Designer: *This template is to assist in the design of a new Data Center and features the concepts presented in Build the Best Data Center Facility for Your Business, by Douglas Alger. The template is written for a company project manager who needs to present Data Center design guidelines to a contracted architectural firm. It is assumed that the architectural firm will, in turn, create construction documents to be reviewed by the appropriate municipal planning department and ultimately followed by the project's contractors—electricians, mechanical contractors, cabling vendors, and so on.*

Notes to the designer introduce each section of the document. Notes are also placed at key paragraphs to clarify requirements or explain what information must be entered.

Variables in this document—data points you must enter—are highlighted in teal. Cable counts and other quantities have been suggested where appropriate. In other instances, variables are represented by a description (for example., Your Company) or symbol (for example, #).

Remove all italicized notes and color-coding after you fill out the template.

Company Logo

Data Center Design Guidelines

Issued for Design: Date

Name
Project Manager
Your Company
(Address Information)
(Address Information)
(Phone number)
(E-mail)

TABLE OF CONTENTS

SECTION 7—DATA CABLING SYSTEM

7.1 Scope of Work
7.2 Network Room to Network Row
7.3 Network Row to Network Substations
7.4 Network Substations to Server Cabinet Locations
7.5 Network Row to SAN Equipment Cabinet
7.6 Standards
7.7 Copper Specifications
7.8 Fiber Specifications
7.9 Execution of Cabling
7.10 Labeling
7.11 Copper Testing
7.12 Copper Performance Requirements
7.13 Fiber Testing
7.14 Certification Requirements

Designer: The sample drawings listed here are available in PDF format on the Cisco Press website. To best understand this template, download and review those drawings at the same time as this text document.

SUPPLEMENTAL DRAWINGS

FIG. 1—Cabinet Location Plan
FIG. 2—Floor Tile Location Plan
FIG. 3—Electrical Location Plan
FIG. 4—Data Routing Diagram
FIG. 5—Under-Floor Power and Cable Detail
FIG. 6—Power and Data Cable Detail
FIG. 7—Under-Floor Labeling Details
FIG. 8—Fixed Cabinet Installation Detail
FIG. 9—Network Row Elevation
FIG. 10—DC Network Row To Outside Network Room Connection Detail
FIG. 11—Network Row Fiber Detail
FIG. 12—Network Row Copper Detail
FIG. 13—Network Substations Detail
FIG. 14—Network Substation Fiber Detail
FIG. 15—Network Substation To Network Row Detail
FIG. 16—Network Substation Copper Detail

Designer: *Section 1 summarizes the scope of the Data Center project and outlines basic expectations of the project's contractors. These requirements include the need for contractors to clean up after their work and provide certain documentation at the start and end of the project.*

SECTION 1—GENERAL INFORMATION

1.1 Introduction

1.11 Your Company is building a new Data Center at Address. It will be # square feet (# square meters) in size and will be a robust, modular, flexible, and productive environment that hosts Your Company's most critical applications and intellectual property.

1.12 The drawings and written instructions in this Design Guidelines document are intended to assist in the creation of Data Center construction documents by contracted architectural firm.

1.13 All Data Center-related installations—including but not limited to room infrastructure, in-room electrical, standby power, cooling, data cabling, monitoring lights, and fire suppression systems—must be completed at least (2) weeks prior to cutover of the site. This includes all testing and provision of documentation by the respective vendors for each section of this project.

Designer: *The time period listed in 1.13, suggested at 2 weeks, is to allow for supplemental work to be performed in the Data Center after principal construction is complete and before the server environment is brought online. Such work can include reviewing structured cabling test results, stocking the Data Center with supplies, and installing networking devices. Two weeks is usually appropriate. Increase this time period if the Data Center is large—i.e., more than 10,000 square feet or 1000 square meters—or if you want to put more time in the construction schedule to allow for missed deadlines.*

1.14 Changes to these Design Guidelines must be approved in writing by the original issuer to be valid.

1.2 Standards

1.21 Only new equipment and materials are to be used in this Data Center project. All items will be from reputable and qualified companies and meet prevailing industry standards. All equipment and individual connections will be verified by the Project Manager before completion.

1.22 Additional standards for individual components are specified within the corresponding sections of this document. (i.e., Section 3—In-Room Electrical System; Section 7—Data Cabling System).

1.23 Where a discrepancy between this document and local building codes or building control standards occurs, the more stringent will apply.

1.3 Client Approval

1.31 Your Company reserves the right to inspect and unilaterally reject installations that do not conform to its standards of workmanship, neatness, and cleanliness. Materials used in this project that do not conform to this Design Guidelines document or receive written approval for substitution will not be compensated for.

1.4 Acronyms and Abbreviations

1.41 The following acronyms and abbreviations are used in this document:

EPO—Emergency Power Off
MM—Multimode fiber
PDU—Power Distribution Unit
SAN—Storage Area Network
SC—Server Cabinet
SM—Singlemode fiber
UPS—Uninterruptible Power Source

1.5 Cleanup Requirements

1.51 Debris generated during installation and testing of the room's infrastructure systems—power, cooling, data cabling, emergency lights, and fire suppression—must be removed by the corresponding contractor upon conclusion of its work.

1.52 At the conclusion of all construction, the Data Center's raised floor surface and subfloor plenum will be professionally cleaned so that all constructed-related dust and debris are removed.

1.6 Submittal Requirements

1.61 Prior to work beginning in the Data Center, the following are to be submitted to the Project Manager:

- Corning Extended Warranty Provider Certificate for cabling contractor personnel working on the project
- Panduit, Belden Integrity Authorized Installer Certificate for cabling contractor personnel working on the project
- Documentation of the cabling contractor's copper and fiber testing procedures, including referencing procedures for fiber optic testing, testing equipment used (manufacturer and model number), and their most recent date of calibration
- Materials list and pricing
- Name and contact information of any cable assembly manufacturer that will be used to make cabling installed in the Data Center
- Schedule of electrical circuits with outlet identification numbers and cross-connect information

Designer: *The Corning and Panduit certifications called for in the prior list are excellent training programs that cover the proper handling, termination, and testing of fiber and copper cabling, respectively. Requiring these certifications helps ensure that cabling contractor employees possess adequate skills and knowledge to install your structured cabling.*

The value of the submittals requested in Section 1.62 is explained in Chapter 14, "Mapping, Monitoring, and Metrics."

1.62 At the conclusion of the project the following are to be submitted to the Project Manager:

- Electrical as-built drawings of the Data Center and Build Room
- Model numbers, capacity, and runtimes of cooling devices and backup power systems supporting the Data Center
- A videotape of the Functional Performance Test
- Drawings indicating paths of distributed cable runs
- Fiber and copper test results with completed fiber Loss Budget Table
- Tile pullers from the cabling vendor

1.7 Monitoring

1.71 Electrical, standby power, cooling, and fire suppression systems will be connected to a building automation system. This system will be compatible with the monitoring system using in Your Company's Operations Command Center at Address.

