DECconnect SYSTEM

DECconnect™ System

Fiber Optic Installation

May 1990

This guide provides all of the steps, procedures, and guidelines needed by experienced fiber optic installers for installing the DECconnect System's fiber optic cable and cable plant hardware.

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Safety ⚠

The following warnings and cautions for fiber optic installation are listed below with their translations in German and French. Warnings and cautions are listed by page number.

WARNING ⚠ (page xvii)	Safety glasses must be worn at all times when performing installation, certification, maintenance, or repairs.
VORSICHT	Tragen Sie immer eine Schutzbrille, wenn Sie eine der folgenden Tätigkeiten ausführen: Installation, Testen, Wartung oder Reparaturarbeiten.
DANGER	Toujours porter des lunettes de sécurité lors des opérations d'installation, de certification, d'entretien ou de réparations.

WARNING ⚠ (inside front cover, page xviii)	Only personnel trained to work with fiber optics or lasers shall perform installation, certification, maintenance, or repairs.
VORSICH	Personen ohne entsprechende Ausbildung dürfen faseroptische Geräte oder Laser nicht installieren, testen, warten oder reparieren.
DANGER:	Les opérations d'installation, de certification et d'entretien doivent impérativement être effectuées par des techniciens qualifiés.

WARNING ⚠ (inside front cover, page 7–1)	Never look into a fiber optic cable or connector port because the light emitted by the source may cause eye damage. Always assume that the cable is connected to a light source.
VORSICHT	Schauen Sie niemals direkt in ein Glasfaserkabel oder einen Glasfaseranschluß, da Laserstrahlen Augenverletzungen verursachen können. Behandeln Sie ein Glasfaserkabel immer so, als wäre es an eine Laser-Lichtquelle angeschlossen.

DANGER	Ne vous avisez jamais de regarder par l'extrémité d'un câble de fibre optique ou dans l'ouverture d'un connecteur. La lumière laser peut provoquer d'importantes lésions oculaires. Considérez toujours que le câble est relié à une source lumineuse.

WARNING⚠ (page 4–7)	The epoxy adhesive is a skin and eye irritant. Use safety glasses at all times and wear appropriate gloves to prevent skin contact.
VORSICHT	Achten Sie darauf, daß der Epoxykleber nicht in die Augen oder an die Haut gelangt. Tragen Sie bei der Arbeit mit Epoxykleber immer eine Schutzbrille und Arbeitshandschuhe, da ansonsten Augen — oder Hautreizungen auftretenkönnen.
DANGER	L'adhésif époxy peut provoquer des irritations de la peau et des yeux. Afin d'évitertout contact accidentel, porter des gants et des lunettes de protection adaptés.

WARNING⚠ (page 4–7, 4–8)	Always wear safety glasses and follow safety procedures when splicing or terminating fibers with connectors. The cleaved glass fiber can penetrate the skin or become embedded in the eye.
VORSICHT	Wenn Sie mit Glasfaserkabeln arbeiten, müssen Sie immer eine Schutzbrille und Handschuhe tragen: absplitternde Faserteile können die Hornhaut des Auges verletzen oder durch die Haut in das Gewebe eindringen.
DANGER	Toujours porter des lunettes de protection lors des opérations d'épissage du câble optique et de montage des connecteurs, afin d'éviter tout risque de pénétration de fragments de fibre de verre dans l'épiderme ou les globes oculaires.

WARNING⚠ (page 4–8)	The coupling gel is a minor eye irritant. Use safety glasses at all times to prevent contact with the eyes.
VORSICHT	Das Verbindungsgel kann die Augen nur leicht reizen. Um zu vermeiden, daß das Gel in die Augen gelangt, sollten Sie trotzdem immer eine Schutzbrille tragen.
DANGER	Le gel de couplage peut provoquer de petites irritations de la peau et des yeux. Afin d'éviter tout contact accidentel, porter des lunettes de protection adaptées.

WARNING⚠ (page 4–7)	Non-connected optical connectors may emit radiation if the far end is coupled with a working laser or LED (light emitting diode). Do not view the fiber or connector with an optical instrument until there is absolute verification that the fiber is disconnected from the laser or LED source and will remain so until the activity is complete.

VORSICHT	Wenn das entfernte Ende eines Glasfaserkabels mit einem aktiven Laser oder einer LED vebunden ist, kann am freien Ende Strahlung austreten. Untersuchen Sie ein Glasfaserkabel oder einen Glasfaseranschluß nicht mit einem optischen Instrument, solange nicht absolut sicher ist, daß das Kabel vom Laser oder der LED getrennt worden ist. Stellen Sie sicher, daß der Laser oder die LED erst wieder angeschlossen wird, wenn die Untersuchung abgeschlossen ist.
DANGER	Les connecteurs optiques sont susceptibles d'émettre des rayonnements dangereux pour les yeux, notamment lorsque l'autre extrémité du câble est raccordée à un laser ou à une diode électro-luminescente en fonctionnement. Avant tout examen optique du câble ou d'un connecteur, s'assurer que celui-ci est absolument déconnecté de toute source lumineuse et le restera pendant toute la durée de l'opération.

