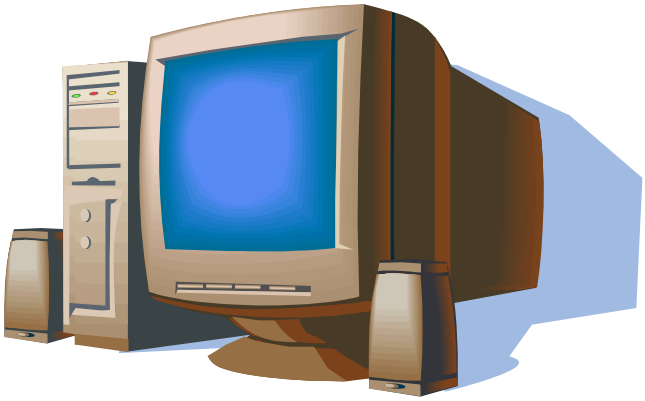
# State of Montana ENTERPRISE WIRING STANDARD



# Table Of Contents

# 1 INTRODUCTION

This standard defines a telecommunications wiring system for State of Montana Agencies, offices or buildings that will support a multi-product environment. The purpose of this standard is to enable planning and installation of building wiring, regardless of the telecommunications products, be it voice and/or data, which subsequently will be installed.

This standard has been adapted from the **TIA/EIA-568B Standard.** The **TIA/EIA-568B Standards** can be obtained from **GLOBAL Engineering Documents,** 15 Iverness Way, East Englewood, Colorado 80112-5704. Phone: 800-624-3974.[1]

Proper adherence to these guidelines will reduce long-term building operation costs by providing a better infrastructure that is adaptable to change.

Telecommunications wiring defined by this standard is intended to have a useful life in excess of ten years.

[1] Appendix A sec 3

# 2 SPECIFICATIONS

## *2.1 Horizontal Wiring*

The horizontal wiring is the portion of the telecommunications wiring systems that extends from the area outlet to the telecommunications closet. This includes the termination at the outlet as well as the termination and cross connects at the closet. The term *horizontal* is used because typically the wire in this part of the wiring system runs horizontally along the floor(s) or ceiling(s) of a building.

The horizontal wiring shall be a star topology, meaning each work area outlet must be directly connected to a telecommunications closet. The maximum horizontal distance shall not exceed 300' from the outlet to the closet as shown in Figure 1.1, an allowance of approximately 20' was made for the patch cables in the wire closet and outlet end because the total length from the equipment in the telecommunications closet and the devise on the end cannot exceed 328' total.

A minimum of two telecommunications outlets shall be provided for each individual work area. A 4-pair 100-ohm UTP CAT 5E solid PVC or plenum cable shall support both outlets**,** solid cable has better electrical performance than stranded cable and is traditionally used for inside walls and through ceilings. Whether plenum or PVC cable depends on where you will run the cable. PVC cable features an outer jacket that gives off toxic fumes when it burns. It's commonly used in runs from the wiring closet to the wall plate, but only if the building features a contained ventilation system running through duct work. Plenum cable has a special coating, which does not give off toxic fumes when it burns. A plenum is a space within a building created by building components designed for the movement of environmental air. Each of these outlets may be used for either voice and/or data. Since both outlet ports are using the same type of cables, it's just a simple matter of cross-connect in the telecommunications closet to either the voice switch or data switch.[2]