1.8 Demonstration and Personnel Instruction

1.81 The corresponding vendors will provide the Project Manager with a videotaped demonstration showing the correct operation of the Data Center's standby electrical, emergency power off, cooling, and fire suppression systems. Included on the video(s) will be a complete review of the posted sequence of operation for each control system.

Designer: *Section 2 specifies many of the physical features of the Data Center— its walls, physical access controls, and flooring. The Data Center is assumed to possess a raised floor—remove these instructions if your room will not. Directions for bolting networking cabinets or racks to the subfloor are included in this section, too, as are specifications for the room's telephones.*

Note that a table lamp icon and a list of figures appear at the top of Section 2. The figure numbers refer to the drawings at the end of this Design Guidelines package that are relevant to this section.

SECTION 2—ROOM INFRASTRUCTURE

The following figures are associated with this section:
FIG. 1—Cabinet Location Plan
FIG. 3—Electrical Location Plan
FIG. 8—Fixed Cabinet Installation Instructions

2.1 Physical Security Guidelines

2.11 The Data Center will have no building exterior doors or exterior windows. If external windows must be present, they will be insulated, furred out, enclosed with drywall board, and then covered with whatever external decorations adorn other building windows, such as vertical blinds.

2.12 All Data Center perimeter walls need to be full height, hard wall construction. The room is to have no windows or transparent walls to an interior corridor.

2.13 All entrances and exits into the Data Center will be covered by digitally recorded closed-circuit television color cameras, monitored by Security.

2.14 Employee entrances will be controlled by a card access control system and equipped with local door alarms that will sound if the door is propped open for an extended period of time. Emergency exit doors are to be alarmed and of solid metal.

2.15 There should be no access through the Data Center to another room not related to the Data Center, such as offices or an electrical room.

Designer: *The clearances in Section 2.2 call for an 18-inch (46-centimeter) raised floor and are assumed to accommodate the height of your Data Center server cabinets and width of a pallet of supplies. Adjust these numbers as needed to reflect the items used in your server environment.*

2.2 Mandatory Clearances

2.21 An unobstructed pathway must exist connecting the Data Center, build room, storage room, and the building exterior. All entrances, corridors, doorways, elevators, and other openings along this path must provide a minimum clearance of 8 feet (2.4 meters) high and 4 feet (1.2 meters) wide.

2.22 There must be at least 10.5 feet (3.2 meters) from the subfloor to the bottom of the false ceiling. This space allows for a raised floor of 18 inches (46 centimeters), 7.5 feet (2.3 meters) tall server cabinets, and an additional 18 inches (46 centimeters) of clearance from the top of those cabinets to the false ceiling.

Designer: The following section on telephones assumes that VoIP (Voice over Internet Protocol) technology is deployed in the Data Center. If not, remove paragraph 2.32.

2.3 Telephones

2.31 Copper: 4 pair UL certified 350 MHz, Cat. 6 cables will be pulled from the telecommunications room to (#) wall phone locations within the Data Center. Cabling will terminate into wall plates mounted 44 inches (112 centimeters) above the surface of the floor. Phones will be installed with cords 25 feet (8 meters) in length.

2.32 (#) of the phones will be connected to the Voice over Internet Protocol (VoIP) phone system. (1) phone must be an analog line independent of the Data Center network enabling it to function in the event of a network outage. The analog line will be near the Data Center entrance, close enough to the Emergency Power Off and fire suppression system buttons so that a person can manipulate these controls and use the phone simultaneously.

Designer: Tables are provided in this template wherever specific infrastructure components are called for in the text. Default descriptions are filled in and additional columns are provided to list part numbers and quantities.

Item	Part #	Quantity
Cat. 6 plenum/low smoke zero halogen cable		
Wall plates		

What country your Data Center is constructed in will determine whether you use plenum-rated or low smoke zero halogen structured cabling.

2.4 Provision and Installation of Cabinets

2.41 The cabling contractor will order and install all networking cabinets (and their power strips) in the Data Center. Server cabinets will be provided after the Data Center comes on line by Your Company's Data Center support staff.

2.42 Networking cabinets will be installed in two sequences—(#) cabinets in the Data Center's main Network Row and (1) cabinet as a Network Substation at the end of each Server Row. Each of these networking cabinets will be aligned onto the edges of the floor tiles directly below it and secured to the cement subfloor by (4) bolts, one at each corner.

2.43 A wire management system will be mounted on the front of all Network Row and Network Substation cabinets. Horizontal wire management will be 2 rack units high—3.5 inches (8.9 centimeters). Vertical wire management will be 8 inches (20 centimeters) or 12 inches (30 centimeters) wide in the Network Row and 6 inches (15 centimeters) or 8 inches (20 centimeters) wide in the Network Substations. Cable troughs will also be installed above the Network Row as needed to route cables.

Designer: *The size and amount of your wire management is driven by how many patch cords must be accommodated, particularly copper cabling. (Fiber patch cords are thinner than copper and therefore have less effect on wire management.) If your Data Center will have only 12 ports of copper cabling to each cabinet location, 6- and 8-inch (15- and 20-centimeter) vertical wire managers are probably fine. If your Data Center has 48 ports to each cabinet location, consider 8- and 12-inch (20- and 30-centimeter) vertical wire management.*

The size of the horizontal wire managers can generally be matched to whatever copper patch panels you use. For example, if the patch panels in your network cabinets house 48 copper ports in 3.5 inches (8.9 centimeters) of space, use 3.5-inch (8.9-centimeter) wire managers to route cables so they can plug in to those jacks.

2.44 Cabinets will be grounded to the building ground.

Item	Part #	Quantity
Cabinet		
Power strip		
3.5-in. (8.9-cm.) Horizontal wire management		
Base and cover		
6/8-in. (15/20-cm.) Vertical wire management		
Base and cover		
8/12-in. (20/30-cm.) Vertical wire management		
Base and cover		
Vertical T fitting wire manager		
Right Angle fitting wire manager		
Waterfall fitting		
Horizontal Cable Management Upper Trough		

2.5 Raised Floor

2.51 The Data Center will have a raised floor with a minimum raised height of 18 inches (46 centimeters), consisting of 2 × 2 feet (61 × 61 centimeters) floor tiles. Vertical stanchions holding the floor up will be anchored to the subfloor with glue and metal anchors.

2.52 There will be (1) entrance ramp, with a 1-in-12 incline—a 1-inch increase in height for every 12 inches in length—or conforming to local regulations. Using the 1-in-12 incline dimensions, the ramp should be 18 feet (549 centimeters) long and feature landings that are 6 feet (183 centimeters) long at both the top and bottom. [6 feet bottom landing + 18 feet ramp + 6 feet top landing = 30 feet/183 centimeters bottom landing + 549 centimeters ramp + 183 centimeters top landing = 915 centimeters]. The ramp and landings should be 6 feet (183 centimeters) wide.

2.53 A handrail will be installed along the ramp per local code. The ramp will be constructed of the same material as the raised floor. It will be covered with slip-resistant treads to enable safe access as well as easy transport of equipment premounted in server cabinets. The ramp must meet the same weight-loading specifications of the raised floor.

