Specifications for Communication Cabling Distribution Systems

General Overview

Listed below are the separate sub-systems of Washington University’s structured cabling system standard. The sub-systems are each summarized and then described in detail as separate sections in this document. All telecommunications wiring systems must adhere fully to all applicable TIA/EIA Telecommunications Building Wiring Standards. The requirements for Washington University (WU) communications cabling sub-systems provide for:

1. **Service Entrance and Termination Room (Entrance Facility – EF)**

   This is the main telecommunications building service entrance. It is the area where the demarcation between inter and intra building cable is located. At WU this room is typically the Telecommunications Room on the lowest level of the building.

2. **Equipment Room (ER)**

   This area contains the electronic equipment that transitions between the core campus data, voice and video backbones and the building backbone. This securable room is to be dedicated to this purpose with no other building services sharing the space. This space may be co-located with the Service Entrance and Termination Room provided the room is sized for both functions. At Washington University all Telecommunications Rooms house active network equipment and are treated as ERs.

3. **Telecommunications Room (TR)**

   This room provides for demarcation between horizontal cabling serving work areas and the building video, data and voice backbone cabling. Additionally, this room may contain electronic equipment that transitions between the data, voice and video building backbone and the end user telecommunications equipment. This securable room is to be dedicated to this purpose with no other building services sharing the space. This space may be co-located with the Service Entrance and Termination Room and/or ER provided the room is sized for both functions. At Washington University all TRs house active network equipment and are treated as ERs.

4. **Communications Conduits (CC)**

   Communication conduit requirements depart from that for “normal” electrical power distribution. Communications conduit sizing does not follow NEC in terms of the maximum number of conductors allowed per unit volume. Due to the need for facilitating frequent adds, moves and changes, communications conduits are generously sized. Conduits entering the building are usually 4 inches with inner duct partitioning. Conduits between building TRs are also usually 4 inch. in diameter. Conduits servicing end user spaces are usually 1”. Conduits between floors interconnecting TRs are usually “stubbed” and 1” conduits servicing end users information outlets are also usually “stubbed “ to above the ceiling and thence to the nearest corridor/hallway telecommunications horizontal pathway leading to the TR.
5. **Communications Pathways (CP)**

Communications pathways are the single most critical component of the structured cable system. WU does not, in general, require a separate “home-runned” 1” conduit from the end user information outlet to the per floor TR. In general, WU prefers to utilize wiring hangers, sometimes known as J-Hooks, or cable trays. A key feature of the j-hook/cable tray arrangement is its flexibility in ongoing moves, adds, and changes to the cabling system over the lifetime of the building. Cable trays are required through all hallways and corridors and will terminate in TR.

6. **Telecommunications Wiring**

WU specifies the latest standard in twisted pair wiring. This cable carries the bulk of data and voice services. In general, WU does not require fiber or coaxial cable to the desktop though limited instances of this may be required and will be specified during the design process. All cable is plenum rated.

7. **Building Riser**

The building backbone riser system connects TRs to each other, to the main service entrance room and to the ER. WU specifies several separate cable systems to provide for the data, video and voice needs of the building occupants. Riser rated twisted pair copper “bulk” cables, coax, and both single mode and multimode fiber along with their termination systems are specified.

8. **Grounding and Bonding**

All cabling systems and electronics distribution equipment must be grounded for both safety and electromagnetic interference reasons. Specifications for how this is to be affected are found in this section.

9. **Electrical Power**

Provisioning the electrical power for communications systems requires special attention. Electrical interference as well as power quality must be attended in order to minimize long-term maintenance costs and end user disruptions.

**SERVICE ENTRANCE AND TERMINATION ROOM (EF)**

This room is the required service entrance for Telecommunications service (voice, data, video, FASS, BACS). The minimum size and number of conduits to a building is four 4” conduits with two of the four having three 1¼” inner ducts for fiber optic cabling. If the building has a tunnel attached, then interbuilding conduits will not be required.