[2] Appendix A sec 5-2

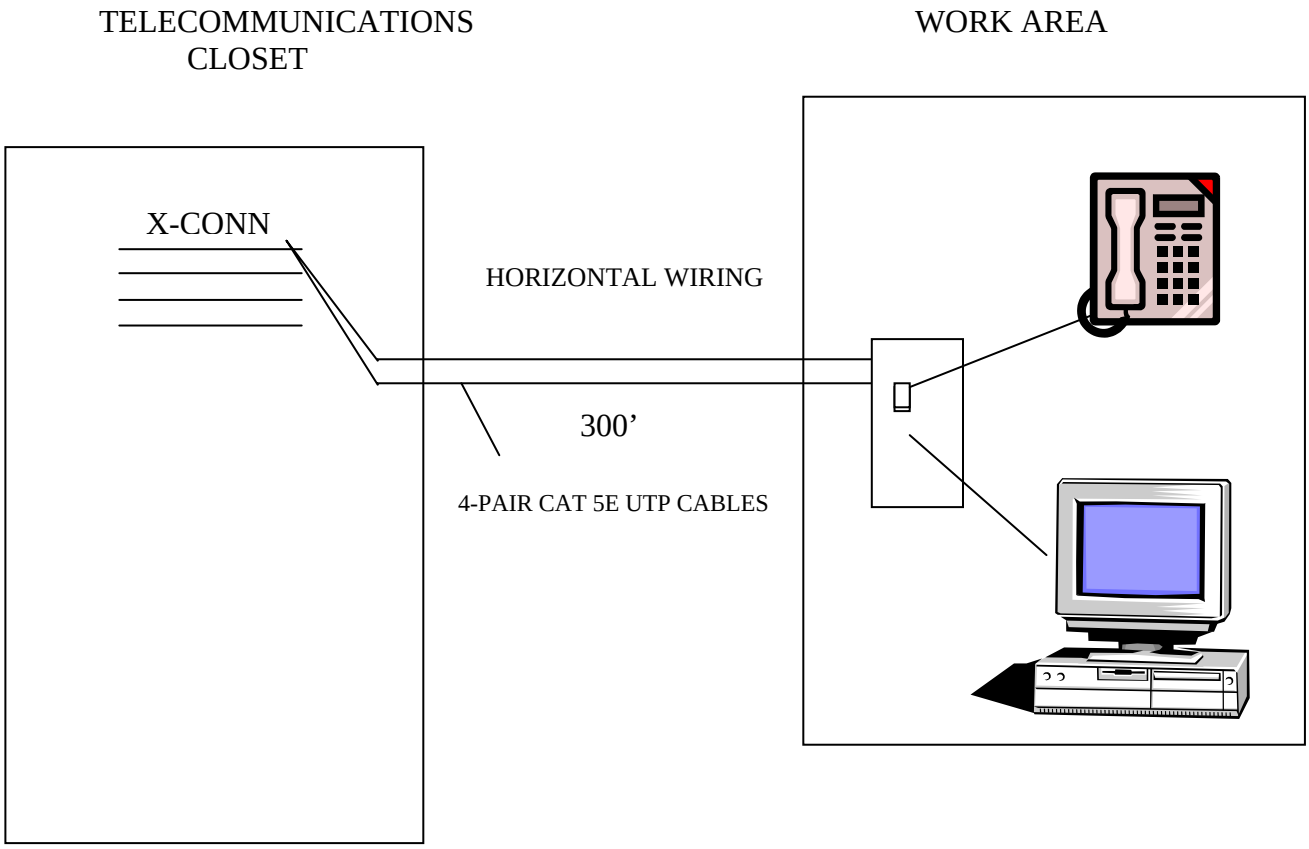



***FIGURE 1.1*** ***Typical Horizontal and Work Area Wiring***

## 2.2 Installation

Category 5E wiring requires special installation practices. Pair twisting, for instance, is one of the critical physical characteristics of the cable that affects near-end cross talk performance. As a result, the **EIA/TIA Standard** requires that the pair twist be maintained to within one-half inch of the termination point on each end of the cable. This requirement is imposed to minimize untwisting of wire pairs and the separation of conductors within a pair.

Our standards call for special termination practices when terminating CAT.5E cable to ensure LAN speeds of up to 1 gigabit to ensure users get the most of their local area network.

When placing cables adhere to the following:

- Use a minimum bend radius of ten times the cable diameter equivalent to placing data wire around a 1" conduit.
- Follow building and fire codes penetrations made during routing of cable through firewalls. Firewalls must be sealed with fire stop materials. This stops the flow of smoke, flames, toxic fumes and etc.
- Avoid routing cables near Electro-magnetic interference noise sources, such as motors and power lines. Hangers are necessary to support the cable above fluorescent fixtures and other sources, which can induce noise on the cable.
- Use the same cable throughout. Do not mix cabling from different manufacturers.
- Avoid coiling cables. This can lead to degradation of its performance.
- Cable ties should be applied with just enough tension to hold the cables in place, but not tightly enough to squeeze the cables, also space the ties randomly.
- Cables must be supported a maximum of 5 feet intervals and cannot be attached to electrical conduit, heating or plumbing hardware or ceiling grid wires.[3]

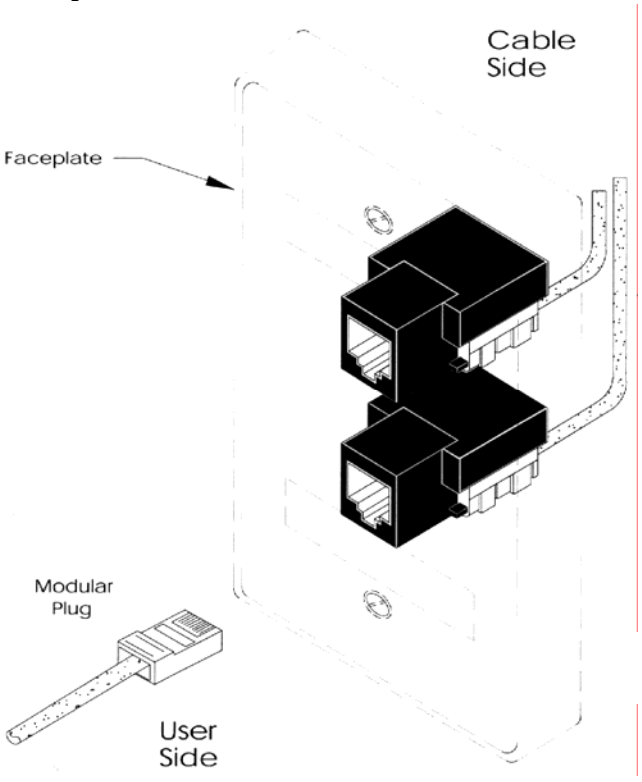
[3] Appendix A Sec 5

## *2.3 Work Area (Outlet Location)*

The work area components extend from the telecommunications outlet end of the horizontal wiring system to the station equipment. The station equipment can be any of a number of devices including telephones, fax machines and personal computers.

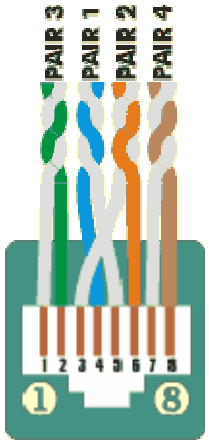
Work area wiring may vary in form depending on the application. A cord with identical connectors on both ends often is used. Our Standard calls for a CAT.5E stranded patch cord when the application is a LAN Data device.

Patch Cables are made of stranded copper conductors for flexibility. This construction is great for the flexing and the frequent changes that occur at the wall outlet or patch panel. The stranded conductors do not transmit data signals as far as solid cable. The TIA/EIA 568A which is the governing standard regarding commercial cabling systems limits the length of patch cables to 10 meters in total length. These 10 meters of total length include both the work area and telecommunications closet patch cords. When adaptations are needed they shall be external to the telecommunications outlet.[4]
Each 4-pair cable shall be terminated in an eight-position CAT.5E Modular Jack as shown in the example below.




[4] Appendix A Sec 6-1

2.3.1.1.1.1.1 **T568A**




| Pin # | Conductor Color Code |
|---|---|
| 1 | white/green |
| 2 | green |
| 3 | white/orange |
| 4 | blue |
| 5 | white/blue |
| 6 | orange |
| 7 | white/brown |
| 8 | brown |

FIGURE 1.2: Eight-Position Jack Pin/Pair Assignments
(Designation T568A)

## 2.4 Telecommunications Closet

A telecommunications closet is an area within a building set aside for the exclusive purpose of housing equipment associated with the telecommunications wiring system. Every building shall contain at least one telecommunications closet or equipment room. There is no upper limit on the number of telecommunications closets, which may be provided within the building.