Item	Part #	Quantity

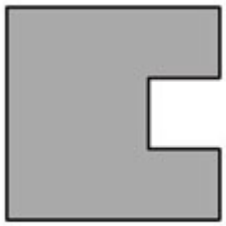
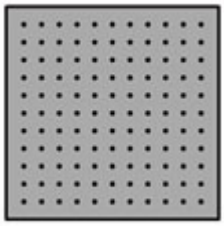
General Purpose Slip-Resistant Tread 4-inch (10-centimeter) strips

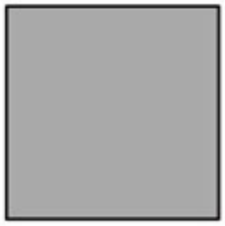
2.54 The Data Center's raised floor, including ramps, and its subfloor must be sufficient to support fully loaded server cabinets weighing at least 2000 pounds (907.2 kilograms).

Designer: *As discussed in Chapter 5, "Overhead or Under-Floor Installation," consider setting the structural capacity of your Data Center at least twenty percent greater than the heaviest item that the room is expected to house. This enables headroom to accommodate greater equipment density in the future.*

Paths to the Data Center must have sufficient structural capacity to support this same amount of weight. This includes corridors, equipment receiving areas, build or storage rooms, and—if the Data Center is above the ground floor—the freight elevator.

2.55 The raised floor will consist of floor tiles that are 2 × 2 feet. (60 × 60 centimeters). The types and number required for this project are:

Image	Type	Tile Location	Quantity
	Cut/Notched Cutout dimensions: 8 × 8 inches (20 × 20 centimeters)	Behind server cabinets and below network cabinets	(#)
	Perforated	In front of all cabinet locations	(#)

	Blank	All other floor locations	(#)

2.56 Perforated tiles will have manual volume dampers. Openings will be lined with molded inserts.

2.57 (#) tile pullers will be provided by the floor tile contractor. Placards for holding tile pullers will be wall mounted by the contractor within the Data Center. Placards will be placed about 5 feet (1.5 meters) above the raised floor, near the inside of each entrance.

2.58 Replaceable tacky mats will be installed atop the raised floor, immediately inside each Data Center entrance.

Item	Part #	Quantities
Pre-Molded Trim for floor panels		
Hand-held tile puller		
Acrylic wall tile-puller holder		
Tacky Mats		

2.6 Floor Sealing for the Subfloor

2.61 The subfloor cement pad will be coated with a static dissipative and nonconductive porous surface sealant designed for high-technology environments.

Designer: Section 3 covers electrical infrastructure within the Data Center. (Standby electrical infrastructure is outlined in Section 4.) As written, the section calls for power to run by way of individual electrical conduits from Power Distribution Units to remote circuit panel boards and then to individual cabinet locations. Adjust this language as needed for the electrical infrastructure you want installed in your Data Center.

SECTION 3—IN-ROOM ELECTRICAL SYSTEM

The following figures are associated with this section:
FIG. 3—Electrical Location Plan
FIG. 5—Under-Floor Power and Cable Detail
FIG. 6—Power and Data Cable Detail
FIG. 7—Under-Floor Labeling Details

3.1 Provision of Power

3.11 Power will be provided from Power Distribution Units (PDUs) and carried to electrical panels installed at one end of each row. (2) panels will be located adjacent to each Network Substation and at one end of the Network Row, positioned back-to-back. Each panel will be fed by a different PDU.

3.12 Power will be distributed from panels by flexible electrical conduits. Provide (2) such whips to each cabinet location, one from each electrical panel. Each whip will be the required distance plus 2 feet (61 centimeters).

Designer: The configuration in paragraphs 3.11 and 3.12 provides power from two separate sources to each Data Center cabinet location, for a degree of redundancy.

3.13 Individual whips will be secured by the electrical contractor to specified support posts in the raised floor framework using hook and loop plenum cable ties.

Designer: Conduits may alternately be routed through a cable tray system. If you wish to use cable tray, alter the language in 3.13 accordingly and include an illustrative drawing among the figures.

3.14 Breakers in the PDUs and electrical panels are to be bolt-in type. Snap-in breakers are not allowed.

3.2 Termination Requirements

3.21 The electrical contractor will provide all necessary tools and materials not specified (tie wraps, screws, consumables, hardware, and so on) and equipment (ladders, lifts, storage containers, and so on) necessary to provide a complete and operating system.

3.22 There will be (#) circuits run to each cabinet location via (#) flexible whips.

3.23 Power will terminate in the following:

Designer: *Sample power configurations are listed below. Choose the correct type and number of receptacles for this project. Common U.S. receptacles are listed first, followed by common European receptacles.*

Receptacle	Circuits per Whip	Amps	Voltage	Whips per Location	Room Total
NEMA 5-20R	2	20	120	2	(#)
NEMA L6-30R	2	30	220	4	(#)
MK Commando BS 4343 (BS EN 60309-2 1992)	1	16/32	220/240	2	(#)

3.3 Grounding

3.31 A signal reference grid will be installed according to IEEE 1100-1999—Grid of Copper Wire. The high frequency signal reference structure will consist of a 2 × 2 feet (60 × 60 centimeters) bare copper, round wire grid.

3.32 The raised floor will be connected to the grounding grid at each pedestal as well as all other under-floor substructures and each PDU and air handler. Each network cabinet will be grounded to the grid with (2) grounding straps or bonding conductor.

3.33 All Network Row and Network Substation cabinets will be grounded to the building ground. Electrical contractor will install ground bar and ground to the building ground.

3.4 Emergency Power Off

3.41 Emergency Power Off (EPO) controls will be located inside any room entrance. The EPO system will shut down all PDUs, air handlers, and convenience outlets at the electrical source that is outside the Data Center.

3.42 EPO controls will be a switch-knob. The controls will be covered with a transparent plastic shell to inhibit accidental activation, and equipped with an audible alarm that will sound, once the shell is removed.

3.5 Labeling and Signage

3.51 Circuits within each electrical panel will be numbered and labeled to match the installed electrical outlets. Panel schedules will include outlet type and cabinet location.

3.52 Receptacles will be labeled with circuit information indicating its location in the source panel.

3.53 EPO buttons will be labeled “Emergency Power Off.” Signage explaining basic EPO function will be installed immediately above the button. A map indicating the EPO’s zone of effect will be posted above the button at eye level.

3.6 Testing

3.61 The following will be performed upon the Data Center electrical system:

1) **Load Bank test**—A field load bank will be conducted on the Uninterruptible Power Source (UPS) batteries and standby generator.

2) **Circuit injection test**—Electrical current will be applied to the breakers at all major distribution points in the electrical system to confirm their trip characteristics.

3) **Functional Performance Test**—Utility source will be shut down to the Data Center to confirm the load will be supported by UPS and then transferred to standby generator. The test will include transferring Data Center load back to utility source. During all stages of the test, measuring devices will be used on random electrical outlets to confirm that voltage levels remain steady.

