- i. During Installation: 20 times the outside cable diameter
- ii. After Installation: 10 times the outside cable diameter

c. Buffered Fiber Minimum Bend Radius: 0.75 in.

d. Operating Temperature Range: -40 to 185 degrees F

e. Storage Temperature Range: -40 to 185 degrees F

2. Optical Specifications a. Maximum Fiber Loss - Depressed Clad

- i. 0.4 dB/km at 1,310 nm
- ii. 0.3 dB/km at 1,550 nm

b. Maximum Fiber Loss - Matched Clad

- i. 5 dB/km at 1,310 nm
- ii. 0.5 dB/km at 1,550 nm

3. Number of fiber strands as required for service.

4. Indoor composite. 2.04 Fiber Optic Connectors

A. LC Connector.

2.04 Fiber Optic Connectors

2.05 Interbuilding Distribution Data Copper Cable

A. Horizontal distribution copper cable shall be specified as either 4-pair, plenum rated, Category 6 or Cat 6A cable. High-speed cable shall be UL Verified Category 6 or Cat 6A and UL Listed Type CMP for use in return air handling spaces. Bare solid copper conductors shall be insulated with FEP, twisted into pairs and jacketed with low-smoke PVC.

B. The number of patch cords supplied to the Owner shall be twice the number of terminated and available ports on the patch panels PLUS 5% overhead to cover possible damaged or defective cords. Copper patch cords shall be tested to same standards as horizontal cabling.

C. Patch cords shall be equal number of both Cat 6 or Cat 6A (Lt. Blue) 7FT and 14FT (unless other lengths specified by Facilities Planner).

2.06

2.07

2.08 Network Transceivers, Switches and Hubs

A. All network transceivers, switches, and any other “active” equipment used for internetworking are generally not a part of a contract and shall be supplied by others. Our summary of work involves the implementation of a network “backbone” cabling system that can be used for interconnection of buildings and sites.

2.09 Equipment Racks

A. Floor-Mounted, Full Height Racks

1. Full height equipment racks shall be universal self-supporting racks made from high strength 6061- T6 aluminum extrusion construction. Fifty (50) special #12-24 mounting screws with combination Phillips/straight head in roll-formed mounting holes. Universal 5/8”-5/8”-1/2” alternating hole pattern. 19” EIA standard rack width and 7’ rack height. Each rack shall be equipped with two single sided non-vented shelves (P/N 40108-519) and will be equipped with both a Ground Terminal Block (P/N 080009-001) and a rack mounted Ground Bar (P/N 10610-019) installed with green #6 wire to the building ground. Include rack and frame mounting installation kits. Floor anchors shall be 5/8” expandables for 5/8” allthread. Anchors to be epoxied in concrete. Chatsworth Products, Inc. (P/N 46353-503)

2.10 Standard Equipment Rack Accessories

A. Rack Enclosure:

1. To be used where shown on drawings. Enclosure shall have cable access with removable sides, rear-kick panel and cut-out top sections. Modular design with lockable Plexiglas or metal doors. Ventilation fan and filter assembly, capable of at least 400 CFM, with integrated design, shall be included with the rack enclosure. Chatsworth Products, Inc. M Series

B. Stand Off Tie Brackets:

1. Stand off tie brackets are mounted to the back of the equipment racks for cable management. Use where appropriate to provide neat and organized cable run dressing behind the equipment racks. Brackets are made from aluminum. Chatsworth Products, Inc., Part #10559-500.

C. Patch Cord Organizers

1. Patch cord organizers shall provide horizontal pathways for routing of cords and cables. Organizers shall be able to mount properly onto a standard 19" rack.

D. Modular Jack Patch Panels

1. Patch panels shall be able to mount properly onto a standard 19" rack. Rear of panel shall have 110D connecting blocks mounted on a printed wiring board (PWB) for cable termination. The 110D connecting blocks shall have a continuous connection to the 8-pin modular jack field on the front of the panel through the PWB interconnections. Wiring shall comply with EIA/TIA Standard T568B. Include label strips for modular jack identification

2. Patch panels shall be for Cat 6 and Cat 6A.

2.11 Modular Jacks

A. Shall be 8-position/8-conductor high-density modular information jacks designed for high speed networking applications up to 350 MHz. Modular jacks shall be acceptable for EIA/TIA 568B wiring. Compatible with M series modular faceplates, frames, or surface mounted boxes.

