THE PENNSYLVANIA STATE UNIVERSITY

TELECOMMUNICATIONS & NETWORKING SERVICES

MINIMUM STANDARDS FOR

TELECOMMUNICATION FACILITIES

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Revised February 28, 2006
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1.0 PURPOSE
This document sets forth the minimum standards and requirements of Penn State's Telecommunications & Networking Services (TNS), Special Projects - Engineering Group for new construction, rewiring, and renovations of buildings.

All designs must be reviewed and approved by the TNS Engineering Group.

All designs shall be in compliance with all applicable Federal, State, and Local codes, ordinances, laws and other regulations that have jurisdiction over the project.

If any variances exist with the material in this standard, the most demanding requirement shall apply.

2.0 GENERAL
All local, state and federal rules and regulations must be adhered to. This shall include, but not be limited to "OSHA" safety regulations, Pennsylvania "One Call" requirements, and NESC safety concerns.

REFERENCES:


• Building Industry Consulting Service International's (BICSI), Telecommunications Design Methods Manual (TDMM)

• Electronic Industries Association/Telecommunications Industry Association (EIA/TIA), Building Wiring Standards.

• American Association of State Highway and Transportation Officials, (AASHTO).

• Occupational Safety and Health Administration, (OSHA).

• National Electrical Safety Code, (NESC).

• National Electrical Code, (NEC).
3.0 OUTSIDE PLANT - UNDERGROUND

3.1 Conduits

All exterior underground conduits used for telecommunications applications shall be 5-inch NEMA TC-6 type EB PVC plastic duct encased in concrete as outlined in the latest revision of Penn State's Design and Construction Standards.

A minimum of six 5-inch ducts shall be installed between manholes and a minimum of four 5-inch ducts shall be installed into a building. All conduits are to be encased in a 3-inch concrete envelope as shown in figure 3-1 and 3-1A.

Conduit shall be placed at a minimum depth of 30-inches below ground level to the top of the structure. Under roadways depth will be a minimum of 36-inches. Cover and concrete encasement will contain 1/2-inch deformed steel reinforcing bars as shown in figure 3-1.

Changes in direction either vertical or horizontal, shall be accomplished with bends of the appropriate angle (90, 45, 22 1/2 or 11 degrees) to provide a smooth transition and mild pulling radius. The aggregate total of bends between structures (i.e., manhole to manhole, manhole to pole, building or pad) shall not exceed 180 degrees. All bends shall have a minimum radius of 60 inches.

Special circumstances may utilize conduits of different size or composition. All variations must be reviewed and approved by TNS Engineering.

Conduit joints shall be joined utilizing a good quality solvent cement (i.e., Carlon Co.). Joints shall be staggered in their placement. Conduits shall be spaced 2-inches apart both vertically and horizontally as shown in figure 3-1 and 3-1A.

Upon completion of a duct structure all conduits shall be tested by drawing an appropriately sized slug or mandrel through each duct to assure the integrity. A pull line with a minimum tensile strength of 300 pounds and composed of a non-degradable material shall be placed in all conduits.

3.2 Building Entrance Conduit

Conduit from a manhole to a building shall consist of a two-by-two configuration of four 5-inch PVC conduits encased in concrete as shown in figure 3-1A. Dependent on approval of TNS Engineering, it may be acceptable in the case of smaller buildings to place two 5-inch PVC conduits.

At the point of entry, into either a building or manhole wall, steel reinforcing bars shall be placed along the conduit within the concrete to extend within the foundation or manhole wall. This reinforcing is to extend a minimum of four inches into the wall and five feet in the conduit structure. See figure 3-1. This is to eliminate the potential of the conduit shearing where the two structures meet.

The four 5-inch conduits shall terminate inside the room equipped with bushings. All conduits shall be sealed with rubber conduit plugs, Jackmoon U.S.A. Inc., Part No. 50D535U, Carlon Telecom Systems, Part No. MAEPG8, General Machine Products Co. Inc., Part No. 66638 or TNS Engineering approved equivalent. The 5-inch conduit entering the building beyond the point of penetration shall be installed in compliance with the National Electrical Code (NEC).
3.3 Manholes

3.3.1 Precast manholes

The standard manholes for campus applications shall be precast concrete, 6-foot wide, by 12 foot long, by 7 foot head room, industry standard type 38Y, available in type A (figure 4-1) and type J, L, and T (figure 4-2). Local conditions may dictate a different size or configuration of manhole, in which case, it must be approved by TNS Engineering.