WARNING⚠ (page 7–14)	Do not look into a fiber optic connector or cable end while the cable is connected to an OTDR. Follow safety procedures recommended by the OTDR manufacturer.
VORSICHT	Sehen Sie niemals in einen Glasfaseranschluß oder ein Glasfaserkabel, wenn dieses an ein OTDR-Gerät angeschlossen ist. Beachten Sie die Sicherheitsvorschriften des Herstellers!
DANGER	Ne vous avisez jamais de regarder dans l'ouverture d'un connecteur ou d'un câblede fibre optique pendant que celui-ci est connecté à un OTDR. Respectez les mesures de sécurités indiquées par le fabricant de l'OTDR.

CAUTION⚠ (inside front cover)	The people who install the cabling system described in this guide should be familiar with local building codes, fire codes, and any other applicable codes or regulations. The manufacturers or their distributors and agents will not be responsible for damage due to improperly installed cabling, neglect, misuse, or improper connection of devices to the cabling system.
ACHTUNG	Die Personen, die die in diesem Handbuch beschriebene Verkabelung installieren, sollten mit den lokalen Bau-und Brandschutzvorschriften vertraut sein. Hersteller undVertriebspersonal übernehmen keine Haftung für unsachgemäßeoder nachlässige Installation, Mißbrauch sowie unsachgemäßen Anschlußder Geräte.
ATTENTION	Les personnes travaillant à l'installation des produits décrits dans ce guide doivent connaître les codes en usage dans les immeubles et en protection incendie, ou toutes autres codifications ou régulations applicables. Les constructeurs, ou leurs distributeurs ou agents, déclinent toute responsabilité concernant les éventuelles dommages dûs à la négligence, à des conditions d'installation et d'utilisation inadéquates ou à la connexion inappropriée de périphériques.

CAUTION⚠ (page 3–17)	Care must be used when installing cable ties because they can shatter the fibers within the cable if the ties are too tight. To avoid damaging the fibers, make sure you do not constrict the cable jacket when securing the cable tie.
ACHTUNG	Bei Verwendung von Kabelmanschetten ist darauf zu achten, daß diese nicht zu fest angezogenwerden, da ansonsten die Fasern im Kabel beschädigt werden können. Wenn Sie eine Kabelmanschette anbringen, müssen Sie darauf achten, daß die Kabelhülle nicht gequetscht wird.
ATTENTION	Veillez à serrer modérément les fixations des câbles. Tout excès peut entraîner la dégradationdes fibres à l'intérieur du câble. Assurez–vous que la fixation ne provoque pas l'étranglement de l'enveloppe ducâble.

CAUTION⚠ (page 3–21)	When pulling cable never allow the peak tension to exceed the recommended pulling tension.
ACHTUNG	Wenn Sie ein optisches Kabel verlegen, müssen Sie darauf achten, daß die empfohlene Zugspannung nicht überschritten wird.
ATTENTION	Lorsque vous tirez les câbles, assurez–vous que la tension maximale appliquée au câble n'excède à aucun moment la valeur recommandée.

CAUTION⚠ (page 3–23)	When pulling cable through conduit, be careful not to exceed the minimum bend radius of the cable.
ACHTUNG	Wenn Sie Kabel in Rohrleitungen verlegen, sollten Sie darauf achten, daß der minimale Biegungsradius nicht überschritten wird.
ATTENTION	Lorsque vous tirez les câbles dans des canalisations, assurez–vous que le rayon de courbure ne soit pas en dessous de la valeur minimale.

CAUTION⚠ (page 7–4)	Take care not to bend the launch cable beyond its minimum bend radius of 12.7 centimeters (5 inches).
ACHTUNG	Der minimale Biegungsradius von 12,7 cm des ersten Kabels darf nicht überschrittenwerden.
ATTENTION	Veillez à ne pas courber le guide au dessous de son rayon minimal de courbure de 12,7 cm.

Preface

The *DECconnect System Fiber Optic Installation* guide contains guidelines for installing fiber optic cables and passive equipment in a DECconnect System fiber optic structured wiring cable plant, and test procedures used to certify the installation.

This guide assumes the ducts, raceways, trays, and underfloor cellular systems are in place. If not, see the project manager to find out when the site will be ready for installing cables.

This document presents installation guidelines that seek to meet international requirements wherever possible. However, most countries regulate construction via building and electrical codes that are strictly enforced by local agencies. When planning new construction, expansion, or renovation, it is important to understand and implement all regulations imposed by these local codes.

Although this document makes reference to certain codes such as the National Electrical Code (NEC) which has been adopted by jurisdictions across the United States, it is beyond the scope of this guide to address specific local codes in detail. It remains the responsibility of the designer and installer to ensure conformance to local building and electrical codes.

Intended Audience

This guide is for fiber optic network installers with experience in cabling campuses and buildings for computer and communications networks, as well as experience with installing network hardware. The installers must be familiar with local, state, and national building, fire, safety, and electrical codes and must know how those codes affect the installation of fiber optic cabling.

WARNING ⚠

Safety glasses must be worn at all times when performing installation, certification, maintenance, or repairs.

WARNING ⚠

Only personnel trained to work with fiber optics or lasers shall perform installation, certification, maintenance, or repairs.

Structure of This Guide

This document has seven chapters and two appendices, as follows:

Chapter 1	Provides an overview of the system site and its cabling requirements.
Chapter 2	Details a preinstallation review.
Chapter 3	Provides guidelines on how to install fiber optic cable.
Chapter 4	Provides guidelines on how to install passive equipment.
Chapter 5	Describes installing passive equipment, active and passive equipment, and cable management.
Chapter 6	Provides guidelines for installing modular office wallboxes.
Chapter 7	Describes verification of the facilities cable plant installation.
Appendix A	Contains a listing of applicable codes and standards.
Appendix B	Describes core blocking, unit splitter installation and buffering.

