

1 Campus Cabling Systems Introduction

This document represents the campus cable and infrastructure standards adopted and supported by the XXXX. All new construction and renovation should conform to these standards except where approved in writing by the XXXX.

On any cable or infrastructure project the Networking Department shall be consulted during the design, bid, and construction phases.

1.1 Warranty

All cabling and infrastructure projects for XXXX must provide a full one-year parts and labor warranty.

1.2 Materials Bid

All bids for work specified in this document shall include the cost of all materials and labor including but not limited to conduits, sleeves, fire stopping, digging, hole coring, damaged ceiling tile replacement, terminating devices, cabling, and trenching required to install new cable and infrastructure.

1.3 Structured Cabling Overview

The structured wiring systems specified here are in accordance to EIA/TIA 568. Campus structured wiring systems consist of three separate systems: outside plant backbone, inside plant backbone, and horizontal.

1.3.1 Outside Plant Backbone

The outside plant cable system provides the connection between buildings. This cable system typically is placed in a star configuration from a core networking facility to the Telecommunications Service Entrance Room (TSER) of each building served.

Cabling placed in the outside plant backbone must be suitable for outdoor placement. This means that cabling must be warranted by the

manufacturer for use outdoors. It is preferred that this cabling be placed underground in conduit systems, but it is permissible to place cabling overhead where cost or other considerations make underground facilities impractical.

The outside plant cabling includes:

- Twisted Pair Telephone Backbone. [This part can be deleted if you do not have a need to support traditional analog telephone lines for devices such as fax machines]. This type of cabling is to be placed only if your campus cabling system needs to support traditional telephone systems. If you need to provide telephone services, we strongly encourage campuses to consider using Voice over IP for your primary telephone system. However, even with Voice over IP, there is often a need to provide some twisted pair to buildings for applications that require traditional analog phone lines. Examples include FAX lines and emergency telephones for elevators. The pair count from the campus core to the TSER shall be specified on drawings as part of the construction specification. Twisted pair backbone that is placed as part of the outside plant backbone is always installed with lightning protection and is always grounded at both ends.
- Multi mode Fiber. Multi mode fiber has limited distance and shall only be specified for distances of 200 meters or less. Where multi mode fiber is used, a minimum of 12 multi mode fibers shall be installed.
- Single mode Fiber. Single mode fiber shall be installed between the campus core and every building TSER. For buildings that are within 200 meters of the campus core, a minimum of 6 single mode fibers shall be installed between the campus core and the building TSER. For buildings that exceed 200 meters from the campus core, a minimum of 12 single mode fibers shall be installed between the campus core and the building TSER.

Please refer to the Cable Specifications Section for detailed specifications of the cabling to be utilized in the outside plant backbone.

1.3.2 Inside Plant Backbone

The inside plant cable system provides the connection between the Telecommunications Service Entrance Room (TSER) and each Telecommunications Equipment Room (TER) in a single building. The inside plant backbone typically runs in a star configuration from the TSER to each TER.

If the cable type installed includes a metallic shield or bonding element, then it shall be grounded at the TSER.

The inside plant cabling system includes:

- Twisted Pair Telephone Backbone. [This part can be deleted if you do not have a need to support traditional analog telephone lines for devices such as fax machines] This type of cabling is to be placed only if your campus cabling system needs to support traditional telephone systems. The pair count from the TSER to each TER shall be specified on drawings as part of the construction specification.
- Multi mode Fiber. If the distance between the TSER and TER is less than 90 meters, a minimum of 6 multi mode fibers shall be installed, but need not be terminated. If the distance between the TSER and TER is between 100 and 200 meters, a minimum of 12 multi mode fiber shall be installed and terminated. If the distance between the TSER and TER exceeds 200 meters, multi mode fiber shall not be installed.
- Single mode Fiber. If the distance between the TSER and TER is less than 200 meters, single mode fiber is optional. If placed, it shall include a minimum of 6 single mode fibers. If the distance between the TSER and TER exceeds 200 meters, a minimum of 12 single mode fibers shall be installed and terminated.
- Category 5e unshielded Twisted Pair. If the distance between the TSER and TER is less than 90 meters, 12 category 5e cables shall be installed and terminated.

Please refer to the Cable Specifications Section for detailed specifications of the cabling to be utilized in the inside plant backbone.

1.3.3 Horizontal

The horizontal cable system provides the connection between each station outlet and the serving Telecommunications Equipment Room (TER). This cabling runs in a star configuration from the TER to each individual station outlet.