The telecommunications closet shall contain the mechanical terminations for a portion of the horizontal wiring system and a portion for the backbone wiring system. In this usage, the telecommunications closet shall provide facilities (space, power, grounding, etc.) for the passive (cross-connect) or active devices or both used to interconnect the two systems.[5]

## 2.5 Labeling

Each telecommunications outlet shall have a label placed on the Faceplate or cover of jack, this is to identify the outlet for record keeping as well as for maps or floor plans. Each label will contain the xx-yyy identifier. The xx is the number of the patch panel that the particular outlet is terminated in. The yyy is the number of the outlet. [6]

Example: Patch Panel A, position 24 **A-24**

[5] Appendix A Sec 4.3
[6] Appendix A sec 8.1

## 2.6 Testing

Testing is critical. Test results shall be automatically evaluated by the equipment, using the most up-to-date criteria from the TIA/EIA Standard, and the result shown as pass/fail. Test results shall be printed directly from the test unit or from a download file using an application from the test equipment manufacturer. The test results shall include all tests performed, the expected test result and the actual test result achieved.[7]

Each new cable that is placed shall be tested and certified for **EIA/TIA 568B, TSB-36, and TSB-40 standards.** These standards require the following:

- Shorts
- Opens
- Insertion Loss
- Pair-to-Pair Near End Crosstalk (NEXT)
- Power Sum Near End Crosstalk (PSNEXT)
- Equal Level Far End Crosstalk (ELFEXT)
- Power Sum Equal Level Far End Crosstalk (PSELFEXT)
- Return Loss (RL)

## 2.7 Backbone Wiring

The function of the backbone wiring is to provide interconnection between telecommunications closets, equipment rooms and entrance facilities in the telecommunications wiring system structure. Typically multi-pair cable and/or fiber optics cable are used as backbone cables.

The backbone wiring shall use the conventional hierarchical star topology where in each telecommunications closet is wired to a main cross-connect or an intermediate cross-connect then to a main cross-connect.

Backbone wiring defined by this standard is applicable to a range of different user requirements. Depending upon the characteristics of the individual application, choices with respect to transmission media have to be made. In making this choice, factors to be considered include:

- Flexibility with respect to supported services;
- Required useful life of backbone wiring;
- Site size and user population

[7] Appendix A Sec 7

To determine the size of the backbone cable you need to estimate the number of users that could be assigned to work out of this particular closet. You then double that figure and round up to the nearest 100. Example: if 40 phones, faxes or modems are utilized, double it to 80 and round up to the nearest hundred. So in this case, a hundred pair cable should be sufficient.[8]

[8] Appendix A Sec 4.2

# 3 Acronyms and Abbreviations

| | |
|---|---|
| **EIA/TIA** | Electronics Industries Association/ Telecommunications Industries Association |
| **EMI** | Electromagnetic Interference |
| **FDDI** | Fiber Distributed Data Interface |
| **IC** | Intermediate Cross-connect |
| **LAN** | Local Area Net |
| **MC** | Main Cross-connect |
| **TC** | Telecommunications Closet |
| **UTP** | Unshielded twisted Pair |
| **WAN** | Wide Area Net |

# State of Montana
# Enterprise
# Cabling System Technical Specification
# Enhanced Category 5 UTP

## 1 Introduction

### *Purpose*

The intent of this document is to provide a standard specification that will be used for all State of Montana facilities requiring cabling installation. This document provides the minimum performance criteria for the components and sub-systems comprising a complete cabling system.

Product specifications, general design considerations, and installation guidelines are provided in this written document. Quantities of telecommunications outlets, typical installation details, cable routing and outlet types for a specific State facility will be provided as an attachment to this document. If the bid documents are in conflict, the written specification shall take precedence. The successful vendor shall meet or exceed all requirements for the cabling system described in this document.

The Customer's Cable Infrastructure Project requires a Siemon structured cabling system, or equivalent single-manufacturer solution. The Enhanced Category 5 portion of the cabling system shall comply with the link and channel performance requirements of ANSI/TIA/EIA 568-B.

The successful Contractor is required to furnish all labor, supervision, tooling, miscellaneous mounting hardware and consumables for each cabling system installed.

## 2 QUALITY ASSURANCE

### *2.1 Contractor Qualifications*

The Contractor shall at a minimum possess the following qualifications:

Be in business a minimum of three (3) years.

Contractor shall demonstrate satisfaction of sound financial condition and can be adequately bonded and insured if the project deems necessary.

Possess those licenses/permits required to perform telecommunications installations in the specified jurisdiction.

Personnel knowledgeable in local and state codes and regulations. All work shall comply with the latest revision of the codes or regulations. When conflict exists between local or national codes or regulations, the most stringent codes or regulations shall be followed.

Must possess current liability insurance certificates.

Must have personnel fluent in the use of Visio or Computer Aided Design and possess and operate Visio or CAD software using Microsoft Visio drawing or DWG or .DXF format.

The Contractor shall own and maintain tools and equipment necessary for successful installation and testing of optical and Category 5E metallic premise distribution systems.

### *2.2 Required Contractor Training*

The Contractor shall be fully conversant and capable in the cabling of low voltage applications such as, but not limited to data, voice and imaging network systems. The Contractor shall at a minimum possess the following qualifications:

Personnel trained and certified in the design of a Structured Cabling System.

Personnel trained and certified to install a Structured Cabling System.

Provide references of the type of installation provide in this specification.

Personnel trained and certified in fiber optic cabling, splicing, termination and testing techniques. Personnel must have experience using a light meter and OTDR.

Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.

### *2.3 Contractor Responsibility*

Contractor shall be obligated to exercise the highest standard of care in performing its obligations as defined in this request for proposal.

Contractor acknowledges that The State of Montana will rely on contractor's expertise, ability and knowledge of the system being proposed and shall be obligated to exercise the highest of standard care in performing it's obligation as defined in the following Scope of Work.

### *2.4 Manufacturer Quality & Product Substitutions*

All telecommunications connecting hardware and cable must be made by an ISO 9001:2000 Certified Manufacturer.

All products must meet the technical requirements listed in sections 4-5. Any products not meetings these requirements will not be considered.

## 3 INDUSTRY REQUIREMENTS

The following installation, documentation, component and system industry specifications shall be met or exceeded:

- ANSI/TIA/EIA-568-B.1 and addenda
  *"Commercial Building Telecommunications Cabling Standard - Part 1: General Requirements"*
- ANSI/TIA/EIA-568-B.2 and addenda
  *"Commercial Building Telecommunications Cabling Standard - Part 2: Balanced Twisted-Pair"*
- ANSI/TIA/EIA-568-B.3 and addenda
  *"Commercial Building Telecommunications Cabling Standard - Part 3: Optical Fiber Cabling and Components Standard"*
- ANSI/TIA/EIA-569-B and addenda
  *" Commercial Building Standard for Telecommunications Pathways and Spaces"*

- ANSI/TIA/EIA-606-A and addenda
  *" Administration Standard for the Telecommunications Infrastructure of Commercial Buildings"*
- ANSI-J-STD-607-A and addenda
  *" Commercial Building Grounding and Bonding Requirements for Telecommunications"*
- ANSI/TIA/EIA-526-7
  *"Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant"*
- ANSI/TIA/EIA-526-14A
  *"Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant"*
- IEC/TR3 61000-5-2 - Ed. 1.0 and amendments
  *"Electromagnetic compatibility (EMC) - Part 5: Installation and mitigation guidelines - Section 2: Earthing and cabling"*
- ISO/IEC 11801:2002 Ed2.0 and amendments
  *" Information technology - Generic cabling for customer premises"*
- CENELEC EN 50173:2000 and amendments
  *" Information Technology - Generic cabling systems"*

# 4 SYSTEM DESIGN REQUIREMENTS

## *4.1 Horizontal Cabling*

The Horizontal Subsystem is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet/connector to the horizontal cross-connect in the telecommunications room. It consists of the telecommunications outlet/connector, the horizontal cables, optional consolidation point, and that portion of the cross-connect in the telecommunications room serving the horizontal cable.