The location shall be within 50’ of the point where electrical facilities enter the building.

Never run more than 50’ of exposed non-fire-rated entrance cable within a building. If more than 50’ of cable is required between the entry point and the termination point, use rigid metallic conduit to enclose the cable to within 50’ or less of the termination point or a transition splice from outside plant cable to indoor rated cable is acceptable. Conduit must be grounded.

The room shall be dedicated to Washington University’s Network Services and Support.

The basic requirements for WU’s EF are the same as a TR.
Approved manufacturers of fiber optic cable are Mohawk and Siecor. All outside plant cable in non-protected or protected pathways (tunnels, direct bury, and overhead) shall be loose-tube, armored, and include a trace wire.

*The fiber and copper entrance facility cabling counts will be provided on a per project basis and based on building size, function, and number of users.*

### EQUIPMENT ROOMS (ER)

Equipment Rooms provide space and maintain a suitable operating environment for communications equipment. ERs are generally considered to serve a building, where TRs serve one floor or a section of a floor. In most cases at WU, each TR will house active equipment and will meet all ER specifications.

The room should be located so it has access to the intra and inter backbone pathway, is accessible for delivery of equipment, away from potential sources of EMI, away from machinery that causes vibration, and away from steam pipes, drains, and clean-outs.

If the ER is on a different floor then the Service and Termination Room, it must be stacked above the Service Entrance and Termination Room.

The room shall be dedicated to Washington University’s departments of Communication Services and Network Technology Services.

1. The basic requirements for an ER are:

   Minimum size for small buildings.
   - serving area of <1,000 sq.ft., 3' X 4'.
   - serving area of <5,000 sq.ft., 6' X 6'.

   Minimum size for large buildings.
   - serving area of <8,000 sq.ft., 6' X 10'
   - serving area of <10,000 sq.ft., 8' X 10'
   - serving area of <20,000 sq.ft., 10' X 15'
   - serving area of <30,000 sq.ft., 15' X 15'
   - serving area of <40,000 sq.ft., 17' X 17'
   - serving area of <50,000 sq.ft., 19' X 19'

2. Minimum ceiling height is 9' 6", with the exposed slab as the ceiling.

3. Location, number, and size of conduits, and sleeves between the Service Entrance and Termination Room, ERs, and TRs will be specified during the design phase of the project.

4. Rooms shall have outward swinging, fully opening, and lockable doors that are at least 36 inches in width and 80 inches in height. The door will be outfitted with the University’s standard standalone card reader. If door cannot be outfitted with card reader, then it must be keyed to match the “MD-81” lock.

5. To avoid dust, floors shall be tile and all exposed concrete, brick, and gypsum board shall be painted or sealed. Carpet is not allowed.

6. Rooms shall have a dedicated HVAC, with positive air pressure, to control temperature and humidity. The heat dissipation will be specific to each building, but should be in the range of 750 to 5,000 Btu per
equipment rack. Relative humidity should be controlled at 30% to 50%. Temperature should be controlled at 64 to 75 degrees. Condensing units will not be located in the ER/TR.

7. ERs cannot have any water pipes in the room, above the room, or in the floor below the room. If sprinklers are required in ER or TR, install wire cages or other protection to prevent them from being accidentally set off. Sprinkler heads should not be installed directly over active equipment.

8. Provide a building ground wire, with bus bar, to the room. Locate the bus bar at the lower left corner of the plywood backboard. Network Technology Services or Communication Services will indicate on which backboard to place the bus bar. See Grounding section.

9. Provide a minimum lighting to be equivalent of 540 lux (50 foot-candles) measured 3 feet AFF.

10. Each wall, except the wall which contains the entrance door, shall have 3/4" X 4' X 8' sheets of A-C fire retardant plywood installed on them. The plywood shall reach from corner to corner. Install the plywood vertically at 6" AFF and fastened securely with a minimum of five (5) equally spaced fasteners along each vertical edge and one column of five (5) equally spaced fasteners centered on each sheet of plywood. Paint the plywood with two coats of fire retardant low-gloss, light-colored paint.

