A Deliverable to the
U.S. Immigration & Naturalization Service

INS Service Technology Alliance
Resources Systems Management/Integration
(INS STARS SM/I) Contract

TECHNICAL PAPER
INS STRUCTURED CABLING STANDARDS

DATA COMMUNICATIONS SUPPORT

Task Order No.: 00-SM/I-SID-306: Data Communications Support

FINAL

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Prepared for: INS

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CONTENTS

EXHIBITS

1.0 INTRODUCTION

1.1 Purpose

This document has been prepared for the U.S. Immigration and Naturalization Service (INS) with the specific purpose of setting standards for structured wire 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 INS facilities nationwide

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 INS facilities. The conversion of sites that have cabling in place to this standard will largely depend upon budgetary and time constraints.

This document shall replace, modify, or otherwise supercede previous releases of these standards. For questions or comments regarding this document, contact the INS Data Communication Branch (DCB) Installation Manager at (202) 307-5723.

An electronic version of this document resides in the INS Intranet Enterprise Library, available on the Office of Information Management (OIRM) Web site.

1.2 Background

The INS is a component of the U.S. Department of Justice (DOJ). INS is responsible for enforcing immigration laws and for providing immigration services. There are more than 960 INS border patrol sectors, stations, district offices, sub-offices, ports of entry, and checkpoints located throughout the United States and its territories. Because of increasing demands on Service resources, INS 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 INS facilities, other documents are being developed that provide additional related information such as:

- Enterprise LAN standards
- Enterprise wide area network (WAN) standards
- Workstation and server configurations
- 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
- 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

2.0 NETWORK CABLE PLANT OBJECTIVES

The objective of this network approach is to provide the INS 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 (Gb) speeds. Backbone cable infrastructure shall support bandwidth demands from Gigabit speeds and beyond. The installation of the cable plant infrastructure shall comply with local codes, as well as, industry and Federal standards.

3.0 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 RWC
- Where appropriate, Intra and Inter-building copper backbone cable, that provides connectivity between wiring centers and the MDF
- Work zone distribution cabling for open office space
- Fiber optic intra and inter-building backbone cable, that also provides connectivity between wiring centers and the MDF

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, ANSI/TIA/EIA Addendum 5, and in addition, provide specific guidelines unique to INS. Detailed cable plant material specifications and overall minimum characteristics are provided in Section 4.

3.2 Horizontal Workstation Cabling

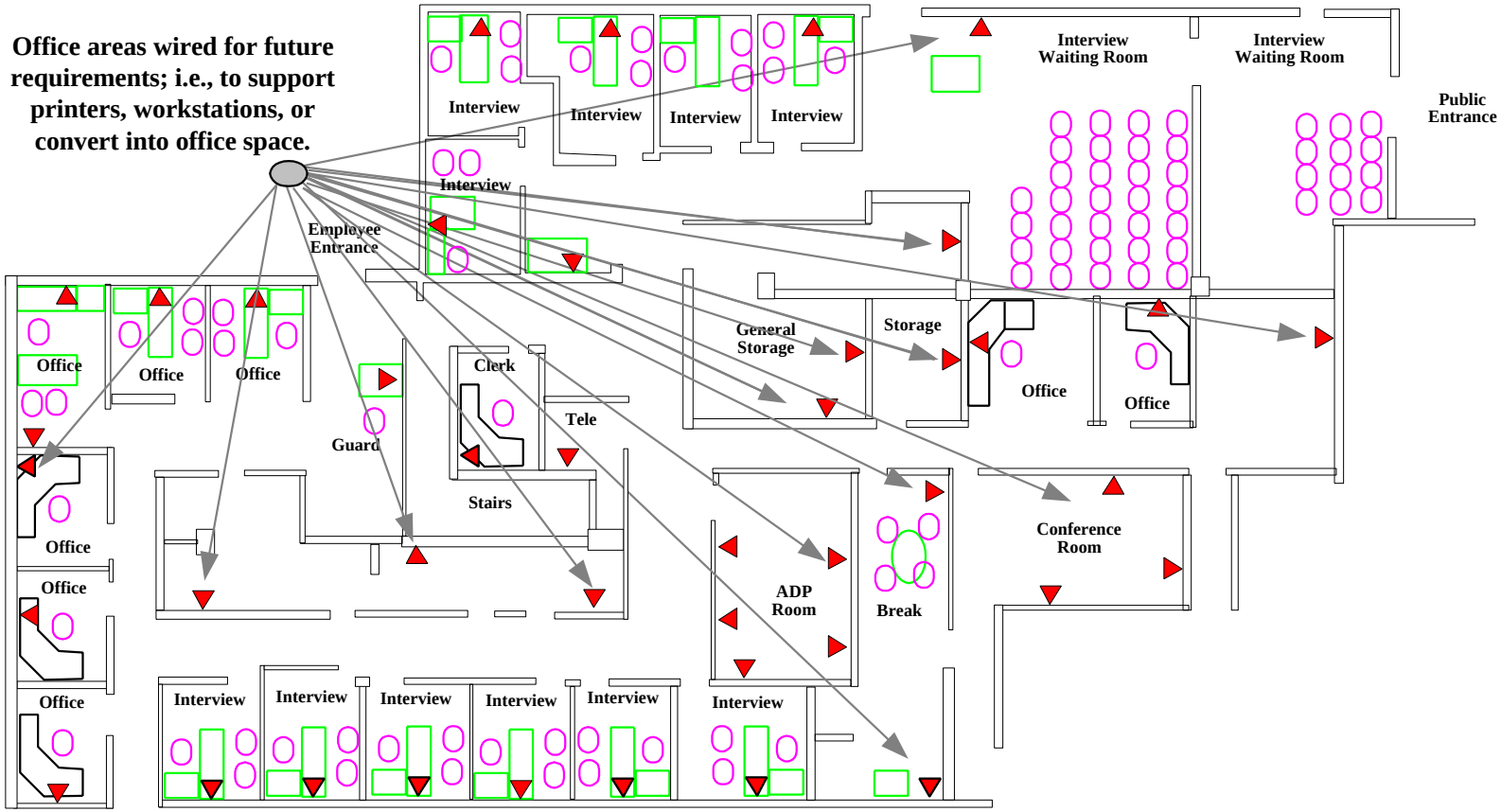
All end-user workstation locations, whether occupied or vacant, shall be cabled to the nearest wiring center. Also, storage rooms, conference rooms and similar space not designated as offices shall be cabled to allow for office expansion, as shown in Exhibit 1.

In general, each RWC equipment rack shall be capable of supporting a maximum of 288 data cables. A second rack is required to support up to 288 voice cables, providing a consolidated voice and data closet. The combined racks provide ample space for a total combined 144 workstation locations (voice and data). In smaller installations, typically less than 72 workstation locations, a single equipment rack will suffice for both voice and data termination.

To comply with ANSI/TIA/EIA 568A 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, communications closets should be located within 90 meters 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 568A specification distance limits.

In a building not exceeding two stories, horizontal workstation cabling may be installed to a single point, such as a computer room, wiring center, or the MDF. This scenario may be used in place of a creating an RWC, thus eliminating any need for backbone cabling systems. This installation method should be utilized when cost is a constraint and the length of the cable run does not exceed the specified distance limits.