The postage–paid **Reader's Comments** form on the last page of this document requests the user's critical evaluation to assist us in preparing future documentation.

Associated Documents

- *DECconnect System Fiber Optic Planning and Configuration* (EK–DECSY–FP)

  Provides an overview of Digital's structured wiring network as well as guidelines for planning, configuring, and designing fiber optic subsystems within the structured wiring network.

- *DECconnect System Requirements Evaluation Workbook* (EK–DECSY–EG)

  Describes how to evaluate network requirements prior to planning a DECconnect System network.

- *AT&T Premises Distribution System Fiber Installation Manual* (555–401–102)
- *LST1U–072/7 Lightguide Termination Shelf Installation* AT&T (636–299–103–5)
- *LSC1U–024/5 Lightguide Combination Shelf Installation* AT&T (636–299–103–6)

- *LSS1U–072/5 Lightguide Splice Shelf Installation* AT&T (636–299–103–11)
- *LSJ1U–072/5 Lightguide Storage Shelf Installation* AT&T (636–299–103–14)
- *LT1A Splice Organizer Installation* AT&T (636–299–103–15)

CHAPTER 1

1

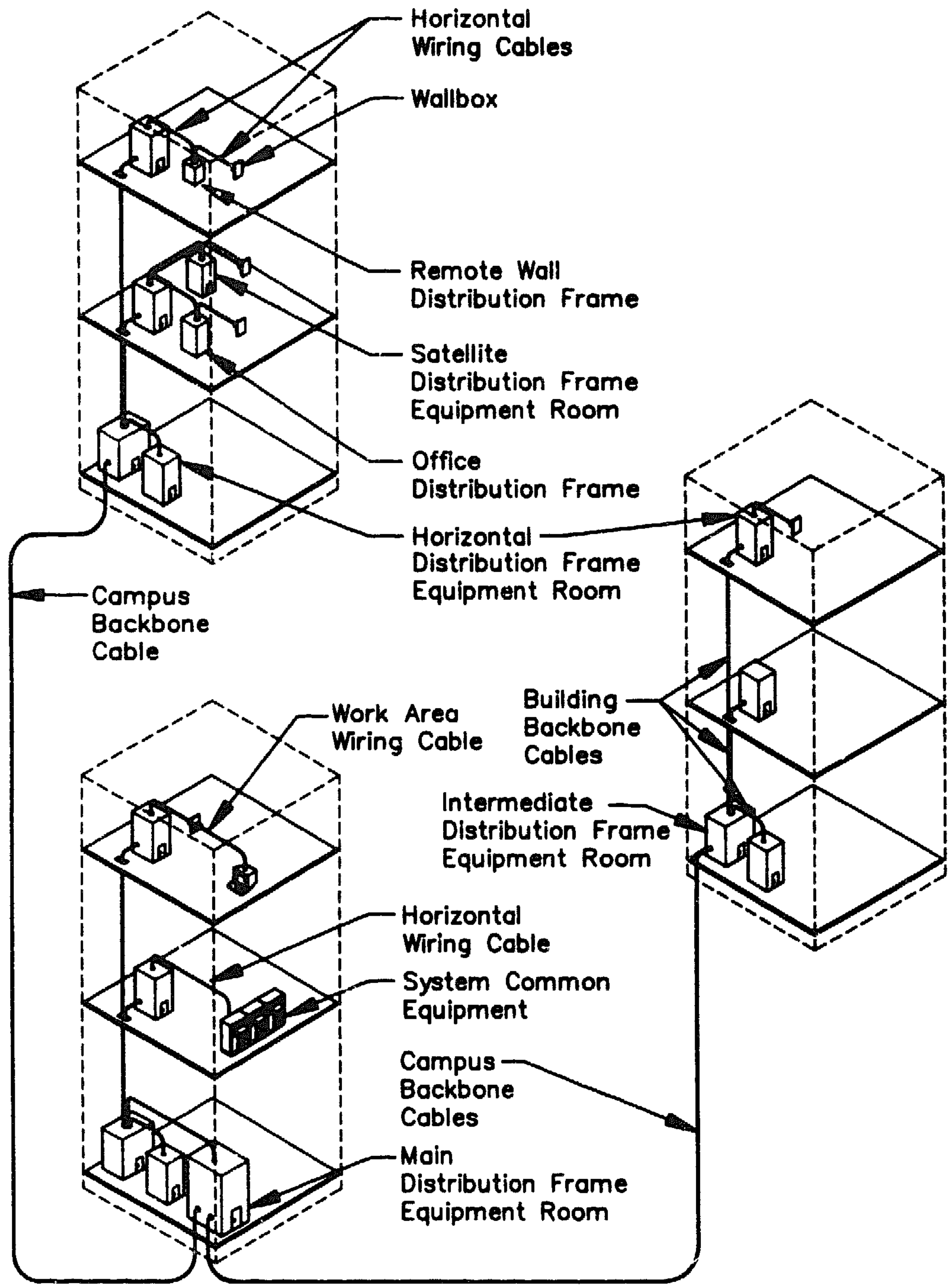
General Description

1.1 Introduction

The DECconnect System fiber optic structured wiring is made up of the following functional elements (see Figure 1–1) as described in the *DECconnect System Fiber Optic Planning and Configuration* guide:

- Campus Backbone Distribution — connects buildings in a multibuilding environment.
- Building Backbone Distribution — provides cable routes in a building.
- Horizontal Wiring Distribution — connects the backbone distribution and the work area. Horizontal wiring is always located on one floor and terminates at the modular office wallbox.
- Work Area Wiring Distribution — completes the connection between the modular office wallbox and the user's active equipment.
- Administrative Subsystem — the hardware and documentation involved in connecting the subsystems and managing those links.