Manholes must be set with a minimum 2-foot of cover to top of the concrete roof, and where possible, placed off of roadways in grass plots, medial strips or lawn areas.

3.3.2 Cast in place manholes

Certain locations may require a cast in place manhole. All cast in place manholes must meet the American Association of State Highway and Transportation Officials (AASHTO) specifications.

   a. All conduits entering or leaving manholes shall be placed at basically the same elevation and placed in such a fashion as to permit pull through type cable placement, see figure 4-3.

   b. Provide two 30 inch Type "B" cast iron frames and covers, ladder and racking as specified in the equipment section of this standard. See figure 4-8.

   c. Provide a 12 inch round or 12-inch square by 8-inch deep sump hole in the floor under one of the lids. The floor shall slope to the sump hole.

3.3.3 Manhole Equipment

All manholes shall be equipped with two 30-inch cast iron frames and covers. The castings shall be set on concrete collars or on a minimum of two courses of brick laid flat and parged to seal. Manholes shall be racked with all galvanized hardware as shown in figures 4-4, 4-5 and 4-6. Cast in place and non-standard manholes shall have inserts cast in the walls at the spacing shown in figure 4-5. Provide pulling in irons cast in the walls directly opposite the various duct entrances as shown in figure 4-7. All manholes shall be equipped with a free standing galvanized steel ladder with anti-slip steps, of the appropriate length to extend from the floor to a point in the collar just below the lid as shown in figure 4-8.

3.3.4 Frame and Cover Adjustments

From time to time the elevations of the manhole casting may change to accommodate paving and surface reconstruction. This may require removing the frame and cover and building up the collar or brick and resetting the frame. In some cases the raising operation may be accomplished through the use of manhole extension rings (cast iron or steel). These rings must be ordered to fit the appropriate diameter (36-inch, 30-inch, or 27-inch) and the appropriate rise required (1 1/2-inch, 2-inch, or 3-inch). It is required that an epoxy-based cement be used on the contact surfaces of the extension ring. It is also required that TNS Engineering be involved in the determination of utilizing extension rings or requiring the frame to be reset.

4.0 OUTSIDE PLANT - AERIAL

From time to time it may become necessary to install cable plant in an aerial manner. All aerial cable installations must be approved by the TNS Engineering.
5.0 BUILDING DISTRIBUTION REQUIREMENTS

5.1 Telecommunication Rooms

5.1.1 General

Each building shall have at least one dedicated telecommunications room.

The requirement for a single telecommunications room is based on the premise that the cable distance from the furthest jack location to the room cannot exceed 90 meters. When there are multiple equipment rooms within a building they shall be connected with a minimum of two 4-inch conduits with pull wires. If the rooms are stacked, sleeves may be provided between the floors. All sleeves shall be equipped with fire stops.

The horizontal cable distance cannot exceed 90 meters (295 ft.) from the patch panel to the telecommunications outlet faceplate.

The minimum required square footage of the telecommunications room is determined by multiplying the assignable square footage for the building by 0.0075. The minimum is 150 square feet with a minimum width of 7 feet and a minimum ceiling height of 8 foot 5 inches without obstructions. A false ceiling shall not be provided.

The room shall be equipped with a door, 3 foot 0 inches by 6 foot 8 inches minimum size, that opens out into a public hallway and is fitted with a mechanical/electric lock connected to an electronic card swipe (compatible with current Sensormatic system) or approved TNS lock.

Floor loading must be able to sustain 250 lb. per square foot.

Telecommunications room space shall be dedicated to the telecommunications function and related support facilities. Telecommunications rooms shall not be shared space with electrical, mechanical or janitorial facilities.

Telecommunications rooms shall be free of all plumbing.

Floors, walls, and ceiling shall be treated to eliminate dust. Finishes will be light in color to enhance the room lighting.

A minimum of two walls shall be covered with rigidly fixed 3/4 inch A-C plywood, void free and extend from 12 inches above the finished floor (AFF) to 84 inches AFF and capable of supporting the attached equipment. Plywood shall be treated as follows: Initially seal the plywood with one coat of Sherwin Williams, part No. B49 W 2 wall and wood primer. Follow with one coat of Flame Control 10-10 Intumescent Fire Retardant Paint. Finish with Flame Control 40-40 Fire Resistant paint.

Refer to fig. 5.1 for a typical Telecommunications Room layout.