4) A visual inspection of all monitoring lights, as documented in Section 4, will be conducted during each step of the functional performance test to confirm that they are functioning correctly.

5) A test of the Emergency Power Off system, confirming that all PDUs, air handlers, and convenience units shut down correctly.

3.7 Convenience Outlets

3.71 (#) power outlets will be placed on each Data Center wall, 18 inches (46 centimeters) above the floor's top surface. These outlets will not be connected to the room's backup power system, but will be connected to the EPO system.

3.8 Room Lights

3.81 All room lights are to be connected to the standby power system. Some of these lights will be equipped with battery packs so they can continue functioning until the standby system engages, or in the event that the standby system does not function. These battery-equipped lights should be plentiful enough to enable safe departure of the room or shutdown of servers.

3.82 Life safety components, (exit lights per code, security, and so on) are also to have battery packs installed per codes.

Designer: *Section 4 addresses the standby electrical infrastructure for your Data Center—typically a battery system UPS and a generator. The section also provides direction for the installation of beacon lights within the Data Center to monitor the status of this standby infrastructure.*

SECTION 4—STANDBY POWER SYSTEM

The following figure is associated with this section:
FIG. 3—Electrical Location Plan

4.1 Overview

4.11 The Data Center standby power system will be designed with an Uninterruptible Power Source (UPS), placed in a dedicated location within the site's building, and a standby generator, located outside of the building.

4.12 The system will be configured such that, if utility power to the room fails, the load will be supported by the UPS and transferred to the standby generator.

4.13 The UPS and generator will be sized for N/N + # coverage of the Data Center. The UPS and standby generator will each have a capacity no less than ten percent greater than the maximum possible electrical load in the Data Center.

4.14 When the Data Center is at full load, the UPS must run for a minimum of twenty minutes and the generator must run for a minimum of eight hours without refueling.

4.2 Monitoring Lights

4.21 (#) beacon lights will be installed in key locations inside and outside of the Data Center to monitor the room's standby power system. The lights will be wired in to the standby power system such that they will operate when commercial power to the building is interrupted.

4.22 Lights will be mounted so their domes are 12 inches (30 centimeters) below the Data Center ceiling. A red-domed light will indicate when the UPS is supplying the room with power. A blue-domed light will indicate when the generator is running and supporting the room with power.

Item	Part #	Quantity
Red light		
Blue light		
Red dome		
Blue dome		
Wall-mounting bracket		

4.3 Testing

4.31 Performance of the monitoring lights will be verified during the full system test conducted upon the Data Center In-Room Electrical System. See Section 3.6.

4.32 Monitoring lights must activate immediately upon each start of the UPS or generator. The red light must activate when UPS begins actively supporting the room's power load; the blue light must activate when the generator is running. The red light must shut off when the UPS is no longer supporting the load. The blue light must shut off when the generator is no longer providing power.

Power Status	Red Light	Blue Light
Utility power holding Data Center load	OFF	OFF
Utility power fails	--	--
UPS holding Data Center load	**ON**	OFF
Generator starts	--	--
Generator holding Data Center load	OFF	**ON**
Utility power resumes, generator still on	--	--
UPS takes commercial power	--	--
Utility power holding Data Center load	OFF	OFF

Designer: *Section 5 provides instruction for Data Center cooling infrastructure. The wording is intended to accommodate a server environment with or without hot and cold aisles. (Information about hot and cold aisles is provided in Chapter 8, "Keeping It Cool.")*

Be aware that the Data Center depicted in this template's sample figures does not have hot and cold aisles. Server rows would need to alternate directions. The infrastructure feeding those rows would additionally need to be routed so as to always be on the back side of each server row.

SECTION 5—COOLING SYSTEM

The following figures are associated with this section:
FIG. 1—Cabinet Location Plan
FIG. 2—Floor Tile Location Plan

5.1 Scope of Work

5.11 The Data Center will be designed with N/N+# cooling coverage, including (#) redundant external chillers as well as (#) spare air handlers within the room. The cooling infrastructure must be capable of providing # watts per square foot (# watts per square meter) of cooling.

5.12 The Data Center will be maintained at 68 to 72 degrees Fahrenheit (20 to 23 degrees Celsius) 24 hours a day, 7 days a week. The room will have a constant humidity level of 50 percent, plus or minus 10 percent (40 percent to 60 percent).

5.13 The area below the Data Center's raised floor will serve as the room's plenum.

5.14 Ducting will be installed in the ceiling immediately behind each server row to help draw heated air back to the room's air handlers. This configuration, in conjunction with placing perforated floor tiles in front of each server row, helps to effectively circulate cool air through and around Data Center servers and networking devices.

5.15 Air handlers will be positioned to provide the most effective cooling to the server rows. Install the units close to Data Center walls so as to conserve floor space. Also, provide sufficient buffer areas around each air handler to enable future maintenance access.

5.16 Place only blank floor tiles immediately in front each air handler, so as to avoid short-cycling.

Designer: *Section 6 provides specifications for the Data Center's smoke detection and fire suppression infrastructure. Various types of suppressant are discussed in Chapter 8, "Keeping It Cool."*

SECTION 6—FIRE SUPPRESSION SYSTEM

6.1 Smoke Detection

6.11 The Data Center will be equipped with a continuous air-sampling system that will provide early warning of a fire. System settings must be adjustable to different levels of sensitivity.

6.2 Suppression System Description

6.21 The fire suppression system will provide for total flooding of the Data Center with a gaseous fire suppression agent that is clean, dry, noncorrosive, nondamaging, and nondeteriorating. The choice of substance, traditionally Heptafluorpropane—FM-200 or HFC-227—or Inergen, will be determined and installed in accordance with local regulations.

6.22 The fire suppression system will also provide for particle and air sampling to initiate stages of alarms in preparation for release of the agent.

6.23 Fire suppression system cylinders will preferably be located outside the Data Center in a controlled room. If cylinders are placed in the Data Center, the Project Manager must be contacted prior to installation to discuss their location.

6.24 A sprinkler system will be installed in the Data Center, per local building codes/building control standards and fire codes. This will be a dry-pipe system.

6.3 Labeling and Signage

6.31 Signage explaining fire suppression system functions will be installed adjacent to system controls and alarm components. The following two images are examples of appropriate signage.

6.4 Fire Extinguishers

6.41 Fire extinguishers will be installed within the Data Center, wall-mounted in multiple locations around the room. These handheld extinguishers will be of the appropriate type for a room containing electronic equipment and must meet local building codes/building control standards and fire codes.

Designer: *Section 7 details the Data Center's structured cabling system. This template assumes the use of a distributed cabling design, with a Network Substation at one end of each server row. The principles behind this design are explained in Chapter 7, "Designing a Scalable Network Infrastructure."*

LC fiber connectors are specified throughout this section, although others may be used without any detriment to the design.

