U.S. Immigration and Customs Enforcement

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# Structured Cable Plant Standard

*September 6, 2012*
*Version 7.4*

**Office of the Chief Information Officer (OCIO)**
**Network Implementation Branch (NIB)**
**Engineering Division**

Homeland Security

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# Revision History

| No. | Date | Reference: Page, Table, Figure, Paragraph | A = Add. M = Mod. D = Del. | Change Description |
|---|---|---|---|---|
| 6.1 | 7/14/2010 | | M | Update contents of document (Version 6.1) |
| 6.2 | 7/30/2010 | | M | Update contents of document (Version 6.2) |
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| 7.1 | 4/20/2011 | | M | Update contents of document (Version 7.1) |
| 7.2 | 4/30/2012 | | A | Added new Fiber Specifications |
| 7.4 | 8/9/2012 | | M | Modified Drawing in Figure 1 |

# Introduction

## 1.1 Purpose

This document has been prepared for Immigration and Customs Enforcement (ICE) with the specific purpose of setting standards for structured cable plants in support of Local Area Network (LAN) and voice connectivity that will function as follows.

- Accommodate the functional requirements of present and future information services.
- Support a multi-product and multi-vendor environment.
- Facilitate the planning and installation of cabling systems that will support the diverse communication needs of building occupants.
- Ensure uniformity of structured wiring and hardware infrastructure installations in all ICE facilities, saving time, effort, and tax payer dollars.

The primary focus of this document is to define the standards for material, infrastructure, design, installation, and certification with respect to structured cabling systems for ICE facilities. This document shall replace, modify, or otherwise supersede previous releases of these standards. For questions or comments regarding this document, contact the ICE Network Implementation Section Chief.

- An electronic version of this document resides in the ICE Intranet Enterprise Library, available on the Office of Chief Information Officer (OCIO) Web site.

## 1.2 Background

Immigration and Customs Enforcement (ICE) is a component of the U.S. Department of Homeland Security (DHS). ICE brings a unified and coordinated focus to the enforcement of federal immigration laws, customs laws, and air security laws. ICE brings to bear all of the considerable resources and authorities invested in it to fulfill its primary mission: to detect vulnerabilities and prevent violations that threaten national security.

Because of increasing demands on Service resources, ICE personnel must be able to share information rapidly and efficiently in order to succeed in fulfilling the Service mission.

In addition to this document, which establishes the cabling standards for ICE, other documents are being developed that provide additional related information such as:

- ICE LAN standards.
- ICE Wide Area Network (WAN) standards.
- ICE Voice Communications standards.

## 1.3 Scope

### 1.3.1 System

Typical structured cabling systems include the following elements:

- Horizontal cable.
- Horizontal cross-connects.
- Transition point (optional).
- Main cross-connect (MC).
- Intermediate cross-connect.
- Backbone cabling, intra and inter building.
- Workstation locations or information management outlets (IMO).
- Remote wiring closet (RWC).
- Main distribution frame (MDF).
- Entrance facility (EF).
- Grounding.
- Administration.

### 1.3.2 Documentation

This document is intended to address the following specifications and installation practices related to structured cable plant installation:

- Recognized media.
- Closet requirements, environmental and design.
- Distribution cabling.
- Cabling specifications and limits.
- Installation practices.
- Performance testing.
- Supporting documentation.

# 2 Network Cable Plant Objectives

The objective of this network approach is to provide ICE with a standardized, cost-effective cable plant infrastructure that will accommodate present and future voice, video, and data requirements. Workstation cabling infrastructure shall support bandwidth demands from 10 Megabits per second (Mbps) to Gigabit speeds. Backbone cable infrastructure shall support bandwidth demands from Gigabit speeds and beyond. The installation of the cable plant infrastructure shall comply with all state and local codes, as well as, industry and Federal standards.

# 3 Structured Cable Plant Design

The network cable plant shall utilize the following cable distribution methods to support connectivity throughout the building:

- Horizontal workstation cabling, which will connect the user workstation, or information management outlet (IMO) to the nearest Remote Wiring Closet (RWC).
- Where appropriate, Intra and Inter-building backbone cable, which provides connectivity between wiring centers and the MDF.
- Work zone distribution cabling for open office space.

## 3.1 Structured Cable Plant Approach

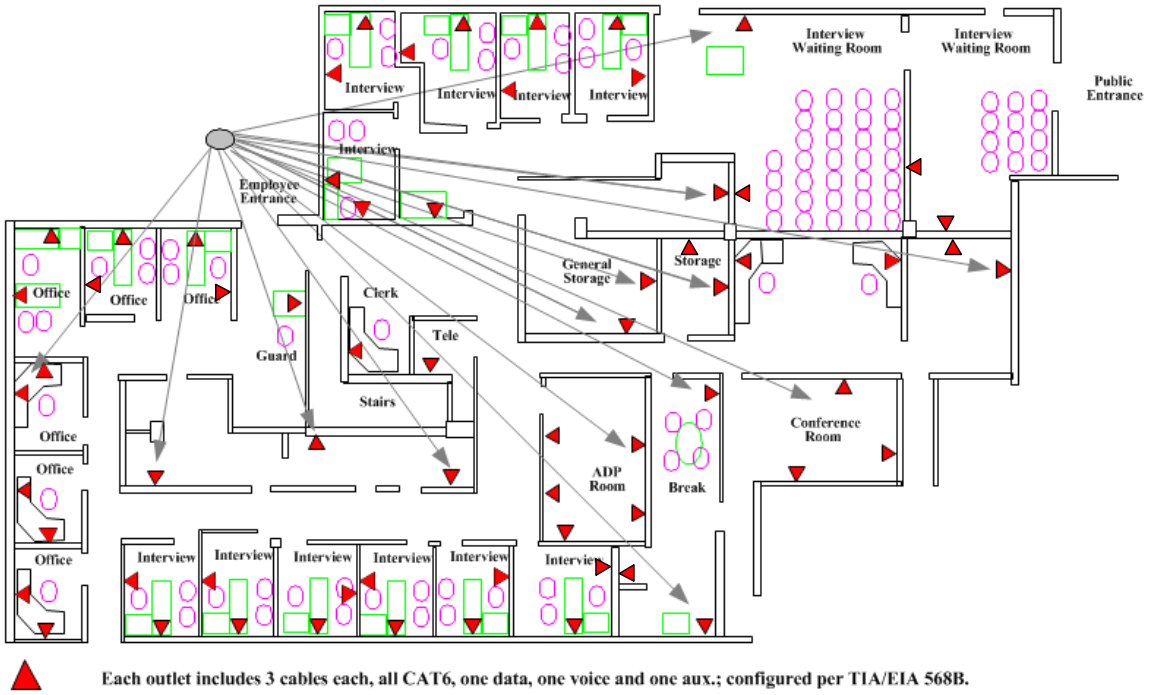
This section will describe the approach to structured cabling, identify and describe the various cable types, and provide detailed cable specifications for cable plant installation. These are minimum specifications for new cable plant installations or major renovations. These specifications follow the American National Standards Institute (ANSI)/Telecommunications Industries Association (TIA)/Electronic Industries Association (EIA) recommendations, and in addition, provide specific guidelines unique to ICE. Detailed cable plant material specifications and overall minimum characteristics are provided in Section 4.

## 3.2 Horizontal Workstation Cabling

All end-user workstation locations, whether occupied or vacant, shall be cabled to the nearest wiring center. Also, storage rooms, conference rooms and similar space not designated as offices shall be cabled to allow for office expansion, as shown in Figure 1.

To comply with ANSI/TIA/EIA-568-B.1 specification distance limits, the cable run from any user workstation location to the nearest wiring center shall not exceed 100 meters (328 feet). The actual length of a cable run is defined as the total combined length of the station cord, workstation cable, and patch-panel cable. When planning or designing office space the communications closets should be located within 90 meters (295 feet) of any workstation outlet. This design approach allows the addition of patch cables and workstation cords to connect devices, without exceeding the ANSI/TIA/EIA-568-B.1 specification distance limits.

**Figure 1 Typical Office Cable Planning**




All drop locations will be configured with three Category 6, plenum rated cables identified as “A”, “B” and “C”. All cables shall be terminated in the LAN closets on Category 6 compliant Patch Panels. This configuration allows each cable, “A”, “B” or “C”, to be used for either a voice or data device offering maximum flexibility in deploying devices throughout the facility.

Each workstation cable that is routed through a suspended ceiling area shall be secured in a manner that will keep all cable plant off of any suspended ceiling tiles, sprinkler systems, ceiling suspension hangers, and adhere to local and Federal building codes. Cable plant installed in plenum environments should provide enough slack to facilitate minor construction modifications, or cable re-locations, without the need to install new cable altogether. This installation approach normally requires approximately 20 feet of cable slack, secured in an appropriate manner, to ensure cable is minimized from radio frequency interference (RFI) and electro-magnetic interference (EMI) sources. However, installed cable shall at no time exceed the overall specifications for total lobe length of 100 meters in accordance with the ANSI/TIA/EIA standards. An independent suspension system shall be installed for the cable plant, to keep the cables off of and away from the existing ceiling grid and fixtures.

All end-user workstation locations, whether occupied or vacant, shall be cabled to the nearest wiring closet. Every office should have a minimum of two drops installed. Every cubical should have a minimum of one drop installed. Storage rooms, conference rooms and similar space not designated as offices should have a minimum of two drops installed to allow for office expansion.

When routed above a suspended ceiling, horizontal cables should be routed down the inside of walls wherever possible to ensure no exposed cable is visible. If walls cannot be fished, surface mounted (external) raceway may be used to route the cable from the ceiling to the information outlet and installed in a surface-mounted outlet box. The horizontal cable is not to be exposed within the building area, providing a neat, professional installation. Horizontal cables shall never be exposed to outdoor

elements without being protected in proper conduit/raceway systems and have proper lightning and bonding protection installed.

Optical fiber cable can also be used for horizontal workstation connectivity when the following conditions exist:

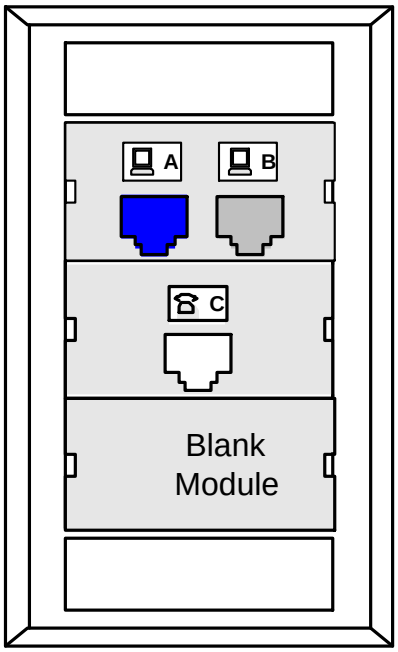
- Distance requirements exceed the 100 meter cable-length specification.
- Known high bandwidth/security requirements that exceed copper cable limitations and business case support the installation.
- Space inside or outside of the walls to support the minimum fiber cable bend radius.
- Severe EMI or RFI in the copper cable plant.
- EMI or RFI from other sources.
- Proposed fiber optic to the desktop is approved by the NIB.

If optical fiber cables are used for workstation connectivity, each workstation location shall be cabled with a 2, 4 or 6-strand, 50/125 micrometer (µm) multimode, plenum rated optical fiber cable. The cable shall be labeled as described in Section 12 of this document.