B. Data, RJ-45 type, Cat 6 compliant and Blue in color.

C. Data, RJ-45 type, Category 6 compliant and Orange color.

E. Voice, RJ-45 type, Category 6 compliant and Ivory color, unless specified white.

2.12 Cable Runways

A. Cable runways (trays) shall be tubular rectangular steel ladder construction. Side stringers are to be 1-1/2"X3/8". Cross members are to be 1/2"X1" and welded to side stringers at 9" on center. 12" wide. UL Classified. Use factory mounting brackets, joiners, retainers, 5/8" All Thread hangers, cable posts and end posts to make a complete and operable system.

B. Chatsworth Products, Inc.

2.13 Cable Supports

- A. Shall comply with UL, NEC and EIA/TIA requirements for structured cabling systems. Provides support of Category 6, fiber optic and coaxial cable as required. Suitable for air plenums. Cable supports shall be used with raised floor system - as defined in a separate section of this specification. Anchorage appropriate for sub floor system, per manufacturer's recommendations.
- B. Cable support shall be "Under-The-Floor" Support or approved equal.

2.14 Faceplates and Wall Boxes

- A. Faceplates shall be capable of accepting up to 4 modular jacks per faceplate. Compatible with a standard single gang wall box. Compatible with M-series modular information outlets. Ivory finish unless specified white.
- B. Flush or surface mounted wall boxes shall be single gang type, compatible with outlet as shown on the drawings. Specified elsewhere in this specification.

2.15 Innerduct

- A. One to 2" diameter plenum innerduct, sized as required for 40% cable fill.
- B. Corrugated, PVDF to meet plenum requirements for low friction
- C. Shall comply with UL-910. ITS Unified Communications X Data Network Wiring 11/4/2014 Page 8
- D. Shall be provided in orange or white color.
- E. Endot Industries, Model Type Endocor, Plenum rated, or approved equal.

2.16 Cable Pull Ropes

- A. 3/16" polypropylene 800 lbs. minimum test pull rope in 2" conduits and above. 1/8" polypropylene 200 lbs. minimum test pull rope in conduits below 2".

2.17 Interbuilding Horizontal Distribution Coaxial Cable and Connector Cords

- A. Horizontal distribution coaxial cable shall have the following characteristics:
 - 1. Plenum, Coaxial Computer, Instrumentation and Broadcast Cable. RG-6/U, 18 AWG solid bare copper-covered steel conductors with FEP insulation. 100% shield coverage - shielded and tinned copper braid, 95% coverage. Black tint FEP jacket.
 - 2. Temperature Rating: 200°C.
 - 3. Suggested Operating Temperature Range (Non-UL): -70°C to +200°C.
 - 4. Maximum Operating Voltage (Non-UL): 300 Volts RMS.

B. Video Connector Cords:

1. The number of connector cords supplied to the Owner shall be equal to the number of available outlets located within the space, plus 5% overhead to cover possible damaged or defective cords. Typical length of 10 feet with "F" barrel connectors at both ends. Coaxial connector cords shall be tested to same standards as horizontal cabling.

C. Cable shall be Plenum RG-6,

2.18 Coaxial Cable Connectors

A. General F Barrel Connectors

1. Deep crimp ring for plenum cable, metal to metal.
2. Brass body with bright acid tin plating.
3. Teflon insulator.
4. No thread flats.
5. Phosphor bronze contacts.

B. RG-6 Connectors

1. Connectors rated to 1 GHz. Connectors compatible with RG-6 cable specified above, or approved equal.

2.19 Broadband Distribution Fiber Optic Equipment

- #### A. Provide fiber optic conversion equipment as specified within the Contract Drawings.