## *4.2 Backbone Cabling*

Cables allowed for use in the backbone include: 4-pair 100Ω balanced twisted-pair copper, multi-pair 100Ω balanced twisted-pair copper, hybrid or bundled 100Ω balanced twisted-pair copper, 50/125μm or 62.5/125μm multimode optical fiber, and 8.7-10μm single mode optical fiber cables. The cable shall support voice, data and imaging applications. The bending radius and pulling strength requirements of all backbone cables shall be observed during handling and installation.

### INTRABUILDING CABLING

The cable route within a building, connecting closet to closet or closet to the equipment room is referred to as the Intrabuilding Backbone Subsystem. It links the Main Cross-connect (MC) in the equipment room to Intermediate Cross-connects (IC) and Horizontal Cross-connects (HC) in the Telecommunications Rooms (TR). It consists of the backbone transmission media between these locations and the associated connecting hardware terminating this media.

### INTERBUILDING CABLING

When a distribution system encompasses more than one building, the components that provide the link between buildings constitute the Interbuilding Backbone Subsystem. This

subsystem includes the backbone transmission media, associated connecting hardware terminating this media, and electrical protection devices to mitigate harmful voltages when the media is exposed to lightning and/or high voltage power surges that pass through the building cable. It is normally a first-level backbone cable beginning at the main cross-connect in the equipment room of the hub building and extending to the intermediate cross-connect in the equipment room of a satellite building

### *4.3 Telecommunications Room*

The Horizontal Cross-connect shall consist of rack or wall mounted wiring blocks or panels for termination of copper cables or rack or wall mount interconnect centers or fiber management panels/trays for the termination of optical fibers.
Cross-connect spaces include the labeling of hardware for providing circuit identification and patch cords or cross-connect wire used for creating circuit connections at the cross-connect.
The telecommunications room shall be equipped to contain telecommunications equipment, cable terminations, and associated cross-connects.
Separation from sources of EMI shall be in accordance with ANSI/TIA/EIA-569-A and local codes.
Communication grounding / earthing and bonding shall be in accordance with applicable codes and regulations. It is recommended that the requirements of IEC/TR3 61000-5-2 - Ed. 1.0, ANSI-J-STD-607-A, or both be observed throughout the entire cabling system.
The telecommunications room shall be dedicated to the telecommunications function. Access to telecommunications rooms shall be restricted to authorized service personnel and shall not be shared with building services that may interfere with the telecommunications systems or be used for building maintenance services.
Lighting in the telecommunications room should be a minimum of 500 lx (50 foot candles) at the lowest point of termination. Light switch should be easily accessible when entering the room.
A minimum of two dedicated duplex or two dedicated simplex electrical outlet, each on a separate circuit, should be provided for equipment power. Additional convenience duplex outlets should be placed at 1.8 m (6 ft) intervals around the perimeter walls.

## 5 INSTALLATION

### *5.1 Site Survey*

Prior to placing any cable pathways or cable, the contractor shall survey the site to determine job conditions will not impose any obstructions that would interfere with the safe and satisfactory placement of the cables. The arrangements to remove any obstructions with the Project Manager need to be determined at that time.

### *5.2 Physical Installation*

#### CABLE PATHWAYS

Pathways shall be designed and installed to meet applicable local and national building and electrical codes or regulations.

Grounding / Earthing and bonding of pathways shall comply with applicable codes and regulations.

Pathways shall not have exposed sharp edges that may come into contact with telecommunications cables.

The number of cables placed in a pathway shall not exceed manufacture specifications, nor, will the geometric shape of a cable be affected.

Pathways shall not be located in elevator shafts.

If a J-hook or trapeze system is used to support cable bundles all horizontal cables shall be supported at a maximum of five-foot intervals - at no point shall cable(s) rest on acoustic ceiling grids or panels

Cable shall be installed above fire-sprinkler and systems and shall not be attached to the system or any ancillary equipment or hardware

**INTRABUILDING CABLE ROUTING**

The backbone subsystem shall include cable installed in a vertical manner between floor telecommunications rooms and the main or intermediate cross-connect in a multi-story building and cable installed horizontally between telecommunications rooms and the main or intermediate cross-connect in a long single story building like a school or factory.

Unless otherwise recommended by the manufacturer, all fiber cables will be run in innerduct.

Fibers will be terminated in the telecommunications rooms using SC, ST, MT-RJ, or LC connectors in wall mounted interconnect centers or rack mounted panels equipped with sufficient ports, slack storage space and splice trays if required to terminate and secure all fibers.

Adequate riser sleeve/slot space shall be available with the ability to ingress the area at a later date in all telecommunications rooms, such that no drilling of additional sleeves/slots is necessary.

The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each telecommunications room. An intermediate cross-connect may be present between the main cross-connect and the horizontal cross-connect. This is known as a hierarchical star topology.

At least one 4-pair balanced twisted-pair, hybrid/bundled or multi-pair cable should be run for each Intrabuilding backbone segment.

Optical fiber should be run for any backbone segment greater than 90 m (295 ft.). If the Intrabuilding backbone segment is less than 90 m (295 ft), and fiber is not routed, the balanced twisted-pair cable shall be category 5e or higher.

Backbone pathways shall be installed or selected such that the minimum bend radius of backbone cables is kept within manufacturer specifications both during and after installation.

## INTERBUILDING CABLE ROUTING

The backbone subsystem shall include cable installed between buildings via underground, tunnel, direct -buried, aerial or any combination of these from the main cross-connect to an intermediate cross-connect in a multi-building campus.