## 3.3 Workstation Outlets

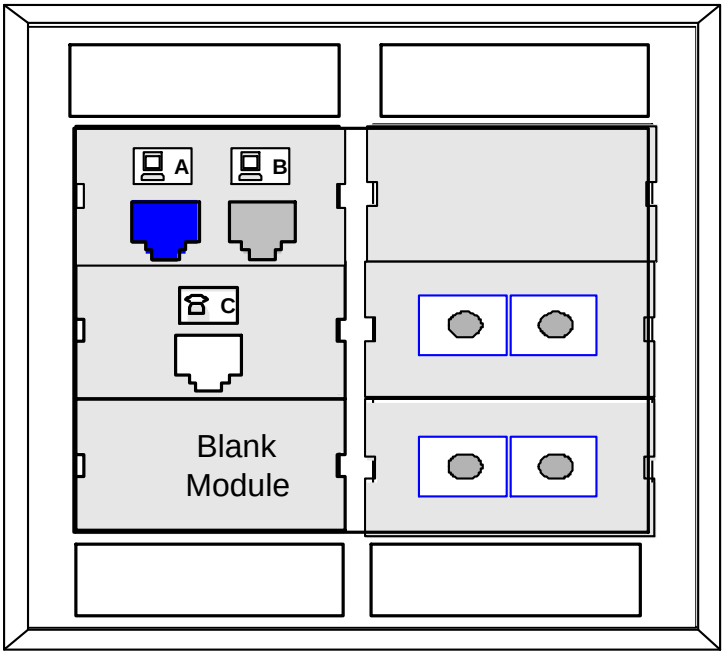
Each workstation area shall use a standard faceplate that can support a minimum of three connection interfaces. Regardless of the installation contractor, all voice and data cable shall utilize a single Information Outlet. Unless otherwise specified, the “A” jack shall be Blue, the “B” jack shall be Gray and the “C” jack shall be Ivory or White. Information outlets can be either single gang or dual gang standard size; sizing will be determined by number of cables being installed.

**Figure 2 Workstation Faceplate - Single Gang**




Where fiber-optic cable is installed to the desktop, the corresponding IMO faceplate shall provide space to install at least three RJ-45 jacks and at least two optical fiber connectors (see Figure 3).

**Figure 3 Workstation Faceplate Double Gang with Fiber Optic SC connectors**



## 3.4 Backbone Cabling

Intra and Inter-backbone cabling consists of both optical fiber and copper cables and are required where there exists more than one wire center. The intra and inter-backbone shall be installed to provide structured connectivity between closets (see Figures 4 and 5). The installation provides a star-topology cable infrastructure that is capable of supporting high-speed and high bandwidth requirements between key resources in an enterprise building or campus environment. Copper backbone cabling is required to support voice services.

### 3.4.1 Optical Fiber Backbone Cabling

A multimode, single mode or combination of fiber-optic backbone structure provides the means of interconnecting all wiring closets to the MDF in a multi-segmented environment. Optical fiber not only provides extensive bandwidth capabilities to the LAN and voice, but it also provides a solution to the distance-related problems encountered with copper cables in large installations and campus environments.

Each remote wiring closet shall be connected to the MDF with a multi-strand, optical fiber backbone cable that runs directly from the wiring center to the MDF. All strands will be terminated with SC style connectors in accordance with the ANSI/TIA/EIA standards in rack-mounted patch panels. A minimum twelve-strand fiber shall be installed in any facility providing connectivity between communications closets. It is estimated that 12 strands of multimode fiber will meet most of the intra and inter backbone connectivity needs currently deployed and planned for ICE facilities. Considering the myriad of site functions, building designs, physical layout, application requirements and future technologies, backbone design is a critical element in the planning stages. To ensure facilities are properly engineered with respect to backbone fiber types and counts, the Network Implementation Branch will provide engineering design in concert with local IT Field Operations (ITFO) support personnel and facilities architects. This ensures both short-term and long-term requirements are met in a cost-effective manner.

The optical fiber Intra and Inter-backbone cabling shall have one port per strand for cross-connection, and will conform to the specifications in Sections 4 and 6 of this document.

### 3.4.2 Copper Backbone Cabling

Copper backbone cabling is required to support voice services. Designs including sizing and cable specifications are determined on a site-by-site basis. ICE OCIO NIB shall review and approve Copper backbone designs prior to installation.

A mulitpair copper tie cable shall be installed from the building Demarcation (DEMARC) to the ICE MDF terminating on 110 blocks at each end.

In facilities employing multiple wiring closets, appropriately sized copper backbone cables shall be installed from the MDF to each RWC. The cables will terminate on 110 blocks near the PBX in the MDF and terminate 1-pair per port patch panels in each RWC. The voice tie patch panels need not be Category 6. The last pair of each binder (Vio/SLT) shall be coiled and spared for possible future use. The voice tie patch panels should be placed as close as possible to the “C” horizontal cable patch panels.

**Figure 4 Backbone Distribution**

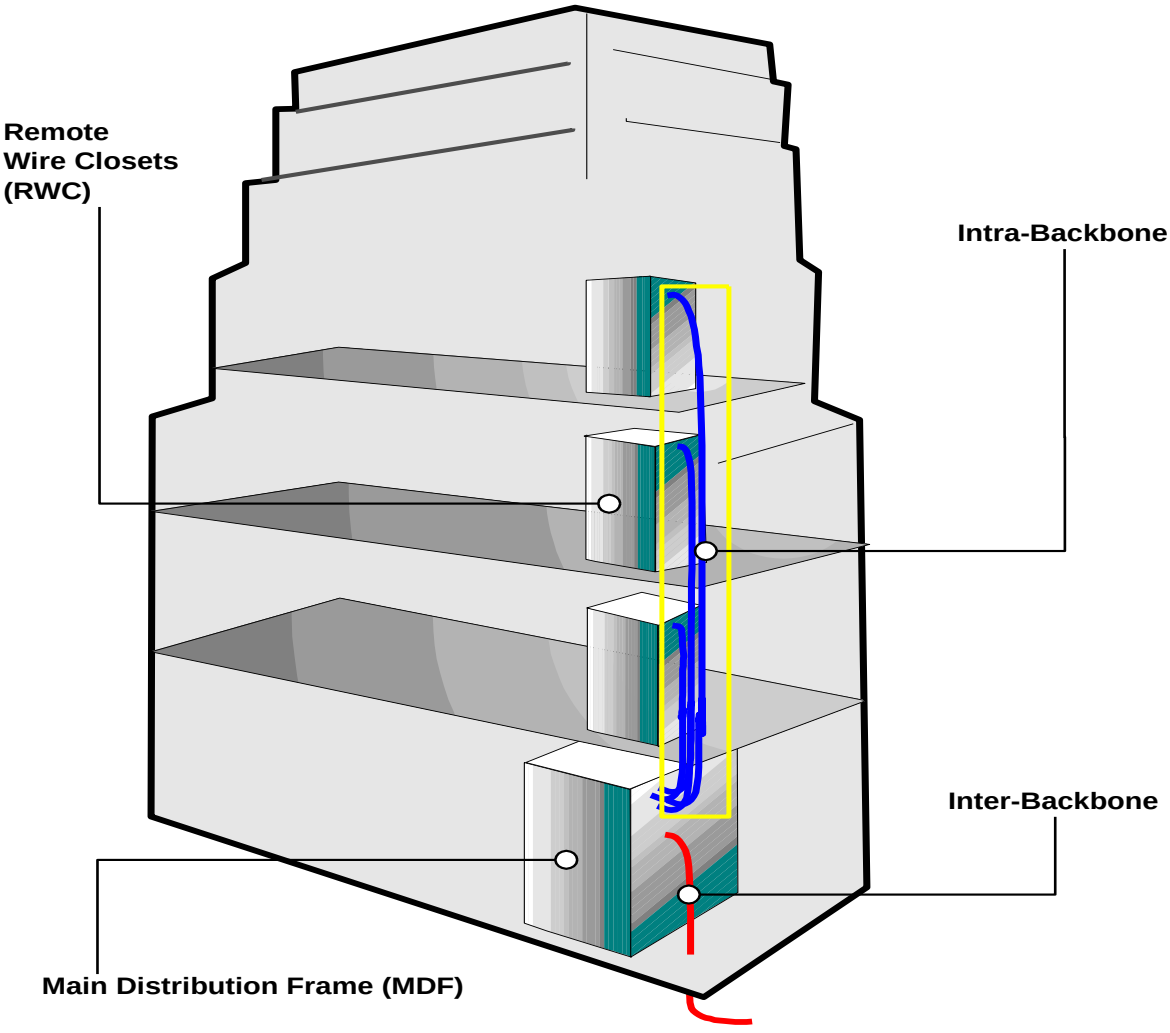
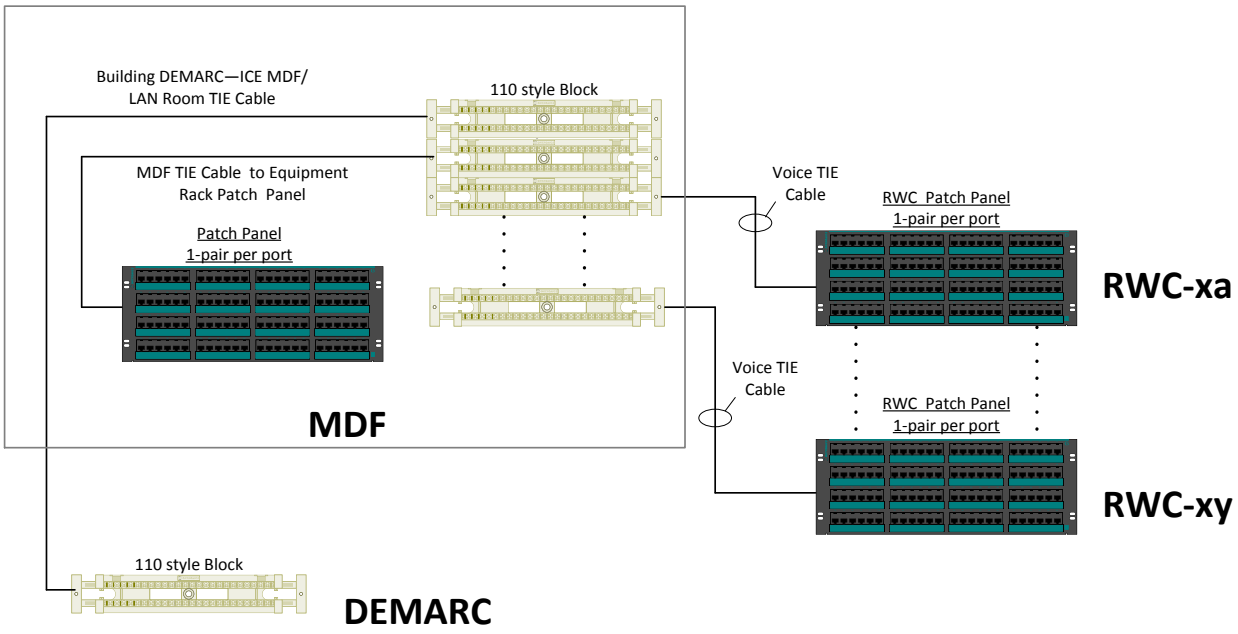


**Figure 5 Copper Tie Distribution**




# 4 Specifications

This section provides detailed component characteristics and specifications with respect to the materials used to install the structured cable plant.

## 4.1 Horizontal Cables

All cable, equipment, and materials shall meet applicable ANSI/TIA/EIA-568-B, National Electrical Code (NEC) 770, Institute of Electrical and Electronics Engineers (IEEE) 802 and Underwriters Laboratory (UL) Verification Program standards. All cable equipment and materials must be manufactured by facilities that are International Organization for Standardization (ISO) 9001 registered and certified.