5.1.2 Environmental requirements

Temperature range from 65 to 75 degrees with a humidity range from 30 to 55 percent relative. The expected heat dissipation may vary between 2,500 to 5,000 BTUs per hour per cabinet. Anticipated heat loads will be determined by TNS Engineering. The above-specified environmental requirements must be able to be maintained 24 hours per day, 365 days per year.
5.1.3 Electrical

Lighting shall be a minimum of fifty foot candles, measured 3 feet above the finished floor in the middle of the aisles between the racks and cabinets. The lighting is to be controlled by one or more switches located near the entrance door to the room. Lighting fixtures will not be powered by the same circuit as the other outlets in the room.

Power into the room shall be a minimum of two dedicated 120 VAC, 20 Amp circuits, terminated in quad type outlets, located on the walls, spaced approximately 8'-0" on center around the room. Number of circuits and locations will be determined at the time of the design as load requirements are determined. These outlets are to be mounted 8 inches AFF to keep them under the plywood.

Two separate dedicated 120 VAC, 20 Amp circuits will be installed in such a manner to distribute electrical power to the 19-inch equipment racks. Each equipment rack will have at least one 120 VAC duplex outlet securely mounted on the bottom of the wire tray above it.

If the building is equipped with emergency power, consideration should be given to connecting the equipment outlets to the emergency power system. The exact location of emergency power outlets will be determined by the TNS Engineering. If an Uninterruptible Power System (UPS) is present or planned it should be planned to connect to the emergency power system if present.

The telecommunication rooms shall be equipped with smoke detectors. If a building alarm system is present, the telecommunications room shall be connected to it. If a building alarm system is not present, an audible and visual alarm shall be provided outside of the telecommunications room door.
5.1.4 Grounding

Telecommunications rooms will be grounded in accordance with the EIA/TIA-607 Standard.

A Telecommunications Main Grounding Busbar (TMGB), shall be installed in the telecommunications room.

The TMGB shall be bonded to the building electrical service entrance ground. Connections to the TMGB shall be made via two hole compression connectors. The size of this green covered copper conductor, and corresponding connector, shall be as follows:

<table>
<thead>
<tr>
<th>Distance</th>
<th>Connector Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 50 ft.</td>
<td>#6 AWG (solid)</td>
</tr>
<tr>
<td>Up to 50 ft.</td>
<td>#6 AWG (stranded)</td>
</tr>
<tr>
<td>50 ft. to 100 ft.</td>
<td>#4 AWG</td>
</tr>
<tr>
<td>100 ft. to 150 ft.</td>
<td>#2 AWG</td>
</tr>
<tr>
<td>150 ft. to 200 ft.</td>
<td>#1/0 AWG</td>
</tr>
<tr>
<td>Greater than 200 ft.</td>
<td>#3/0 AWG</td>
</tr>
</tbody>
</table>

The connector shall be secured to the busbar with two silicon bronze bolts, each with two washers, one lock washer and nut.

In buildings that have additional telecommunications rooms, a Telecommunications Grounding Busbar (TGB), as described in ANSI/TIA/EIA-607, shall be installed and bonded to the TMGB in the main telecommunications room using wiring sizes as described above.

CATV splitters and electronic key telephone systems which utilize #10 AWG ground wires shall be bonded to the TMGB or TGB with a TNS Engineering approved connector.
5.2 Telecommunications Outlets

Whenever possible, outlets shall be flush mounted. In existing buildings when walls cannot be fished, surface outlets will be acceptable.

A flush outlet shall consist of a double gang, 2 and 1/8 inch deep outlet box of steel, with a 1 inch conduit from the box to above an accessible ceiling, wire tray, pull box or telecommunications room. If a plaster ring is used it should be a single gang plaster ring so that a single gang faceplate as described elsewhere in this document can be installed.

A non-flush outlet shall consist of a single gang 2 and 3/4 inches deep surface mounted metallic or non-metallic box with surface raceway to above an accessible ceiling or the telecommunications room. A single gang faceplate as described elsewhere in this document is to be installed. This raceway shall be sized appropriately to accept the total number of wire combinations that may be run through this raceway at 40 percent fill (Example: single outlet, four-Category 6 & one coaxial RG-6 or, back to back outlets eight-Category 6 and two coaxial RG-6 cables, etc.).

Outlets shall be mounted at a height to match the existing outlets in the building.