11. On each wall, except the wall containing the door, install two A/C 20-amp electrical fourplex outlets at 12" AFF. In the larger rooms, 10' X 15' and larger, install three A/C 20 amp electrical fourplex outlets evenly spaced along each wall. See Power section. Install a dedicated 208 volt 30-amp circuit to support a rack mountable UPS with L6-30 receptacle. The size of the UPS will be determined during the design phase along with the size and type of electrical receptacle.

12. Minimum floor loading should be 4.8 kPA (100 lb/ft²).

13. Install three 7' racks, without panels, to support network termination devices and network electronics. The amount of services required to support the building may require more than one cabinet to be installed. Fasten the cabinet(s) to the floor and bond the cabinet to the ground bus. Number and location of the cabinets will be supplied during the design phase of the project.

14. Install cable tray from the cabinet(s) to the plywood backboard. Bond the cable tray(s) to the ground bus. Cable tray fences are required every 12" to 16" to support cable bundles. The exact amount is determined by the total length of tray for each room.

15. When the ER is also used as a Service and TR and/or a TR, Network Technology Services or Communication Services will alter the size of the room based on the type and amount of services required to support the building. Network Technology Services or Communication Services will also take into consideration the intended use of the building when determining the size of the ER.

16. Install one Uninterruptible Power Supply in each ER.

TELECOMMUNICATIONS ROOMS (TR)

A per floor centrally located TR shall be provided for in the design of the building. If a horizontal distance of 90m between TR and work area outlet cannot be attained a second TR might be required per floor. These rooms will not be shared with other physical plant systems. In most cases at WU, each TR will house active equipment and will meet all ER specifications.

A TR provides the connection point between the building backbone and horizontal distribution pathways.
The TRs must be stacked above each other on each floor. If rooms are not stacked, the TR shall have a means to access the TR's on the floor above and below via metal conduits or sleeves.

The location shall be as close as possible to the center of the floor it is intended to serve. This is to minimize the horizontal cable lengths and duplication of electronic equipment.

The basic requirements for a TR are:

1. Maximum distance between the TR and a telecommunications outlet is 295 ft. as per the cable pathway.

2. There shall be at least one TR per floor.

3. The basic requirements for an TR are:
   - Minimum size for small buildings.
     - serving area of <1,000 sq.ft., wall enclosure.
     - serving area of <5,000 sq.ft., 4.5' X 4.5'
   - Minimum size for large buildings.
     - serving area of <5,000 sq.ft., 10' X 7'
     - serving area of <8,000 sq.ft., 10' X 9'
     - serving area of <10,000 sq.ft., 10' X 11'

4. The typical WU ER/TR size is 10' X 11' per each floor.

5. Minimum ceiling height is 9' 6", with the exposed slab as the ceiling.

6. Provide and install four STI EZPath Series 44 (part # EZD44) sleeves between TRs located on different floors. One 3" conduit shall be installed between TRs located on the same floor. Location of conduits, cable trays, and sleeves shall be coordinated with Network Services and Support.

7. Rooms shall have outward swinging, fully opening, and lockable doors that are at least 36 inches in width and 80 inches in height. The door shall be outfitted with the University standard standalone card reader. If the door cannot be outfitted with a card reader, then it must be keyed to match the "MD-81" lock.

8. To avoid dust, floors shall be tile and all exposed concrete, brick, and gypsum board shall be painted or sealed. Carpet is not allowed.

9. Rooms shall have a dedicated HVAC, with positive air pressure, to control temperature and humidity. The heat dissipation will be specific to each building, but should be in the range of 750 to 5,000 Btu per equipment rack. Relative humidity should be controlled at 30% to 50%. Temperature should be controlled at 64 to 75 degrees. Condensing units will not be located in the ER/TR.

10. TRs cannot have any water pipes in the room, above the room, or in the floor below the room. If sprinklers are required in ER or TR, install wire cages or other protection to prevent them from being accidentally set off. Sprinkler heads should not be installed directly over active equipment.