- Shall be Category 6 rating in accordance with ANSI/TIA/EIA-568-B.2
- Four-pair, 100-Ohm, 24 American Wire Gage (AWG).
- The cable should have contiguous, 2-foot segment-length markers printed on the cable jacket. The markings must also show the applicable performance Category 6, as well as the fire rating of the cable being installed.
- The finished cable shall be 100% plenum rated in accordance with the requirements of NEC Article 800, UL 444, NFPA 262, (UL 910), and applicable Canadian Standards Association (CSA) standards.

**Note:** Category 6 cables types must meet or exceed specifications listed in Table 1.

**Table 1 Category 6 Cable Specifications**

| Specification | Category 6 |
|---|---|
| Frequency Range | 1-250 MHz |
| Attenuation (maximum) | 35.8 dB |
| NEXT (minimum) | 33.1 dB |
| PSNEXT (minimum) | 30.2 dB |
| ACR (minimum) | -2.7 dB |
| PSACR (minimum) | -5.7 dB |
| ELFEXT (minimum) | 15.3 dB |
| PSELFEXT (minimum) | 12.34 dB |
| Return Loss (minimum) | 8dB |
| Propagation Delay (maximum) | 548 nanoseconds (ns) |
| Delay Skew (maximum) | 50 ns |

## 4.2 Information Management Outlets

- Provide ANSI/TIA/EIA symbol icons for application identification (LAN, Voice, etc).
- Provide individual label window for cable identification.
- Provides a high-density design.
- Offers solutions for secure environments.
- Must match make and model in existing facilities.
- Meets or exceeds ANSI/TIA/EIA Category 6 specifications.
- Mounts to standard electrical 2 inch and 4 inch boxes.
- Meets all Federal Communications Commission (FCC) Part 68 specifications.
- Provides standard 110D type insertion displacement connector (IDC) Printed Circuit Board (PCB) mounted connector.
- Provides interchangeability between modules.
- Offers RJ-45 style connectors.
- Offers 568SC modular fiber connectors.
- Offers 568LC modular fiber connectors.
- Is available in the ANSI/TIA/EIA-T568B wiring configuration.

## 4.3 Fire Stop Requirement

Sealing of openings between floors, through rated fire and smoke walls, existing or created the contractor for cable pass through shall be the responsibility of the contractor. Sealing material and application of this material shall be accomplished in such a manner which is acceptable to the local fire and building authorities having jurisdiction over the cabling work. Creation of such openings as are necessary for cable passage between locations as shown on the drawings shall be the responsibility of the contractor's work. Any openings created by or for the contractor and left unused shall also be sealed as part of the work.

## 4.4 Fiber Backbone Cabling

Backbone cabling shall be a minimum of 12-strand multimode fiber optic. In limited instances, single mode fiber-optic cable may be used for distances that exceed 500 meters, in accordance with the Institute of Electrical and Electronics Engineers (IEEE) and the Gigabit Ethernet Alliance organizations. The IEEE 802.3z and IEEE 802.3ab published standards apply to gigabit Ethernet and overall specifications.

Unless otherwise noted, all fiber cables shall be of interlocking armor construction eliminating the need for conduit or plenum rated inner duct.

Fiber cable shall be colored orange to denote multimode fiber, yellow to denote single mode and aqua to denote laser-optimized multimode fiber.

Plenum rated fiber cable is required for backbone cables routed within buildings.

Outside plant fiber cable shall have a water block construction and meet the requirements for compound flow and water penetration.

### 4.4.1 Intra-Building Fiber Optics

Specifications for fiber backbone cabling that will interconnect closets within a single building or high-rise environment are defined in this section. ANSI/TIA-568-C.3 and ISO/IEC 11801 identify multimode fiber cables with the prefix of OM and the single mode fiber cables with the prefix of OS. ICE recognizes all these fiber types. ICE sites deployed prior to 2005 used 62.5/125 OM1 multimode fiber. 50/125 OM2 multimode fiber was installed in new sites between 2005 and 2011. OM3 is now the requirement for new ICE sites.

#### 4.4.1.1 Multimode Fiber Optics

**OM1** - 62.5/125-µm Optical Fiber

- Maximum Attenuation: 3.5/1.5 dB km at 850/1300 nm.
- Minimum Bandwidth: 200/500 MHz km at 850/1300 nm
- Tight buffered, armored, plenum rated.

**OM2** - 50/125-µm Optical Fiber

- Maximum Attenuation: 3.5/1.5 dB km at 850/1300 nm.

- Minimum Bandwidth: 500/500 MHz km at 850/1300 nm
- Tight buffered, armored, plenum rated.

**OM3** - 50/125-µm Laser-Optimized optical fiber

- Maximum Attenuation: 3.5/1.5 dB km at 850/1300 nm.
- Minimum Bandwidth: 1500/500 MHz km at 850/1300 nm
- Tight buffered, armored, plenum rated.

**OM4** - 50/125-µm Laser-Optimized optical fiber

- Maximum Attenuation: 2.5/0.8 dB km at 850/1300 nm.
- Minimum Bandwidth: 3500/500 MHz km at 850/1300 nm
- Tight buffered, armored, plenum rated.

#### 4.4.1.2 Single mode Fiber Optics

**OS1 & OS2 Single mode optical fiber**

- Maximum Attenuation: 0.5/0.5 dB km at 1310/1550 nm.
- Tight buffered, armored, plenum rated.

### 4.4.2 Inter-Building Fiber Optics

Acceptable fiber cable types used for interconnect building within a campus environment includes all types identified above for Intra-Building fiber but will use loose tube construction and will not be plenum rated. Outdoor fiber typically is gel filled to protect from moisture. The fiber type needs to be specified on a case by case basis. Some locations require fiber to be installed in conduits. Some require a direct bury option. Other sites may require aerial installation or a combination of all the above. ICE OCIO NIB shall review and approve the design prior to installation.

## 4.5 Patch Cables (Workstation and Patch Panel)

- Shall conform to the ANSI/TIA/EIA Category 6 specifications.
- 4-pair, UTP stranded cable.
- RJ-45 connectors on both ends.
- The patch cables shall be wired in accordance with the ANSI/TIA/EIA-568-B.2 and ANSI/TIA/EIA-568-B.3 specifications.
- Certified by the manufacturer as compliant with the ANSI/TIA/EIA Category 6 criteria.
- Cables shall be available in a wide variety of colors and lengths.

## 4.6 Patch Panels

- Shall conform to the ANSI/TIA/EIA Category 6 specifications.
- The patch panel wiring shall be in compliance with the ANSI/TIA/EIA T568B wiring configuration.
- Provide back wire management hardware to support no less than 24 patch cords.
- Provide modular design to facilitate field repairs.
- Provides standard 110D type IDC PCB mounted connector.
- Available in low and high-density configurations.
- Meet the standard EIA-310 rack spacing specifications.
- Provide RJ-45 interface.
- Meets all FCC Part 68 specifications.
- Available in 12, 24, and 48 port capacities.
- Match make and model within existing facilities, where possible.

## 4.7 Equipment Racks

- Shall conform to the ANSI/TIA/EIA standards.
- Conform to the standard EIA-310 mounting specification.
- Provide pre-tapped 10-32 threading.
- Provide a flexible modular concept.
- Provide vertical wire management.
- Provide floor-mounting hardware except for swing gate style hardware.
- Match make and model within existing facilities, where possible.

## 4.8 Cabinets and Swing Gates

- Shall conform to the ANSI/TIA/EIA standards.
- Conform to the standard EIA-310 mounting specification.
- Provide pre-tapped 10-32 threading.
- Provide a flexible modular concept.
- Provide vertical wire management.
- Provide floor-mounting hardware except for swing gate style hardware.

- Match make and model within existing facilities, where possible.
- Available in depths of 24 inches or more.
- Available in heights of 48 inches or more.
- Allow fan assembly installation.
- Lockable and offer matching key/lock design where multiple cabinets are installed.
- Are of a welded, uni-body construction.
- For areas located within seismic activity, meet Zone 4 earthquake vibration test conditions in accordance with National Electrical Bell Standards (NEBS) document TR-NWT-000063, Issue 4, 1992

# 5 Copper Cable Installation Specifications

This section details the specifications that are to be used when installing all copper cabling. All work shall be ANSI/TIA/EIA–568-B, ANSI/TIA/EIA-569-A, ANSI/TIA/EIA-606-A, NEC 770 and IEEE 802 standard specification quality (as applicable). All copper cable installed within a building must be plenum rated.

## 5.1 Horizontal Cables

Unless otherwise specified, horizontal cable shall be provided color coding the different jack designations. The “A” cables shall be Blue. The “B” cables shall be Gray. The “C” cables shall be white.

These are cables installed from a typical workstation location back to a central point within a building or facility. These cables connect the Information Outlet (IMO), back to a central point, the closet. The closet may be the MDF or an RWC. These cables shall be installed in compliance with ANSI/TIA/EIA, building and industry practices. Cables should never be exposed nor create any safety hazards for the public.

Horizontal cabling will be terminated on the wall in an office environment or routed through raceways in modular furniture. Prior to the modular furniture installation the horizontal cabling will be bundled and coiled above the ceiling until the furniture is installed at which time the cable vendor will route the bundled cable through the furniture and terminate either on the work surface or in a termination box imbedded in the base of the furniture.

In the event the modular furniture cabling is routed in cable trays under the floor, then the cabling should be installed from the MDF or RWC after the installation of the furniture.

All copper cables shall be positioned at a minimum distance of 4 inches from any EMI device (such as a light ballast, electrical motor, or power line). If contact is unavoidable (as in modular furniture), the copper cables shall not run more than 5 feet in parallel with the interference-generating medium. If traversing is necessary, all copper cables shall cross power lines and electrical conduits at a 90-degree angle to minimize interference.

Copper cables installed in a suspended ceiling environment shall at all times be self-suspended in the plenum air space by the use of a separate suspension system (cable ladders) or installation in the

building construction frame at the top of the permanent ceiling, if it exists. At no time shall cables be secured to the suspended ceiling grid, water pipes, or electrical conduits.

All cables should be installed as far above the suspended ceiling as possible, and should be bundled together with tie-wraps or fabric loop-and-hook fasteners at intervals no less than 6 feet unless a dedicated cable tray system is available to support the cable. The tie-wraps should not be installed so tight as to "dent" or compress the cable jacket because this could create excessive crosstalk in the cables, causing failure during the testing of the cable to meet Category 6 specifications.

## 5.2 Patch Cables (Workstation)

The workstation patch cable connects the end user devices (personal computer, terminals, etc.) to the IMO. For most installations, these patch cables will be provided and left on-site for the deployment team or local ITFO to install when setting up workstations and are not included in the overall cable plant certification. The workstation patch cable may be any length as long as the combined length of the workstation patches cable, the horizontal workstation cabling, and the patch-panel cable does not exceed 100 meters (328 feet). These cables are normally pre-constructed, certified and ordered in standard one-foot incremental lengths. If the installation vendor chooses, custom-length, certified station cables can be used.

## 5.3 Patch Cables (Rack)

The patch-panel cable connects the horizontal cable port to the voice and data electronics within a central wire center or closet, typically a RWC or MDF. These cables are identical to the workstation cables and are pre-constructed and certified by the manufacturer. It is the cable installer's responsibility for patching all active cable locations into active ports, unless otherwise directed by the ICE manager or designated representative. These cables are pre-certified by the manufacturer; therefore, it is unnecessary to include them in the cable plant certification. Wire management and organization is important to facilitate troubleshooting, repair, and documentation and, as such, there are key elements to ensure patch cords are properly installed. The following requirements shall be followed for patching workstation ports to electronics:

- The patch-panel cable may be any length, provided that the combined length of the workstation patches cable, the horizontal workstation cabling, and the patch-panel cable does not exceed 100 meters (328 feet).
- If the installation vendor chooses, custom-length, certified station cables can be used.
- Unless otherwise directed by the ICE manager or designated representative, Patch cables must be labeled and matching on both ends in a standard one-up numeric convention. An example would be a closet that has 100 active workstations, thus 100 patch cables are installed, one for each active node, starting with cable identification (ID) number one and ending with ID number 100. Any support personnel would be able to view the station patch panel and electronics equipment to determine which specific port a particular station is connected.
- Patch cable numbering shall be affixed to both ends of each of the patch cords for any patch cords approximately one inch from the terminator or mod plug.