All surface raceways shall be run level and plumb in a neat manner and shall be fastened to the surface with screws or fasteners designed for the purpose. Adhesive fastening is unacceptable.

5.3 Wiring

Wiring for new or renovated buildings shall be 4 pair, 24 gauge, Category 6, unshielded, twisted pair wire. This wire shall be UL Listed as to appropriate fire rating and ETL verified Category 6 for electrical performance. The ratings are to be identified on the exterior sheath.

A minimum of two Category 6 wires shall be installed to each outlet in a lab, classroom, office or other area, to the telecommunications room.

The horizontal cable distribution distance cannot exceed 90 meters (295 ft.) from the patch panel to the telecommunications outlet faceplate.

The Category 6 wire shall be rated CM, CMR, CMP as required by the NEC and shall have the rating identified on the exterior sheath.

For acceptable manufacturers see,

For fire rating: Underwriters Laboratories Inc.

For performance rating: Directory of ETL Verified and ETL Listed Cabling Products, "current edition."

5.4 Telecommunications Faceplates

Faceplates will be stainless steel single gang with 4 openings or double gang stainless steel with 8 openings whichever is appropriate for the outlet location.

They should accommodate various manufacturers high density jacks so that the surface of the jack is flush with the surface of the faceplate. They should also accommodate a snap in adapter to hold a coax barrel and a blank snap in for unused holes. The surface of these snap in adapters is also to be flush with the surface of the faceplate.

Semtron 1FM(4)OE or 2FM(8)OE or equivalent. See Figure 6-1 for typical outlet layouts.
5.5 Wire Termination

The Cat 6 wire at the outlet shall be terminated on a "grey" Category 6 jack wired using 568B wiring, and installed in a stainless steel faceplate.

The Cat 6 wire, in the telecommunications room shall be terminated on a Category 6 patch panel mounted in a 19 inch wide by 84 inch high free standing, floor mounted rack or a 19 inch wide by 35 inch high wall mounted rack. The patch panel shall have 110 type connections and be wired using 568B wiring. A wire management panel will be supplied between each jack panel.

In the telecommunications room, each panel will be labeled with a number from A01 to AN in sequence with 1/2" high black letters on a yellow background. The label should be on the left center of the panel. If there are multiple telecommunications rooms, repeat the preceding instructions and denote a leading letter designating the appropriate telecommunications room. (example: A01 through AN for telecommunications room "A" and B01 through BN for telecommunications room "B," etc.).

At the faceplate the Cat 6 wire is to be labeled with a non-degradable permanent labeling material by Brady or TNS Engineering approved equivalent. The jack number will be a combination of the panel number (in the telecommunications room) and the jack number in the panel. (I.e. A0122 where A is the telecommunications room designator, 01 is the panel number and 22 is the jack number in that panel.)

The jack numbers are to be recorded on an as-built drawing and two copies turned over to the TNS Engineering Group. One copy for the Telecommunications room and one copy for TNS Engineering.

In the telecommunications room, there will be additional patch panels that cross connect to 110 blocks on the wall to facilitate cross connects of voice services. These are to be labeled as XA0102, etc. where X indicates cross connect wiring, A is the closet designator, 01 is the panel number, and 02 is the jack number on the panel.

Refer to fig. 5-3 for labeling details.

5.6 Coaxial Cable Termination

Video cable, where specified, will be terminated on the same faceplate as the voice and data jacks. The cable will terminate with a hex crimp 1/2 inch long with an integral crimp ring "F" type connector as recommended by the connector manufacturer. The connector shall be compatible with the manufacturer and part number of the coaxial cable. The terminated cable will be attached to an "F" type female to female splice (Barrel) connector in the faceplate. The splice shall be prevented from rotating in the faceplate by the addition of a nut and washer (i.e. D flat or hex indentation in the faceplate adapter.) The splice or barrel will be of sufficient length that after installation in the faceplate with nut and washer that enough splice is exposed to install an "F" connector such that the rotational part of the connector does not bottom out before the ferrule tightens to the splice.

Each video cable will be terminated in the telecommunications room with a hex crimp 1/2-inch long with an integral crimp ring "F" connector as recommended by the connector manufacturer. It shall be compatible with the manufacturer and part number of the coaxial cable. Each terminated cable will be attached to an "F" barrel in a wall mounted 96 port bottom hinged panel.

A #10 ground wire will be run from each panel to the Telecommunications Grounding Busbar (TGB) in the room.