Unless otherwise recommended by the manufacturer, all fiber cables will be run in innerduct.

Fibers will be terminated in the telecommunications rooms using SC, ST, MT-RJ or LC connectors in wall mounted interconnect centers or rack mounted panels equipped with sufficient ports, slack storage space and splice trays if required to terminate and secure all fibers.

In an underground system, adequate underground conduit space shall be available and accessible at each building. The conduits shall not exceed a fill factor of 40%.

All underground systems shall be designed to prevent water runoff from entering the building.

The backbone cables shall be installed in a star topology, emanating from the main cross-connect to each satellite building telecommunications room. All Interbuilding cables shall be installed to the applicable codes and regulations.

Optical fiber shall be run for all Interbuilding backbone segments, and as a recommendation, at least one balanced twisted-pair cable should be run for each Interbuilding backbone segment.

Backbone pathways shall be installed or selected such that the minimum bend radius and pulling tension of backbone cables is kept within cable manufacturer specifications both during and after installation.

## HORIZONTAL CABLE ROUTING

All horizontal cables, regardless of media type, shall not exceed 90 m (295 ft) from the telecommunications outlets in the work area to the horizontal cross connect.

The combined length of jumpers, or patch cords and equipment cables in the telecommunications room and the work area should not exceed 33 ft unless used in conjunction with a multi-user telecommunications outlet.

Two horizontal cables shall be routed to each work area. At least one horizontal cable connected to an information outlet shall be 4-pair, 100 Ω balanced twisted-pair.

It is recommended that a minimum horizontal cable distance of 49 ft shall be maintained between the telecommunications room and the work area.

For installations with consolidation points, a minimum horizontal cable distance of 49 ft shall be maintained between the telecommunications room and consolidation point, and 16 ft between the consolidation point and the work area.

Horizontal pathways shall be installed or selected such that the minimum bend radius of horizontal cables is kept within manufacturer specifications both during and after installation.
In open ceiling cabling, cable supports shall be provided by means that is structurally independent of the suspended ceiling, its framework, or supports. These supports shall be spaced no more than 5 ft apart.
Telecommunications pathways, spaces and metallic cables, which run parallel with electric power or lighting, which is less than or equal to 480 Vrms, shall be installed with a minimum clearance of 2 in.
The installation of telecommunications cabling shall maintain a minimum clearance of 3 m (10 ft) from power cables in excess of 480 Vrms.
No telecommunications cross-connects shall be physically located within 20 ft of electrical distribution panels, step down devices, or transformers, which carry voltages in excess of 480 Vrms.
For voice or data applications, 4-pair balanced twisted-pair or fiber optic cables shall be run using a star topology from the telecommunications room serving that floor to every individual information outlet. The customer prior to installation of the cabling shall approve all cable routes.
The Contractor shall observe the bending radius and pulling strength requirements of the 4-pair balanced twisted-pair and fiber optic cable during handling and installation.
Each run of balanced twisted-pair cable between horizontal portion of the cross-connect in the telecommunication closet and the information outlet shall not contain splices.
In a false ceiling environment, a minimum of 3 inches shall be observed between the cable supports and the false ceiling.
Continuous conduit runs installed by the contractor should not exceed 100 ft or contain more than two (2) 90 degree bends without utilizing appropriately sized pull boxes.
All horizontal pathways shall be designed, installed and grounded to meet applicable local and national building and electrical codes.
The number of horizontal cables placed in a cable support or pathway shall be limited to a number of cables that will not cause a geometric shape of the cables.
Maximum conduit pathway capacity shall not exceed a 40% fill. However, perimeter and furniture fill is limited to 60% fill for move and changes.
Horizontal distribution cables shall not be exposed in the work area or other locations with public access.
Cables routed in a suspended ceiling shall not be draped across the ceiling tiles. Cable supports shall be mounted a minimum of 3 in above the ceiling grid supporting the tiles.

## WORK AREA TERMINATION

All balanced twisted-pair cables wired to the telecommunications outlet/connector, shall have 4-pairs terminated in eight-position modular outlets in the work area. All pairs shall be terminated.
Termination 568A
Voice jacks in horizontally oriented faceplates shall occupy the left-most position(s).
Data jacks in horizontally oriented faceplates shall occupy the right-most position(s)
The telecommunications outlet/connector shall be securely mounted at planned locations.
The height of the telecommunications faceplates shall be to applicable codes and regulations.

## PULLING TENSION

The maximum cable pulling tensions shall not exceed manufacturer's specifications.

## BEND RADIUS

The maximum cable bend radii shall not exceed manufacturer's specifications.
In spaces with balanced twisted-pair cable terminations, the maximum bend radius for 4-pair cable shall not exceed four times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.
During the actual installation, bend radius on 4-pair cable shall not exceed eight times the outside diameter of the cable and ten times for multi-pair cable. This shall be done unless this violates manufacturer specifications.

## SLACK

In the work area, a minimum of 12 in should be left for balanced twisted-pair cables, while 3 ft be left for fiber cables.
In telecommunications rooms a minimum of 10 ft of slack should be left for all cable types. This slack must be neatly managed on trays or other support types.

## CABLE TIE WRAPS

Tie wraps shall be used at appropriate intervals to secure cable and to provide strain relief at termination points. These wraps shall not be over tightened to the point of deforming or crimping the cable sheath.
Hook and loop cable managers should be used in the closet where reconfiguration of cables and terminations may be frequent.

**GROUNDING**

All grounding / earthing and bonding shall be done to applicable codes and regulations.

**FIRE PROTECTION**

Properly installed firestop systems shall be installed to prevent or retard the spread of fire, smoke, water, and gases through the building. This requirement applies to openings designed for telecommunications use that may or may not be penetrated by cables, wires, or raceways.
Fire stops shall be done to applicable code.

**WORKMANSHIP**

All work shall be done in a workman like fashion of the highest standards in the telecommunications industry.
All equipment and materials are to be installed in a neat and secure manner, while cables are to be properly dressed.
Workers must clean any debris and trash at the close of each workday.

## 6 BALANCED TWISTED-PAIR PRODUCT SPECIFICATIONS

In addition to meeting the category 5e specifications outlined in ANSI/TIA/EIA-568-B.2, the requirements in this section must also be met for all applicable balanced twisted-pair products as listed below.