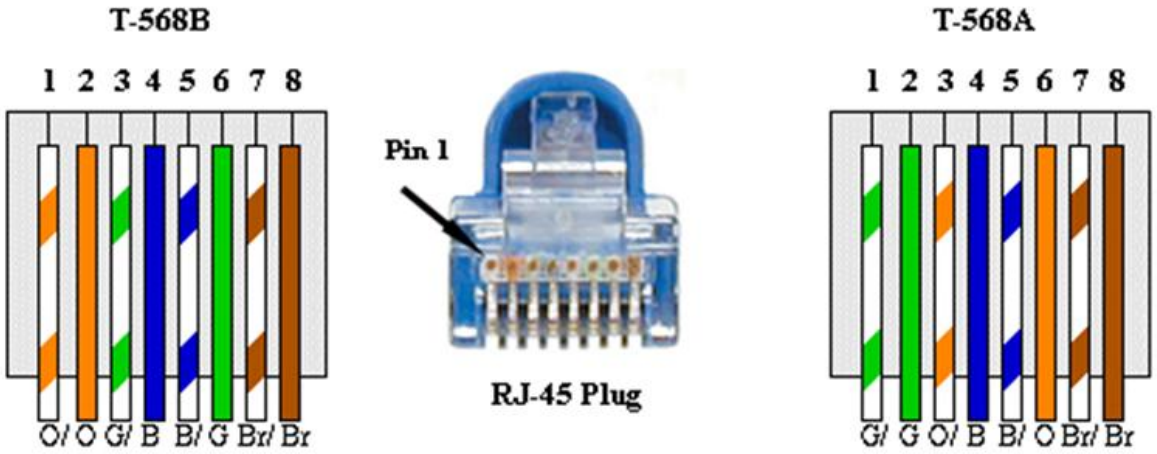
- Label IDs are required to be machine printed. Installers must avoid the use of materials that will distract from the appearance of the installation, or any temporary marking.
- Ensure patch cables are installed in a manner that does not require support personnel to "tug" or "trace" cables in order to determine the active port.
- Cables must have appropriate strain relief and must be dressed utilizing available horizontal and vertical wire management.
- Patch cables should provide a neat and organized appearance, eliminating large bundles of cables in single locations, preventing tangles and using incorrect or oversized cables that produce excess slack.
- Cables shall have appropriate strain relief and shall never exceed the minimum bend radius or have kinks or nicks in accordance with the ANSI/TIA/EIA specifications.
- Cables should utilize left and right vertical wire management to reduce cable patch congestion even cable distribution within a given cabinet.
- Patch cables shall never create a trip hazard or other risk to equipment, services or personnel.

## 5.4 Copper Cable Termination

This section applies to both the workstation and closet cable termination practices. All copper cable terminations shall conform to ANSI/TIA/EIA-568-B standards. The key areas and specifications are highlighted below:

- Pair twists shall be maintained as close as possible to the point of termination. Untwisting shall not exceed 13mm (0.5 in.) for Category 6 links.
- Strip back only as much jacket as is required to terminate individual pairs.
- All connecting hardware shall be installed to provide well-organized cable management in accordance with manufacturer's guidelines.
- All four pairs must be terminated.
- Pin/Pair assignments shall follow the T-568B configuration (see Figure 6).

**Figure 6 T-568B and T568A Pair/Pin Assignments**




# 6 Installation of Optical Fiber Cables and Connectors

This section provides the specifications to be used when installing all optical fiber cabling.

## 6.1 Fiber Horizontal Workstation Cable

The fiber horizontal workstation cable connects the workstation to the wiring center. This cable shall be two, four or six-strand, multimode, 50/125 µm, plenum rated optical fiber cable with contiguous, 2-foot, segment-length markers printed on the cable jacket.

The bend radius of any optical fiber cable installed shall be at least eight times the outside diameter of the cable. For example, a six-strand optical cable with an outside diameter of .30 inches and shall have a minimum bend radius of 2.40 inches.

Pulling tension for optical fiber cables must adhere to and not exceed manufacturer specifications.

## 6.2 Backbone Fiber Cable

The optical fiber home-run backbone cable shall connect each remote wiring closet to the MDF. This cable shall be 12-, 24-, or more strand, multimode, 50/125 µm, optical fiber cable with contiguous, 2-feet, segment-length markers printed on the cable jacket. Optical fiber cables shall be of interlocking armor construction eliminating the need for conduit or plenum rated inner duct.

Fiber-optic cable shall not share conduits with copper medium unless separation between copper and fiber is maintained. For large campus or complex backbone fiber installations where multiple conduits or pathways exist, fiber-optic cable shall be separated from the copper cable installation, wherein fiber-optic cable is dedicated to one conduit, copper to another. In retrofit or existing buildings, where pathways are insufficient to maintain separation between copper and fiber, ICE OCIO NIB shall review and approve the design prior to installation.

## 6.3 Optical Fiber Cable Jacket

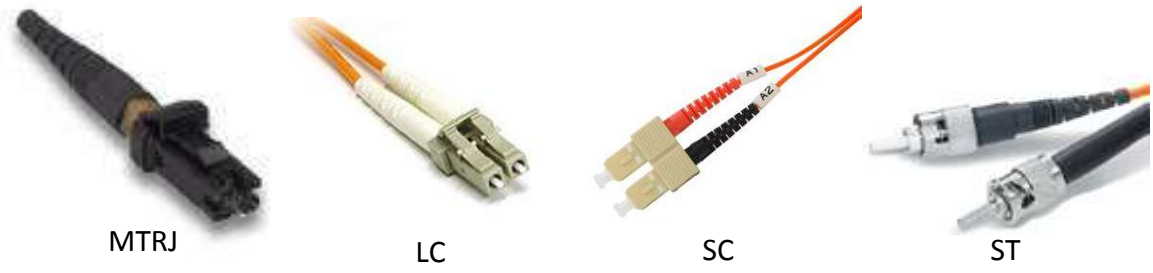
All installs shall use optical fiber cable with a plenum-graded jacket that is marked with a UL rating of "OFNP" or equivalent.

## 6.4 Optical Fiber Connector

The optical fiber connector for workstation or backbone connections shall follow the ANSI/TIA/EIA standards for installation.

New buildings shall use SC type connectors for backbone installation. Workstation outlets shall user either SC or LC dependent upon the application.

**Figure 7 Typical Fiber Connector Types**




## 6.5 Optical Fiber Cable Termination

All optical fiber cables shall be light tested prior to installation. This is typically done while the cable is still on spools or reels and only ensures all strands pass light prior to pulling cable into conduits and pathways.

The minimum termination shall be two strands for a horizontal cable. When installing fiber-optic backbone cabling, all strands will be terminated with the appropriate connectors and capped with a dust boot. All strands shall be terminated and tested.

All optical fiber cables shall have a twenty foot storage coil (wrapped in an appropriately sized loop for the minimum bend radius of the cable) positioned at each end, where possible before being terminated with connectors. All intermediate slack in the optical fiber cable shall be loosely coiled and suspended to avoid hard bends or kinks.

# 7 Faceplate Configuration

Workstations that are not connected to an optical fiber cable typically utilize a single-gang faceplate that can support up to six connection ports (see Figure 2). Blank inserts shall be installed in all remaining positions.

Workstations that are connected to optical fiber cables shall have a double-gang faceplate and junction box installed that can support up to 12 connection ports (see Figure 3).

# 8 Patch Panels

Patch panels, both fiber and copper are the approved methods of providing connectivity between horizontal cables, Intra and Inter-backbone copper, fiber backbone, and common network service devices, such as switches, PBX, routers, and other electronics.

Patch panel installation must adhere to manufacturer specifications and installed utilizing all wire management hardware, both front and back. Panels shall be installed to best utilize both vertical and horizontal wire managers, and should be separated by horizontal wire managers. There should be a minimum of two horizontal wire managers for each group of patch pane ("A", "B" and "C"). Panels must be clearly marked as to the outlet designation. Labels must be of permanent indelible typed materials.

## 8.1 Copper Patch Panels

Each panel will be installed to provide the maximum use of rack space. Each panel will be mounted in an equipment rack that shall conform to the EIA-310 mounting-hole spacing standard.

Separate patch panels will segregate "A", "B" and "C" cables. The upper patch panel will be used for "A", the middle patch panel will be used for "B" and the lower patch panel will be used for "C". In addition, and depending on the number of total cables, all cables may also share a single standard 7-foot equipment rack, swing gate or cabinet enclosure. Figures 8, 9, and 10 shall be used as a model for all new installations, and should be followed as close as possible for major retrofits and renovations with respect to existing cable plant configurations. Deviations to these layout figures shall be reviewed and approved by the NIB.

## 8.2 Fiber Optic Patch Panels

Optical fiber cable patch panels for workstation connections (also called fiber cabinets) shall provide 568SC or 568LC couplers depending upon design specifications. Optical fiber cable patch panels for backbone cabling (also called fiber cabinets) shall provide 568SC couplers. The color scheme and the port numbering scheme on the patch panel shall be consistent in any given installation to reduce confusion and to prevent mistakes in making cross-connections. Fiber patch panels shall be installed in standard increments of six-position; 568SC loads or interconnect couplers, as required in each wiring closet and MDF

# 9 Equipment Rack

There are a multitude of equipment racks and cabinets that are acceptable for use in ICE installations. Wherever possible, separate secure communication closets are recommended and are the preferred method for voice and data installation. In these dedicated communications closets, open racks, cabinets and swing gates may be used to meet the needs of the installation.

When open racks or swing gates are used, they shall be located within the wiring closets, and they shall provide structural support for the patch panels and required electronics. The open rack will be a standard 19 inches wide by 7 feet tall when used in a floor mount configuration. When space considerations mandate, it is acceptable to use an open, wall-mounted equipment rack (swing gate). If a

wall mount configuration is used, the rack must be hinged, and space must be provided so that the rack can swing fully open and provide full access to the back of the rack.

All floor or wall-mounted equipment racks, cabinets and swing gates installed in earthquake-prone geographic areas shall be installed in compliance with specific seismic guidelines, regulations and codes. Special attention must be taken to ensure the proper installation techniques are followed to minimize risk to electronics and cable plant, and most importantly prevent the mounting hardware from toppling over during seismic activity.

Equipment shall be mounted on the rack via holes in the frame or by using mounting hardware that conforms to the EIA-310 mounting-hole spacing standard. As an alternative for non-rack mountable devices, equipment may be placed on flat shelves that are attached to the rack. All racks shall be secured either to the floor or wall with bolts or other fasteners that are rated to withstand the recommended weight limits and shear loads for the rack. Each rack shall include all mounting and assembly hardware (such as nuts and bolts) for full configuration use. When multiple racks and/or cabinets are used and they are butted together in the closet, they shall be bolted together for additional stability.

Floor mounted racks and cabinets shall have a minimum of 36 inches of clearance in front of, behind, and on at least one side. Where space or room layouts limit the minimum clearances required, the installation contractor shall notify the NIB or designated representative for technical direction.