SECTION 7—DATA CABLING SYSTEM

The following figures are associated with this section:
FIG. 4—Data Routing Diagram
FIG. 8—Fixed Cabinet Installation Detail
FIG. 9—Network Row Elevation
FIG. 10—DC Network Row to Outside Network Room Connection Detail
FIG. 11—Network Row Fiber Detail
FIG. 12—Network Row Copper Detail
FIG. 13—Network Substations Detail
FIG. 14—Network Substation Fiber Detail
FIG. 15—Network Substation to Network Row Detail
FIG. 16—Network Substation Copper Detail

7.1 Scope of Work

7.11 This Data Center will consist of (#) rows—(1) Network Row and (#) Server Rows.

7.12 Network connections will be provided via copper and fiber structured cabling. This cabling will run in bundles from the Network Row (NR) to a Network Substation (NS) at one end of each Server Row and then from each Network Substation to all server cabinet locations (SC) in that row. Structured cabling will also extend from the Network Row to an external Network Room.

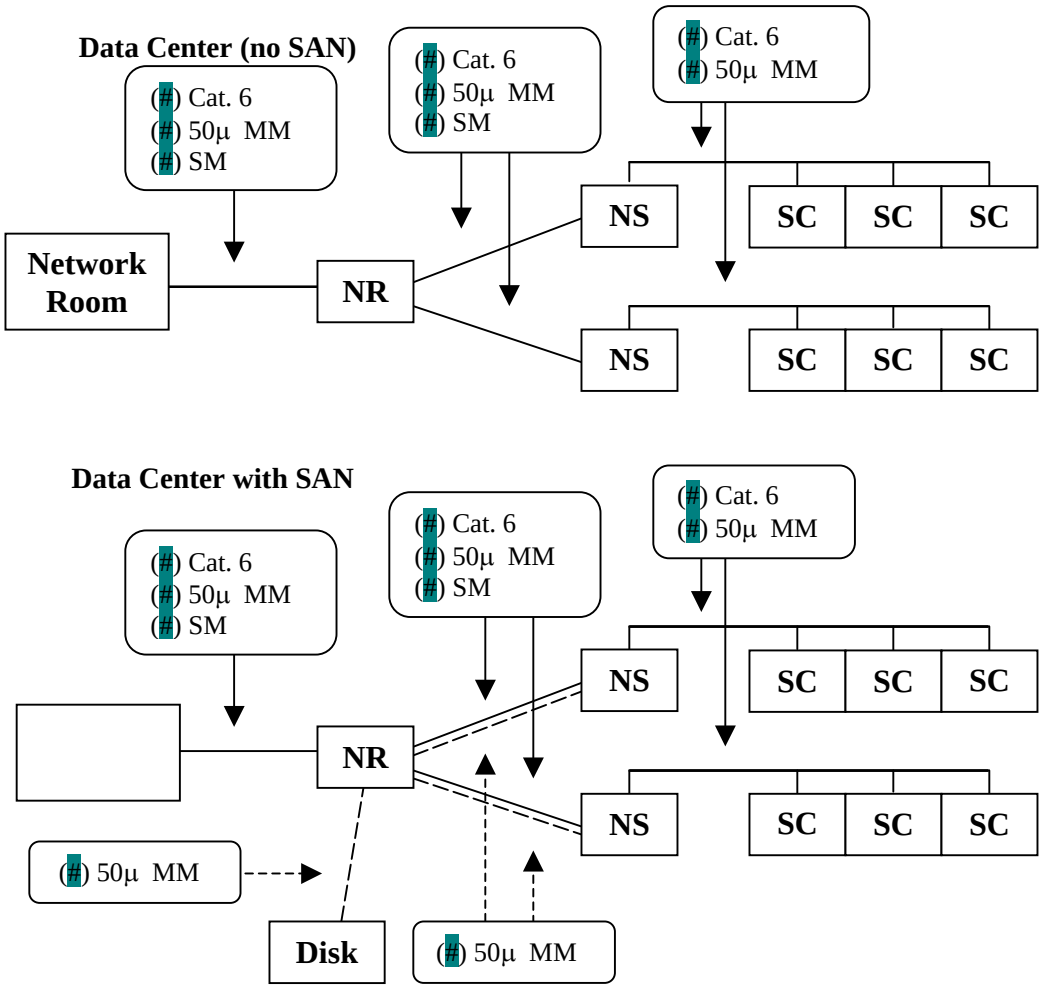
7.13 Cabling between the Network Row and Network Room will be run over the ceiling in cable trays, using waterfall supports when entering or exiting cabinets. All other Data Center cabling will be run below the raised floor.

Designer: *Specify the type of cabling you want installed in your Data Center.*

7.14 All structured cabling for this project will be plenum/low smoke zero halogen rated.

Designer: *The two line drawings that follow illustrate a Data Center with a distributed cabling design—one with a Storage Area Network (SAN) and the other without. Choose whichever is appropriate for your Data Center and fill in desired quantities. (Each drawing has been inserted within a document table. Delete the table row to remove the image. To modify the line drawing, use the drawing toolbar.)*

The cabling hierarchy for this Data Center will be:



Designer: *Dotted lines in the second line drawing highlight SAN connections. This is merely for clarity—there is no physical difference between the structured cabling run for SAN and standard network connections.*

7.15 The scope of work for this project includes all Data Center-related:

- Cabling to cabinet locations and cable-mounting hardware.
- Networking cabinets and wire management.
- Mounting hardware to secure networking cabinets to the cement floor.
- Grounding networking cabinets to the (provided) grounding system.
- Multimedia box cabling, jacks, patch panels, and connecting cables.
- Ladder rack and cable runs, including cable shielding.
- Fire-stop materials as well as splicing and protection materials.

Designer: *For the convenience of your cabling contractor, you may want to provide the specific cabinet locations where structured cabling should terminate. These variable are represented by XXYY. More specific details, down to what ports terminate in which panels, are shown in accompanying Figures 10-16.*

If you want to color code your Data Center, specify colors for all ports and housings that are installed. The template's default language calls for black jacks for connections to network cabinets, white jacks for connections to server cabinet locations, and violet jacks for connections that exit the Data Center. No colors are specified for the housings.

7.2 Network Room to Network Row

7.21

Copper: (#) 4-pair, UL certified, 350 MHz Cat. 6 cables will be pulled from Network Row cabinet XXYY to Network Room cabinet XXYY. Cat. 6 cable will be terminated at both ends in black patch panels containing violet Cat. 6 jacks.

Item	Part #	Quantity
Cat. 6 plenum/low smoke zero halogen cable		
24-port modular patch panel—1U		
Cat. 6 jack (violet)		
6-inch vertical wire manager (front and back)		
8-inch vertical wire manager (front and back)		

7.22

Fiber: (#) 8.3µ SM strands and (#) 50µ MM strands will be run from Network Row cabinet XXYY to Network Room cabinet XXYY, terminating in LC connectors on both ends.