The coaxial cable is to be labeled as defined in section 5.5 at both the faceplate and the panel in the telecommunications room.
5.7 Patch / Distribution Panels
Patch panels shall be 96 port, Category 6, 110 type connections, 19 inch wide as approved by TNS Engineering.

Patch panels are to be mounted in 19 inch wide by 7 foot high floor mounted, free standing, or 19 inch wide by 35-inches high wall mounted equipment racks. Each patch panel shall have a TNS Engineering approved horizontal patch cord organizer. See Figure 5-2.

5.8 Equipment / Relay Racks
Relay racks shall be self-supporting, aluminum, 19 inches wide by 84 inches high and have a 1 1/4 inch by 1/2 inch hole pattern.

Each relay rack shall have a TNS Engineering approved vertical and horizontal wire managers attached when installed. There shall be a minimum of two of the appropriate part number attached to each end of all horizontal patch cord organizers. See Figure 5-2.

Refer to the telecommunication room layout, figure 5-1, for suggested configuration of relay racks within the room.

Electrical power requirements are defined in section 5.1.3.

All relay racks shall be grounded to the grounding bar in the telecommunications room with a #6 copper ground wire as per EIA/TIA standards.

5.9 Raceways for multiple horizontal cables
Raceways to collect multiple horizontal cables from the outlet to the telecommunications closet shall be conduit, cable tray or ‘J’ hooks. Conduit shall be sized in accordance with the NEC for maximum 40 percent fill. Pull or junction boxes shall be located so that the aggregate bends do not exceed 180 degrees. All pull junction boxes shall be accessible. Cable tray shall be 8 inch or 12 inches wide by 4 inches deep, aluminum ladder type tray, NEMA VE-1, class 8C. ‘J’ hooks shall be caddy CAT21 (maximum 15 cables) or caddy CAT32 (maximum 25 cables).

5.10 Acceptance Testing
All Cat 6 wire runs shall be link tested to include the jack at the faceplate and the patch panel or terminal block using test parameters as outlined in TIA/EIA, Bulletin TSB-67. This test shall be completed with a test set that complies with bulletin TIA/EIA/TSB-67, Accuracy Level II. Results will be loaded onto a 3.5 inch - 1.44 meg. disk, formatted for an IBM PC and submitted to TNS Engineering for approval.

Information will be recorded on the attached matrix showing faceplate, room, and jack numbers. See example Figure 6-2 and 6-3.

Contractor shall provide an ASCII file of comma delimited data which includes: building number (character 8); media type (character 1) where D=Cat6 (data), V=Cat6 (voice), U=Cat 6 (universal), C=coax, S= singlemode fiber, M=multimode fiber; closet designator (character 1), Jack number (integer 4); outlet number (Integer 4); and room number (Character 10). Information will be turned over to the TNS engineering area on a 3.5 inch - 1.44 Meg disk formatted for an IBM-PC for approval.

Contractor shall provide a complete set of as-built drawings upon completion of final testing and installation. Drawings shall be provided in both hard copy and disk format, AutoCAD R14. This is to include CAD floor plans indicating outlet locations, numbers and drawings with equipment locations within the rack(s).
6.0 TELECOMMUNICATIONS OUTLET REQUIREMENT AND LOCATIONS

6.1 Offices
Each office shall have two outlets per 100 square feet, and a minimum of two outlets. Each telecommunication outlet shall contain at a minimum two Cat 6 jacks. Where possible, when multiple outlets are to be placed on the same wall surface area they should be combined into one multiple outlet (four Cat 6 jacks) to reduce installation costs.

6.2 Classrooms

6.3 Laboratories
Each lab will contain a minimum of two outlets. Each outlet shall contain two Cat 6 jacks and one coax jack.

Additional outlets may be required depending on the room use and application.

6.4 Residence Halls - University Park
All layouts must be reviewed and approved by Housing and Food Services.

Each resident room shall contain four Cat 6 jacks and 1 coax jack. The location shall suit the room layout. Where possible, services shall be located in a single outlet.

Each lounge area shall have at least one outlet. The outlet shall contain two Cat 6 jacks and one coax jack. Dependent on the size and layout of the lounge, additional outlets may be required.

6.5 Residence Halls - Non University Park
Locations and quantities are similar to University Park, except that variations exist between the different campus locations. Designs shall be discussed with Housing and Food Services, TNS Engineering and campus representatives.
7.0 MINIMUM CABLE SPECIFICATIONS:

7.1 ENTRANCE (BLACK) CABLE

Type, Quantity and Size of Entrance Cables will be determined and specified by TNS Engineering.