Equipment layout, specifically with respect to rack, cabinet, and swing gate location are critical design elements that ensure future growth, maintenance and flexibility are protected. Proper clearances also allow installers and maintenance personnel the required room to perform work safely and ensure electronics environmental conditions are maintained.

The patch cables shall run neatly through the wire management panels above the electronics, run down the sides of the rack, run below the electronics, and plug neatly into the respective port. The cables between the patch panels and the electronics shall not be excessively long nor shall they lie on the floor. The patch cables shall be secured and bundled using fabric hook-and loop fasteners.

> **Caution**: The use of tie-wraps is not acceptable when bundling and securing patch cables on the rack.

A power strip with surge suppression and an on/off switch shall be mounted to the back of the rack to supply at least six outlets for AC power (120-volt, 20-amp service).

**Figure 8 Single Typical Rack layout for Smaller Installations**

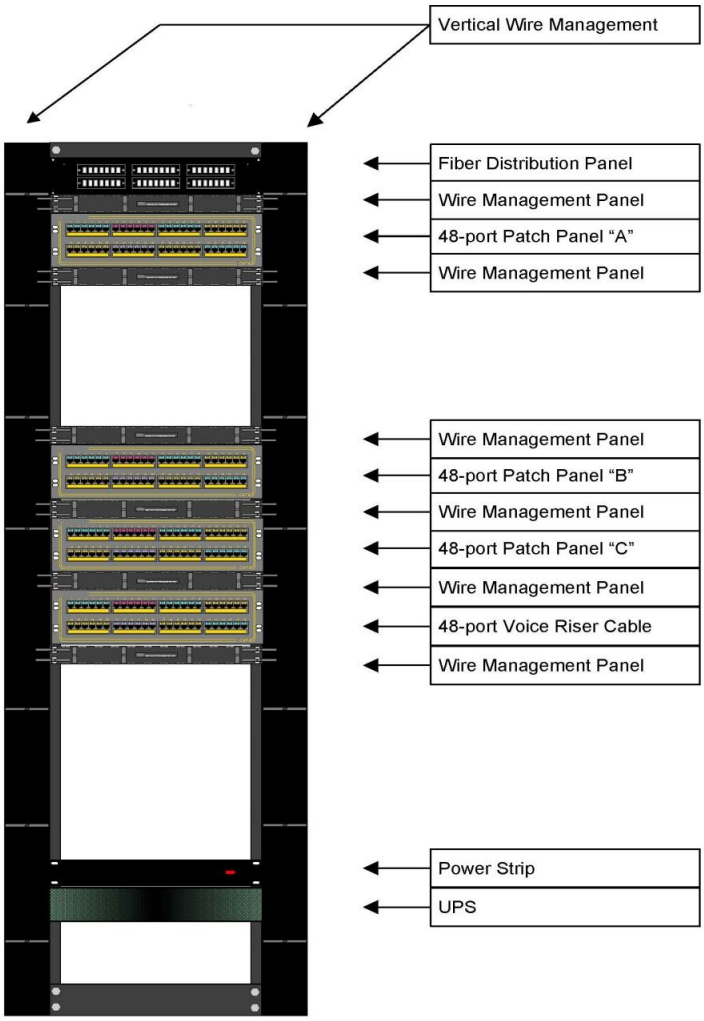


**Figure 9 Typical Two Rack Layout**

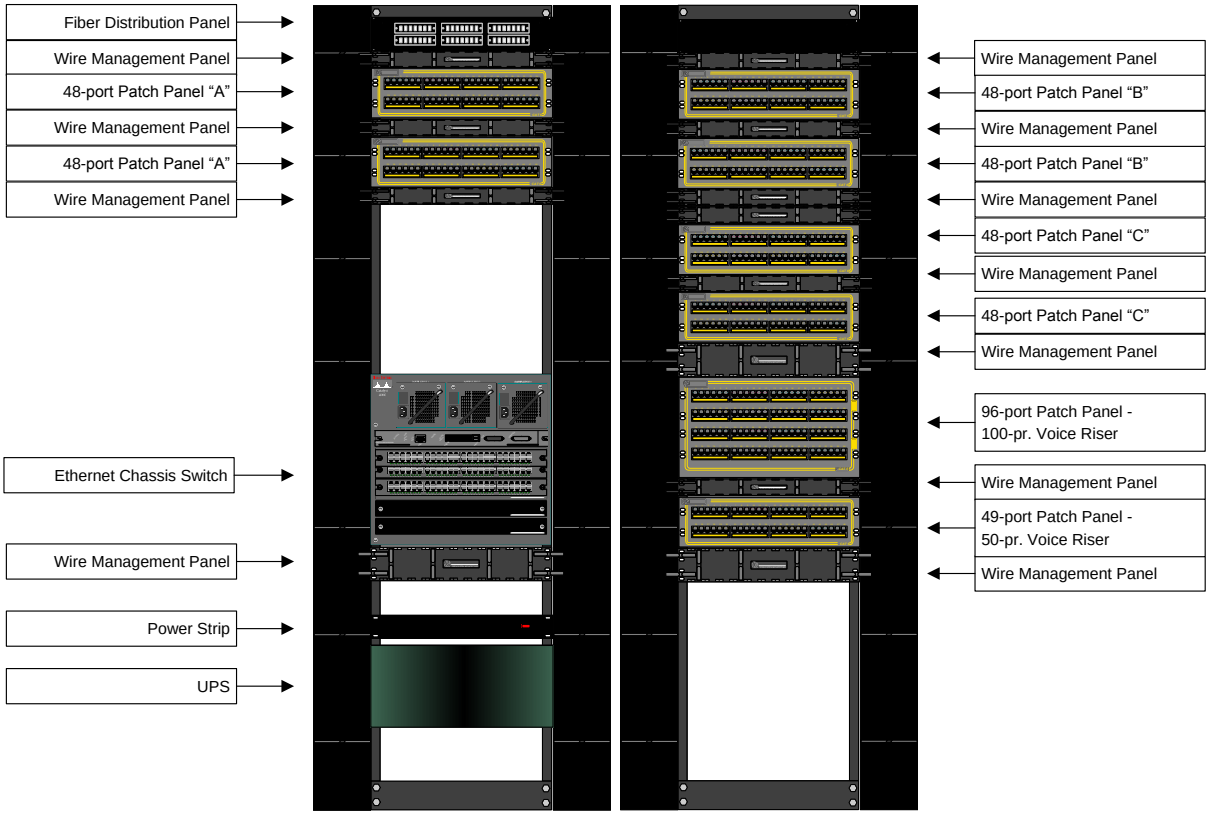
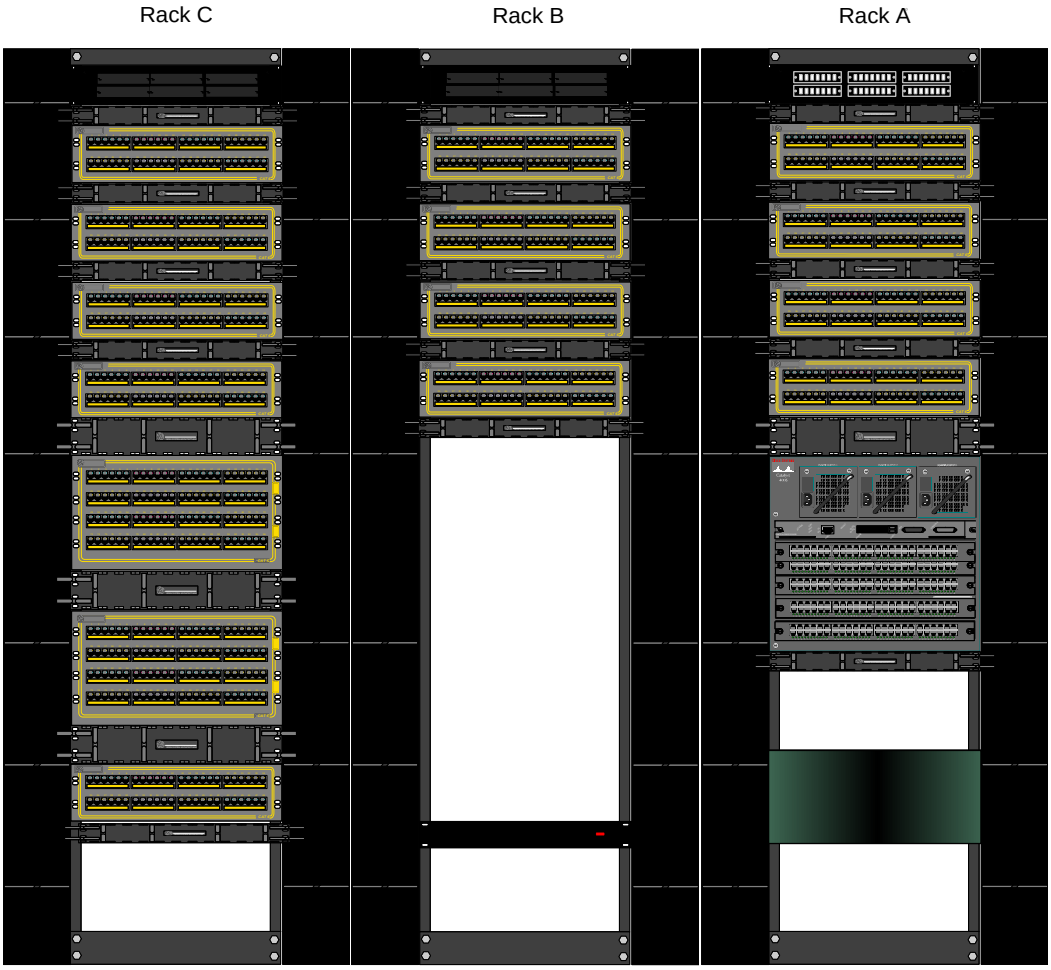


**Figure 10 Typical Three Rack Layout for Larger Installations**



# 10 Grounding

The NEC provides guidelines to ensure that electrical installations in buildings meet the necessary safety practices to prevent electrical shock hazards to personnel, ensure fault clearance of unintentional electrical breakdowns that could cause fire, and prevent transient voltages from causing electrical damage to installed network components. NEC Article 800 pertains to telecommunications industry and should be consulted for specific guidelines related to this topic. Article 800 also has references to other articles as the need arises.

In all new buildings and major retrofit projects an independent ground bus, installed in each communications closet, shall be provided. The independent ground bus in each closet should be installed by a certified electrician, or properly licensed installer. The independent ground buses are designated for, and utilized exclusively, by the communications equipment. In existing buildings, an independent ground is certainly desirable. In general, all communications systems, cable plant devices, equipment, and components shall be properly grounded and bonded.

All grounding shall be performed to meet the following published standards and guidelines:

- ANSI/TIA/EIA 607
- ANSI/IEEE C-142
- Federal Information Processing Standard (FIPS) 94
- NEC Articles 250 and 800
- UL
- ANSI CI-1978

All equipment racks, cabinets and systems must be properly connected to the independent ground bus per the ANSI/TIA/EIA 607 specifications. It is the responsibility of the cable installer to connect all common closet equipment racks and cabinets to the provided ground bus. It is also the responsibility of the cable installers to report to the ICE Program Manager any discrepancies with respect to improper or omitted grounding systems.

For connecting equipment within the telecommunications/data wiring closets to the ground bus, a number six wire with green insulation should be used. This ground wire should be no longer than 30 feet.

All ground wire should be routed straight, with sweeping bends, neat, and orderly. Ground wire should be routed in the most direct fashion possible to the equipment. Ground wires should be supported by tie-wraps at 12-inch intervals.

The manufacturer instructions and recommendations shall be followed when grounding the electronic equipment installed in the telecommunications/data wiring closets.