Item	Part #	Quantity
50µ MM cable #-strand plenum/low smoke zero halogen MIC		
8.3µ SM cable #-strand plenum/low smoke zero halogen MIC		
Anaerobic, epoxy polish LC, SM connector		
Anaerobic, epoxy polish LC, 50µ connector		
1.6 crimp ring		
Connector boot for the SM connector		
Connector boot for the MM connector		
#-port LC SM adapter panel for LC connectors		
#-port LC 50µ adapter panel for LC connectors		
Large fiber housing		

7.3 Network Row to Network Substations

7.31 Copper: (#) 4-pair, UL certified, 350 MHz, Cat. 6-rated cables will be pulled from Network Row cabinet XXYY to each Network Substation—cabinets XXYY, XXYY, XXYY, XXYY, XXYY, and XXYY.

7.32 Cat. 6 cable will be terminated at both ends in RJ45 patch panels with black Cat. 6 jacks.

Item	Part #	Quantity
Cat. 6 plenum/low smoke zero halogen cable		
48-port patch panel—1U		
24-port patch panel—1U		
Cat. 6 jack (black)		

7.33 Fiber: (#) 8.3µ SM strands will be pulled from Network Row cabinet XXYY to each Network Substation—cabinets XXYY, XXYY, XXYY, XXYY, XXYY, and XXYY. Cabling will terminate in fiber housings with LC connectors.

7.34 Fiber: (#) 50µ MM strands will be pulled from Network Row cabinet XXYY to each Network Substation—cabinets XXYY, XXYY, XXYY, XXYY, XXYY, and XXYY. Cabling will terminate in fiber housings with LC connectors.

Item	Part #	Quantity
50µ MM cable #-strand plenum/low smoke zero halogen MIC		
8.3µ SM cable #-strand plenum/low smoke zero halogen MIC		
Anaerobic, epoxy polish LC, SM connector		
Anaerobic, epoxy polish LC, 50µ connector		
1.6 crimp ring		
Connector boot for the SM connector		
Connector boot for the MM connector		
#-port LC SM adapter panel for LC connectors		
#-port LC 50µ adapter panel for LC connectors		
Large fiber housing		

Designer: *Section 7.4 calls for structured cabling to terminate in multimedia boxes below server cabinet locations. If you prefer to terminate into patch panels directly into server cabinets, adjust the text and alter the component in the list of materials.*

7.4 Network Substations to Server Cabinet Locations

7.41 Structured cabling will terminate in patching fields within the Network Substations and in multimedia boxes directly below each server cabinet location. Cables will be routed in separate bundles and carefully secured to specific support posts in the raised floor framework, using hook and loop cable ties. Bundles will each measure distance plus 36 inches/1 m. and will not contain more than (12) Cat. 6 cables.

7.42 Copper: (#) 4-pair UL certified 350 MHz, Cat. 6 plenum-rated cables will be pulled from each Network Substation to the copper-designated multimedia box below each server cabinet Location. White Cat. 6 jacks are to be used.

Item	Part #	Quantity
Cat. 6 plenum/low smoke zero halogen cable		
Cat. 6 jack (white)		
48-port patch panel—1U		
Multimedia box		

7.43 Fiber: (#) strands of 50µ MM fiber cables will be pulled from each Network Substation to the fiber-designated multimedia box below each server cabinet location.

Item	Part #	Quantity
50µ MM cable #-strand, plenum/low smoke zero halogen MIC		
Anaerobic, epoxy polish LC, SM connector		
Anaerobic, epoxy polish LC, 50µ connector		
1.6 crimp ring		
Connector boot for the MM connector		
#-port LC 50µ adapter panel for LC connectors		
Large fiber housing		
Multimedia Box		

Designer: *If your Data Center uses a Storage Area Network (SAN), you may or may not need additional fiber structured cabling run to SAN disk frames. The cabling is generally needed when disk frames are placed in a server cabinet location, but unnecessary when the frames are placed in the Network Row and patch cords are used. This subsection is provided in the event that the additional cabling is required.*

7.5 Network Row to SAN Equipment Cabinets

7.51 (#) 50µ MM strands will be run from Network Row cabinet XXYY to SAN disk frames at server cabinet locations XXYY and XXYY, terminating in LC connectors on both ends.

Item	Part #	Quantity
50µ MM cable #-strand, plenum/low smoke zero halogen MIC		
Anaerobic, epoxy polish LC, 50µ connector		
1.6 crimp ring		
Connector boot for the MM connector		
#-port LC 50µ adapter panel for LC connectors		
Large fiber housing		

7.6 Standards

7.61 Reference material to ensure conformity to the Design Guidelines:

- IEEE C2, *National Electric Safety Code* (*NESC*), 2002 Edition
- NFPA 70, *National Electric Code* (*NEC*), 2002 Edition
- Underwriters Laboratories (UL): Applicable listings and ratings
- Underwriters Laboratories (UL) LAN Cable Certification Levels III and IV
- TIA-526-7, *Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant—OFSTP-7* (February 2002)
- TIA-526-14, *Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant—OFSTP-14* (August 1998)
- TIA/EIA-568-B.1, *Commercial Building Telecommunications Cabling Standard Part 1: General Requirements* (May 2001)
- TIA/EIA-568-B.1 addendums 1 through 4:
  - *Addendum 1—Minimum 4-Pair UTP and 4-Pair ScTP Patch Cable Bend Radius* (August 2001)
  - *Addendum 2—Grounding and Bonding Specifications for Screened Balanced Twisted-Pair Horizontal Cabling* (February 2003)
  - *Addendum 3—Supportable Distances and Channel Attenuation for Optical Fiber Applications by Fiber Type* (February 2003)
  - *Addendum 4—Recognition of Category 6 and 850 nm Laser-Optimized 50/125µ Multimode Optical Fiber Cabling* (February 2003)
- TIA/EIA-568-B.2, *Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components* (May 2001)
- TIA/EIA-568-B.2 addendums 1 through 5:
  - *Addendum 1—Transmission Performance Specifications for 4-pair 100Ω Category 6 Cabling* (June 2002)
  - *Addendum 2—Balanced Twisted Pair Cabling Components* (December 2001)
  - *Addendum 3—Additional Considerations for Insertion Loss and Return Loss Pass/Fail Determination* (March 2002)
  - *Addendum 4—Solderless Connection Reliability Requirements for Copper Connecting Hardware* (June 2002)
  - *Addendum 5—Corrections to TIA/EIA-568-B.2* (January 2003)
- TIA/EIA-568-B.3, *Optical Fiber Cabling Components Standard* (April 2000)
- TIA/EIA-568-B.3 addendum 1:
  - *Addendum 1—Additional Transmission Performance Specifications for 50/125 µm Optical Fiber Cables* (April 2002)
- TIA/EIA-569-A, *Commercial Building Standard for Telecommunications Pathways and Spaces* (February 1998)
- TIA/EIA-569-A addendums 1 through 7:
  - *Addendum 1—Surface Raceways* (April 2000)
  - *Addendum 2—Furniture Pathways and Spaces* (April 2000)
  - *Addendum 3—Access Floors* (March 2000)
  - *Addendum 4—Poke-Thru Fittings* (April 2000)
  - *Addendum 5—In Floor Systems* (June 2001)
  - *Addendum 6—Multi-Tenant Pathways and Spaces* (September 2001)
  - *Addendum 7—Cable Trays and Wireways* (December 2001)
- TIA/EIA-598-B, *Optical Fiber Cable Color Coding* (December 2001)

- TIA/EIA-606-A, *Administration Standard for Commercial Telecommunications Infrastructure* (May 2002)
- J-STD-607-A, *Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications* (October 2002)
- National, State and Local building and fire (NFPA) codes
- OSHA Standards

7.62 All backbone fiber cable—from the Network Room to Network Row, Network Row to Network Substations, and Network Substations to server cabinet locations—will have a "flip" in the fiber positioning for each connector.