Grounding and protection requirements for entrance cable will be defined by TNS Engineering.

Protector Panel shall be Lucent 188 or 190 Type, or TNS engineering approved equivalent.
7.2 COAXIAL CABLE - INTERBUILDING

Coaxial cable shall be approved by TNS Engineering equivalent

Interbuilding coaxial cable must meet the following standards:

- Copper clad aluminum center-conductor
- Expanded polyethylene dielectric
- Solid sheath with outer jacket of polyethylene
- Must have flooding compound such as Migra-Heal between the jacket and the aluminum sheath

Physical dimensions:

- Center conductor diameter 0.111 inches
- Diameter over sheath 0.500 inches
- Sheath thickness 0.025 inches
- Diameter over outer jacket 0.600 inches

Electrical characteristics:

- Impedance 75 ohms + or - 2 Ohms
- DC resistance at 68 degrees F
  a.) Inner conductor 1.2 ohms/1K ft.
  b.) Outer conductor 0.40 ohms/1K ft.

Maximum attenuation from 5-750 MHz, 2.16 dB/100 ft.

Acceptance testing:

- All Coaxial cables are to be tested to verify length and dB loss. A printed copy of the results will be turned over to TNS Engineering with as built drawings for approval.

7.3 COAXIAL CABLE - INTRABUILDING

Coaxial cable shall be of the type Com Scope - Part No. F1111VR or approved TNS Engineering equivalent

Specifications:

Intrabuilding coaxial cable RG-6 must meet the following standards:

- Foam dielectric
- Bonded-foil type
- 18 AWG Copper-covered steel center conductor
- inner-shield aluminum tape bonded to the dielectric
- Outer shield of at least 60% aluminum or copper braid
- Outer shield of polyvinylchloride or polyethylene
- Cable jacket will be minimally marked CATVR

Electrical characteristics:

- Nominal impedance 75 ohms + or - 2 Ohms
- Maximum attenuation from 5 to 750 MHz 5.65 dB/100 feet.

Acceptance testing:

- All Coaxial cables are to be tested to verify length and dB loss. A printed copy of the results will be turned over to TNS Engineering with as built drawings for approval.
7.4 FIBER PERFORMANCE SPECIFICATIONS

Singlemode Fiber:
- core diameter of 8.3 microns
- cladding diameter of 125 microns
- maximum attenuation of:
  1.) 0.44 dB/Km @ 1310 nm
  2.) 0.35 dB/Km @ 1550 nm
- zero dispersion wavelength of 1310 nm ± 10 nm

Multimode Fiber:
- graded index, dual window
- core diameter of 62.5 microns
- cladding diameter of 125 microns
- numerical aperture of 0.275
- maximum attenuation of:
  1.) 3.75 dB/Km @ 850 nm
  2.) 1.50 dB/Km @ 1300 nm
- minimum bandwidth of:
  1.) 160 MHz-Km @ 850 nm
  2.) 500 MHz-Km @ 1300 nm
7.5 LOOSETUBE FIBER CABLE

- PE or PVC sheath with water blocking gel or tape
- Non-metallic strength member
- Non-armored
- Suitable for underground (in conduit) and aerial installation
- Cable sheath rated and marked OFNR for riser applications per NEC
- Distances shall be marked on the outside in feet/meters in such a way that normal installation does not rub them off or make them unreadable
- Six or twelve fibers per buffer tube filled with water blocking gel
- Use standard color codes on sub buffers per EIA/TIA SPECIFICATION 598:

  a.) blue  
  b.) orange  
  c.) green  
  d.) brown  
  e.) slate  
  f.) white  
  g.) red  
  h.) black  
  i.) yellow  
  j.) violet  
  k.) rose  
  l.) aqua

**Note**: Sub buffers are to be colored. Printing of the color name on the sub unit is **NOT** acceptable.

- Have a pull string installed to facilitate removal of the outer sheath. **Note**: a pull string of kevlar is **NOT** acceptable.