# 11 Cable Ladders and Fasteners

All cables installed in overhead spaces (such as above ceiling panels) shall be securely strapped on cable ladders that are fastened to the ceiling slab to avoid contact with lighting equipment or drop ceiling supports. Wire management channels or cable ladders shall be used to provide orderly arrangement of all installed cables in and around the equipment racks.

As a general rule, all cables shall be securely suspended, fastened, tied, and bundled firmly (without damaging the cable jackets or creating kinks in the cable) to minimize the amount of space required for cabling.

# 12 Administration and Labeling Conventions

Label conventions shall apply to all sites, regardless of the number of buildings at the site. This section describes the ICE standard labeling convention for all cable installations, whether new or retrofit.

## 12.1 Building Designation

The designation for the building shall be a two to four character alphanumeric scheme. Buildings typically have unique names/numbers, whether in multi-story complexes or in campus environments. The first designation should represent the unique building the cable plant is wired within. This nomenclature will rarely change throughout the life of the building and allows a structured naming convention to be used for Inter-building backbone cable installations.

### 12.1.1 Floor

The designation for the floor shall be a two-digit number. If the floor is a single number such as “4,” place a leading zero before the single-digit, for example “04.”

### 12.1.2 Wiring Closets

The designation for a wiring center is a single letter. The Computer Room or MDF shall always have the wiring closet designation of “M.” Remote wiring closets that are all located on the same floor shall be labeled A-L and N-Z (“M” is reserved for the MDF). Closets that stack directly on top of each other shall have the same letter designation.

### 12.1.3 Cable Numbers

The designation for the cable shall be a three-digit number, followed by an “A”, “B” and “C”. Use leading zeros as necessary. For example, the designation for drop #3A would become 003A.

## 12.2 Information Outlet

The IMO is the interface for the workstation cable and the horizontal workstation cable, which terminates in a wiring closet. This is typically referred to as the “jack” in the industry, also an enhancement to the Bell Labs Universal Service Order Code (USOC) specifications. These specifications also referenced the RJ pin assignments. The ANSI/TIA/EIA now prefers to use the term 8-pin modular plug or connector when describing jack pin-outs. Each information outlet should be labeled according to the following guidelines:

The designations on single-gang and double-gang faceplates will be as follows:

- Building (AANN, or combination). [Optional in single building environment]
- Floor (NN, with a leading zero).
- Wiring center (A).
- Cable drop (NNN, with leading zeros).

**Example**: "TW-12-C-111"

Where: **TW**= TechWorld building

**12**= 12th floor

**C**= wiring center and

**111**= cable drop #111.

## 12.3 Intra and Inter-Building Backbone Cables

These backbone cables interconnect wiring closets either within a building or interconnect buildings in a campus environment.

The naming convention applies the same for Intra and Inter backbone cable labeling. Standard nomenclature for backbone cabling shall be as follows:

- First Building (4–6 alphanumeric characters).
- First wiring closet (includes floor, closet and pair or strand designations).
- Second Building (2–4 alphanumeric characters).
- Second wiring closet (includes floor, closet and pair or strand designations).

**Example**: "TW801I-06-W-001 – TW800K-01-M-001"

Where: **TW801I**= TechWorld building 801 I is the first building (origination point)

**6**= 6th floor

**W**= wiring center, closet W

**001**= cable pair (copper) or strand (fiber)

**TW800K**= TechWorld building 800 K is the second building (destination point)

**1**= 1st floor

**M**= wiring center, Main Distribution Frame

**001**= cable pair (copper) or strand (fiber)

The cable label shall be affixed to both ends of the cable, approximately 2 to 3 inches from the termination point. Heat shrink labels are preferable. Wrap-around labels are permissible as long as they are printed using indelible ink and the labels are easily read.

## 12.4 Patch Panel Patch Cables

The patch panel patch cord connects the horizontal workstation cable to the network electronics. Patch cables in each wiring closet should be identified on each end of the patch cable in a standard, one-up, numeric order, so that an individual patch cable can be easily identified without having to physically "tug" the cable to follow and identify it.

The cable label shall be affixed to both ends of the cable, approximately one inch from the termination connector or modular plug. The labels should be printed using indelible ink, and the labels should be positioned so they can be easily read.

# 13 Test and Documentation Procedures

The installation contractor shall complete all testing of the cable plant. The installation contractor is responsible for providing all personnel, equipment, instrumentation, and supplies that are necessary to perform the required testing.

## 13.1 Testing of Installed Copper Cable

All installed copper cables shall be tested with a Level III cable tester to certify that the cable conforms to ANSI/TIA/EIA-568-B specifications. The test device shall provide printed and electronic (soft) Pass/Fail test results that show the following:

- Electrical length in feet (accurate to 0.5 feet).
- Cross-talk in dB for each of the four pairs.
- End-to-end attenuation in dB for each of the four pairs.
- Drop number.
- Continuity (for all eight wires).
- Capacitance
- DC resistance
- Impedance
- Date of test
- Name and model of the field tester (i.e. Fluke OMNIScanner 2).
- Software version or level.
- Date the field tester was last calibrated.

- Which test was being performed (permanent link test, channel test).

## 13.2 Testing of Optical Fiber Cables

Testing shall be of the optical link as specified in ANSI/TIA/EIA-568-B.3 for multimode fiber optics and ANSI/TIA/EIA-526-7 method A for single mode fiber optics. An optical fiber link is defined as the passive cabling network between two optical cross-connects (patch panels or outlets). This includes cable, connectors and splices but does not include active components. The link test contains the representative connector loss at the patch panel associated with the mating of patch cords, but does not include the performance of the connector at the equipment interface.

If the manufacturer of cables or connecting hardware has supplied post-manufacture performance data, copies of such data are to be included in the documentation.

Testing of installed multimode fiber cable shall meet or exceed the specifications in Table 2.

**Table 2 Multimode Fiber Cable Specifications**

| Horizontal Fiber | Attenuation 850 nm | Attenuation1300 nm |
|---|---|---|
| ≤ 90 m (295 ft) | ≤ 2.0 dB | ≤ 2.0 dB |
| Backbone Fiber | | |
| ≤ 2000 m (6560 ft) | ≤ fiber length (km) x 3.75 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB | ≤ fiber length (km) x 1.5 dB/km + number connector pairs x 0.75 dB + number of splices x 0.3 dB |

Testing of installed single mode fiber cable shall meet or exceed the specifications in Table 3.

**Table 3 Single Mode Fiber Cable Specifications**

| Length | Attenuation1310 nm | Attenuation1550 nm |
|---|---|---|
| ≤ 90 m (295 ft) | ≤ 2.0 dB | ≤ 2.0 dB |
| 91-1000 m (3281 ft) | ≤ 3.0 dB | ≤ 3.0 dB |
| 1001-2000 m(6562 ft) | ≤ 3.3 dB | ≤ 3.3 dB |
| 2001-5000 m (16404 ft) | ≤ 4.7 dB | ≤ 4.7 dB |

Test reports shall include the following information for each cabling element tested:

- Actual measured and maximum allowable attenuation (loss) at the specified wavelengths.
- Reference method.
- Number of mated connectors and number of splices (if any).
- Actual length and maximum allowable length.
- Group refractive index (GRI) for the type of fiber tested, if length was optically measured.

- Tester manufacturer, model, serial number and software version.
- Fiber ID number and project/job name.
- Link criteria used.
- Overall pass/fail indication.
- Date and time of test.

Test reports may be submitted in hardcopy, electronic, or both formats. ICE prefers these reports to be provided in the electronic format over hardcopy.

# 14 Building Pathways, Conduit, and Closets

## 14.1 Closet Specifications (MDF and RWC)

Typical communications closets house common equipment required to support both voice and data connectivity to workstations. Communication closets/rooms are typically centrally located on the floor, and adhere to the ANSI/TIA/EIA specifications for cable lobe lengths (e.g. maximum cable from closet to workstation will not exceed 100 meters, end-to-end). Closets/rooms should be vertically stacked, with a sufficient number of sleeves interconnecting each closet. All end-user workstation locations, whether occupied or vacant, shall be cabled to the nearest wiring closet. Every office should have a minimum of two drops installed. Every cubical should have a minimum of one drop installed. Storage rooms, conference rooms and similar space not designated as offices should be cabled to allow for office expansion. All wiring centers shall comply with or support the following specifications and requirements.

### 14.1.1 General Requirements

- The space should be environmentally temperate, convenient, and professional looking.
- The communication closets must have sufficient infrastructure required to support the variety of communication services provided to ICE and contractor staff. Typically this includes items such as conduits, cable trays, building grounding system, etc.
- Communications closets should be designed for growth, and flexibility supporting new technologies without the need for major room modifications and rearrangements.
- For non-raised floor installations, electrical service shall be provided on overhead racks.
- For raised floor installations, electrical service shall be provided under the floor.

### 14.1.2 Environmental

- Room should be dust free with positive air pressure where possible and meet Federal guidelines for specified material to reduce airborne contaminants caused by off gassing.
- Ceilings should be finished with similar drop tiles used throughout the floor.

- Overhead lighting sufficient to provide 80 candle feet measured five feet above the finished floor, is to be switched controlled and is not to be connected to communications equipment circuits.
- Care must be taken to avoid structural columns, ductwork, and other building structures, which would restrict the functionality of the space.
- Ceiling space above communications closets should be open and clear of major Heating, Ventilation, and Air Conditioning (HVAC) systems and ductwork, including major motors, elevator motors, generators, or equipment that induce excessive EMI and/or RFI to communications equipment or systems.
- Room temperature must be maintained between 60 to 72 degrees Fahrenheit, with a relative humidity range of 20 to 60 percent (non-condensing). When heat-generating equipment is placed into communication closets, maintaining environmental parameters is essential, thus avoiding down time due to equipment failures caused by equipment overheating. Where the building HVAC is insufficient to maintain these parameters, a standalone HVAC system is required to maintain these environmental ranges for a 24 hour, 7 days a week (24/7) schedule.
- Where no dedicated HVAC system is required for plenum air return buildings, there should be a minimum of two diffusers for fresh HVAC air intake, with a minimum of two air return vents, vented door and a positive air flow maintained. Buildings without air return systems should provide clean air 24/7. Additionally, rooms without dedicated HVAC systems should have a continuous airflow 24/7.

### 14.1.3 Construction

Closets vary in size depending on their function. However, minimum communications closet size should never be less than specified in the applicable ANSI/TIA/EIA specifications. The typical closet minimum size for ICE installations should be no less than 80 square feet, whereas the recommended size is calculated by the ANSI/TIA/EIA specifications.

- Floor Space Served
  - There must be at least one LAN Closet per floor
  - Multiple closets are required if the:
    - Usable floor space to be served exceeds 10,000 $ft^2$
      or
    - The Cable length between the wiring closet and the IMO exceeds 90m (295 ft)
- Size Requirements
  - Minimum size requirements are based on usable floor space as follows:
  - 5,000 $ft^2$ or less – The wiring closet must be at least 10 ft x 7ft (70 $ft^2$).

- Greater than 5,000 $ft^2$ and less than 8,000 $ft^2$ – The wiring closet must be at least 10 ft x 9ft (90 $ft^2$).
- Greater than 8,000 $ft^2$ and less than 10,000 $ft^2$ – The wiring closet must be at least 10 ft x 11ft (110 $ft^2$).

**NOTE**: The above recommendations specify space required for cable plant equipment racks only. The MDF or Computer room will require additional space based on the amount of equipment being installed. Server Racks, PBX Racks, etc. each require additional floor space. In general, each additional equipment rack requires 12 $ft^2$ over and above the guidelines provided above. Often the MDF serves as the Telco DEMARC as well. Wall space should be allowed for keeping in mind service personnel outside of ICE will need access for installations and maintenance. These components should be located close to ICE equipment but clearly separated at the same time.