Figure 1–1: A DECconnect System Fiber Optic Structured Wiring Site



Installation of fiber optic structured wiring begins with planning. For structured wiring spanning large geographical distances, installation planning entails dividing the wiring into easily-handled individual sites. At each site, the installation planning is performed by, or in conjunction with, a network installation specialist. This specialist may be an in-house employee, an independent contractor, or a Digital Equipment Corporation representative.

Installation planning consists of the following steps:

1. Studying the DECconnect System fiber optic structured wiring facilities cabling installation plan. This plan includes:
   - A site diagram
   - Network floor plans for individual buildings
   - Concept diagrams
   - A network schematic
   - Worksheets
   - Distribution frame layout diagram
   - A bill of materials (BOM) and ordering information for the DECconnect System fiber optic structured wiring system components
   - Architectural, structural, mechanical, electrical, site and HVAC drawings for each building
   - Local building and wiring codes
2. Hiring licensed contractors who are familiar with local regulations to do the physical installation.
3. Defining an installation schedule based on the construction schedule, including:
   - A schedule for all structural, electrical, mechanical, and environmental design specifications
   - A schedule for all building modifications
   - A schedule for network hardware installation and verification
4. Ensuring all ordered materials are on site, or that they will be delivered prior to installation.

5. Obtaining a copy of the following documents and reviewing them for building installation procedures:

   - *BICSI Telecommunications Distribution Methods Manual*
     The Building Industry Consulting Service International, Inc. (BICSI)
     TESTMARK Laboratories
     Publications Department
     3050 Harrodsburg Road
     Lexington, KY 40503
     (606) 223-3061

   - *National Electrical Code (NEC)*
     The National Fire Protection Association (NFPA)
     1 Batterymarch Park
     Quincy, MA 02269
     1-800-344-3555

Once the installation planning is complete, the installation team must coordinate the physical installation and must ensure the proper installation of all cable and DECconnect System fiber optic structured wiring components.

1.2 The Installation Team

The installation team consists of the following:

- The project manager (the installation coordinator)
- The network designer
- The telecommunications contractor
- A computer field service organization
- The network manager

1.2.1 The Project Manager

The project manager monitors and manages the entire installation. This includes:

- Day-to-day management of the installation
- Ensuring that permits have been applied for
- Inspection of each task as it is completed
- Final inspection of the finished installation

The project manager is the primary interface between the network designers, network installers, and the network manager.

1.2.2 The Network Designer

The network designer designs the entire network. This includes:

- Creating the network schematic
- Designing the network floor plan
- Developing the bill of materials (BOM)

The network designer is available as a consultant in the event of any changes or questions.

1.2.3 The Telecommunications Contractor

This contractor installs most of the DECconnect System fiber optic structured wiring system and has experience in installing fiber optic cables and connectors. In a DECconnect System fiber optic structured wiring installation, the telecommunications contractor oversees:

- Installing the fiber optic cables
- Installing the passive equipment and mounting the active equipment
- Installing the wallboxes

The telecommunications contractor is responsible for all of the installation procedures given in this guide, including installing lag bolt anchors for equipment room racks.

A specialized subcontractor may be hired to install the fiber connectors.

1.2.4 The Field Service Organization

This organization installs active equipment, verifies the cable plant, and activates components associated with DECconnect System fiber optic structured wiring. This organization has experience in network and computer installations.