11. Provide a building ground wire, with bus bar, to the room. Locate the bus bar at the lower left corner of the plywood backboard. Network Services and Support will indicate on which backboard to place the bus bar. See Grounding section.
12. Provide a minimum lighting to be equivalent of 540 lux (50 foot-candles) measured 3 feet AFF.

13. Each wall, except the wall which contains the entrance door, shall have 3/4” X 4’ X 8’ sheets of A-C fire retardant plywood installed on them. The plywood shall reach from corner to corner. Install the plywood vertically at 6” AFF and fastened securely with a minimum of five (5) equally spaced fasteners along each vertical edge and one column of five (5) equally spaced fasteners centered on each sheet of plywood. Paint the plywood with two coats of fire retardant low-gloss, light-colored paint.

14. On each wall, except the wall containing the door, install two A/C 20-amp electrical fourplex outlets at 12” AFF. In the larger rooms, 10’ X 15’ and larger, install three A/C 20 amp electrical fourplex outlets evenly spaced along each wall. See Power section. Install a dedicated 208 volt 30-amp circuit to support a rack mountable UPS with L6-30 receptacle. The size of the UPS will be determined during the design phase along with the size and type of electrical receptacle.

15. Minimum floor loading should be 2.4 kPA (50 lb/ft²).

16. Install three 7’ racks, without panels, to support network termination devices and network electronics. The amount of services required to support the building may require more racks to be installed. Number, manufacturer, and location of these cabinets will be provided during the design phase of the project. Fasten the cabinet(s) to the floor and bond the cabinet(s) to the ground bus.

17. Install cable tray from the rack(s) to the plywood backboard. Bond the cable tray(s) to the ground bus. Cable tray fences are required every 12” to 16” to support cable bundles. The exact amount is determined by the total length of tray for each room. The manufacturer and location will be provided during the design phase of the project.

18. When the TR is also used as a Service and Termination Room and/or an ER, Network Services and Support will alter the size of the room based on the type and amount of services required to support the building. Network Services and Support will also take into consideration the intended use of the building when determining the size of the TR.

19. Each TR shall contain a smoke/fire sensor as part of the overall building fire alarm system.

20. The Ethernet cables will be terminated in the data rack in patch panels with cable management. The voice cables will be terminated on wall mounted racks. CATV will be mounted on a wall mounted swing rack. The specific part numbers of the patch panels, racks, and cable management devices will be provided during the design phase of the project.

21. The room shall be dedicated to Washington University’s Network Telecommunication Services.

22. Install one Uninterruptible Power Supply in each TR.

See attached document labeled “Typical Washington University Telecommunications Room Layout”.

COMMUNICATIONS CONDUITS AND INFORMATION OUTLETS

The minimum conduit and outlet specifications for Washington University’s communication cabling system are as follows:

1. The communication entrance conduit shall consist of at least four (4), four (4) inch conduits run from the nearest existing maintenance hole, hand hole, or tunnel to the Service Entrance and Termination.
Room of the new facility. At least one 4” conduit will contain (3) 1 ¼” inner ducts. These conduits shall not contain more than two 90-degree bends and be placed with a minimum of 1/4 inch per foot slope to allow proper water drainage from the ducts. No run of conduit shall exceed 500 feet between hand holes/maintenance holes. New manholes shall contain permanent ladders, pull rings, grounding system, a sump pit, and a floor drainage system to drain water. New hand holes shall contain, pull rings, grounding system, a sump pit, and a floor drainage system to drain water.

2. Conduit run outdoors for other communication purposes shall be a minimum of one-inch diameter, and be placed with a minimum of 1/4 inch per foot slope to allow proper water drainage from the ducts. No run of conduit shall exceed 500 feet between pull points and contain no more than two 90-degree bends. If pull boxes are installed the conduits shall enter the pull box one foot above the bottom and the pull box shall have a means to drain water from them.