- Smaller Buildings / Smaller Floor Spaces

  Smaller floor spaces (less than 1,000 $ft^2$) can use more shallow closets with wall mounted equipment racks or cabinets. Such installations should be considered carefully and used when no other options are available.

- Electronic badge access only for all communication rooms will conform to local security requirements.
- Door must be a minimum 36 inches wide by 80 inches high and fire retardant (2-hour). The door should swing out to facilitate equipment installation and provide maximum space utilization by allowing higher density equipment designs and configurations without the concern of lost space due to door travel.
- Floor should be rated to withstand 100 pounds per square foot and should be covered with appropriate tile or linoleum. Carpets are not acceptable in communications closets.
- Each communications closet should have a minimum of one 120 Volt, 20 Amp quad outlet on a dedicated circuit. The MDF and larger wiring closets should have a minimum of two 120 Volt, 20 Amp quad outlet each on a dedicated circuit and two dedicated 120 Volt, 30A circuits installed for cable plant electronics. Preferred outlets are the National Electrical Manufacturers Association (NEMA) 5-20 receptacles and the locking L5-30. Outlets should be installed overhead to avoid power cords laying across open floor areas when they may be a tripping hazard and/or inadvertently disconnected.
- A certified electrical ground and buss shall be installed into each closet for communications equipment grounding and be connected to a dedicated building ground that is compliant with the ANSI //TIA/EIA 607.
- For the MDF, a pre-treated, fire-rated, plywood backboard (3/4 inches by 4 feet by 8 feet sheets) shall be fastened properly to the wall for riser cable control, where required.
- All cable shall be neatly bundled and anchored every 3 feet on the backboard.

- ICE occupied floors that are contiguous, with stacked closets, should have a minimum of two 4-inch sleeves between closets for ICE Data and Voice cables. Additional sleeves will be required for the building voice riser system. Where ICE data and voice cables must pass through communications closets not controlled by ICE or the US government, mechanical protection must be provided. Thin wall ridged conduit will be sufficient for this requirement.

## 14.2 Conduits

Conduit installations shall comply with all ANSI/TIA/EIA-569-A specifications. Highlights of that specification are as follows:

- A maximum fill factor of 40% per conduit shall be adhered to for new conduits. If possible, installers shall avoid using those conduits that have exceeded the 40% fill factor.
- A pull-box shall be installed every 100 feet and every two 90-degree turns.
- All bends in the conduit must be made hydraulically to create smooth, sweeping turns.
- All pull-boxes shall be sized to allow for the largest minimum bend radius for any of the cables that are used.
- Where local codes mandate that rigid conduit must be installed from the distribution closet to the IMO, a minimum of one 1-inch diameter conduit from wiring center to workstation IMO is required. This single, 1-inch conduit will support both voice and data grade cabling to the workstation and requires a consolidated voice and data closet.
- In buildings, which local codes do not mandate rigid conduit from the distribution closet to the IMO, a minimum of one 1-inch diameter conduit stubbed above ceiling grids to each respective IMO is preferred and recommended by ICE NIB. Where stubbed conduit installation is impractical, "ring and string" installations are an acceptable alternative.
- Open office space (e.g., systems furniture where two or more IMO's are fed by a single column or feed) typically does not require conduit stubs or home-run conduits. If conduits or stubs are installed, then conduit sizing shall ensure fill factor does not exceed 40%.
- A minimum of two 4-inch diameter sleeves shall be provided for vertically stacked closets. In an open plenum environment, where access to closets is not blocked by building structures or fixtures, and a clear pathway exists, conduit installation is not required to interconnect closets. Exceptions will be made by the ICE Project Manager
- A minimum of two 4-inch diameter conduits shall be provided in any building or campus environment where cable is subject to damage or there is no clear pathway for installation. These may be areas such as underground parking

garages, outside cable routes, pathways through office space not under ICE control, or areas that prevent cable installation at future dates, such as main building lobbies, under-floor pathways, etc.

- A minimum of two 4-inch diameter conduits shall be provided between buildings in a campus environment.

# 15 Documentation

Upon completion of the cable plant installation, a documentation package shall be completed within 30 calendar days that shall include the following items:

All of this information shall be provided in both hardcopy and electronic formats, except as follows:

**Table 4 Documentation Requirements**

| Cable Installation Report | Electronic Format |
|---|---|
| Letters of Certification | Microsoft Word 2007 or newer |
| Implementation Report | Microsoft Word 2007 or newer |
| Cable Test Certification Letter | Microsoft Word 2007 or newer |
| Cable Plant Test Results | Fluke Networks Linkware 2.3 or equivalent |
| As-built Site Drawings | Autodesk AutoCAD Version 2004 or newer |
| Drop List | Microsoft Excel 2007 or newer |
| PDF Cable Installation Report and Test Results | Adobe Acrobat 9.0 or newer |

## 15.1 Letter of Certification

A letter of certification shall be supplied to the designated ICE Program Manager from the authorized project supervisor. A sample of the recommended letter of certification is included as Appendix C of this document. The letter of certification should be submitted in electronic format using word Processing software compatible with Microsoft Word 2007 or newer.

## 15.2 Implementation Report

A brief implementation report shall be submitted as part of the completed documentation package. This implementation report, at a minimum, should include the following information:

- Installing company name and address.
- Contract number and Task or Delivery Order, if any.
- Beginning and ending dates of the installation project.
- Names of personnel assigned to the installation project.
- Installation summary, including deviations from the original task order.
- Responsible party names, address, and phone number.
- The electronic version of this report shall be submitted using word Processing software compatible with Microsoft Word 2007 or lower. A sample implementation report is provided as Appendix C of this document.

## 15.3 Copper Cable Test Results

Test results for all cables shall be included in electronic format (ASCII text format) within the completed documentation package upon completion of the project. The cable test results shall be provided in numeric order on a per closet basis for horizontal cables. All copper tie and backbone cables shall be included as a sub-section and also numbered. A sample cable test certification report is provided as Appendix D of this document.

## 15.4 Fiber-optic backbone Cable Test Results

A hard copy of all fiber-optic cable test results shall be included as part of the completed documentation package. Opposite ends of each fiber strand tested should be included side by side or in direct sequential order. The fiber optic test results shall be submitted in a closet by closet format.

The electronic trace version of the test results should also be included. If a specific executable program is required to view the trace on a personal computer, a copy of this executable file shall be included with the electronic files. A sample cable test certification report is provided as Appendix D of this document.

## 15.5 As-Built Site Drawings and Drop List

Complete As-Built site drawings of the cable plant shall be included as part of the completed documentation package. As-Built Drawings shall contain, but are not limited to, the site drawing, drop list, and Fluke Network test report on each drop as tested. At a minimum, the following information shall be included on the drawing:

- Accurate, reasonable facsimile of the building floor plan.
- Room and area numbers assigned for identification purposes.
- Location and designation of all wiring closets.
- Location and designation of all information outlets installed
- Routes for all cables, including horizontal, tie, and backbone.
- Location of all vertical penetrations.
- Location of horizontal penetrations through firewalls.
- Any special service application notes.
- Backbone and tie cable lengths between closets.

The As-Built site drawings shall be completed using computer-aided drawing software that produces vector graphics data files, preferably AutoCAD version 2004 or newer.

The Drop List shall include, but is not limited to the following:

- Full site address and Requisition number (provided by the Government)
- IT Service Request Number (provided by the Government),

- Per drop information (floor number, room number, drop ID, closet terminated in)
- Test results for each room (date of initial testing, results of initial testing, discrepancies/failures and/or issues identified, date of mitigation if any, date of re-test, results of re-test)
- Summary page identifying all of the rooms and a total number of each drop type(s).

The electronic version of this report shall be submitted using word Processing software compatible with Microsoft Excel 2007 or newer. A sample cable test certification report is provided as Appendix E of this document.

# Appendix A – Acronyms

| Term | Description |
|---|---|
| A | |
| AC | Alternating Current |
| ACR | Attenuation to crosstalk ratio |
| ADP | Automated Data Processing |
| ANSI | American National Standards Institute |
| | |
| B | |
| | |
| C | |
| CAT | Category |
| CSA | Canadian Standards Association |
| D | |
| dB | Decibel |
| DO | District Office |
| DHS | Department of Homeland Security |
| E | |
| EF | Entrance Facility |
| EIA | Electronic Industries Association |
| ELFEXT | Equal Level Far End Cross-talk |
| EMI | Electromagnetic Interference |
| F | |
| FCC | Federal Communications Commission |
| FIPS | Federal Information Processing Standard |
| G | |
| GRI | group refractive index |
| H | |
| HVAC | Heating, Ventilation, and Air Conditioning |
| I | |
| ICE | Immigration and Customs Enforcement |
| ID | Identification |
| IDC | Insertion Displacement Connector |
| IEEE | Institute of Electrical and Electronics Engineers |

| Term | Description |
|---|---|
| IMO | Information Management Outlet |
| ICE | Immigration and Customs Enforcement |
| ISO | International Organization for Standardization |
| ITFO | Information Technology Field Operations |
| J | |
| | |
| K | |
| km | Kilometers |
| L | |
| LAN | Local Area Network |
| M | |
| µm | Micrometer |
| Mbps | Megabits per second |
| MC | Main cross-connect |
| MDF | Main Distribution Frame |
| MHz | Megahertz |
| N | |
| NIB | Network Implementation Branch |
| NEC | National Electrical Code |
| NEBS | National Electrical Bell Standards |
| NEMA | National Electrical Manufacturers Association |
| NEXT | Near End crosstalk |
| NFPA | National Fire Protection Agency |
| ns | Nanosecond |
| O | |
| OCIO | Office of Chief Information Officer |
| OFNP | Optical Fiber Plenum |
| OFNR | Optical Fiber Riser |
| OFN | Optical Fiber, not rated |
| OM | Optical Fiber, multimode |
| OS | Optical Fiber, single mode |
| OTDR | Optical Time Domain Reflectometer |
| P | |
| PCB | Printed Circuit Board |
| PS ACR | Power sum attenuation to crosstalk ratio |

| Term | Description |
|---|---|
| PS NEXT | Power sum near-end crosstalk |
| PS ELFEXT | Power sum |
| Q | |
| | |
| R | |
| RFI | Radio Frequency Interference |
| RJ | Remote Jack |
| RWC | Remote Wiring Closet |
| S | |
| | |
| T | |
| TIA | Telecommunications Industries Association |
| TR | Technical Reference |
| TSB | Telecommunications Services Bulletin |
| U | |
| UL | Underwriter's Laboratory |
| USOC | Universal Service Order Code |
| UTP | Unshielded Twisted Pair |
| V | |
| | |
| W | |
| WAN | Wide Area Network |
| X | |
| | |
| Y | |
| | |
| Z | |
| | |
| | |