Exhibit 1: Typical Office Cable Planning



One outlet, includes 3 or 4 cables each, all CAT5e, one or two voice, two data; configured per TIA/EIA 568A.

Each user workstation location shall be cabled with two 4-pair, unshielded twisted pair (UTP), Category (CAT) 5e copper cables for data transmission, that will be labeled as "Data A" and "Data B." The cable shall have a fire-retardant, plenum rated jacket.

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. If required, 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.

If the building being cabled is a new installation, cable installation shall include voice wiring in addition to data. The workstation location shall be cabled with a minimum of one 4-pair, UTP, CAT 5e cable for voice or modem/fax services. It is recommended that two voice cables bee installed rather than a single voice cable; however, budget and overall technical requirements will determine the need on a case-by-case basis. For planning and budgeting, two voice cables should be used in the design phase. Voice cable(s) shall be labeled "Voice A" or "Voice A" and "Voice B" while adhering to the labeling conventions as described in Section 12.

When routed above a suspended ceiling, horizontal cables should be routed down the inside of walls ("fished") 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. All attempts should be made to ensure no horizontal cable is 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 a business case supports 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
- Adequate funding
- Proposed fiber optic to the desktop is approved by the DCB

If optical fiber cables are used for workstation connectivity, each workstation location shall be cabled with a 4-strand, 62.5/125 micrometer (μm), graded index, multi-mode optical fiber cable

with proper coating to meet local fire and building codes, whereas plenum is recommended. The cable shall be labeled as described in Section 12 of this document.

3.3 Workstation Outlets

Each workstation area shall use a standard IMO (faceplate) that can support a minimum of three dual-connection interfaces (remote jack [RJ]-45, ST, SC, or MTRJ connectors). Regardless of the installation contractor, all voice and data cable shall utilize a singe Information Outlet. Information outlets must be capable of future growth without the need to replace the entire Information Outlet. Information outlets can be either single gang or dual gang standard size, sizing will be determined by number of cables being installed. The data cables shall be installed on two RJ-45 keyed jacks.

Exhibit 2: Workstation (IMO) Faceplates without Optical Fiber Cables, Single Gang

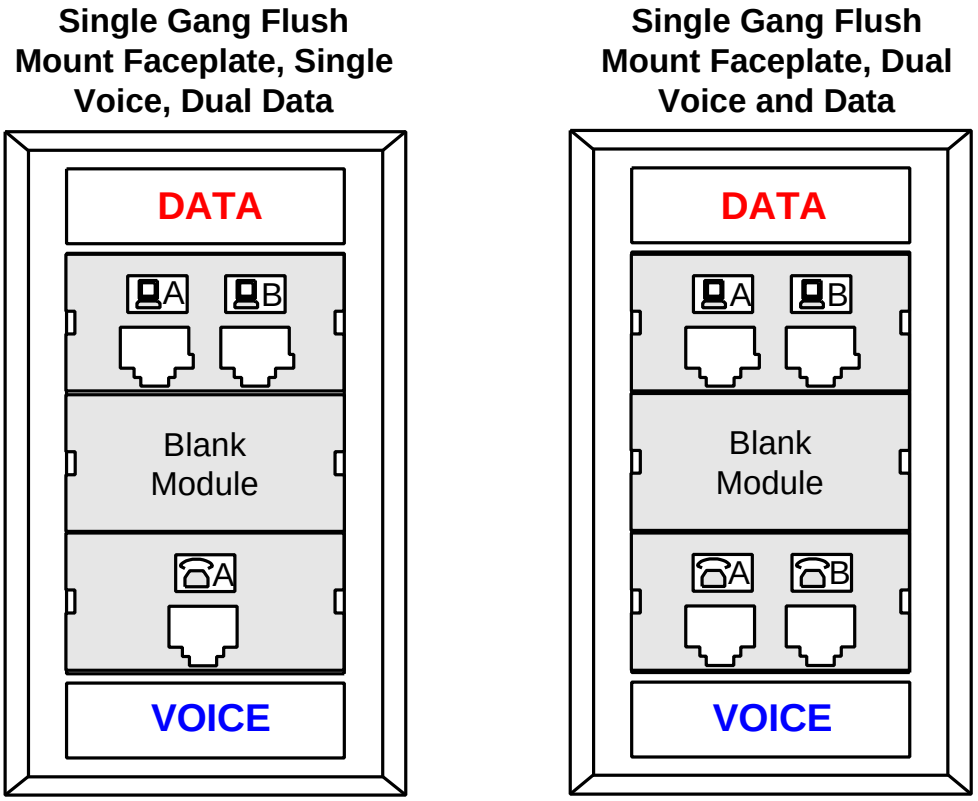
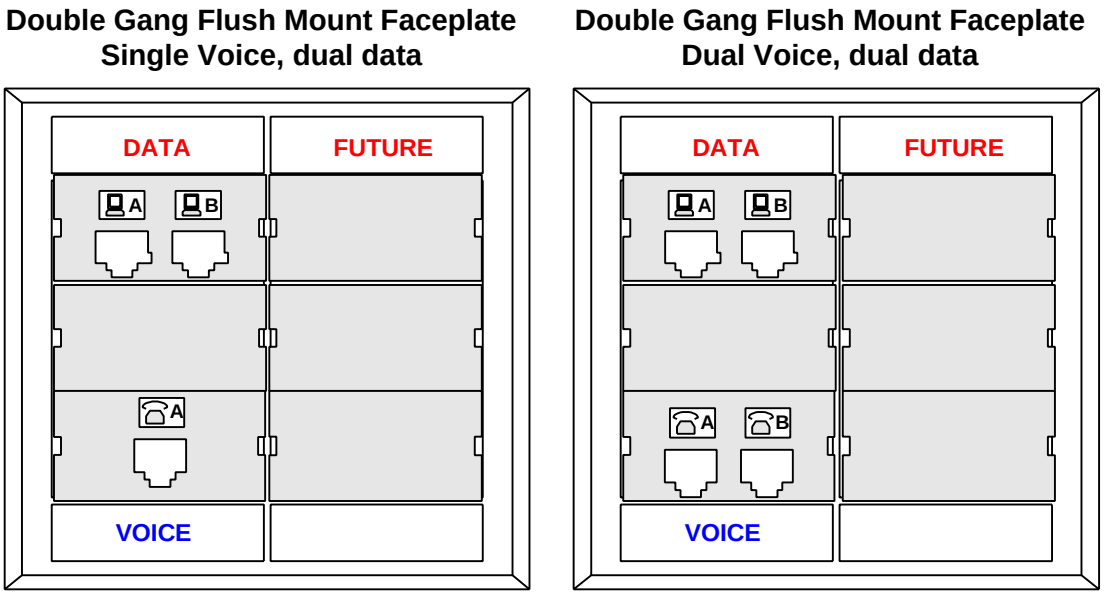
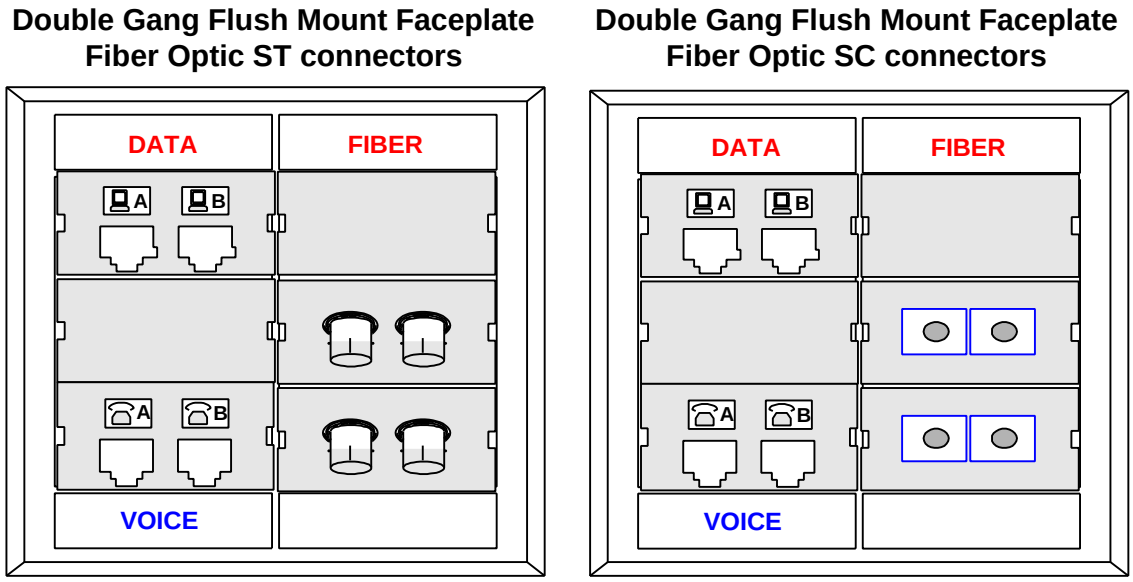