2.20 Broadband Distribution Amplifiers

- #### A. Distribution amplifiers shall be for high output and low noise amplification, and made for VHF, FM and UHF signal reception. Specific model shall include a manual variable gain control capable of the output signal as noted on the drawings. Lighting and surge protected power supplies shall be included with the unit. Distribution amplifiers shall be Blonder Tongue, Model #ZTA-series, or approved equal.

2.21 RF Signal Splitters, Taps and Combiners

- #### A. All RF signal distribution devices shall be 2, 3, 4 or 8 way models. Performance up to 750 MHz minimum. Die cast housing, RF shielding, mounting tabs and grounding blocks. Blonder Tongue, Model #CR-series, or approved equal.

Part 3: Execution

3.01 Examination

- A. Contractor will be held to have familiarized himself with the existing site conditions and no extra payment will be allowed for work required because of these conditions, whether specifically mentioned or not.
- B. Contractor must verify locations, routes, and dimensions by inspecting the site prior to installation. In addition, the Contractor must verify that all electrical requirements are installed and the installed conduits and sleeves have the capacity to carry the cabling defined on the Drawings. Any discrepancy noted between the site conditions and information shown on the plans must be brought to the attention of the Facilities Planner in writing. Commencement of work after field examination implies the acceptance of site conditions.
- C. Lines of other services damaged, as a result of this work, shall be promptly repaired at no expense to the Owner, and to the complete satisfaction of the Owner. Ceiling grid, ceiling and floor tiles, architectural features, paint work, broken or defaced by the Contractor during the installation and testing process must be replaced by the Contractor, at no cost, and to the complete satisfaction of the Owner. Landscaping, sidewalks, and other exterior features damaged, broken, or defaced by the Contractor during the installation and testing process must be replaced by the Contractor, at no cost, and to the complete satisfaction of the Owner.
- D. The Drawings and Specifications do not necessarily describe all work required to achieve the intent of the Contract Documents. On the basis of the summary of work described herein, and/or indicated on the Drawings, the various Contractors shall furnish all items and labor required for the proper execution and completion of the work.

3.02 Testing

- A. All data and cable testing shall comply with applicable IEEE, SCTE and EIA/TIA standards.
- B. All optical fibers shall be end to end tested at 850 nm with a power loss test device, from one direction only.
- C. Fiber optic cables shall meet the FOTP standards put forth by the EIA-455 standard, and shall use an Optical Time Domain Reflectometer (OTDR). OTDR test signature trace of cable shall include (1) attenuation per kilometer and (2) total length of each strand. Test multimode at 850 nm and single-mode at 1310 nm. Each strand shall be tested in both directions.
- D. Testing of all twisted pair copper cabling shall comply to or exceed Category 5 (voice) or Category 6 (data) performance limits and transmission specifications in accordance with EIA/TIA-568(A/B), EIA/TIA SP 2840, EIA/TIA TSB36, TSB40, TSB41 and NEMA Low Loss extended frequency requirements, including Near End Cross Talk (NEXT) and Attenuation requirements.
- E. Complete Cat 5 or Cat 6 4-pair testing must be performed with full sweep frequency measurements for, at least, 1 to 100 MHz. This test will establish each channel's installed performance measurement. Cable must meet or exceed manufacturer's specifications and be tested at the highest applicable speeds.

1. Near End Cross Talk and Attenuation Standards

a. At Frequency of 1.0 MHz

i. NEXT = 60.3 dB at 100 m.

ii. Attenuation = <2.4 dB/100 m at 20 degrees C.

b. At Frequency of 4.0 MHz

i. NEXT = 50.6 dB at 100 m.

ii. Attenuation = <4.7 dB/100 m at 20 degrees C.

c. At Frequency of 8.0 MHz

i. NEXT = 45.6 dB at 100 m.

ii. Attenuation = <6.3 dB/100 m at 20 degrees C.

d. At Frequency of 10.0 MHz

i. NEXT = 44.0 dB at 100 m.

ii. Attenuation = <7.0 dB/100 m at 20 degrees C.

e. At Frequency of 16.0 MHz

i. NEXT = 40.6 dB at 100 m.

ii. Attenuation = <9.0 dB/100 m at 20 degrees C.

f. At Frequency of 20.0 MHz

i. NEXT = 39.0 dB at 100 m.

ii. Attenuation = <10.0 dB/100 m at 20 degrees C.

g. At Frequency of 25.0 MHz

i. NEXT = 37.4 dB at 100 m.

ii. Attenuation = <11.3 dB/100 m at 20 degrees C.

h. At Frequency of 31.25 MHz

i. NEXT = 35.7 dB at 100 m.

ii. Attenuation = <12.6 dB/100 m at 20 degrees C.