The cable distance between the station outlet and the associated TER shall not exceed 90 meters. Where a cable distance from a station outlet to an existing TER exceeds 90 meters, a new TER shall be installed for the associated station outlets.

The horizontal cabling system includes:

- Category 5e Twisted Pair. Cabling to station outlets should provide a minimum of four 4-pair cable sheaths to each outlet.

Please refer to the Cable Specifications Section for detailed specifications of the cabling to be utilized in the horizontal cabling system.

2 Telecommunications Rooms

There are two basic types of telecommunications rooms: Telecommunications Service Entrance Rooms (TSER) and Telecommunications Equipment Rooms (TER). Either a TSER or TER can serve individual station outlets. Often a TSER or TER is referred to generically as a telecommunications room.

The cable distance between the station outlet and the associated telecommunications room shall not exceed 90 meters. Where a cable distance from a station outlet to an existing closet exceeds 90 meters, a new telecommunications room shall be installed for the associated station jacks.

2.1 Telecommunications Room Locations

All new telecommunications rooms will be located in spaces dedicated for that use. These rooms shall not be shared with custodial, office, or mechanical rooms. It is acceptable if these rooms contain electrical panels. Telecommunications rooms shall be suitably sized for the intended use. The minimum sizes shall be determined based upon equipment and service requirements, however, the minimum recommended is 2 meter by 2 meter. The preference is a minimum two meter by three meter floor area, no ceiling, walls extending to structure overhead, door opening outward and fluorescent switched lighting.

A space considered for a telecommunications room would be considered unsatisfactory if any one of the following existed within the space: access is solely through a private office, in wash rooms, custodial closets, where water vapor exposure, steam pipes, drains, clean outs, chemical exposure, air handling units, EMI or RFI situations, transformers or a air plenum environment exist.

2.2 Telecommunications Room Relay Racks

Telecommunications rooms will be outfitted with either free standing or wall mount relay racks. Drawings will typically be provided to indicate the number and positioning of 19" relay racks in each telecommunications room.

The Contractor is responsible for providing earthquake bracing and support for all free standing relay racks installed in

telecommunications rooms. Free standing relay racks shall be firmly fastened to the floor and have overhead ladder rack run from the top of the each rack to the wall at the rear of the rack. Each free standing relay rack must have front facing vertical wire management chases installed on each side of the rack.

Wall mount relay racks are to be firmly fastened to the wall with anchors suitable for supporting at least 50kg.

All relay racks shall be filled from top to bottom, left to right. No relay rack shall be filled with more than $\frac{3}{4}$ full of patch panels and wire management. The bottom portion of each relay rack is reserved for use by the owner for installation of switches and other equipment.

2.3 Environmental Controls for Telecommunications Rooms

All telecommunications rooms shall have environmental controls that maintain the room environment at a temperature range of 20 to 27 degrees Celsius, 24 hours a day, 7 days a week. This provides an environment suitable for computer equipment.

2.4 Electrical Circuits for Telecommunications Rooms

Each TSER and TER telecommunications equipment room will have at least one receptacles on a separate circuit (not shared with any other receptacle) and a ground wire run directly to the ground bus of a nearby electrical panel.

3 Outside Plant Infrastructure

The outside plant cable system provides the connection between buildings. This cable system typically is placed in a star configuration from a core networking facility to the Telecommunications Service Entrance Room (TSER) of each building served.

When considering outside plant cabling, placing the cabling in underground infrastructure shall be preferred to overhead.

All cabling placed in the outside plant shall be warranted for use outdoors by the cable manufacturer.

3.1 Underground Construction

3.1.1 Trenching

Excavate trenches for underground conduits to required depths. Recommended depth is at least 1 meter. After excavation of trench and before placement of conduit, the bottom of the trench shall be filled with sand or gravel to form an even surface to place conduit.

3.1.2 Backfilling

All work in trenches shall be inspected after conduit is placed, but before backfilling begins. After inspection, backfill of native soil shall be placed in layers 20cm deep, adequately tamped and wetted or flushed before the next layer of earth is laid in place. Back fill shall be compacted to 95% density. Continue process until trenches are filled. A warning marker tape that contains a metallic element shall be placed 30cm below the finished surface. Use no roots, large rocks, or foreign materials of any description in backfilling trenches. Furnish additional native soils material as required. Remove excess materials and debris from site. Minimum cover over conduit shall be 90cm unless otherwise noted by UO.

3.1.3 Shoring

Excavation and backfilling shall be done in a manner so as not to disturb adjacent structures. Furnish any shoring as required.