7.7 Copper Specifications

7.71 Station Data Cable and Backbone Data Cable: (4) unshielded twisted pairs of 24 AWG solid copper conductors. Individually insulated conductors under a common sheath. Cable must be plenum/low smoke zero halogen.

7.72 Cable jacket marking must be legible and include:

1) Copper conductor gauge
2) Pair count
3) UL or ETL and CSA listing
4) Category rating
5) Sequential length markings

Minimum Performance Specifications: EIA/TIA 568B, Cat. 6

7.8 Fiber Specifications

7.81 Fiber-optic cable used within the Data Center must conform to the following. Specifications apply to both MM and SM fiber unless specified otherwise.

7.82 Fiber-optic specifications:

1) Fiber cable (50µ MM): Corning 50/125
2) Fiber cable (SM): Corning 8.3/125
3) Tight buffer—900µ
4) Fiber strength—100 kpsi minimum
5) Color code—industry standard color coded fibers and buffer tubes

7.83 Fiber cable construction specifications:

1) Core—Buffered fibers will be supported in aramid yarn matrix
2) Armor—None
3) Jacket—Plenum
4) Cable listing—UL OFNP

7.84 Cable jacket marking must be legible and include:

1) Manufacturer's name

2) Fiber size (50µ MM)—50/125
3) Fiber size (SM)—8.3/125
4) Sequential length markings

7.85 Minimum Cable Performance

50µ MM
Max. attenuation: 3.5 dB/km @ 850 nm and 1.5 dB/km @ 1300 nm
Typical attenuation: 3.0 dB/km @ 850 nm and 1.0 dB/km @ 1300 nm
Min. bandwidth: 500 MHz-km @ 850 nm and 500 MHz-km @ 1300 nm

SM
Max. attenuation: 1.0 dB/km @ 1310 nm and .75 dB/km @ 1550 nm
Typical attenuation: .5 dB/km @ 1310 nm and .4 dB/km @ 1550 nm

7.9 Execution of Cabling

7.91 The cabling vendor will install all cabling and devices as shown on appended drawings. Work will be done by qualified personnel in a neat, high quality manner and conform to the most stringent of applicable local, state, and national building codes/building control standards.

7.92 Cables will be placed with sufficient bending radius so as not to kink, shear, or damage jackets, binders, or cables, including where cables are coiled for future use or slack. Bending will not exceed manufacturers' specified bend radii. Hook and loop tie wraps will not be pulled so tight as to kink or crimp cable jackets. When left unattended during installation, cabling will be secured and protected so as to avoid damage.

7.93 Contractors will ensure that floor and wall penetrations are returned to their original fire stop rating as required by applicable codes. Sleeves and conduits will be fire stopped to a one-hour fire rating.

7.94 The cabling vendor will individually and properly ground cabinets and other contractor-supplied hardware to Cisco-supplied building grounds. Daisy chaining of equipment ground is not permitted. Grounding will conform to EIA/TIA 607 and NEC articles 250 and 800. NEC Article 800-40 requires minimum #6 AWG or better wire be used for grounding to main building ground.

7.95 Cables will contact only dedicated and properly protected cable accesses and support mechanisms. Cables will maintain proper distances from power and lighting branch circuit conduits and electromagnetic energy sources, including a 5 inches/13 centimeters separation from fluorescent fixtures (per recommended good practices within ANSI-TIA-EIA 569 Section 10).

7.96 Ceiling grid support wires will not be used for cable hangers. Installers will observe applicable requirements and recommended good practices contained within ANSI-TIA-EIA 568A—Telecommunications Standards and Installation Practices For Unshielded Twisted Pair Cabling.

7.97 Cabling will be organized and identified so as to facilitate locating and handling individual sheaths for maintenance.

7.98 Each cable bundle will be neatly tied without overcinching or overstressing, using hook and loop tie wraps. Copper bundles are not to exceed (12) Cat. 6 cables per bundle.

7.10 Labeling

7.101 Cable runs will be labeled <from>/<to> where <from> is the origination cabinet and <to> is the destination cabinet ID (i.e., Row 1 cabinet A = 1A). For example, cabling that runs from the Network Substation at the end of row one to an adjacent cabinet will be labeled 1A/1B.

7.102 Labels will be placed upon the copper patch panels and fiber housings within the Network Row and Network Substations.

7.103 Multimedia boxes will be labeled on their top surface, with the corresponding server cabinet location and what cables are terminating within them.

7.104 Copper ports within the multimedia boxes will be labeled sequentially, 1-12. Each *pair* of fiber strands terminating within multimedia boxes will also be labeled 1-12.

7.11 Copper Testing

7.111 Test results must be permanently recorded and presented in both hard copy and computer-readable format to the Project Manager for review. Any installation failing to meet the above standards will be removed and replaced at no cost to Cisco with an installation that proves through testing to meet the standards. The installation will not be accepted until all terminations meet the appropriate standards.

7.112 For all installed Cat. 6 links, the following parameters will be tested as defined by Section 11.2.4 of TIA/EIA-568-B.1.

1) Wire Map
2) Length
3) Insertion Loss (Attenuation)
4) Pair-to-pair Near-end Cross talk (NEXT)
5) Power Sum Near-end Cross talk (PSNEXT)
6) Pair-to-pair Equal-level Far-end Cross talk (ELFEXT)
7) Power Sum Equal-level Far-End Cross talk (PSELFEXT)
8) Return Loss
9) Propagation Delay
10) Delay Skew

7.113 All testing will be performed on the completely installed system. Any disturbance of a termination after testing will invalidate the certification of that link and require retesting.

7.114 Copper test equipment will be capable of performing permanent link testing, whereby the test leads are not part of the measured system. The type of test performed will be permanent link testing, not basic link testing or channel testing.

7.115 When testing, the nominal velocity of propagation (NVP) must be set for the type of cable being tested per the manufacturer's instructions.

7.12 Copper Performance Requirements

7.121 For each of the parameters listed in items 1 and 2 above, the values measured for each permanent link will be within the limits defined in Section 11.2.4 of TIA/EIA-568-B.1. For items 3 through 10, the TIA/EIA values listed for Cat. 6 will apply.