1.2.5 The Network Manager

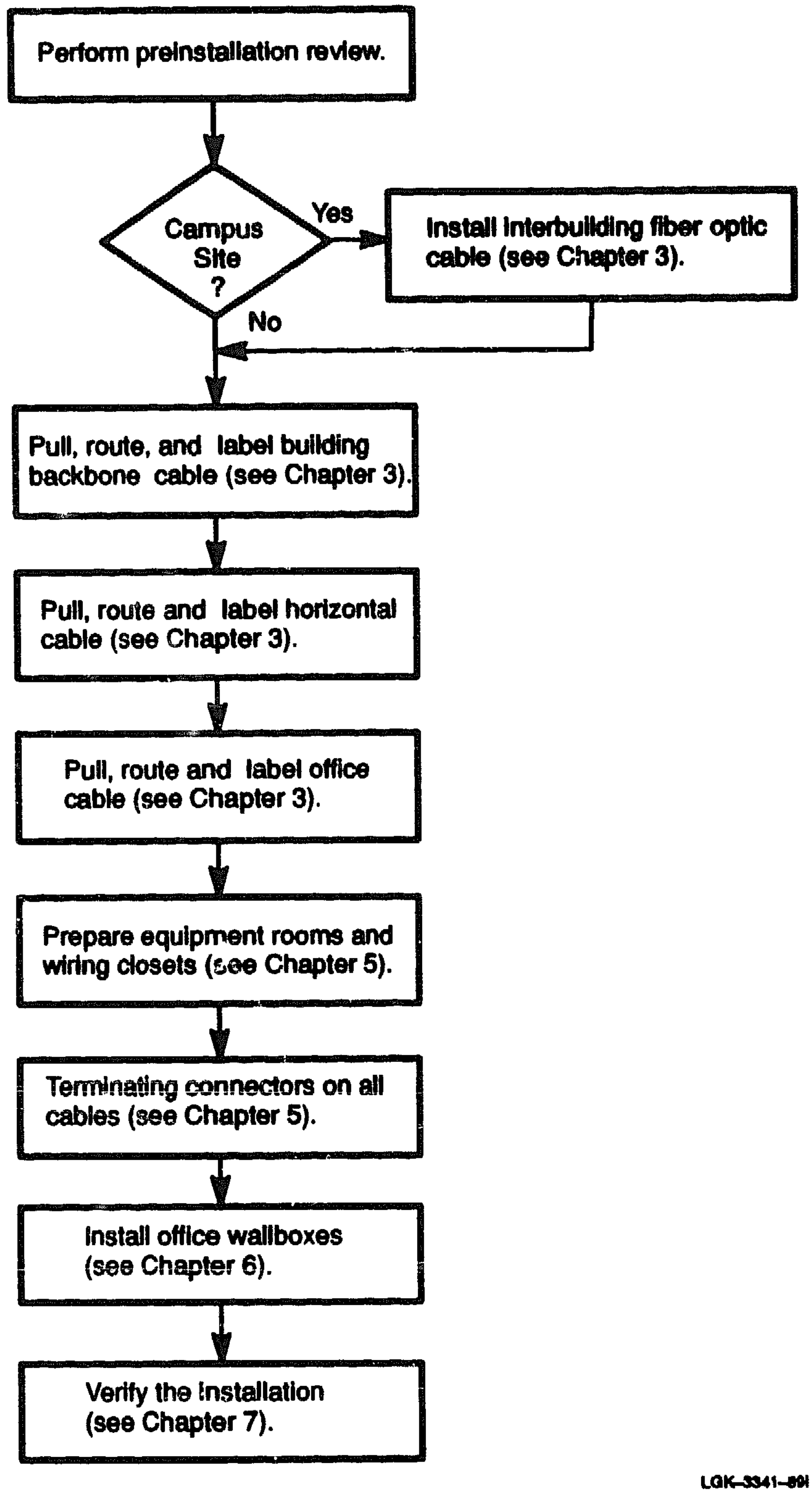
The network manager accepts the finished DECconnect System fiber optic structured wiring installation from the project manager. Once this is done, the network manager assumes day-to-day control of the network operations.

1.3 DECconnect System Structured Wiring Installation Overview

For the purposes of this guide, the facilities cabling installation process consists of the following steps, which are shown in Figure 1–2:

1. Prior to installation, everyone involved must review the entire process. This includes reviewing the installation plan and the responsibilities of each party, and touring the entire site.
2. Installing any campus backbone distribution cable by aerial, underground or buried installation methods.
3. Pulling, routing, and labeling the building backbone distribution cable throughout each building.
4. Pulling, routing, and labeling the horizontal distribution cable through each floor
5. Preparing any equipment rooms or wiring closets by installing support structures for cable routing and active and passive equipment.
6. Terminating connectors onto fibers at equipment rooms and installing equipment.
7. Installing the modular office wallbox in the work area and terminating the horizontal distribution cable.
8. Verifying complete and proper installation of the entire DECconnect System fiber optic structured wiring system facilities cabling, and reviewing all installation documents for completeness and accuracy. The project manager and the network manager jointly perform the verification.

Figure 1–2: The Installation Process



1.4 Safety Considerations

It is important to understand the safety considerations and requirements of fiber optics and lasers. Training is the key to resolving this issue. Warnings and cautions appear in the Safety Warnings section, at the beginning of this manual, with translations in German and French. The warnings and cautions are not intended to replace formal training in the area of fiber optics.

In addition to the safety warnings and cautions, people who install fiber optic products should be aware of the following precautions when handling fiber optic cable assemblies.

NOTE

Keep all surfaces clean. To avoid damaging the fiber optic cable, never touch the exposed fiber ends with your hands. Even invisible contaminants can severely reduce system performance, especially at connectors. Always use liberal amounts of pure alcohol with cotton swabs and clean, compressed air.

Always maintain minimum bend radius. The fiber in fiber optic cables can suffer damage if the cables are bent too sharply. There is a minimum radius that must be maintained. It is usually 10 to 20 times the cable outside diameter, depending on whether the cable is under a tensile load.

Do not exceed maximum pull tensions. Like any cable, fiber optic cables have maximum pull tensions that can not be exceeded. These tensions or loads range from a few pounds to several hundred pounds, depending on the type and application of the cable.

1.5 Generating Fiber Optic Cable Management Documentation

An integral part of every facilities cabling installation is generating cable management documentation, including:

- Attaching labels to the individual cables as they are installed.
- Recording the results of the individual procedures used to install, test, and verify each cable on a report form.
- Recording reports in the log book (refer to Section 3.4.1).
- Recording any deviations to the installation plan in the as-built documentation (refer to Section 3.5).