3. The conduits entering from outside of the building shall terminate 4” after they penetrate the outside wall. Cable tray shall be installed or conduit extended to the TR from the penetration point. A ground wire with bus bar shall be installed at the location the cable enters the building.

4. A one-inch conduit shall connect the work area outlet to the nearest cable tray or J-hook run. The conduit shall terminate within 4’ of the nearest cable tray or J-hook. The minimum size conduit run from the Telecommunications outlet to the nearest cable tray of J-hook shall be a one-inch EMT conduit.

5. The total length of conduit runs shall not exceed 150 feet in length, with the distance between pull boxes not to exceed 100 feet. Provide pull boxes in readily accessible locations. The installation of pull boxes in the conduit run shall be placed in line with the conduit run such that wire or fiber optic cable can be pulled through the pull box without incurring damage to the cable. No turns or bends of the conduit run are allowed within pull boxes.

6. Conduit installed for payphones, emergency phones and elevator phones shall be a ¾” EMT conduit and be a home run back to the TR and shall have a pull box after every 180 degree change in direction or elevation for every 150 feet. Conduit runs shall not exceed 295 ft. in length. Provide pull boxes in readily accessible locations. The installation of pull boxes in the conduit run shall be placed in line with the conduit run such that wire or fiber optic cable can be pulled through the pull box without incurring damage to the cable. No turns or bends of the conduit run are allowed with pull boxes.

7. No LB type fittings of any size are to be used for communication conduit.

8. No PVC conduit or PVC sleeves are to be used for communication conduit within the confines of a building.

9. Minimum radii for bends shall be 9-1/2 inches for 3/4-inch conduit, 10-1/2 inches for one inch conduit and the equivalent of long radius factory bends for larger sizes. The short radius bends of larger diameter conduit normally installed for electrical installations is not sufficient for communication cabling. Four (4) inch conduits installed for communication cabling will have a minimum four-foot radius bend.

10. Label all pull and junction boxes.

11. Provide a nylon pull cord in each empty conduit and run with a 200 LB pulling tension.

12. Conduit installation for communication purposes shall be installed with the probability of fiber optic cable being installed in it and pulling tension and minimum bend radius being critical factors for installing usable fiber optic cable as well as the category 5E cable.
13. All pathways and cable penetrations are required to use the approved STI fire stopping methodology.

COMMUNICATIONS PATHWAYS SPECIFICATIONS

The standards adopted by Washington University provide that a clear and accessible pathway for telecommunications horizontal cabling shall be maintained. These pathways are located between the TRs and the rooms containing the telecommunications outlets. The Architect and the Mechanical/Electrical/Plumbing consultants shall prepare drawings and specifications that insure a clear and accessible pathway for telecommunications wiring. Any pathway that is not accessible and/or provides a clear and workable pathway will need to be removed and reinstalled to provide a clear and accessible pathway.

There are several methods available for providing a pathway for supporting telecommunications cables. The architectural design of each building is unique and requires an analysis of which method(s) are best suited for that building. At WU, J-Hooks and cable trays are the preferred method of providing a pathway. All pathways and spaces must adhere to current TIA/EIA-569-B. Both pathway types are listed below.

1. Cable Trays: The cable tray shall be installed in accordance with the applicable electrical code. The cable tray is for dedicated use by Communication Services and Network Technology Services. No other cabling is to share the cable tray. Cable Tray must be installed with 12” of vertical space above the tray and with a minimum of 3” between the tray and finished ceiling.

2. J-Hooks: The model to use will be determined by the number of cables in that pathway. No other cabling is to share the J-Hooks with Communication Services and Network Technology Services. J-Hooks must be located on 4’ to 5’ centers to adequately support and distribute the cables weight.