3.1.4 Drainage

All drainage ways, whether pipe or open channel, and all inlets must be kept open and clean to permit proper drainage at all times during construction. Debris and earth material must be kept out of storm sewers, and if allowed to enter such pipe, must be removed by the contractor.

3.1.5 Concrete/Asphalt

When existing concrete and/or asphaltic concrete is to be removed, the cut for the limits of removal shall be made cleanly and in a straight line. Where asphaltic concrete is to be replaced, a concrete patch shall be poured within 5 cm of finished grade. The remaining 5cm shall be asphaltic concrete. Where concrete is to be replaced, it shall be with the same thickness and finish as existing.

3.1.6 Intermediate Vaults

Vaults placed as part of the outside plant infrastructure may be of precast type or cast in place. Minimum vault size is 1.5m long by 1m wide by 1m deep. Where the vault may contain fiber optic splice cases, the size of the vault shall be increased to 1.5m square by 1 meter deep. Vault covers shall be suitable for the location and can be constructed of steel or concrete.

3.1.7 Existing Utility Locates

The existence and location of underground utilities shall be thoroughly investigated and verified prior to any excavation. Excavation in the vicinity of existing structures and utilities shall be carefully done by hand. The contractor shall be responsible for the costs of damage to, and maintenance and protection of existing utilities and structures adjacent to the construction site.

3.1.8 Entry Into Buildings

Care shall be taken in terms of how the underground conduit system enters the building and TSE room. Conduit shall enter the building in a manner that prevents water from flowing from the outside conduit/vault system into the building. All conduits entering the building shall be fitted with duct plugs to prevent the passage of fumes, dust, insects, or rodents from the outside system into the building.

3.1.9 Conduit

Buried conduit shall be 5cm or 10cm inside diameter schedule 40 PVC that is warranted by the manufacturer for installation in underground locations. A minimum of two such conduits shall be installed in every run. Conduit shall be installed in accordance with manufacturer instructions. Visible conduit, e.g. conduit inside buildings that contain extension of the outside cable plant cabling shall be equivalently sized but shall be metal. All conduit serving the outside plant backbone shall have a minimum sweep bend radius of 10 times the conduit diameter. All installed conduit must be rated for use by the manufacturer for use for communications cabling. Conduit or pipe that is designed for carrying water is not allowed.

Conduit shall enter buildings either by penetration underground into a basement level room or by turning and running up the exterior wall of the building. In the case where the conduit runs up the exterior wall of the building, the conduit shall transition into the building with a metallic weatherproof junction box that is at least 40cm x 40cm. The conduit shall run up the exterior of the building and enter the bottom

of the junction box. There shall be conduit run from the back of the junction box into the building.

Where the Telecommunications Service Entrance Room (TSER) is not at the location where the outside conduit penetrates the building, metallic conduit shall be run through the building from the point of entry to the TSER.

All installed conduit shall be left clean and dry with at least a 100kg rated pull line inside.

No conduit installed either outside or inside of buildings to serve the outside plant shall exceed 200m between pull points (junction boxes or vaults). The 200m distance shall be reduced by 50m for every 90 degrees of bend in conduit. A maximum of 180 degrees of conduit bend is allowed between any two pull points.

A minimum of 100% spare vault to vault conduit shall be installed in all trenches between all existing and newly constructed vaults. At the end of construction, every trench shall have at least one empty conduit for future cabling.

4 Inside Plant Infrastructure

4.1 Inside Cable Installation

All cable installed inside of buildings shall be concealed in conduit, raceways, cable trays, above ceilings, within walls, below floors, or similar concealed areas. Exposed cabling is not allowed unless agreed to in writing.

Cable may be run above suspended ceilings without being enclosed in cable trays or conduit. It must be appropriate fire or plenum rating and must be properly gathered and supported. It must be protected from other building members in the ceiling space and must not be tied to or draped over fire or electrical systems.

Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical coupler installed between the cable points of origin and termination except as shown on drawings and or specifications.

4.2 Inside Conduit

Conduits shall be provided as per local code requirements for their specific use. Best practices dictate that metallic conduit shall be

used where exposed, above ceilings, in walls, and in all other inside areas. Conduits embedded inside concrete slabs are to be rigid metallic or schedule 40 PVC. Conduit penetration through floors or fire barriers shall be fire stopped per local building fire codes.

4.2.1 Conduit Layout

In all cases, it is preferred to have single, home runs of conduit from each station jack location to the associated TER. However, in many cases, this may not be practical due to cost or other considerations.