Exhibit 3: Workstation (IMO) Faceplates without Optical Fiber Cables, Double Gang



Where fiber-optic cable is installed to the desktop, the corresponding IMO faceplate shall provide space to install at least four RJ-45 jacks and at least two ST, SC, or MTRJ optical fiber connectors (see Exhibit 4).

Exhibit 4: Workstation Faceplate with Optical Fiber Cables



3.4 Backbone Cabling

Intra and Inter-backbone cabling may consist of either or both copper and optical fiber 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 Exhibit 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.

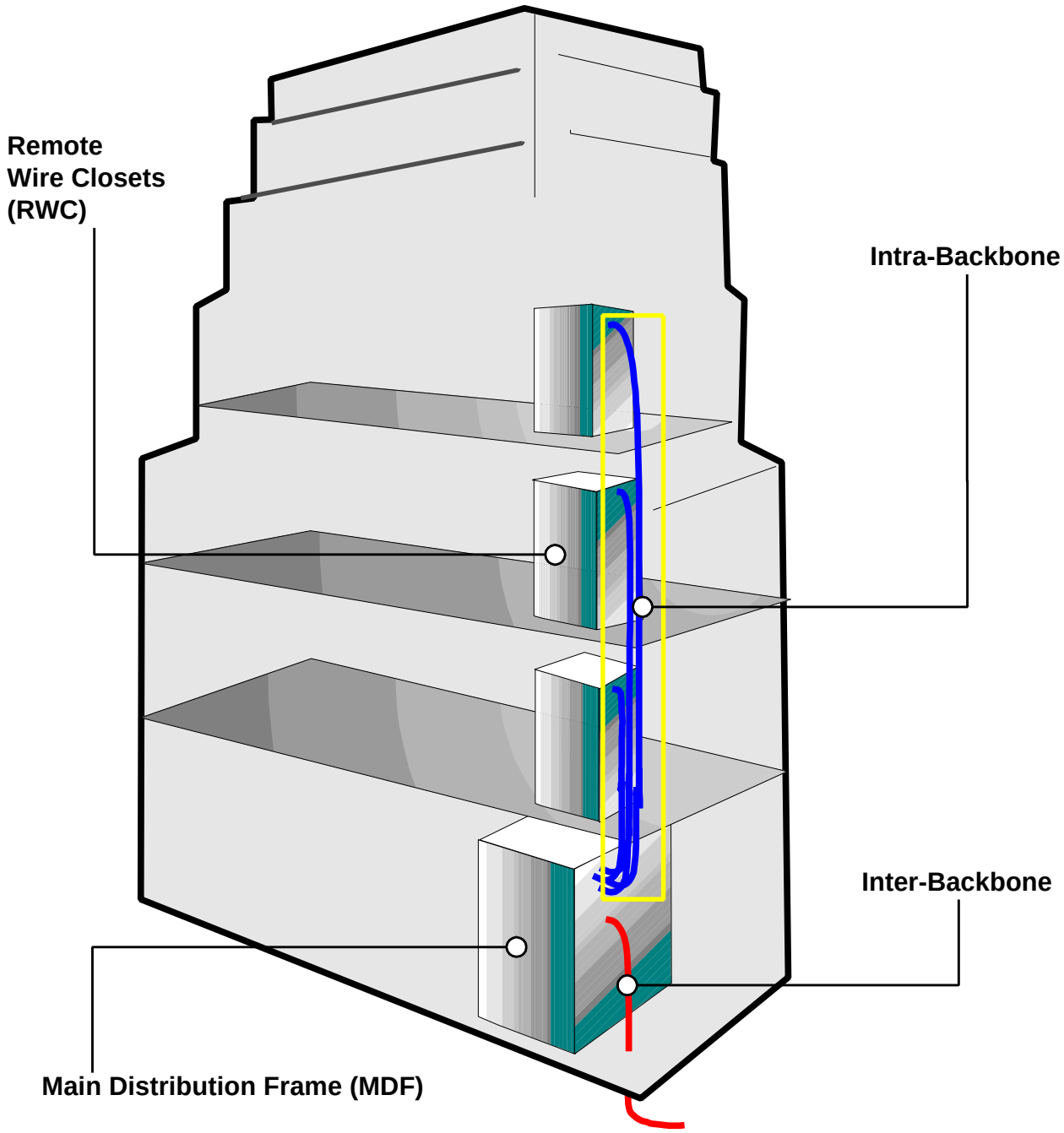
A multi-mode, single mode, or combination of fiber-optic backbone structure provides the means of interconnecting all wiring closets to the MDF in a multi-segmented environment. Optical fiber not only provides extensive bandwidth capabilities to the LAN and voice, but it also provides a solution to the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

Copper backbone cabling is required to support voice services, however, the specifications and designs are determined on a site-by-site basis. This is due to the variety, funding, capacity and availability of voice services and designs. Copper backbone may also be installed to support networking services, where distance limitations do not exceed the ANSI/TIA/EIA 568-A specifications. Copper backbone cabling provides a redundant connectivity option in the event of a catastrophic fiber failure, and shall be installed where voice and data closets are physically separated.

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 ST, SC, or MTRJ-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 multi-mode fiber will meet most of the intra and inter backbone connectivity needs currently deployed and planned for INS 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, DCB will provide engineering design in concert with local Automated Data Processing (ADP) 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.