Installation:

- The number and type of fibers will be specified by TNS Engineering
- Fiber shall be installed in innerduct within conduits.
- Multiple fibers shall be pulled in the same innerduct whenever possible.
- Fiber shall be installed in one continuous piece unless prior approval is given by TNS Engineering
- Any excess fiber shall be coiled neatly and secured to a wall above plywood backboard so it is out of the way of normal traffic and is not subject to unusual flexing.
- Innerduct is to be installed as follows:
  a.) In a clear 5 inch duct, four each 1.25 inch nominal [1.6 inch OD]
  b.) In a clear 4 inch conduit, four each 1 inch nominal [1.4 inch OD]
  c.) In ducts with other cables, as many as possible without damaging the existing cables.
7.6 TIGHT BUFFER FIBER CABLE

- tight buffered
- buffer outer diameter of 0.9 mm.
- nonmetallic strength member
- fire-rated OFNP or OFNR for inside rated cable per NEC
- distances marked on the outside of the fiber in feet
- Use standard color codes on sub buffers per EIA/TIA SPECIFICATION 598:

  a.) blue     g.) red
  b.) orange   h.) black
  c.) green    i.) yellow
  d.) brown    j.) violet
  e.) slate    k.) rose
  f.) white    l.) aqua

**Note:** Sub buffers are to be colored. Printing of the color name on the sub unit is **NOT** acceptable.

- Have a pull string installed to facilitate removal of the outer sheath.
  **Note:** a pull string of kevlar is **NOT** acceptable.

**Installation:**

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- Fiber shall be installed in innerduct within conduits.
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  b.) In a clear 4 inch conduit, four each 1 inch nominal [1.4 inch OD]
  c.) In ducts with other cables, as many as possible without damaging the existing cables.
7.7 FIBER TERMINATION, SPLICING AND TESTING:

- Fiber will be terminated in a patch panel at each end to facilitate cross-connections.
  - Fiber will be terminated with the following type connectors:
    a.) Interbuilding multimode fiber is to be terminated with "ST" connectors.
    b.) Interbuilding singlemode fiber is to be terminated with "simplex SC/APC " connectors, green in color.
    c.) Intrabuilding multimode fiber is to be terminated with "duplex SC" connectors, blue in color.
    d.) Couplers in the panel will have the same color as the connectors listed above.
- There should be 24 inches of breakout at each end.
- Fiber may be terminated with pigtails or directly terminated with the appropriate connector.
- Fiber may be spliced using fusion splices. All fusion splices are to be placed in splicing trays in an appropriate housing. The fiber count is to be marked on the splice tray exterior. [i.e. UNF-##,1-12]
- All patch panels will be labeled as to sheath number [i.e. UNF-##], fiber number, and location of the opposite end. This information will be provided on the splicing drawing supplied by TNS Engineering.

7.7.1 Fiber testing

TNS Engineering will be provided with the following documentation:

- OTDR trace from each end at 850 nm or 1300 nm.
- Power meter loss measurements in both directions at a wavelength of 850 nm or 1300 nm.
- A printed copy of all fiber cable test results will be turned over to TNS Engineering for approval.
- Contractor will provide a complete set of as-built drawings upon completion of final testing and installation.
8.0 REVISION NOTES:

1. 2002/08/08 Changed OTC to TNS.
2. 2002/12/22 Changed Cat 5E to Cat 5e and Category 5E to Category 5e.
5. 2005/04/13 Changed wire to Cat 6
6. 2006/02/28 Changed classroom outlet requirements
1/2" REINFORCING RODS: STEEL REINFORCING IS REQUIRED AT ROAD CROSSINGS AND AT BUILDING/MANHOLE ENTRANCES

CONCRETE ENCASEMENT: CONCRETE TO HAVE MINIMUM COMPRESSION STRENGTH OF 2500 PSI WITH MAXIMUM AGGREGATE SIZE OF 1/2" (STONE IN CONCRETE MIX)

CONCRETE POURED ON UNDISTURBED EARTH

30° MINIMUM COVER

FIGURE 3-1: TYPICAL 6-5" DUCT STRUCTURE
1/2" REINFORCING RODS:
STEEL REINFORCING IS REQUIRED
AT ROAD CROSSINGS AND AT
BUILDING/MANHOLE ENTRANCES

CONCRETE ENCASEMENT:
CONCRETE TO HAVE MINIMUM
COMPRESSIVE STRENGTH OF 2500 PSI
WITH MAXIMUM AGGREGATE SIZE
OF 1/2" (STONE IN CONCRETE MIX)

CONCRETE POURED ON
UNDISTURBED EARTH

FINAL GRADE

30' MINIMUM COVER

FIGURE 3-1A: TYPICAL BRANCH/SUBSIDIARY CONDUIT
(i.e. BUILDING ENTRANCES)
FIGURE 3-2: TYPICAL ENTRANCE CONDUIT TERMINATIONS