Where runs provide service to more than one station outlet location, care must be taken to place pull boxes in accessible spaces. In no case shall any conduit be installed with more than 180 degrees of bend without a pull point.

4.2.2 Conduit Sizing

In all cases, conduit systems shall be designed to not exceed 40% conduit fill. The following table is based on a category 5e cable that is 5mm in diameter. If a smaller diameter cable is used, then there will be an increase in the number of cables that can fit in the conduits.

Conduit Size (mm)	Maximum Number Cat5e Cables
16mm	4
21mm	6
27mm	10
35mm	18
41mm	26
53mm	44
78mm	96
103mm	168

For conduit systems that will support inside or outside plant backbone, conduit fill calculations shall be made to assure no conduit is filled more than 40%.

Each 90 degrees of bend or 30m of conduit should decrease the number of sheaths allowed by 15 percent.

4.3 Accessible Ceiling Systems

In new construction with accessible suspended ceiling systems, conduit may be stubbed into the accessible area, into cable trays, or into J-boxes. In all cases, conduit is to be placed into walls, even if it

is simply stubbed into accessible areas. Fishing the walls is not allowed in new construction.

In all locations where conduit is installed, a pull line is to be left in all such conduits and tied off at each end.

4.4 Cable Trays

A cable tray system may be used to provide from station outlet locations to associated TER locations. A minimum clearance of 30cm must be provided above and to one side of trays for access.

4.5 Surface Raceway

Exposed metal wire molding or metal conduit shall be used for all areas where there is either no existing conduit, existing conduit is not located where station outlets are placed, or fishing the wall is not viable. Surface raceway will not be used unless previously agreed upon.

5 Cable Specifications

5.1 Fiber Optic System

Outside plant fiber optic cable shall be warranted for outdoor use by the manufacturer. Cabling installed in areas that are susceptible to rodent damage shall be armored.

Inside plant fiber optic cable shall be rated for indoor use by the manufacturer.

All fiber optic cable shall be installed by hand pulling. No mechanical pulling or winching of fiber optic cable is allowed. Care must be taken to not exceed manufacturer specified pulling tension or bend radius.

Fiber cabling shall be installed with slack loops as follows:

1. Outside plant fiber shall have 15m slack installed into each outside plant vault. This slack shall be neatly coiled and placed into the vault. Vaults that contain a large number of fiber cables will require the coils to be mounted to the wall of the vault.

2. All fiber shall have 10m slack coiled near the termination point. Typically this slack will be neatly coiled and mounted to the wall of the equipment room.

5.1.1 Optical Specifications

All multi mode fiber shall have 50 micron core and meet the ISO/IEC 11801 specification for OM2 fiber.

All single mode fiber shall meet the ITU-T G.652.D specifications for optical performance.

5.1.2 Termination

Outside plant fiber loose tube cables shall have break-out kits installed onto all fiber strands before termination.

Multi mode fiber optic cabling shall be terminated by hand polishing epoxy or hot melt (what style: ST, SC) connectors. Crimp and cleave connectors are not allowed.

Single mode fiber optic cabling shall be terminated by hand polishing epoxy or hot melt (what style: SC or LC) connectors or by fusion splicing factory terminated pigtails. Crimp and cleave connectors are not allowed.

Terminated connectors shall be installed into bulkhead panels of appropriate type mounted in fiber enclosures. Fiber shall be neatly dressed and supported at the termination point.

Locations with 12 or less fiber terminations may utilize a wall mount fiber enclosure. For all locations with more than 12 fiber terminations a rack mount enclosure must be used.

5.1.3 Splices and Closures

The outside plant fiber optic system may require that large strand count cables run from the campus core to splice locations where smaller count cables are run to the TSER of individual buildings. In this case, all splices are to be made with a fusion splicer. Splice closures used outside of buildings shall be of appropriate size water tight and re-enterable. Splice Closures shall be constructed to hold individual splice trays that will accommodate 12, 24 or 36 splices per tray.

Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical

coupler installed between the cable points of origin and termination except as shown on drawings and or specifications.

All splices must be placed in accessible locations. For outside plant backbone applications, this means splices must be in vaults, pull boxes, or TSERs. For inside plant backbone applications, splices shall be avoided.

5.1.4 Testing

All fiber shall be certified by the installer. Certification shall consist of loss testing in both directions on each fiber at two wavelengths specified below. Loss tests shall be recorded for each direction on each fiber for each wavelength. These values shall be used to perform acceptance calculations described below.