Exhibit 5: Backbone Fiber Distribution



4.0 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 568A, 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 CAT 5e rating in accordance with ANSI/TIA/EIA 568-A and Addendum 5 standards.
- 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 CAT 5e, 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: CAT 5e cable types must meet or exceed specifications listed in Exhibit 6.

Exhibit 6: 5e Cable Specifications

Specification	Category 5e
Frequency Range	1-100 MHz
Attenuation (maximum)	24 dB
NEXT (minimum)	30.1 dB
PSNEXT (minimum)	27.1 dB
ACR (minimum)	6.1 dB
PSACR (minimum)	3.1 dB
ELFEXT (minimum)	17.4 dB
PSELFEXT (minimum)	14.4 dB
Return Loss (minimum)	10 dB
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 CAT-5e specifications
- Mounts to standard electrical 2 inch and 4 inch boxes
- Allows all modules (jacks) to be loaded and accessed from the front. No need to remove faceplate
- Meets all Federal Communications Commission (FCC) Part 68 specifications
- Provides standard 110D type insertion displacement connector (IDC) Printed Circuit Board (PCB) mounted connector
- Is offered in a multitude of colors
- Provides interchangeability between modules
- Offers keyed and non-keyed RJ-45 style connectors
- Offers SC, ST or MTRJ interchangeable modular fiber connectors
- Is available in the ANSI/TIA/EIA 568-A wiring configuration

4.3 Backbone Cabling

Backbone cabling shall be a minimum of 12-strand multi-mode 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.

CAT 5e copper backbone cabling shall meet the same specifications as stated in Section 4.1 (Horizontal Cabling), in addition to the multi-pair construction in increments of 25, 50 and 100 pair complements. Voice copper backbone cabling is not specified in this standards document and shall be determined on a case-by-case basis. Voice copper backbone cables are not subject to the same 100 meter distance limitations as specified for networking backbone cabling which is the CAT 5e cable plant.

4.3.1 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.

4.3.1.1 Multi-Mode Fiber Optics

- 62.5/125-µm optical fiber plenum (OFNP) or optical fiber riser (OFNR)
- Maximum Attenuation: 3.5/1.0 dB km at 850/1300 nm
- Minimum Bandwidth: 200/500 MHz km at 850/1300 nm
- Tight buffered

- Plenum or riser rated

4.3.1.2 Single-Mode Fiber Optics

- 8.3/125-µm OFNP or OFNR
- Maximum Attenuation: 1.0/0.5 dB km at 1310/1550 nm
- Tight buffered
- Plenum or riser rated

4.3.2 Inter-Building Fiber Optics

Specifications for fiber cable that will interconnect remote buildings in a campus environment.

4.3.2.1 Multi-Mode Fiber Optics

- 62.5/125-µm OFN, OFNP, or OFNR
- Maximum Attenuation: 3.5/1.0 dB km at 850/1300 nm
- Minimum Bandwidth: 200/500 MHz km at 850/1300 nm
- Loose Tube
- Not Rated, Plenum rated, or Riser rated

4.3.2.2 Single-Mode Fiber Optics

- 8.3/125-µm OFN, OFNP, or OFNR
- Maximum Attenuation: 1.0/0.5 dB km at 1310/1550 nm
- Loose Tube
- Not Rated, Plenum rated, or Riser rated

4.4 Patch Cables (Workstation and Patch Panel)

- Shall conform to the ANSI/TIA/EIA CAT 5e and addendum 5 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 568A specifications
- Certified by the manufacturer as compliant with the ANSI/TIA/EIA CAT 5e, addendum 5 criteria.
- Cables shall be available in a wide variety of colors and lengths

4.5 Patch Panels

- Shall conform to the ANSI/TIA/EIA CAT 5e and addendum 5 specifications
- The patch panel wiring shall be in compliance with ANSI/TIA/EIA 568A wiring standards

- Provide back wire management hardware
- 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 relay rack spacing specifications
- Provide RJ-45 interface
- Meets all FCC Part 68 specifications
- Available in 12, 24, 48, and 96 port capacities
- Match make and model within existing facilities, where possible

4.6 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

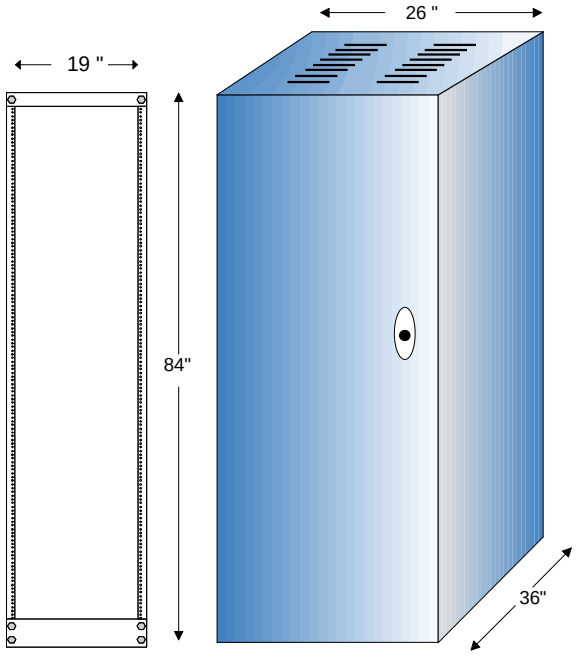
See Exhibit 7 for a typical rack and cabinet structure.

4.7 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 widths up to 26 inches or more
- Available in depths up to 36 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

Exhibit 7: Typical Rack/Cabinet Enclosures



5.0 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 568A, ANSI/TIA/EIA 569, ANSI/TIA/EIA 606, NEC 770 and IEEE 802 standard specification quality (as applicable).

5.1 Horizontal Cables

These are cables installed from a typical workstation location back to a central point within a building or facility. These cables connect the IMO (jack), 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.

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 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 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 CAT 5e specifications.

5.2 Patch Cables (Workstation)

The workstation patch cable connects the end user devices (personal computer, terminals, etc.) to the IMO (jack). For most installations, these patch cables will be provided and left on-site for the deployment team or local ADP 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 patch 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 (Panel)

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 INS 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 patch 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.
- 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 patch cord approximately one inch from the terminator or mod plug.
- Label IDs must be legible and produced with indelible ink. The preferred method is a printed label. Installers must avoid the use of materials that will distract from the appearance of the installation, or any temporary marking

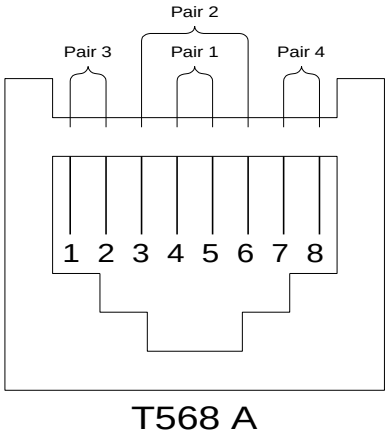
- Ensure patch cables are installed in a manner that does not require support personnel to “tug” or “trace” cables in order to determine the active port.
- Cables must be dressed utilizing available horizontal and vertical wire management
- Patch cables should provide a neat and organized appearance, eliminating large bundles of cables in single locations, preventing tangles and using incorrect , or oversized cables that produce excess slack
- Cables shall 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 produce and 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 568A 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 CAT 5e 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 T568A configuration (see Exhibit 8)

Exhibit 8: T568A Pair/Pin Assignments



6.0 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 four-strand, multi-mode, 62.5/125 μm, optical fiber cable with graded index 250 or 900 μm buffer. Contiguous, 2-foot, segment-length markers shall be 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-, or 24-, or more strand, multi-mode, 62.5/125 μm, optical fiber cable with graded index, 250 or 900 μm buffer, and contiguous, 2-feet, segment-length markers printed on the cable jacket. All Intra and Inter-backbone fiber cables shall be installed in 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, INS DCB shall review and approve the design prior to installation.