7.122 Test results are to be reported in this format:

Jobsite: XYZ Data Center in (City, State)

Tester #1: (Person Testing) Tester #2: (Person Testing)

Tester Model: (Model #) Tester Model: (Model #)

PORT #	From	To	Pass or Fail

7.13 Fiber Testing

7.131 Test results must be permanently recorded and presented in both hard copy and computer-readable format to the Project Manager for review. Any installation failing to meet the above standards will be removed and replaced at no cost to Your Company with an installation that proves through testing to meet the standards. The installation will not be accepted until all pairs meet the appropriate standards.

7.132 All fiber optic cables will be tested as follows:

1) Using an optical power meter, measure end-to-end attenuation for all installed cables, including all splices, the terminated fiber itself, all connectors, and patch panels. Total loss will be measured and reported for each cable at the appropriate operating wavelengths. MM—850 and 1300 nm; SM—1310 and 1550 nm.

2) Optical attenuation measurements are to be done in one direction, end-to-end (Main Data Center panels to Building Equipment Room panels and Building Equipment Room panels to Voice/Data Room panels or Special Equipment Room panels). Maximum permissible loss on each cable must be less than 3.5dB/km for MM and 1.0dB/km for SM. Losses through any mated connector

pair are not to exceed .75 dB. Losses through any fusion splice, if required, will not exceed .05 dB.

It is recommended the cabling contractor test the quality of each cable while still on the reel, prior to installation, to verify that no damage occurred during shipment..

3) Per above, each fiber link will have a maximum allowable loss budget, which can be determined through completion of a loss budget table. The contractor is required to fill out a table, as below, and submit prior to testing.

Fiber Link	Connector Loss by Mated Pair (dB)	Number of Mated Pairs	Loss of all Mated Pairs (dB)	Total Loss of Cable Length (dB)	Total Budgeted Loss Per Link (dB)
		x	=	+	=
Network Room to Network Row	.75	2	1.50	< .50	2.00
Network Row to Substation	.75	2	1.50	< .50	2.00
Substation to Server Cabinet	.75	2	1.50	< .50	2.00
Network Row to SAN Disk Frame	.75	2	1.50	< .50	2.00

7.133 Losses for all fiber runs may not exceed 2.00 dB. All testing will be performed on the completely installed system. Any disturbance of a termination after testing will invalidate certification of that link and require retesting.

7.134 Fiber test equipment must meet or exceed TIA/EIA-526-14A Section 3 requirements. For test jumpers, only factory produced cable assemblies manufactured by Corning Cable Systems will be used.

7.135 Fiber Optic Testing Procedure

1) If a single light source and a single power meter are used and if the equipment has only one fiber transceiver (i.e., ST or SC), the contractor will follow the procedure in the latest revision (at this writing, Revision 3, dated September 2000) of Corning Cable Systems Applications Engineering Note (AEN) 62.

2) If multiple light sources and multiple power meters are used but each has only one fiber transceiver (i.e., ST or SC), the contractor will follow the procedure in the latest revision (at this writing, Revision 3, dated September 2000) of Corning Cable Systems AEN 63.

Specific details of the Corning Cable Systems Applications Notes cited above will supercede the related details of TIA/EIA-568-B.1, TIA/EIA-526-14A and other specifications.

7.136 The reference must be reestablished whenever any of the following conditions apply:

- Power to the tester has been interrupted.
- The test jumper has been disconnected for any reason at the equipment interface of the light source.
- Test jumpers anywhere in the setup have been replaced.

7.137 Record all optical power measurements to the nearest tenth of a unit of measure (to one significant digit in the decimal place, i.e., -14.3 dB) and report results in this format:

Jobsite: XYZ Data Center in (City, State)

Tester #1: (Person Testing) Tester #2: (Person Testing)

Tester Model: Model # of Tester Tester Model: Model # of Tester

Ref # TX Loc (Location) RX Loc (Location)

		Panel A		Panel B	
PORT #	Fiber #	850nm	1300nm	850nm	1300nm
1	1				
	2				
2	3				
	4				
3	5				
	6				

		Panel A		Panel B	
PORT #	Fiber #	1310nm	1500nm	1310nm	1500nm
1	1				
	2				
2	3				
	4				
3	5				
	6				

7.138 The contractor is required to provide documentation of their copper and fiber testing procedures, including referencing procedures for fiber optic testing, prior to testing. This document must list equipment to be used (manufacturer and model number) and the date when it was last calibrated.

7.139 All test equipment used will have been factory calibrated (or by an approved calibration service provider) within the past two years.

7.14 Certification Requirements

7.141 The contractor's technicians installing the data cabling are required to have completed certification classes to install and test the copper and fiber systems specified in this document. Contractors are required to provide certificates of the technicians working on the project, showing completion of Corning's EWP training and Panduit's Integrity Authorized Installer training.

Designer: The drawings that follow are sample details useful for illustrating a Data Center design.

*Figure 1—**Cabinet Location Plan**—This depicts a Data Center's overall layout. The drawing is useful for showing spacing and orientation of server rows and major infrastructure.*

*Figure 2—**Floor Tile Location Plan**—The raised floor grid, including floor tile cutout dimensions and the placement of perforated tiles.*

*Figure 3—**Electrical Location Plan**—The types and locations of all electrical infrastructure within the Data Center. Five examples of electrical receptacles are listed in the symbol key.*

*Figure 4—**Data Routing Diagram**—Paths for structured cabling. This illustration not only conveys the distributed cabling hierarchy concept, but can also guide vendors so that cabling doesn't criss-cross and risk tangling.*

*Figure 5—**Under-Floor Power and Cable Detail**—This detail shows the placement of infrastructure under each server row, including routing data cabling and electrical conduits along separate but parallel paths.*

*Figure 6—**Power and Data Cable Detail**—Similar to FIG. 5, with a top-down viewpoint.*

*Figure 7—**Under-Floor Labeling Details**—Labeling examples for electrical receptacles and multimedia boxes where structured cabling terminates under the raised floor. This illustration helps ensure that the cabling vendor labels this infrastructure correctly and consistently.*

*Figure 8—**Fixed Cabinet Installation Detail**—Instructions for installing network cabinets.*

*Figure 9—**Network Row Elevation**—This shows where various cabling media, network devices, and wire management are to be placed in the Data Center Network Row.*

*Figure 10—**DC Network Row to Outside Network Room Connection Detail**—Explanation of labeling and representations of specific components.*

*Figure 11—**Network Row Fiber Detail**—Sample labeling and illustration of specific components within the Network Row's fiber housings.*

*Figure 12—**Network Row Copper Detail**—Sample labeling and illustration of specific components within the Network Row's copper patch fields.*

*Figure 13—**Network Substations Detail**—A front-view of a network substation, showing the relative locations of infrastructure, wire management, and networking devices.*

*Figure 14—**Network Substation Fiber Detail**—This detail shows specifically where to terminate fiber components within a network substation. Part numbers and sample labeling are shown.*

*Figure 15—**Network Substation To Network Row Detail**—An illustration of the connections between the key networking locations in the Data Center.*

*Figure 16—**Network Substation Copper Detail**—This detail shows specifically where to terminate copper components within a network substation. Part numbers and sample labeling are shown.*