- Gathering and including into the system installation log all warrantees, invoices, certification reports, etc.

These documents are generated at each step in the installation and must be checked for accuracy and completeness by the project manager during the installation acceptance. The system installation log, a combination of the installation documents and all network planning documents, is used to define a baseline for modifying or adding to the network. The documents also help network troubleshooters trace data paths and locate possible fault sources.

After installation acceptance, the system installation log is given to the network manager as a permanent record of the network installation.

1.6 Fiber Optic Structured Wiring Connections and Labeling

The telecommunications contractor obtains copies of the following from the project manager:

- Distribution Subsystem connection worksheets
- Splice description worksheets
- Identifier worksheets
- Connection label maps
- Crossconnect/interconnect maps

The Distribution Subsystem connection worksheets provide the installer information on connecting the fiber cables to the patch panels at each subsystem. Splice description worksheets provide information on splicing cables at splice closures for campus backbone cables, and splice shelves at the distribution frames. Identifier worksheets identify the connections and the cable labels for each wallbox, termination shelf, combination shelf, backbone cable, and horizontal wiring. Connection label maps contain relevant information on labeling the patch panel. Crossconnect/interconnect maps contain information on connecting the patch cables. The worksheets and maps were generated by the network designer from the *DECconnect System Planning and Configuration* guide.

During the installation process, the telecommunications contractor:

- Uses the Distribution Subsystem connection worksheet to connect all fiber cables at each patch panel (termination and combination shelves).
- Uses the indentifier worksheets to connect fibers to the wallbox and the horizontal wiring subsystem patch panels.
- Uses the splice description worksheets to splice the identified fibers together.

- Uses the identifier worksheets to create the cable labels.
- Uses the connection label maps to create the patch panel labels.
- Uses the crossconnect/interconnect maps to connect the patch cables at each patch panel and to connect the active equipment to the patch panel.

Two basic cabling methods within the horizontal wiring distribution are shown in Figure 1–3 and Figure 1–4; cabling from the office distribution frame to the horizontal distribution frame, and cabling from the office to the remote wall enclosure distribution frame to the equipment room. The cable labeling scheme carries through the complete DECconnect System fiber optic structured wiring installation. These figures identify how the labeling scheme includes all cables, active devices, passive devices, and wall-boxes, as follows:

- Wallbox labels
- Cable labels
- Passive patch panel labels

The labels ensure correct installed cable paths between distribution subsystems.

Figure 1–3: DECconnect System Fiber Optic Structured Wiring Label Scheme: Office-to-ODF-to-HDF