6.3 Optical Fiber Cable Jacket

All overhead or above-ceiling installations shall use optical fiber cable with a plenum-graded jacket that is marked with a UL rating of “OFNP” or equivalent. All non-air-return (non-plenum) installations can use optical fiber cable with either a plenum or non-plenum jacket (such as PVC) that is marked with a UL rating of “OFNR” 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. INS is reviewing the MTRJ as an acceptable connector, but the use of this style will be determined on a case-by-case basis.

New buildings shall use SC or MTRJ type connectors for workstation and/or backbone installation.

In retrofit buildings, fiber connectors should match the existing installed connectors.

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 four 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.

7.0 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 Exhibits 2 and 3). When data only is installed in the faceplate, a dual, RJ-45 keyed information outlet shall be used, and it shall be installed in the top left position regardless of whether a single or dual gang faceplate is used. When voice and data are installed in the same faceplate, the dual RJ-45 information outlet shall conform to the configuration as outlined in Exhibit 2 and 3, whereas data is always keyed and voice is non-keyed. Voice shall be installed at the bottom left, data at the top left positions of all information outlets. 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 Exhibit 4).

8.0 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 one horizontal wire manager for each horizontal patch panel. 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 “Data A”, “Data B”, “Voice A”, and “Voice B” cables. The upper patch panel will be used for “Data A” only; the lower patch panel will be used for “Data B” only. In addition, and depending on the number of total cables, voice cables may also share a single standard 7-foot equipment rack, swing gate or cabinet enclosure. Exhibits 9, 10, and 11

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 exhibits shall be reviewed and approved by the DCB.

8.2 Fiber Optic Patch Panels

Optical fiber cable patch panels for workstation connections (also called fiber cabinets) shall provide ST, SC, or MTRJ couplers. Optical fiber cable patch panels for backbone cabling (also called fiber cabinets) shall provide SC or MTRJ 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, ST, SC or MTRJ, loads or interconnect couplers, as required in each wiring closet and MDF.

9.0 EQUIPMENT RACK

There are a multitude of equipment racks and cabinets that are acceptable for use in INS 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 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.

Exhibit 9: Consolidated Closet, Voice and Data

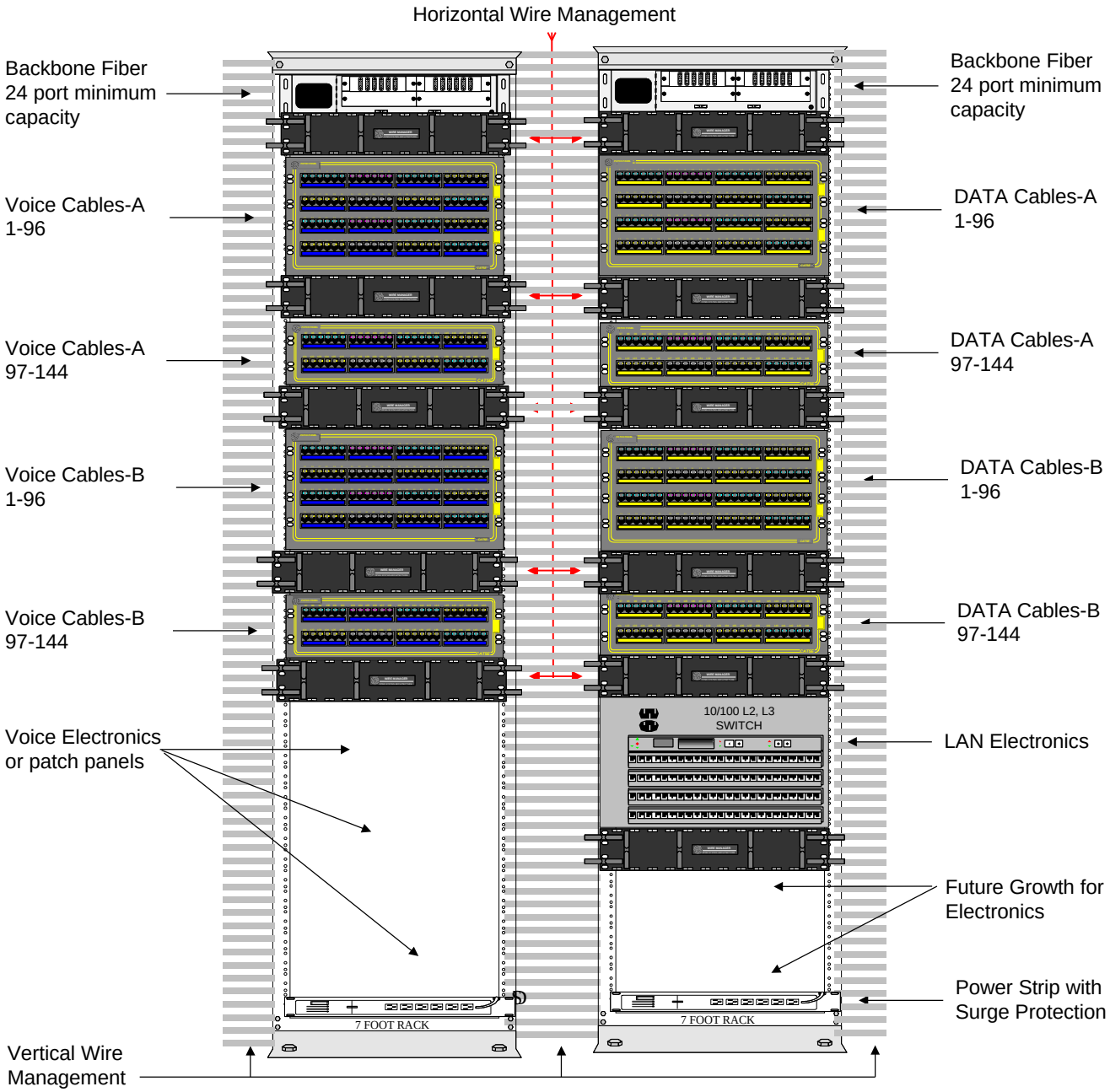


Exhibit 10: Single Rack, Data Only (Voice and Data Not Consolidated)