### *6.1 Outlets*

All category 5e information outlets designed for termination of 4-pair balanced twisted-pair category 5e copper cable must possess the following characteristics at the minimum:

Be independently verified for category 5e component compliance to 200 MHz

- Have available a gravity feed (45 degree angled) low profile as well as flush mount design.
- Utilizes tri-balance technology with optimized pair balance design and linear crosstalk response to address applications up to 160 MHz.
- Have 310 style insulation displacement connectors with quadrant pair isolation and a pyramid wire entry system. Termination is accomplished with a single conductor impact tool.
- Be backwards compatible to allow lower performing categories of cables or connecting hardware to operate to their full capacity.
- Have rear protective strain relief caps with side or rear entry, which can be installed onto cable before or after termination.
- Support industry standards for T568A on each individual outlet.

- Allow installation from the front or rear of the faceplate, and allow for the jack to pass through the faceplate without re-termination.
- Be side-stackable for high-density solutions.
- Have a color matching protective, hinged or flexible door to protect the outlet from dust and other airborne contaminants.
- Provide color-coded, slide-in icons available for circuit identification.
- Be constructed of high impact, flame-retardant thermoplastic.
- Have, as an option, an outlet, which can be mounted into an IEC 60603-7 compliant opening (keystone).
- Must be certified by Underwriters Laboratories to United States Standards
- Meet the following performance specifications:

| 6.1.1.1Margin over category 5e @ 160MHz | | |
|---|---|---|
| **Parameters** | **Worst Case** | **Typical** |
| Insertion Loss (dB) | 0.12 | 0.14 |
| NEXT* (dB) | 2.20 | 3.54 |
| FEXT* (dB) | 8.38 | 8.86 |
| Return Loss (dB) | 8.58 | 14.92 |

*** Tested in both Differential and Common modes**

*Siemon Company MAX® 5e Modules Recommended*

### *6.2 Patch cords*

All category 5e modular equipment cords shall:

Be 100% transmission tested with laboratory grade network analyzers for proper performance
Utilize stranded cable within a round, flame-retardant jacket
Be backwards compatible with lower performing categories
Be equipped with modular 8-position plugs on both ends, wired straight through with standards compliant wiring
Use modular plugs, which, exceed FCC CFR 47 part 68 subpart F and IEC 60603-7 specifications, and have 50 micro-inches minimum of gold plating over nickel contacts
Be resistant to corrosion from humidity, extreme temperatures, and airborne contaminants
Be available with red and blue jackets
Be available in standard lengths of 3,4, 5, 6,7,8,10, 15 and 20 feet with custom lengths available upon request
Meet or exceed TIA/EIA and ISO/IEC category 5e electrical performance
Be certified by Underwriters Laboratories to United States Standards
Utilize stranded cordage that meets the following performance specifications:

| Frequency (MHz) | Insertion Loss (dB/100m) | PS NEXT (dB) |
|---|---|---|
| 1 | 2.4 | 62.3 |
| 4 | 4.9 | 53.3 |
| 10 | 7.8 | 47.3 |
| 16 | 9.9 | 44.3 |
| 20 | 11.1 | 42.8 |
| 31.25 | 14.1 | 39.9 |
| 62.5 | 20.4 | 35.4 |
| 100 | 26.4 | 32.3 |

### *6.3 Patch panels*

All termination panels shall facilitate cross-connection and inter-connection using modular patch cords and shall conform to EIA standard, 19 inch relay rack mounting requirements.

- Allow the use of the same modular outlets used in the work area
- Be made of black, lightweight, high strength brushed aluminum in 16-, 24-, and 48-port configurations
- Allow the use of other multimedia outlets including optical fiber and coaxial
- Have openings, which allow terminated jacks to pass through panel for easy rearrangement
- Have port identification numbers on both the front and rear of the panel
- Accommodate at least 24 ports for each rack mount space (1RMS = 44.5 mm [1.75 in.])
- Be available with an integrated rear wire management bar

*Siemon MAX® Series Patch Panel Recommended*

### *6.4 Connecting Blocks*

The connecting block shall facilitate cross-connection and/or inter-connection using patch cords.
The 66 blocks shall posses the following characteristics:
Be made of high-impact, flame-retardant thermoplastic
Be available in 4x50-pair size to support up to 12 4-pair balanced twisted-pair cables
Have optional colored, hinged covers for protection and designation available in white, red, gray, yellow, blue, green, violet, orange and brown
Have mounting features to allow direct wall mounting, bracket mounting or 19” panel mounting via optional frame
Incorporate fanning strips on each side of block for management of horizontal cabling and cross-connect (jumper) wires as well as providing a labeling surface for circuit identification
Have available accessories to include: standoff-brackets, organizer rings, clear snap-on covers, designation strips and category 5e modular test adapter
Have connecting blocks with a minimum of 200 re-terminations without signal degradation below standards compliance limit
Support wire sizes: solid insulated 22-26 AWG (0.64 mm - 0.40 mm) or solid stripped 18-19 AWG (1.02 – 0.91mm)
Meet or exceed TIA/EIA and ISO/IEC category 5e component specifications
Must be Communications Circuit Accessory Listed per Underwriters Laboratories Standard UL 1863

*Siemon S66™ Wiring Blocks Recommended*

### *6.5 Cable*

**TWISTED-PAIR CABLING**

All qualified cables shall exceed the most severe requirements provided in the Industry Requirements by the worst case margins listed below for all specified frequencies (except where noted):

| 4 Parameter | Margin 1-100 MHz (over Category 5e) | Performance @ 100 MHz |
|---|---|---|
| Insertion Loss | 0 % | 22.0 dB |
| NEXT | 0 dB | 35.3 dB |
| PSNEXT | 0 dB | 32.3 dB |
| ACR | - | 13.3 dB |
| PSACR | - | 10.3 dB |
| ELFEXT | 0 dB | 23.8 dB |
| PSELFEXT | 0 dB | 20.8 dB |
| Return Loss | 0 dB | 20.1 dB |
| Propagation Delay | 0 % | 538 ns |
| Delay Skew | 0 % | < 45 ns |

- Attenuation-to-Crosstalk Ratio (ACR)
  Using " pair-to-pair NEXT Loss", all Qualified Cables shall exhibit worst case ACR performance of greater than 15.0 dB in the frequency range of 1 to 80 MHz and greater than 13.3 dB in the frequency range of 80 to 100 MHz per 100 meter test sample.

- Power Sum Attenuation-to-Crosstalk Ratio (PSACR)
  Using "Power Sum NEXT Loss", all Qualified Cables that shall exhibit worst case ACR performance of greater than 12.0 dB in the frequency range of 1 to 80 MHz and greater than 10.3 dB in the frequency range of 80 to 100 MHz per 100 meter test sample.