- i. At Frequency of 62.5 MHz
 - i. NEXT = 30.6 dB at 100 m.
 - ii. Attenuation = <18.3 dB/100 m at 20 degrees C.
- j. At Frequency of 100.0 MHz
 - i. EXT = 27.1 dB at 100 m.
 - ii. Attenuation = <23.6 dB/100 m at 20 degrees C.

F. Perform sweep testing on all coaxial cable from 5 to 1000 MHz, and adhere to the electrical and transmission standards for capacitance, impedance and attenuation of RG-6 cabling, as defined by the Society of Cable Television Engineers (SCTE).

1. Coaxial Attenuation Standards - RG-6 Cable

- a. At Frequency of 5.0 MHz
 - i. Attenuation = <0.81 dB/100 m at 20 degrees C.
- b. At Frequency of 55.0 MHz
 - i. Attenuation = <1.6 dB/100 m at 20 degrees C.
- c. At Frequency of 211.0 MHz
 - i. Attenuation = <3.08 dB/100 m at 20 degrees C.
- d. At Frequency of 270.0 MHz
 - i. Attenuation = <3.5 dB/100 m at 20 degrees C.
- e. At Frequency of 300.0 MHz
 - i. Attenuation = <3.7 dB/100 m at 20 degrees C.
- f. At Frequency of 330.0 MHz
 - i. Attenuation = <3.89 dB/100 m at 20 degrees C.
- g. At Frequency of 400.0 MHz
 - i. Attenuation = <4.3 dB/100 m at 20 degrees C.
- h. At Frequency of 450.0 MHz
 - i. Attenuation = <4.58 dB/100 m at 20 degrees C.

- i. At Frequency of 550.0 MHz
 - i. Attenuation = <5.09 dB/100 m at 20 degrees C.
- j. At Frequency of 750.0 MHz
 - i. Attenuation = <6.0 dB/100 m at 20 degrees C.
- k. At Frequency of 870.0 MHz
 - i. Attenuation = <6.5 dB/100 m at 20 degrees C.
- l. At Frequency of 1000.0 MHz
 - i. Attenuation = <7.0 dB/100 m at 20 degrees C.

G. Test results (cable run sheets) must be recorded and presented to the Facilities Planner in report format. Any fiber, cable or link failing to meet the testing standards defined herewith must be removed and replaced, at no additional cost to the Owner, with a fiber, cable or link that adheres to the same testing standards. Final closeout will not be approved until all materials meet the appropriate standards.

1. Test report shall identify each cable link by label identification, and shall include the following results for each technology:
 - a. Fiber Optic Cable: OTDR testing, insertion loss, attenuation and end-to-end integrity.
 - b. Copper Cable: NEXT and attenuation testing at each frequency, all opens/shorts/grounds, impedance, delay, and total loop resistance.
 - c. Coaxial Cable: Attenuation testing at each frequency.

3.03 Installation

- A. Install in accordance with manufacturer's instructions.
- B. Wiring shall conform with EIA/TIA-568A wiring standards.
- C. Maintain Category 5E, 6 and fiber optic bend radius, pulling tension and cable support requirements in the cabling runs. The cable manufacturer's specifications for each particular cable type shall be following exactly. All cable shall be installed in continuous runs, end to end, between patch bays. No splices or taps will be permitted.
- D. Provide cable protectors at far end of all cable that is run underground from the Computer Center or Switch location.
- E. All cable shall be visually inspected for insufficient bend radius during and after pulling. Appropriate forms shall be used to maintain proper radii at cable entrances and exits. All cable shall

be pulled using an appropriate measuring device to ensure that the specified maximum pulling force is not exceeded. Install bending forms in all junction boxes to ensure minimum bend radius.