# Appendix B – Glossary

| Term | Definition |
|---|---|
| A | |
| ACR | Measurement of NEXT-Attenuation |
| Attenuation | The decrease in magnitude of a wave as it travels through any transmitting medium, such as a cable or circuitry. Attenuation is measured as a ratio or as the logarithm of a ratio decibel. |
| B | |
| | |
| C | |
| Category 5e | Currently defined in TIA/EIA-568-B. Provides performance of up to 100 MHz, and is used for both 100 Mbit/s and gigabit Ethernet networks. |
| Category 6 | Currently defined in TIA/EIA-568-B. It provides performance of up to 250 MHz, more than double category 5 and 5e. |
| Conduit | A pipe, usually metal, that runs either from floor to floor or along a floor or ceiling to protect cables. |
| Cross-talk | A type of interference caused by audio frequencies from one line being coupled into adjacent lines. The term is loosely used also to include coupling at higher frequencies. |
| D | |
| Delay Skew | The propagation delay difference between the slowest and fastest cable pair. |
| E | |
| EIA | Electronic Industries Association: the US national organization of electronic manufacturers. It is responsible for the development and maintenance of industry standards for the interface between data processing machines and data communications equipment. |

| Term | Definition |
|---|---|
| EMI | “Noise” generated in copper conductors when electromagnetic fields induce current. External signals that disrupt the data transmitted on the local area network or electronic device being operated. |
| End-To-End Connection | A continuous connection, for example, from a workstation to a concentrator. |
| F | |
| FC Connector | A type of optical fiber connector identifiable by its round, screw-operated locking nut. It is usually metal. Its ruggedness leads it to be widely used in test equipment. (Source BICSI Telecommunications Dictionary) |
| FEXT | Cross-talk measured at the opposite end from which the disturbing signal is transmitted. |
| Frequency | The number of times a periodic action occurs in a unit of time. The number of cycles that an electrical current completes in one second, expressed in Hertz. |
| Frequency Range | The range, measured in Hertz of a test signal. |
| G | |
| | |
| H | |
| Hertz | The unit of frequency, one cycle per second. |
| I | |
| IEEE | Institute of Electrical and Electronics Engineers: An international professional society that issues its own standards and is a member of ANSI and ISO. |
| J | |
| | |
| K | |
| | |
| L | |

| Term | Definition |
|---|---|
| LAN | A geographically limited communications network intended for the local transport of data, video, and voice. Often referred to as a customer premises network. |
| Loose Tube | The fiber is contained in a plastic tube for protection. To give better waterproofing protection to the fiber, the space between the tubes is sometimes gel-filled. Typical applications are outside installations. One drawback of loose buffer construction is a larger bending radius. Gel-filled cable requires the installer to spend time cleaning and drying the individual cables, and cleaning up the site afterwards. |
| M | |
| Megabits | A million bits per second: A unit of data transmission speed. |
| MDF | The main distribution frame, where central networking components are located. This refers to closets and large computer rooms and in most cases houses the WAN equipment and circuits. These rooms are the core rooms in a building or campus environment. |
| N | |
| Nanosecond | One billionth of a second ($10^{-9}$ seconds). |
| NEXT | Crosstalk measured at the end from which the disturbing signal is transmitted. Near End crosstalk is a measure of how much energy is coupled at the near end in a pair that is adjacent to an energized pair, and FEXT is the same measure at the far end from the transmitter. When all pairs are energized, as with Gigabit Ethernet, NEXT and FEXT are generated by each disturbing pair and must be power-summed to obtain a true measure of the coupled energy. |
| O | |
| OFN, OFNP, OFNR | Type of optical fiber cable construction, which stands for: general purpose, plenum(P) or Riser (R) |
| P | |
| Patch Panel | A modular termination and connection point for horizontal distribution cabling. |

| Term | Definition |
|---|---|
| Plenum | A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. (Source National Electric Code) |
| Protocol | The means used to control the orderly exchange of information between stations on a data link or on a communications network or system. |
| Propagation Delay | The amount of time that passes between when a signal is transmitted and when it is received at the opposite end of a cable or cabling. |
| PS NEXT | Power sum near end crosstalk. Measurement |
| PVC | Polyvinyl Chloride: A type of plastic material used to make cable jacketing. |
| Patch Panel | A modular termination and connection point for horizontal distribution cabling. |
| Q | |
| | |
| R | |
| Return Loss | Return loss is a measure of the signal reflections occurring along a channel or basic link and is related to various electrical mismatches along the cabling. |
| RJ-45 Keyed Connector | An eight-conductor modular phone-style receptacle with a plastic tab on the side. This type of connector can only be inserted into a keyed jack. |
| RJ-45 Non-Keyed Connector | An eight-conductor modular phone-style receptacle without a plastic tab. This type of connector can be inserted into either a keyed or non-keyed jack. |
| S | |
| SC connectors | Fiber connector that is duplexed into a single connector clip with both transmit and receive fibers. |
| ST connectors | Keyed, bayonet-style connector. |
| T | |

| Term | Definition |
|---|---|
| TIA | Telecommunications Industries Association: The US national organization of telecommunications manufacturers. It is responsible for the development of data processing machines and data communications equipment. |
| Tight Buffered | Buffer layers of plastic and yarn material are applied over the fiber. Results in a smaller cable diameter with a smaller bending radius. Typical applications are patch cords and local area network connections. At least one mfr. Produces this type of cable for inside/outside use. |
| U | |
| UTP | A cable with multiple pairs of twisted insulated copper conductors bound in a single sheath. An unshielded twisted pair Category3, 5, 5e or 6 cables usually contains four pairs of wire in a single jacket. |
| V | |
| | |
| W | |
| WAN | Wide Area Network: A network that uses common-carrier-provided lines, usually to connect two or more LANs. |
| X | |
| | |
| Y | |
| | |
| Z | |
| | |

# Appendix C – Sample Letter of Certification

[*Use Corporate letterhead*]

[*Title*]

**Date**: [Current date]

**To**: [Full name of individual to whom the letter is being sent]

**Address** [of individual to whom letter is addressed]

**Re**: Cable Plant Installation

**Task Order No.**: [XXX-xxx]

Dear [*Mr., Ms., or Dr. and last name*]:

I hereby certify that the cabling installation completed for the above referenced ICE site was completed by our firm, according to the ICE Structured Cabling Standards, on [*date of installation in Month Day, Year*].

Our firm has tested each unshielded twisted pair copper cable wire (not just cable pairs) we installed, as well as any previously installed cable if previously agreed to in writing. I hereby certify that every wire and cable was tested and meets or exceeds the Category 6 ANSI/TIA/EIA-568-B.2 transmission test requirements.

Our firm also tested each fiber-optic cable and strand we installed, as well as previously installed fiber-optic cable if previously agreed to in writing. I hereby certify that each strand of every cable meets or exceeds the required standards for fiber-optic cable.

[*Mr., Ms., or Dr. and full name*]
[*Title*]

# Appendix D – Sample Implementation Report

**PROJECT IMPLEMENTATION REPORT**
**SITE C**

**INTRODUCTION**

Company A under sub-contract to Company B, and working under Task Order Number XXX-xxx, recently performed a local cable plant installation at Site C. The project was begun on Monday July 7, 2003, and the installation was completed on Wednesday, July 23, 2003.

PROJECT PERSONNEL

The following ABC Cabling personnel participated in the installation project at the Central City HSI, Central City, USA

| | |
|---|---|
| Mr. Clark Kent | Senior Communications Specialist |
| Mr. Bruce Wayne | Senior LAN Technician |
| Mr. Barry Allen | Senior LAN Technician |
| Mr. Dick Grayson | LAN Technician |
| Ms. Diana Prince | Senior Technical Draftsman |

**INSTALLATION SUMMARY**

(The following is an example of the expected format. It does not contain all examples of work that may be site specific. Be sure to include all work performed at the site.)

The network installation was completed per the Statement of Work (SOW). Per the Statement of Work, the design documentation, the Homeland Security Investigations (HSI) area at the Central City Federal Building was cabled for a total of 15 Category 6 drops. All cabling was run through a self-suspended overhead routing system above the acoustic ceiling tiles.

Remote wiring closet 01-M serves the workstation connectivity needs for Rooms 1264 and 1267 on the first floor. Labels starting with 01-M-001 identify these cables. Eight drops are terminated on three 24-port patch panels in the equipment racks located in Room 2235, which also serves as the main computer room.

Remote wiring closet 0B-A serves the workstation connectivity needs for Room B222 in the basement. Labels starting with 0B-A-001 identify these cables. Seven drops for closet 0B-A are terminated on three 24-port patch panels in the equipment rack located in Room B247.

A 12-strand optical fiber cable was installed connecting the MDF to the RWC in the basement.

A 25-pair copper tie cable for voice was installed connecting the MDF to the RWC in the basement.

All materials were provided and installed per the materials listing in the report.

**PROJECT DOCUMENTATION**

Included within the Cable Installation Package, both in hard copy and electronic format, is the following information:

| **Cable Installation Report** | **Electronic Format** |
|---|---|
| Letters of Certification | Microsoft Word 2007 or newer |
| Implementation Report | Microsoft Word 2007 or newer |
| Cable Plant Database /Cut Sheet | Microsoft Excel 2007 or newer |
| Wiring Closet Detail | Microsoft Visio 2007 or newer |
| As-built Site Drawings | Autodesk AutoCAD 2004 or newer |
| Cable Plant Test Results | Fluke Networks Linkware 2.3 or equivalent |
| PDF of Cable Installation Report | Adobe Acrobat 9.0 or newer |

**CONCLUSION**

The installation project was completed on Wednesday, July 23, 2003.

All materials and workmanship provided by Company A are fully warranted under the terms of the existing contract between Company B and Company A.

Any questions concerning the project installation, documentation, and warranty may be addressed to Mr. Y of Company A. Mr. Y can be reached at (000) 555-0000

# Appendix E – Sample Cable Test Certification Letter

[*Use Corporate letterhead*]

April 5, 2005

Project Manager

DHS-ICE, Suite 860

801-I Street NW

Washington, DC 20001

Re: DHS-ICE Cable Plant Installation at the **Central City FPS**

Purchase Order #

Work Request #

Dear Mr.:

This letter is to certify that all cable test results included for the above mentioned project have been completed by ABC Cabling personnel who have been trained, and are competent in the use of the test equipment used on the project. [State type of equipment used for testing] These test results conform to ANSI/TIA/EIA 568-B requirements.

Please accept this letter as certification of the accuracy of the test results furnished in lieu of individual signatures on each cable test result.

Sincerely,

Clark Kent,

Program Manager

# Appendix F – Sample Fiber Cable Test

**Cable ID: IDF-A07-01 Test Summary: PASS**

Date / Time: 04/07/2005 07:07:49am

**Headroom: 0.94 dB (Loss)**

**Test Limit: TIA568B HRZ**

| | | |
|---|---|---|
| Cable Type: | Multimode | |
| Operator: | F.LANHAM | |
| Software Version: | V02.10 | |
| Model: | CertiFiber | |
| Main S/N: | 55A97L00406 | |
| Remote S/N: | 55B97L00431 | |
| Project: | FED.31038 | |
| certifiber | 4-07-05 fiber.flw | |
| n = 1.4966 | | |
| Propagation Delay (ns) | 320 | |
| Length (ft.), | Limit 295 | 210 PASS |
| Direction | A-B | A-B |
| Wavelength (nm) | 850 | 1300 |
| Result | PASS | PASS |
| Loss (dB) | 1.06 | 0.62 |
| Loss Limit (dB) | 2.00 | 2.00 |
| Loss Margin (dB) | 0.94 | 1.38 |
| Direction | B-A | B-A |
| Wavelength (nm) | 850 | 1300 |
| Result | PASS | PASS |
| Loss (dB) | 0.37 | 0.00 |

| | | |
|---|---|---|
| Loss Limit (dB) | 2.00 | 2.00 |
| Loss Margin (dB) | 1.63 | 2.00 |

**Compliant Network Standards**:

| | | | |
|---|---|---|---|
| TIA568B HRZ | TIA568B CNT | 100BASE-FX | 10BASE-FL |
| 1000BASE-SX | 1000BASE-LX | 3M VOLITION | ATM155 1300 |
| ATM155 850 | ATM622 850 | FDDI ORIG | TOKEN RING |
| FIBCHN266 | | | |

# Appendix G - Sample As-Built Drawing and Rack Elevation