In addition to the requirements listed above, bundled or hybrid cable must also meet the following requirements:

- Be in groupings of 4-pair units.

Be power sum NEXT tested where any disturbed pair within the hybrid/bundle cable shall be 3 dB better than the specified pair-to-pair NEXT loss of a single 4-pair cable of the same category.

### *6.6 Faceplates*

All flush mounted faceplates shall possess the following characteristics.

- Be applicable to both fiber and copper applications.
- Be available in 1-, 2-, 3-, 4- and 6-port single-gang configurations or 6-, 8- and 12-port double-gang configurations.
- Allow modules to be removed from the front of the faceplate.
- Allow UTP modules to pass through faceplates even after termination.
- Have write on designation labels for circuit identification together with a clear plastic cover.
- Feature easily removable designation label covers which can be removed without use of tools.
- Have as a minimum the standard colors of black, white, gray, ivory and light ivory.
- Have optional modular furniture adapters available.
- Have Designer style faceplates and mounting frames available
- Have stainless steel versions available with designation label option.
- Have surface mount boxes and standoff rings available for both single and double gang faceplates.
- Be manufactured using UV resistant, high impact thermoplastic to prevent color fading and provide additional durability.
- Must be certified by Underwriters Laboratories to United States Standards.

*Siemon Company MAX™ Series Faceplates Recommended*

### *6.7 Racks*

For rack-mounted installations in a telecommunications room the installer shall use a 19 in equipment rack.

The rack shall meet or exceed the below characteristics of construction and features:

- Have 3 in by 6 in vertical cable channels as side rails in 7 ft heights.
- Have channels capable of utilizing and re-locating ten high capacities, reusable hook and loop cable managers provided with rack, and have additional managers available in bags of ten.
- Have ten high capacity cable managers provided for the front, side or back of the rack, which can be used for horizontal, or vertical cable management and easily twist and lock into place without the use of screws or tools, and have additional managers available in bags of ten.
- Have standard ANSI/EIA-310-C mounting holes having a full 45 RMS on front and back of rails. Cable routing openings shall be available in the front and rear of the channels.
- Have ladder channel, which acts as a top bracket to easily nest a standard 12 in ladder tray. The channel must have carriage bolt holes for attaching to the ladder system.
- Have available an optional rack top cable tray which manages cable bundles routed above the rack, and eliminates the need for installing a ladder rack for routing cables.

The tray is mounted without the need of tools or hardware and includes up to three (3) separate cable paths featuring removable quarter-turn hook and loop cable managers.

- Be available in aluminum with a black finish and utilize black grommets for unused cable openings.
- Have two optional vertical cable management channels 6in x 7 ft and 3in x 7 ft, which can be located between racks. The channel shall come with cable retainers, which can be hinged left or right and be located in any position along the channel.
- Have floor mounting holes and a ground lug for 0-6 gauge ground cable provided.

*Siemon RS Series Rack System Recommended*

## *6.8 Surface Mounted Raceway System*

This specification covers a latching raceway system used for data network, voice, video and other low-voltage wiring. The latching raceway system shall consist of raceway, appropriate fittings and device boxes.

Latching raceway is to be surface mounted and to be utilized in dry interior locations only. The system is for low voltage cabling only, 50 Volts or less.

The latching raceway system specified herein for data network, voice, video and other low-voltage wiring shall be the Uniduct 2700/2900 System as manufactured by The Wiremold Company. Systems of other manufacturers may be considered equal if, in the opinion, and the written approval of the engineer.

The latching raceway and all system components must exhibit nonflammable self-extinguishing characteristics, tested to comparable specifications of UL94V-0.

The latching raceway shall be manufactured with a co-extruded design of rigid PVC compound with a flexible PVC hinge. The raceway shall have a smooth finish, available in ivory, white, black, gray and brown colors.

- The latching raceway shall be a one-piece design with a flexible hinge. The cover shall open to provide accessibility and latch securely closed. Total width shall be 0.75" by 0.38" [19.05mm by 9.652mm] deep with an approximate thickness of .04" [1.01mm]. The raceway shall be available in 6' and 8' [1.83m and 2.44m] lengths and be supplied with adhesive tape backing.

- A full compliment of fittings (2700 Series) must be available including but not limited to flat, internal and external elbows, tees, drop ceiling fitting, cover clips, and end caps. They shall be manufactured of a rigid PVC compound. The fittings shall have a smooth texture, available in ivory, white, black, gray and brown colors to match the raceway. They shall overlap the raceway to hide uneven cuts. A transition fitting shall be available to adapt to Uniduct 2800 and 2900 Series latching raceways manufactured by The Wiremold Company.

- Device boxes shall be available for mounting standard devices and faceplates. A communications box shall be available to mount voice, video, data and fiber optic

connectors. The communications box shall provide a means of storage for fiber optic cable. Device and communication boxes shall be snapped onto a base. They shall be manufactured of rigid PVC compound. They shall be available in ivory, white, black, gray and brown colors to match the raceway.

- The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for UTP/STP, Fiber Optic, Coaxial and other cabling types with face plates and bezels to facilitate mounting. A complete line of preprinted station and port identification labels, snap-in icon buttons as well as write-on station identification labels shall be available.

## 7 TESTING

Testing of all newly installed cable channels shall be performed prior to system cutover.

### *7.1 Copper Testing*

- All category 5e field- testing shall be performed with an approved level IIe or III balanced twisted-pair field test device.
- All installed category 5e channels shall perform equal to or better than the minimum requirements as specified by the table below:

| Parameter | 100MHz (dB) |
|---|---|
| **Insertion Loss** | 24.0 dB |
| **NEXT Loss** | 30.1 dB |
| **PS NEXT Loss** | 27.1 dB |
| **ACR** | 6.1 dB |
| **PS ACR** | 3.1 dB |
| **ELFEXT** | 17.4 dB |
| **PS ELFEXT** | 14.4 dB |
| **Return Loss** | 10.0 dB |
| **Propagation Delay** | 548 ns |
| **Delay Skew** | 50 ns |

- Category 3, balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the basic link, and 100 m (328 ft) for the channel shall be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), insertion loss, length and NEXT loss (pair-to-pair). NEXT testing shall be done in both directions.
- All balanced twisted-pair backbone cables exceeding 90 m (295 ft) or 100 m (328 ft) shall be 100% tested for continuity if applications assurance is not required.
- Category 5e balanced twisted-pair horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the basic link, and 100 m (328 ft) for the channel shall be 100 percent tested according to ANSI/TIA/EIA-568-B.1. Test parameters include wire map plus ScTP shield continuity (when present), length, NEXT loss (pair-to-pair), NEXT loss (power sum), ELFEXT loss (pair-to-pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.