1. Multi Mode fiber wavelength testing shall be at 850nm and 1310nm.
2. Single Mode fiber wavelength testing shall be at 1310nm and 1550nm.

Contractor shall perform span loss calculations to compute the maximum allowed loss for each span at each wavelength. These span loss calculations shall be compared to measured performance. Span loss shall be calculated based on manufacturer guaranteed performance at the measured wavelength adjusted by the length of the cable. To that figure, span loss shall add .5dB for each mated connector and .2dB for each fusion splice. This figure is the maximum loss at that wavelength that is allowed for the cable span. For example, if the manufacturer warrants that a cable has .4dB loss per km at a specific wavelength and the installed cable is 1.5km and that cable has one fusion splice, the maximum allowed loss would be the sum of:

- .5dB for the connector on the end
- .6dB for the 1.5km fiber span
- .2dB for the fusion splice
- .5dB for the connector on the other end

These figures would provide a maximum allowable loss at the specific wavelength of 1.8dB.

A fiber cable is accepted when the measured loss in all fiber strands in the cable less than the calculated span loss. Cables that are not accepted will be removed and replaced at the contractors expense.

All test results shall be neatly and clearly prepared and provided to on a CD and in printed form.

5.2 Category 5e Unshielded Twisted Pair

Category 5e twisted pair wiring is used for both inside wiring backbone and horizontal (station) wiring. Category 5e wiring should be used in the inside wiring backbone only if the cable distance does not exceed 90 meters. For horizontal wiring, the cable distance between the station jack and the associated telecommunications room (TSER or TER) shall not exceed 90 meters. Where a cable distance from a station jack to an existing telecommunications room exceeds 90 meters, a new closet shall be installed for the associated jacks.

The category 5e cable that is used cannot be a minimally compliant category 5e cable. It must be warranted by the manufacturer as an "extra headroom" cable with at least 350Mhz performance.

Install each category 5e cable as an uninterrupted conductor section between the designated termination points (station jack and TER or TSER and TER), unless otherwise directed by the cable installation specifications. There shall be no splices or mechanical couplers on any installed category 5e cabling.

For inside wiring backbone applications, a minimum of twelve Category 5e UTP cables shall be installed between the TSER and the TER. For cases where the cable distance would exceed 90 meters, this cabling shall be deleted.

For horizontal applications providing service to a station outlet, a minimum of four category 5e cables shall be provided from each station outlet to the nearest telecommunications closet.

5.2.1 Category 5e Wiring Termination

At the station outlet location, all installed cables shall be terminated in category 5e jacks using the ANSI/EIA/TIA T568B wiring pattern and mounted in appropriate device plates. Device plates are to be provided in all instances and are to be mounted at standard industry heights and positions. Typical installations will have the station outlet adjacent to an electrical outlet. Station outlets and electrical outlets should be mounted at the same height above the finished floor.

In telecommunications closets (both TSER and TERs), both horizontal and backbone category 5e cabling shall be terminated on rack mount patch panels. Patch panels shall be mounted in wall mount or free standing open relay racks at each end. Horizontal wire management panels shall be installed above and below each category 5e patch panel.

Category 5e wiring techniques shall be followed on when installing category 5e cabling including, but not limited to: no more than 2cm unsheathed wire, wire shall not be untwisted to ease termination, and the bend radius of the installed wire shall be maintained.

5.2.2 Labeling

At the station jack, each jack shall be uniquely numbered in ink on the device plate. The jack numbering scheme shall be provided by the University. The labeling shall include the TER designation as well as the jack designation.

In the TSER, the terminated cabling will be labeled on the marker strips on the patch panel. The labeling will consist of both the room number/name and jack number assigned.

5.2.3 Testing

All category 5e cables shall be tested and certified to support gigabit Ethernet performance. Cables that cannot be certified must be replaced and certified at the contractors expense.

Upon completion, test results shall be submitted for final approval and acceptance and made part of the cable inspection report along with all as-built drawings.

The contractor shall guarantee 1000baseT Gigabit Ethernet performance on all installed category 5e cables.

5.3 Twisted Pair Telephone Backbone

[This entire section can be deleted if you do not have a need to support traditional analog telephone lines for devices such as fax machines] We strongly recommend VoIP for the primary phone system. However, even with VoIP, there is a need to support analog voice applications for devices such as fax machines and emergency phones in elevators.