PER FLOOR TELECOMMUNICATIONS WIRING SYSTEMS

Installation and physical protection of Telecommunications cable is a very critical element for the cable to deliver its rated bandwidth. A "kink", "pinch", a bend radius less than 1.25 inches in diameter, or stretching of the cable by exceeding the 25 pound maximum pulling tension during installation will damage the cable to the point that it will not meet rated specifications and shall be replaced. Telecommunications cable termination standards requires that no more than the minimum amount of the common sheath be removed that is required for termination and no more than 1/2 inch of untwisting of conductors. Installation personnel shall be BICSI certified installers or equivalent and provide proof of certification.

At WU the minimum wiring system specification varies by building function and type. An addendum to the “Per Floor Telecommunications Wiring Systems” section will be attached separately.

All telecommunications wiring systems must adhere fully to the latest applicable to the current TIA/EIA Telecommunications Building Wiring Standards (ANSI/TIA/EIA-568B.1, B.2, B.3-1, and 569B), including:

1. The cable run from the TR to the work area outlet will not exceed 90m and will contain no splices.

2. All fiber optic cable will be installed in inner duct or armored rated cable.

3. At the user end of the cables, in the outlet box, there shall be 12” of slack after termination to facilitate future re-terminations.
4. Each of these two cables will be labeled on each end with a Telecommunications outlet number. The Telecommunications outlet numbering will contain the floor number and the sequence number of the cable (start with 1 and number sequentially). Each voice and network cable will be labeled with the jack ID.

5. The installation of the data and voice cables shall conform to the following clearances:

   At least 127 millimeters (5 inches) from power lines carrying 2KVA or less
   At least 305 millimeters (12 inches) from power lines carrying from 2 to 5KVA
   At least 915 millimeters (36 inches) from power lines carrying more than 5KVA
   At least 127 millimeters (5 inches) from all fluorescent lights and other sources of electromagnetic interference such as electric motors, HVAC equipment, arc welders, intercoms, etc.

BUILDING RISER SPECIFICATIONS

Twisted pair riser cables, fiber optic riser, and CATV Coax broadband riser cable, shall be installed from the EF to individual floor TRs.

The minimum specifications for this riser system is as follows:

1. Install eight (8) 25-pair category 5 plenum rated cables totaling 200 pair to be terminated on Siemens Siemens 66-blocks and on Homaco frames at the EF and at individual floor TRs.

2. Install one armored composite cable with 12-pair (24 strand) 50/125 (OM3) micron multimode fiber and 12-pair (24 strands) single mode fibers terminated with Siemon SC type connectors and placed in a rack mounted box.

3. Install a minimum of four (4) RG-6 Quad Shield coaxial cables from the EF to individual floor TRs.

GROUNDING AND LIGHTNING PROTECTION

Each EF, ER and the TR shall have a bus bar installed and bonded to ground as per the requirements of Telecommunications Industry Association standard ANSI/TIA/EIA-607 Grounding and Bonding Standard as follows:

1. An insulated copper ground wire shall be run from the building main electrical ground bus to the EF bus bar with no splices or connections other than the designated end points or conduit bonds if run in metal conduit.

2. An insulated copper ground wire shall be run from the EF bus bar to the ER bus bar and the ground bus bar in each TR. This ground wire shall be sized based on the cable size of the main electrical feed and the cable should be one continuous cable containing no splices. In the intermediate closets, the ground bus shall be connected to this cable with a "tap" connection.

3. If there is more than one closet riser in a building, each closet riser shall have the same ground system installed as stated in the previous paragraph. In addition, an insulated copper equipment ground shall be run to connect together the ground buses of each top floor closet and every third floor closet in between.

4. The routing path of this ground should be as direct as possible.
5. The minimum conductor size for this ground shall be a number 3 AWG insulated.

6. All racks and building entrance terminals shall be bonded to ground.

7. If this ground conductor passes through metal conduit or metal enclosures greater than three feet in length, each end of the conduit or enclosure shall be bonded to the ground conductor by approved means.

8. Each grounding plan shall be tested using a Two-Point Test Method, and the ohmic value shall be less than 0.1 ohm to be considered to have an adequate bonding between the two reference points.