### TEST EQUIPMENT CRITERIA

- All balanced twisted-pair field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
- Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters
- Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
- A list of compliant field testers and associated test adapters from approved manufacturers has been provided
  Agilent WireScope 350 or FrameScope 350
  Fluke Networks OMNIScanner,DSP-4000(100,-300), DTX-1200(1800, LT)
  Ideal LT 8100A(155T,600T) LANTEK 6 (7)

## 8 ADMINISTRATION & DOCUMENTATION

### *8.1 Labeling*

- Horizontal and backbone cables shall be labeled at each end. The cable or its label shall be marked with its identifier.
- A unique identifier shall be marked on each faceplate to identify it as connecting hardware.
- Each port in the faceplate shall be labeled with its identifier.
- A unique identifier shall be marked on each piece of connecting hardware to identify it as connecting hardware.
- Each port on the connecting hardware shall be labeled with its identifier.

### *8.2 Drawings*

As-built drawings shall be supplied by the contractor showing the locations of and identifiers for all:

- Horizontal cable routing and terminations
- Telecommunications outlets/connectors
- Backbone cable routing and terminations

### *8.3 Records*

All records shall be created by the installation contractor and turned over at the completion of work

The format shall be computer based and shall be part of the As-built package. The minimum requirements include:

- Cable records must contain the identifier, cable type, termination positions at both ends, splice information as well as any damaged pairs/conductors.

- Connecting hardware and connecting hardware position records must contain the identifier, type, damaged position numbers, and references to the cable identifier attached to it.
- Test documentation on all cable types shall be included as part of the As-built package.

### *8.4 Reports*

All reports shall be generated from the computer-based program used to create the records above. These reports should include but not limited to:

- Cable Reports
- Cross-connect Reports
- Connecting Hardware Reports

# VENDOR WIRING PROCEDURES

Effective May 2, 2002

**In order to ensure that all cable and wiring vendors within the state are provided an opportunity to earn state work, the following procedures will be used for all State inside wiring projects.**

1. Installed and Maintained PBX Site: The contractor (Nextira One Communications) is responsible for installing and maintaining the State's PBX telephone systems will have primary responsibility for the installation and maintenance of the cable plant supporting voice, video and data infrastructure.

2. Installed and Maintained Key System Sites: The contractor (various) responsible for installing and maintaining the key telephone system at each site will have primary responsibility for the installation and maintenance of the cable plant supporting voice, video and data infrastructure.

3. Non-maintenance sites. There are many small agency offices that have not chosen to place the telephone system on a maintenance contract or sites where the original maintenance provider is no longer providing maintenance services. In these cases the following procedures will be used.

    a. Projects estimated not to exceed $5,000. A wiring vendor in the area or one who is willing to travel to the area will be contacted to do the work. A Scope of Work will be provided to the vendor and at least one informal (written or fax) bid obtained for completion of the work. The Voice Operations Section or Data Network Section may initiate this request. The section issuing the request will be responsible for overseeing the installation and acceptance of the work. The Section Supervisor is responsible for approving the vendor invoices and ensuring the work was completed within specifications.

    b. Projects estimated to cost $5,000 to $25,000. The Data Network Design Unit will be responsible for developing a Scope of Work. The Scope of Work will be provided to the vendor community and at least three informal (written or fax) bids will be obtained for the

work. A site visit/vendor walk-through may be required at ITSD discretion based on complexity of the job. The Data Network Design Unit will be responsible for overseeing the installation and acceptance of the work. The Bureau Chief will be responsible for approving the vendor invoices and ensuring the work was completed within specifications.

c. Projects estimated to cost $25,000 to $65,000. The Procurement Services Bureau with the assistance of the Data Network Design Unit and Voice Operations Unit will develop a Bid Document to obtain at least 3 informal (written or fax) quotes. A site visit/vendor walk-through may be required at ISD discretion based on complexity of the job. The Data Network Design Unit would be responsible for overseeing the installation and acceptance of the work. The Bureau Chief will be responsible for approving the invoice and ensuring the work was completed within specifications.

d. Projects exceeding $65,000. The Procurement Services Bureau with the assistance of the Data Network Design Unit and Voice Operations Unit will work with A & E to develop a formal construction bid. Construction bid procedures for advertising and awarding a contract will be followed.

4. Vendor List:

a. The Procurement Services Bureau will develop and maintain a list of qualified vendors.

b. This vendor list will be developed through the use of a “State of Montana Vendor Information” questionnaire. Qualified vendors may be added to this list at any time, when they provide proof of certification to the Bureau.

c. This vendor list will be used by the Information Technology Services Division to obtain the required number of bids to perform the work, as outlined in Section 3 of this document.

5. Wiring Vendor Qualifications:

a. Have successfully performed at least three projects of similar scope within two years of the date of this bid.

b. Certified by an approved manufacturer and adhere to engineering, installation and testing procedures outlined by the manufacturer for the installation of Category 5E high-speed data wiring systems.

c. Certify the cable plant following the Link Certification Process outlined by the wiring manufacturer.

d. Provide a 15-year warranty on the cable plant.

e. Label jacks and cable according to industry standards

f. Provide as built plan view of jack locations and certification documentation.

g. The Wiring vendor will be responsible for adhering to all local, state and federal regulations governing the installation of telecommunications wirings and TIA/EIA standards for the chosen wire type.

6. Successful Vendor Requirements:

a. Will provide proof of Commercial General Liability and Commercial Automobile Liability Insurance (Occurrence Coverage), to include bodily injury, personal injury and property damaged with combined single limits of $500,000 per claim and $1,000,000.00 aggregate per year, from an insurer with the Best's Rating of no less than A-.The above is a minimum amount, the actual amount of insurance is dependent on the total cost of each job.

b. Will provide proof of workers compensation coverage or an independent contractor exemption certificate.

c. Will pay prevailing wages for those jobs exceeding $25,000.

d. Bid security required with bid for jobs over $25,000.

e. Performance security required of successful vendor for all jobs over $50,000.

f. Contractor must be registered with the Department of Labor and Industry, Contractors Registration Unit, for projects over $2,500.