F. Coaxial cables shall have a minimum bending radius of ten (10) times the cable diameter.

G. Maximum cable length from the telecommunications closet to the workstation area is to be 290 feet, excluding patch cords and equipment cords

H. Provide and install cable supports for any horizontal spans greater than three (3) feet. Provide and install cable supports for any vertical spans, between the cable trays and poke throughs/sleeves greater than three (3) feet. Tie wraps shall be used for spans of less than six (6) feet.

I. Provide a minimum of 0 feet of coiled cable near the rack location at each location to facilitate final termination and proper cable dress.

J. All deviations from straight runs shall be made at right angles, wherever possible. Cables shall be mounted as high as practicable, and kept clear of line voltage electrical conduits.

K. Route cable bundles only on the sides of the data racks. Routing of cable bundles directly behind the wall or floor mounted rack is unacceptable.

L. All cables shall be protected from sharp metal edges.

M. Framework and racking must be free from burrs and sharp edges or points. The protuberance of bolts and/or threaded rods shall not exceed a length equal to $\frac{1}{4}$ of the bolt or rod diameter. Frame end sections must be closed with caps, as appropriate.

N. Empty or future conduits shall be correctly plugged with plastic caps or inserts with a 3/8" polyethylene pull rope. Plugging conduits with plastic tape or "duct" tape is not acceptable.

O. Conduit run within new or existing walls shall be EMT type, as specified elsewhere within this specification.

P. Provide a service loop in each pull box and hand hole. At a minimum, enough cable shall be left in each hand hole to loop twice around the interior of the box.

Q. Innerduct shall be used whenever fiber optic cabling is routed in the ceiling space without metallic conduit. (i.e., around beams, existing ductwork, piping, etc.)

R. All patch panels and adjoining cables are to be properly labeled. There shall be no unlabeled cables.

S. Cable trays shall be level. No deviation allowed.

T. Take precautions as required to guard against electromagnetic inductance, which may adversely impact the coaxial broadband cable. Where possible, place broadband cables and cable conveyance systems (i.e. conduit, cable raceway, etc.) a minimum of 12" away from all high voltage devices, conduit, etc., and a minimum of 48" away from all power transformer and motor devices. Should

broadband wiring cross high voltage wiring and/or conduit, the intersection shall be made at 90 degrees.

U. Ensure that all connectors, for fiber optics, copper and coaxial cables, are properly attached as per manufacturer's specifications.

V. Terminate all unused outputs.

W. All labels, boxes, racks, equipment, etc. shall be secured plumb and square.

X. A ten-foot service loop must be made at the station side in all plenum ceilings, floors, and Hoffmann trays, provided cable distance limits are not exceeded.

3.04 Labeling

A. All fiber optic, copper and coaxial cables shall be labeled and serialized using "Brother" brand, or approved equal, machine printed cable labels.

B. All cables must be labeled at each end with cable identification markers spaced not more than 12" away, and not closer than 2", from each cable end.

C. Cable labels shall be machine printed. All labels shall be protected with a clear plastic overwrap or with clear shrink tubing.

D. Cable labels shall include the following information: cable number, cable source (i.e. room number and/or device output) and cable destination (as appropriate).

E. There shall be no unmarked cables.

F. All technology outlets and patch panels shall be uniquely numbered, coordinated and labeled. Labels shall be machine printed (embossing is not acceptable). The labels shall have protective overlays.

3.05 Grounding

A. The Contractor shall provide ground bus bars within each equipment cabinet and equipment rack. Said bus bar shall be bonded to the frame of the cabinet or rack.

B. The Contractor shall provide an individual ground wire from each distribution closet equipment rack ground bar to a building master ground bar. Verify location of master ground bar in field.

C. All telecommunications grounding shall comply with EIA/TIA 607.

3.06 Acceptance

A. Final acceptance will not be given until, at a minimum, the following criteria are satisfied:

1. All test results have been completed and delivered to the Facilities Planner, and approved.

2. All punch list items have been completed to the satisfaction of the Facilities Planner, and approved.

3. All technical documentation has been turned over to the Planner Facilities Planner, and approved.