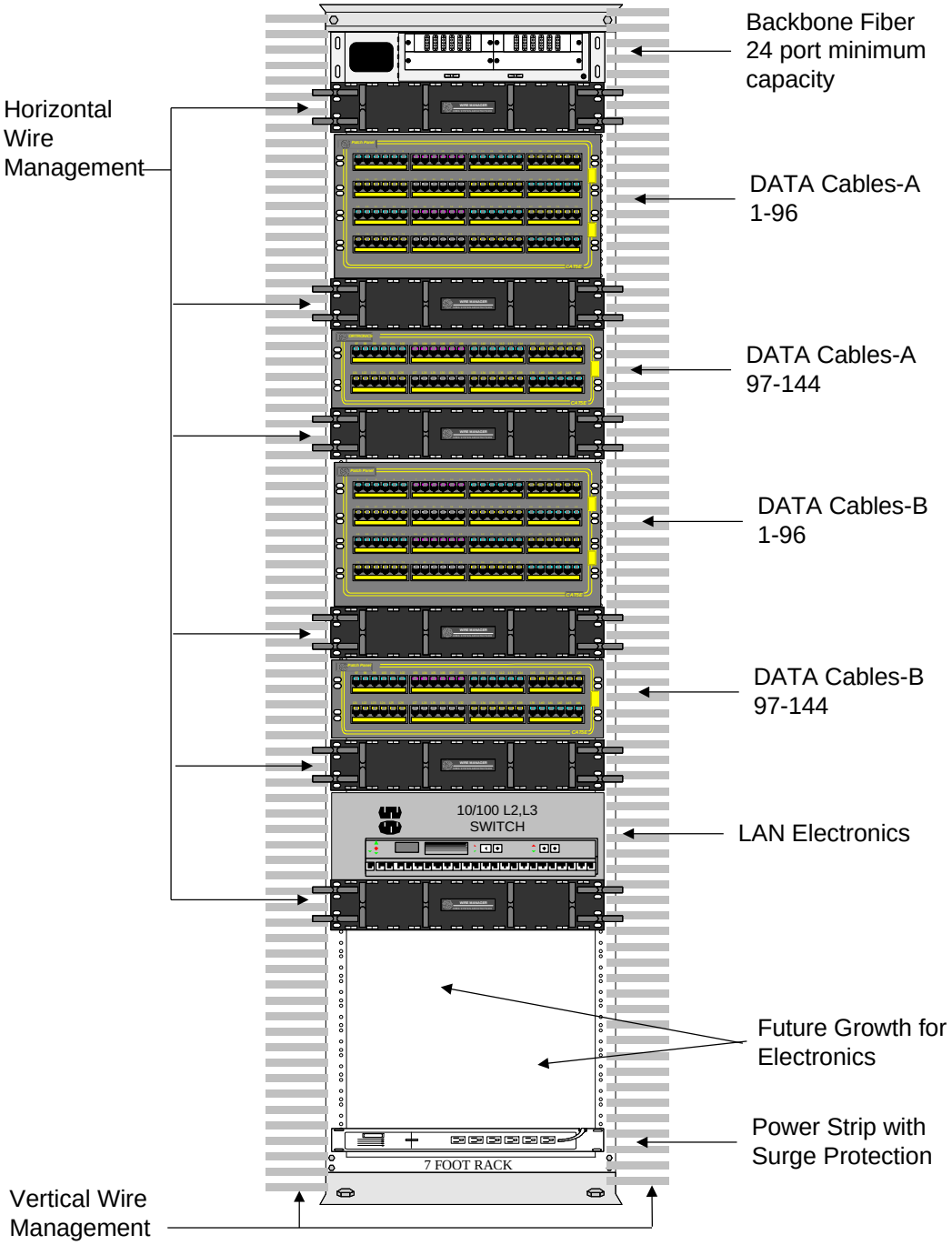
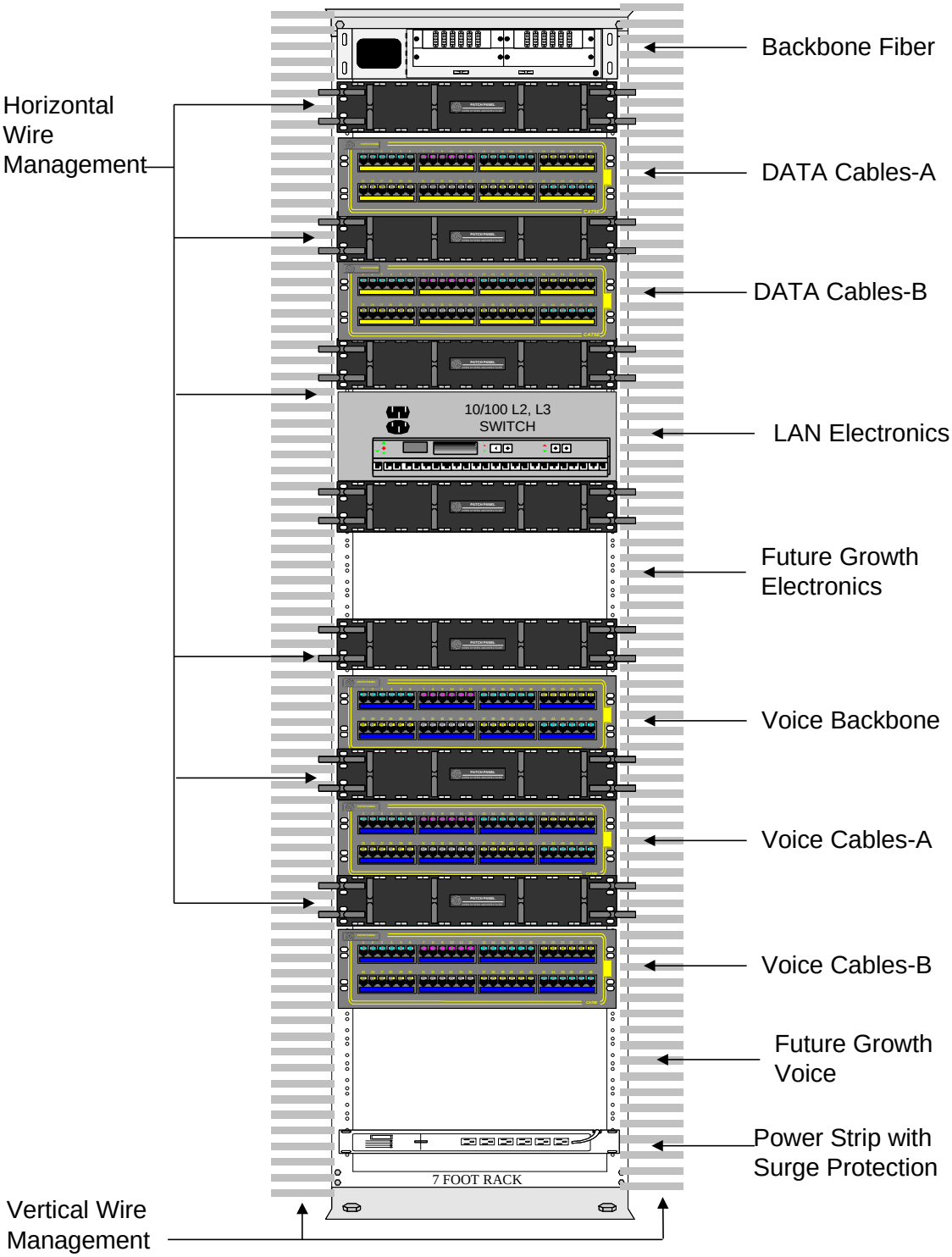


Exhibit 11: Consolidated Closet, Voice and Data; Share Single Rack (less than 72 locations)



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 DCB 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 Velcro securing straps.