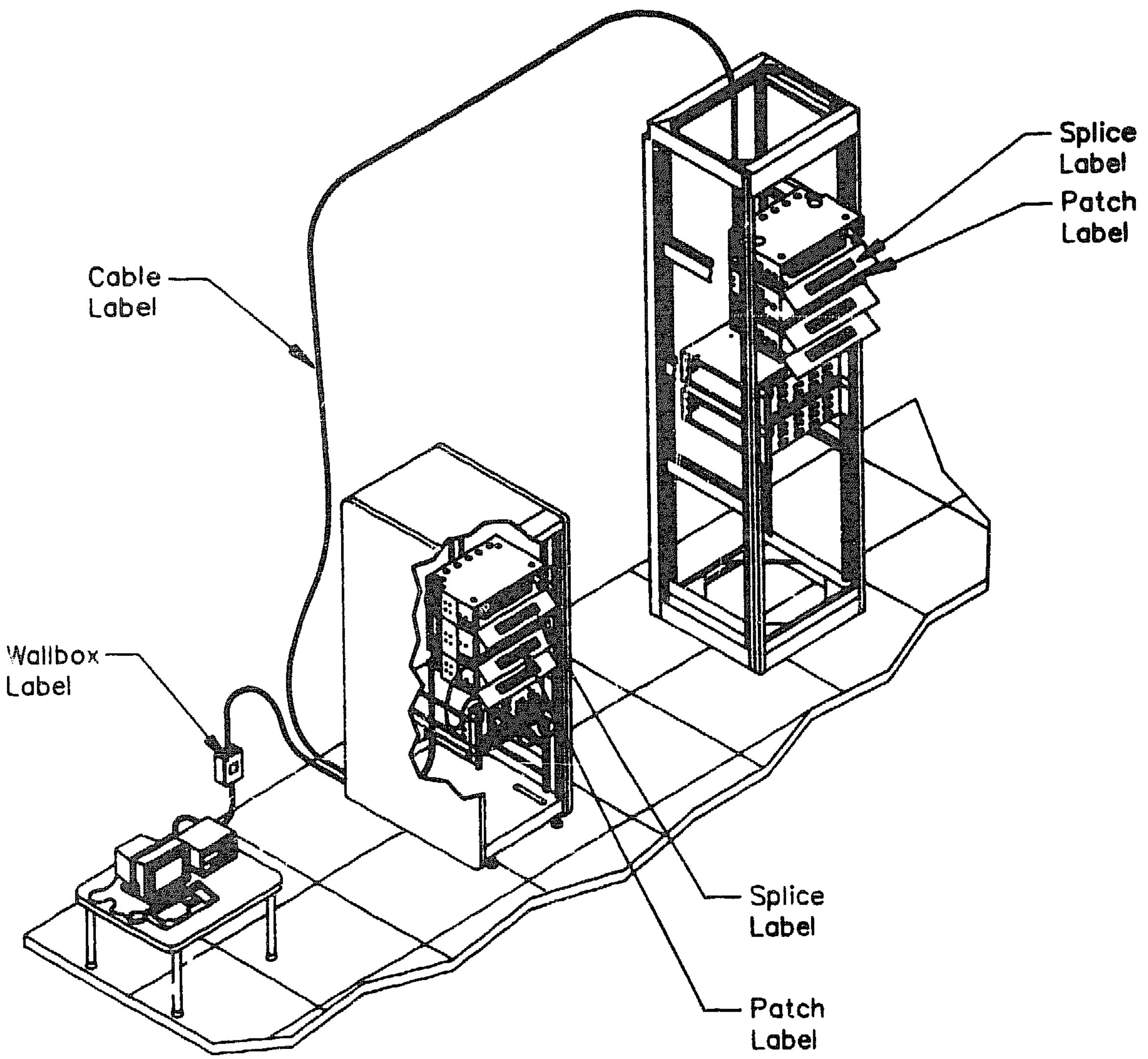
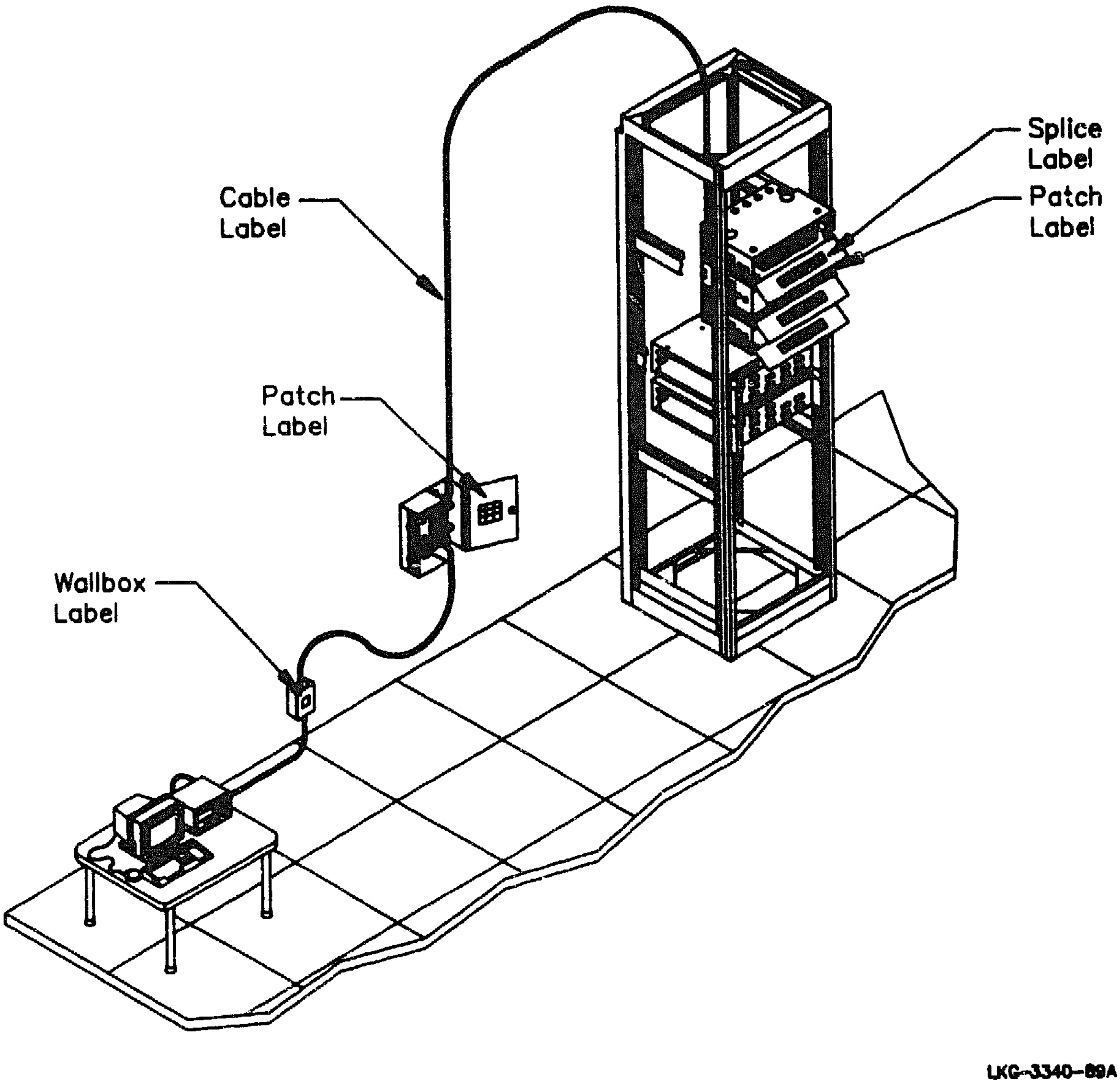


Figure 1–4: DECconnect System Fiber Optic Structured Wiring Label Scheme: Office-to-RWDF-to-HDF



1.6.1 Higher-to-Lower Hierarchical Wiring

The *DECconnect System Fiber Optic Planning and Configuration* guide (Chapter 4) describes a wiring strategy based on a higher-to-lower hierarchical structure. The overall higher-to-lower hierarchical wiring relationship is shown in Figure 1–5.