LIFE SAFETY AND BUILDING AUTOMATION SYSTEMS

The Life Safety and Building Automation Systems typically consist of fire alarm, security and access control, heating, ventilating, and air conditioning, as well as energy management systems. The following outlines the installation of the services applicable to Washington University. It would also include the installation of the USN Network, which is comprised of specified network equipment.

1. Fire Alarm - Install one category 6E cable from fire alarm panel to a Siemens 66-block in the closest TR.

2. Security and Access Control - Install one category 6E cable from security panel to network patch panel in the closest TR.

3. Security loops - Install one category 6E cable from the security panel to the device that needs to be secured, such as AV equipment.

4. Indoor or Entrance Emergency Phones - Install one category 6E cable from phone to a Siemens 66-block in the closest TR.

5. Outdoor Emergency Phones - Install one 3-pair category 3 outside plant cable (with lightening protection) from phone to Siemens 66-block in the closest TR.

6. Elevator Phones - Install one category 6E cable from each elevator controller to a Siemens 66-block in the closest TR.

7. Laundry Controllers and Vending Machines - Install one category 6E cable from device location to network patch panel in the closest TR.

ACCEPTANCE TESTING

Fiber Optics – Backbone and Horizontal Fiber

1. Fiber backbone cables shall be 100% tested for insertion loss and length.

2. Length shall be tested using an OTDR, optical length test measurement device or sequential cable measurement markings.
3. Insertion loss shall be tested at 850 nm and 1300 nm for 62.5/125 µm and 50/125 µm multimode and 1300 nm or 1550 nm for the appropriate single mode cable in at least one direction using the 1-jumper method.

4. All testing must adhere fully to current ANSI/TIA/EIA-568-A-4 Annex H, ANSI/TIA/EIA-526-14-A, and TSB 140 which requires OTDR trace for each fiber.

**CATV Cabling**

Test all cables with TDR for coaxial cables.

**Copper Cabling – Outside Plant and Riser**

1. Testing of all cable pairs from the MC/IC to TR or from TR to TR

2. The system shall be tested for shorts, opens, grounds, crosses, and transpositions.

3. Cable pair defects must not exceed 1 percent of the total number of pairs.

4. All repair and/or replacement of defective material and labor shall be done at no cost to Washington University.

5. All testing must adhere fully to current ANSI/TIA/EIA-568.

**Copper Cabling – Horizontal Cabling**

Horizontal cabling whose length does not exceed 90m for the permanent link and 100m for the channel shall be 100 percent tested to current ANSI/TIA/EIA-568 using a level III tester with Siemon approved test adapters.

**DELIVERABLES - DOCUMENTS**

1. Cable installation and termination personnel shall be specialists in Telecommunications systems installation with at least 5 years’ experience and must be a Siemons certified installer.

2. The contractor shall furnish and install all material required, including installation of communication cable, installation of communication outlets, and termination of all cable in the EF, ERs, and TRs.

3. The contractor shall test and certify all cable and provide documented results of the testing. The documented results of the testing can be supplied in ASCII format electronically, and or 3 printed copies. All Telecommunications cable shall be certified to perform at the speeds referenced in the standard for that cable. If any cable runs tests defective, the contractor shall replace defective cable. A twenty year Siemon System Six warranty shall be included on all cable and hardware installed by the contractor.

4. Contractor shall provide two copies of “as-built” drawings and an AutoCAD version of the completed project showing cable runs and location numbers assigned to rooms. This shall be provided to Network Services and Support, and Washington University Facilities upon completion. All manufacturer warranties will be transferred at this time. An as-built copy must be left behind in each Telecommunications Room referencing the connections that feed from that particular room.
**Revision History** (For Internal Use and Viewing Only)

Revision 1.0 created 09/10/01 by Craig Hager (Network & Telecommunication Services)

Revision 1.1 modified on 11/12/01 to include UPS in each ER and TR.

Revision 1.2 modified on 03/11/01 to add more information regarding Entrance Facility.

Revision 1.3 modified on 01/14/04 to update ANSI/TIA/EIA changes.

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