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).

10.0 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 INS 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.

11.0 CABLE LADDERS AND FASTENERS

All cables installed in overhead spaces (such as above ceiling panels) shall be securely strapped to ceiling slab fasteners or 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.

12.0 ADMINISTRATION AND LABELING CONVENTIONS

Label conventions shall apply to all sites, regardless of the number of buildings at the site. This section describes the INS 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" or "B" designation, indicating the "Data A" or "Data B" cable drop. Use leading zeros as necessary. For example, the designation for drop #3A would become 003A.

12.2 Information Management 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)
- Floor (NN, with a leading zero)
- Wiring center (A)
- Cable drop (NNN, with leading zeros).

For 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)

For 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.

13.0 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. All work shall be ANSI/TIA/EIA 568A, ANSI/TIA/EIA Telecommunications Services Bulletin (TSB)-67, NEC 770, and IEEE 802 standard specification quality (as applicable).

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-A requirements in accordance with the TSB-67 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

13.2 Testing of Optical Fiber Cables

Testing shall be of the optical link as specified in ANSI/TIA/EIA-568-B.3 for multi-mode 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 Exhibit 12.

Exhibit 12: Multimode Fiber Cable Specifications

Horizontal Fiber	Attenuation 850 nm	Attenuation1300 nm
≤ 90 m	≤ 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 Exhibit 13

Exhibit 13: 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. INS prefers these reports to be provided in the electronic format over hardcopy.

14.0 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 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 INS 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.

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, 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 65 to 85 degrees Fahrenheit, with a relative humidity range of 20 to 60 percent. 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 over heating. Where the building HVAC is insufficient to maintain these parameters a standalone HVAC system should be considered to maintain these environmental ranges for 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. INS typical closet minimum size should be no less than 80 square feet, whereas the recommended size is calculated by the ANSI/TIA/EIA specifications.
- Door locks for all communications rooms will conform to local security requirements.
- Door must be a minimum 36 inches wide by 80 inches high. 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 2 separate 120 Volt @20A circuits installed for cable plant electronics. Preferred outlets are the National Electrical Manufacturers Association (NEMA)-20 5 quad receptacles. Outlets should be installed at heights that adhere to the building electrical codes, typically 18 inches above finished floor. Additional circuits may be required as equipment density is increased.
- 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 tie-wrapped and anchored every 3 feet on the backboard
- INS occupied floors that are contiguous, with stacked closets, should have a minimum of two 4-inch sleeves between closets for INS Data and Voice cables. Additional sleeves will be required for the building voice riser system. Where INS data and voice cables must pass through communications closets not controlled by INS 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 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 from above ceiling grids to respective IMO is recommended. These conduits are referred to as "ring and string" within the industry, and typically provide a pathway for plenum cable installation into the outlet box. Although many local codes do not require rigid conduits for low voltage wiring, INS DCB recommends the general contractor install these for each IMO.
- Open office space (e.g., systems furniture where two or more IMOs 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 open plenum environments, where access to closets are 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 INS 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 INS 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 between buildings in a campus environment

15.0 DOCUMENTATION

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

- Letter of certification from the installing organization
- Completed Contractor Information Form
- Detailed materials list
- Cable plant test certification letter
- Electronic Copper cable test results (soft)
- Electronic Fiber-optic cable test results (soft)
- As-built site drawings

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

- Electronic Fiber test results (soft)
- Electronic Copper test results (soft)

15.1 Letter of Certification

A letter of certification shall be supplied to the designated INS Program Manager from the authorized project supervisor. A sample of the recommended letter of certification is included as Appendix B of this document. A letter of certification shall be supplied to the designated INS Program Manager from the authorized project supervisor. A sample of the recommended letter of certification is included as Appendix B of this document. The letter of certification should be submitted in electronic format using word Processing software compatible with Microsoft Word for Windows, Version 6.0 or lower.

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 for Windows, Version 6.0 or lower. A sample implementation report is provided as Appendix D of this document.

15.3 Detailed Materials List

A detailed materials list shall be included as part of the completed documentation package. At a minimum, this list shall include all materials originally called for from the site survey report, actual materials used for the installation project, and a column that shows the deviation between the two. Any unusual deviations in required quantities should be explained in the implementation report, as described previously.

The detailed materials list should be completed and submitted using spreadsheet software compatible with Microsoft Excel for Windows, Version 6.0 or lower. A sample form to be used for this list is provided as Appendix E of this document.

15.4 Cable Plant Test Certification Letter

In lieu of the responsible installation supervisor providing a signature on each printed cable test result, a letter of certification from the installation supervisor may be included to verify that

installation personnel doing the testing have been properly trained in the use of the test equipment and that the test results included have been reviewed and are an accurate reflection of the installed cable plant.

The certification letter should be submitted in electronic format as a word Processing document compatible with Microsoft Word for Windows, Version 6.0 or lower. A sample cable plant test certification letter is included as Appendix F of this document.

15.5 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.

15.6 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.

15.7 As-Built Site Drawings

Complete as-built site drawings of the cable plant shall be included as part of the completed documentation package. 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 fire walls
- Any special service application notes
- Backbone and tie cable lengths between closets.

These as-built site drawings shall be completed using computer-aided drawing software that produces vector graphics data files, preferably AutoCAD version 2000 or lower.

Attachment A

Glossary

AC	Alternating Current
ACR	Attenuation to crosstalk ratio
ADP	Automated Data Processing
ANSI	American National Standards Institute
AWG	American Wire Gauge
CAT	Category
CSA	Canadian Standards Association
dB	Decibel
DCB	Data Communication Branch
DO	District Office
DOJ	Department of Justice
EF	Entrance Facility
EIA	Electronic Industries Association
ELFEXT	Equal Level Far End Cross-talk
EMI	Electromagnetic Interference
FCC	Federal Communications Commission
FIPS	Federal Information Processing Standard
GRI	group refractive index
HVAC	Heating, Ventilation, and Air Conditioning
ID	Identification
IDC	Insertion Displacement Connector
IEEE	Institute of Electrical and Electronics Engineers
IMO	Information Management Outlet
INS	Immigration and Naturalization Service
ISO	International Organization for Standardization
km	kilometers
LAN	local area network
µm	micrometer
Mbps	Megabits per second
MC	main cross-connect
MDF	Main Distribution Frame
MHz	MegaHertz
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
OFNP	Optical Fiber Plenum
OFNR	Optical Fiber Riser
OFN	Optical Fiber, not rated
OIRM	Office of Information Resource Management
OTDR	Optical Time Domain Reflectometer
PCB	Printed Circuit Board
PS ACR	Power sum attenuation to crosstalk ratio
PS NEXT	Power sum near-end crosstalk
PS ELFEXT	Power sum
RFI	Radio Frequency Interference
RJ	Remote Jack
RWC	Remote Wiring Closet
TIA	Telecommunications Industries Association
TR	Technical Reference
TSB	Telecommunications Services Bulletin
UL	Underwriter’s Laboratory
USOC	Universal Service Order Code
UTP	Unshielded Twisted Pair
WAN	wide area network