- TYPICAL MANHOLE ENTRANCE OF MAIN CONDUIT
  - 18" MINIMUM COVER
  - PRECAST CONCRETE MANHOLE
  - CONCRETE ENCASEMENT Poured INTO WINDOW IN MANHOLE WALL
  - 24" MINIMUM
  - 1/2" REINFORCING RODS
  - BELL SHAPED CONDUIT ENDS
  - INTERIOR OF MANHOLE
  - EXTERIOR OF MANHOLE WALL

- TYPICAL BUILDING ENTRANCE OF SUBSIDIARY CONDUIT
  - FOUNDATION WALL
  - 36" MINIMUM COVER
  - CONCRETE ENCASEMENT
  - 1/2" REINFORCING RODS
  - SEE NOTES FOR DUCT Specs
  - 6" 5'
  - 5'
Figure 3-3: Directional Changes

- Right
- Minimum radius: 40 feet
- Wrong
2-36" DIA. HOLES FOR
2-30" TYPE "B" FRAMES
AND COVERS
(SEE FIG. 4-8 FOR DETAIL)

CABLE ENTRANCE WITH
CONCRETE KNOCKOUTS

CABLE ENTRANCE WITH
DUCT TERMINATORS

FIGURE 4-1: TYPE "A" MANHOLE 38Y STANDARD
2-36" DIA. HOLES FOR 2-30" TYPE "B" FRAMES AND COVERS (SEE FIG. 4-8 FOR DETAIL)

CABLE ENTRANCE WITH CONCRETE KNOCKOUTS

CABLE ENTRANCE WITH DUCT TERMINATORS

TO C.O. OR SWITCH
TO POLE, BUILDING, OR MANHOLE

2-30" TYPE "B" FRAMES AND COVERS

MINIMUM OF 4" CONCRETE RING OR 2 COURSES OF BRICK COLLAR, SURFACE TO BE PANGED.

TO POLE, BUILDING, OR MANHOLE

TO SWITCHROOM

TOP VIEW

ALL DUCTS AT SAME APPROX. ELEVATION

SIDE VIEW

FIGURE 4-3: TYPE J, L, OR T MANHOLE 38Y DETAIL
**Figure 4-5: Racking for (6x12x7) Type "A" Manhole**

- **47-Hole Cable Rack**
- **Space for Racking Stub Cables**
- **S Cable Rack Support** (See Fig. 4-6 for detail)
- **B Cable Rack Support** (See Fig. 4-6 for detail)

**Notes:**
- These racks are placed against the wall to support splice cases or lead sleeves.

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**Penn State Information Technology Services**

**Telecommunications and Networking Services**

**Drawing Details:**
- **Drawn By:**
- **Date:** 10/18/1996
- **Revised By:**
- **Date:** 12/11/2002
- **Sheet #:** 4-5
- **Scale:** None

---
S CABLE RACK SUPPORT W/ 47-HOLE RACK ATTACHED

B CABLE RACK SUPPORT
47-HOLE CABLE RACK

1/2" x 1 3/4" GALVANIZED
MACHINE BOLT W/ 1/2"
CONCRETE INSERT OR
EXPANSION SHIELD

1/2" x 1 3/4" GALVANIZED
MACHINE BOLT W/ WASHER AND NUT

FIGURE 4-6: USE OF S & B CABLE RACK SUPPORTS
**FIGURE 4-7: TYPICAL ARRANGEMENT OF PULLING-IN IRONS**

- **CONCRETE WALL**
- **NO. 2 PULLING-IN IRON**
- **NOTE:** 3” MINIMUM CLEARANCE BETWEEN FLOOR & IRON AND BETWEEN WALL & IRON.
- **PULLING-IN IRONS PLACED 6” ABOVE THE FLOOR**
FIGURE 4–8: MANHOLE COVERS AND LADDERS

- Minimum of 1-4" concrete ring or 2 courses of brick
- Lift ports shall be through lid (no blind lifting holes)
- Galvanized steel ladder
- 30" cast iron frame and cover

Length: 12 in. 5/8 in. 12 in. 12 in. centers 12-3/4 in.
FIGURE 5–1: TYPICAL TELECOMMUNICATIONS ROOM
FIGURE 5–3: TYPICAL LABELING STANDARD
FIGURE 6–1: TYPICAL FACEPLATES
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