For outside plant applications, the voice backbone cable must be warranted for the intended use. Cables installed underground shall be shielded and be filled with a water resistant compound that protects the conductors for moisture intrusion. Any cable installed underground must be warranted for use in direct burial or duct installations. Cables installed aerially shall be rated for aerial use by the manufacturer and shall include a support strand or shall be lashed to a support strand. Aerial cables shall be shielded and utilize an air core construction.

For inside plant applications the voice backbone cable must be warranted for use indoors by the manufacturer. Cables installed indoors shall be shielded and utilize an air core construction.

5.3.1 Pair Count

The drawings will specify minimum cable pairs and counts between the campus core and each building TSER as well as from each TSER to each TER. Standard cable sizes with pair count increments of 4, 6, 12, 25, 50, 100, 150, 200, 300, and 400 pair shall be used unless otherwise directed.

5.3.2 Twisted Pair Telephone Backbone Installation

All cables, wires, and equipment shall be firmly held in place. All fastenings and support shall be adequate to support their load with ample safety factors.

Any splices in the system wiring must meet reasonable standards of strength and continuity, and be identified as part of the final system documentation. All splices will be re-enterable, either in inside or outside plant applications. All splices shall utilize insulation displacement type connectors.

Shield continuity shall be preserved at splice locations by bonding shields across all cable splices.

5.3.3 Lightning Protection and Grounding

All outside plant twisted pair cabling shall be installed with lightning protection. Any outside plant cable entering a building shall terminate with a combination protector and line termination unit with replaceable individual protectors. The line termination protector unit shall be fully populated with solid state protectors for all count terminated.

The outside plant twisted pair cabling at the campus core and each building TSER must be grounded by means of an insulated copper ground to a low resistance ground with the maximum resistance to ground at 5 ohms or less. Contractor shall provide all necessary grounding items and must follow all local grounding codes.

The inside plant twisted pair cabling shall be bonded at the TSER location only.

Contractor shall insure electrical continuity of the shields of all shielded cable throughout the network. Accordingly, shield continuity shall be accomplished by bonding shields across all cable splices and at all distribution terminals with multiple cables. All shielded cables shall have the shield grounded at the TSER and shall adhere to the basic requirement to ground the shield of each inter-building cable at each of its ends.

5.3.4 Labeling

All pairs shall be labeled at each cross connect point with the pair identification as specified in this document.

XXXX will designate a cable number for each inside plant twisted pair backbone cable. Both ends of the pairs in that riser will be labeled with that number and the pair numbers.

All cables will be legibly marked or numbered at each end and in intervening vaults and telecommunications rooms and at all splices.

At the campus core, individual pairs shall be identified and installed on the uppermost point on the north most termination and progress downward in order, and in groups of 100 pair.

As each pair is terminated in a building, its terminations must be marked and identified in terms of the numbering on the campus core. The lowest pair number being at the upper most left hand termination and work down and to the right. Building and riser link cables shall be laid out and identified in a similar manner except each set of linking pair numbers shall be unique to the two buildings or closets linked.

5.3.5 Termination

All inside plant backbone twisted UTP pairs shall be terminated on 110 type blocks at the TSER and TER locations.

All outside plant backbone twisted UTP pairs shall be terminated in lightning protectors.

5.3.6 Testing

All pairs in all cables shall be tested for grounds and shorts, continuity of communication conductors and shields, reversals and transpositions.

Upon completion, test results shall be submitted for final approval and acceptance and made part of the cable inspection report along with all as-built drawings. The contractor shall guarantee 99% good pairs on all backbone twisted pair cables with no more than one bad pair in any binder group.

6 As-Built Drawings and Cable Records

A complete set of as-built, reproducible drawings and records shall be provided upon completion of any outside plant/infrastructure, new

building, or building renovation. Drawings and records shall include but not be limited to:

- Drawings showing outside plant and inside plant cable locations including splice locations.
- Inside wire cable-trays or primary conduit runs.
- Outside plant conduit runs, including conduit size and count, pull boxes, manholes, and splice locations.
- All TSER and TER locations shall be indicated on the drawings.
- Station outlet locations shall be shown on building floor plans. Drawings should indicate jack number assigned to each location.
- List of all fiber terminations at all locations corresponding to the labels on the individual fibers and the cables.
- Copies of all test results indicated in this document.

7 Damage to Structures or Grounds

The contractor shall be responsible for replacing, restoring, or bringing to original condition, at his own expense, any damage to floor, ceilings, walls, furniture, grounds, pavement, etc., caused by the contractor's personnel and operations.