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.
CAT 5e	A type of cable passing ANSI/TIA/EIA specifications, which allows data to be transmitted at 100 MHz.
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.
Delay Skew	The propagation delay difference between the slowest and fastest cable pair.
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.
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.
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.
Hertz	The unit of frequency, one cycle per second.
IEEE	Institute of Electrical and Electronics Engineers: An international professional society that issues its own standards and is a member of ANSI and ISO.
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.
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.
MTRJ connectors	The MT-RJ fiber optic couplers provide a complete system for premises applications. As the name suggests, the system was designed to bring many of the benefits of the RJ-45 modular plug and jack system to fiber optics: small size, lower costs, easier application, and easier use.
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.
OFN, OFNP, OFNR	Type of optical fiber cable construction, which stands for: general purpose, plenum(P) or Riser (R)
Patch Panel	A modular termination and connection point for horizontal distribution cabling.
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.
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.
SC connectors	Fiber connector that is duplexed into a single connector clip with both transmit/receive fibers.
ST connectors	Keyed, bayonet-style connector, very commonly used
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.
UTP	A cable with multiple pairs of twisted insulated copper conductors bound in a single sheath. An unshielded twisted pair CAT5 or 5e cable usually contains four pairs of wire in a single jacket.
WAN	Wide Area Network: A network that uses common-carrier-provided lines, usually to connect two or more LANs.

Attachment B

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 INS site was completed by our firm, according to the INS 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 Category 5 or 5e cable, if applicable, which will be re-used as part of this Task Order. I hereby certify that every wire and cable was tested and meets or exceeds the CAT 5e ANSI/TIA/EIA 568A transmission test requirements.

Our firm also tested each fiber-optic cable and strand we installed, as well as previously installed fiber-optic cable that will be used as part of this Task Order. 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*]

Attachment C

Sample Contractor Information Form

CONTRACTOR INFORMATION

JOB NAME: LOCATION:

DATE: **PROJECT:** Cable Plant Installation

FIBER CONTRACTOR

NAME: PHONE:

ADDRESS:

CITY, STATE, ZIP:

CONTACT NAME:

COMPLETION DATE:

SCOPE OF WARRANTY RESPONSIBILITY:
In accordance with Existing Contract

SUPPLIED MATERIALS:
In accordance with Task Order XXX-xxx

COPPER CONTRACTOR

NAME: PHONE:

ADDRESS:

CITY, STATE, ZIP:

CONTACT NAME:

COMPLETION DATE:

SCOPE OF WARRANTY RESPONSIBILITY:
In accordance with Existing Contract

SUPPLIED MATERIALS:
In accordance with Task Order XXX-xxx

Attachment 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, 1997, and the installation was completed on Wednesday, July 23, 1997.

PROJECT PERSONNEL

The following Company A personnel participated in the installation project at Site C:

Mr. X	Program Manager
Mr. Y	Task Team Leader
Mr. Z	Senior Network Engineer

INSTALLATION SUMMARY

The network installation was completed in accordance with the Task Order, using the Site Survey Report as the guide for project completion. In accordance with the design documentation, two buildings at the headquarters site were cabled for a total of 52 dual cable drops. All drops were installed through a self-suspended overhead cable routing system above the acoustic ceiling tiles in the office areas and garage of Site C.

Two wiring closets, designated wiring closet HQ-01-A and HA-01-A, serve the workstation connectivity needs for Site C. The main building cables are identified by labels starting with HQ-01-A. The garage cable drops are identified by labels beginning with HA-01-A. All 45 copper cable drops for closet HQ-01-A terminate on the patch panels in the equipment racks located in room 118, which also serves as the main computer room. The seven drops in the garage in wiring closet HA-01-A terminate on the patch panels located on the equipment rack in room 105.

A six-strand multi-mode fiber-optic cable connects wiring closet HA-01-A in the garage to wiring closet HQ-01-A in the main building.

There were no modifications made to the design documentation from the Site Survey Report. All material was provided and installed in accordance with the materials listing in the report.

PROJECT DOCUMENTATION

Included within the As-built documentation package, both in hard copy and electronic format, is the following information:

Item	Electronic Format
Letter of Certification	Word processing compatible with Microsoft Word for Windows (Version 97), or lower
Implementation Report	Word processing compatible with Microsoft Word for Windows (Version 97), or lower
Contractor Information	Word processing compatible with Microsoft Word for Windows (Version 97), or lower
Cable Plant Database	Spreadsheet compatible with Microsoft Excel (Version 97) or lower
Detailed Materials Listing	Spreadsheet compatible with Microsoft Excel (Version 97) or lower
Cable Plant Test Results	ASCII Text File
Active Equipment Installation Log	Spreadsheet compatible with Microsoft Excel (Version 97) or lower
As-built Site Drawings	CAD format compatible with AutoCAD Version 2000 or lower
Wiring Closet Detail	Raster or Vector drawing compatible with Visio Professional (Version 5.0) or AutoCAD Version 2000 or lower

CONCLUSION

The installation project was completed on Wednesday, July 23, 1997.

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.

Attachment E

Sample Detailed Materials List

Item No.	Description	Projected Quantity	Actual Quantity	Variance
1	Wire Management Panel	6	6	0
2	48 Port Patch Panel	2	2	0
3	24 Port Patch Panel	4	4	0
4	Single Gang Faceplate, 6-plex CAT-5e	25	25	0
5	Workstation Blank Insert	50	50	0
6	Dual RJ-45 Jack, 568A, Keyed	25	25	0
7	CAT-5e Cable, 24-4/P, plenum, feet	15000	15000	0
8	Patch Cord, yellow, 14 feet	30	30	0
9	Patch Cord, yellow, 10 feet	70	70	0
10	Open Rack, self support, double sided	1	1	0
11	Rack Mount Power Outlet Strip	2	2	0
12	Bay Networks Baystack 101 10BaseT Hub	1	1	0
13	Bay Networks Baystack Ethernet NMM	2	2	0
14	Bay Networks Baystack Fiber Media Adapter	1	1	0
15	19" Clear Vented Double Sided Rack Tray	1	1	0
16	Panduit 0.9" x 1.5" Latching Duct, 6 foot lengths	8	8	0
17	Data Tab (Computer Icon) 100/PACK	2	2	0
18	Fiber-optic cable, Six-Strand, feet	600	300	300
19	Bay Networks 3314A-04 Ethernet NMM	2	2	0
20	Bay Networks 3308B 10BaseT Ethernet HM	6	6	0
21	Bay Networks 3000NT Concentrator	1	1	0
22	Box Eliminators	50	50	0
23	Surface Mount Box	14	14	0
24	Panduit 0.53"x1.01" Latching Duct, 6 foot lengths	14	14	0
25	Fiber Distribution Center	2	2	0
26	FDC Connector Panel, Preloaded w/ 6 ST	2	2	0
27	Dual Fiber Jumper Cable, ST to ST, 10 feet	2	2	0

Attachment F

Sample Cable Test Certification Letter

[*Use Corporate letterhead*]

Date: [Current date]

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

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

Re: INS Cable Plant Installation at Site C

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

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

This letter is to certify that all cable test results included for the above mentioned project has been completed by Company A personnel who have been trained, and are competent in the use of, the required cable testing equipment.

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

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