- The Main Distribution Frame (MDF), the point where all campus backbone subsystem cables are connected together, is the higher-most distribution element in the structured wiring hierarchy.
- The wallbox, the point where the active user equipment connects to the structured wiring, is the lower-most point in the hierarchical structure.

Use the Distribution Subsystem connection worksheet to identify where the fibers are to be connected. Each distribution frame patch panel is divided into a left and right side. Fibers arriving at the patch panel from a distribution system higher in the structured wiring hierarchy have their connectors mounted on the left side of the patch panel as shown in Figure 1–6. Fibers arriving from a lower hierarchical distribution subsystem have their connectors mounted on the right side of the patch panel.

Exceptions to the left-side/right-side patch panel mounting strategy can occur as follows:

- At an MDF where all campus backbone fibers are of a lower hierarchical level, individual patch panels are used for connection to each site's buildings.
- At a distribution subsystem, where a large number of fibers arrive from another distribution subsystem, require an entire patch panel. In this case, fibers arriving from a higher distribution point and those coming from a lower distribution point are mounted in separate patch panels as shown in Figure 1–7.

Figure 1–5: Distribution Subsystem Hierarchical Relationship

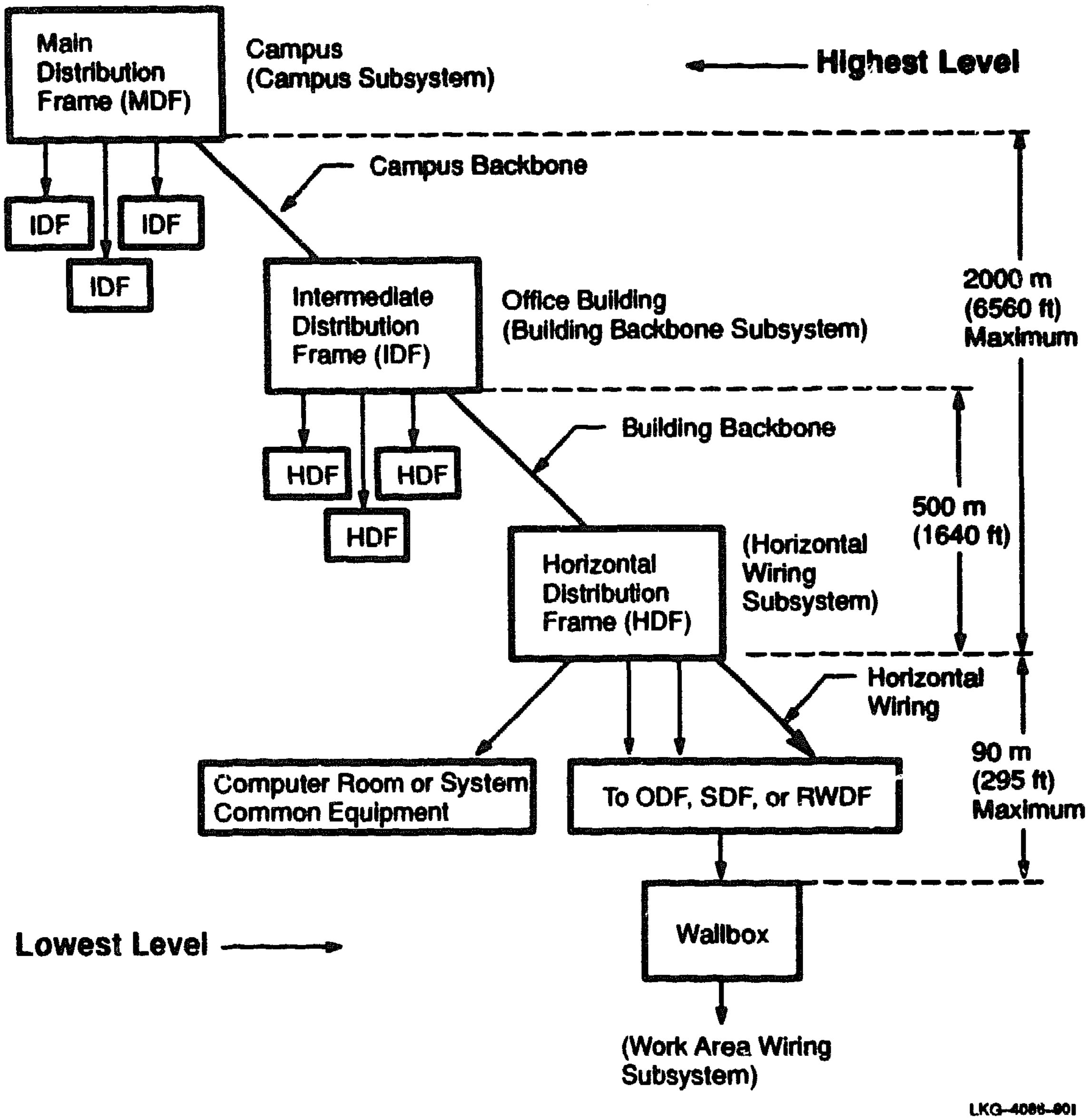


Figure 1–6: Right-Side/Left-Side Patch Panel Mounting

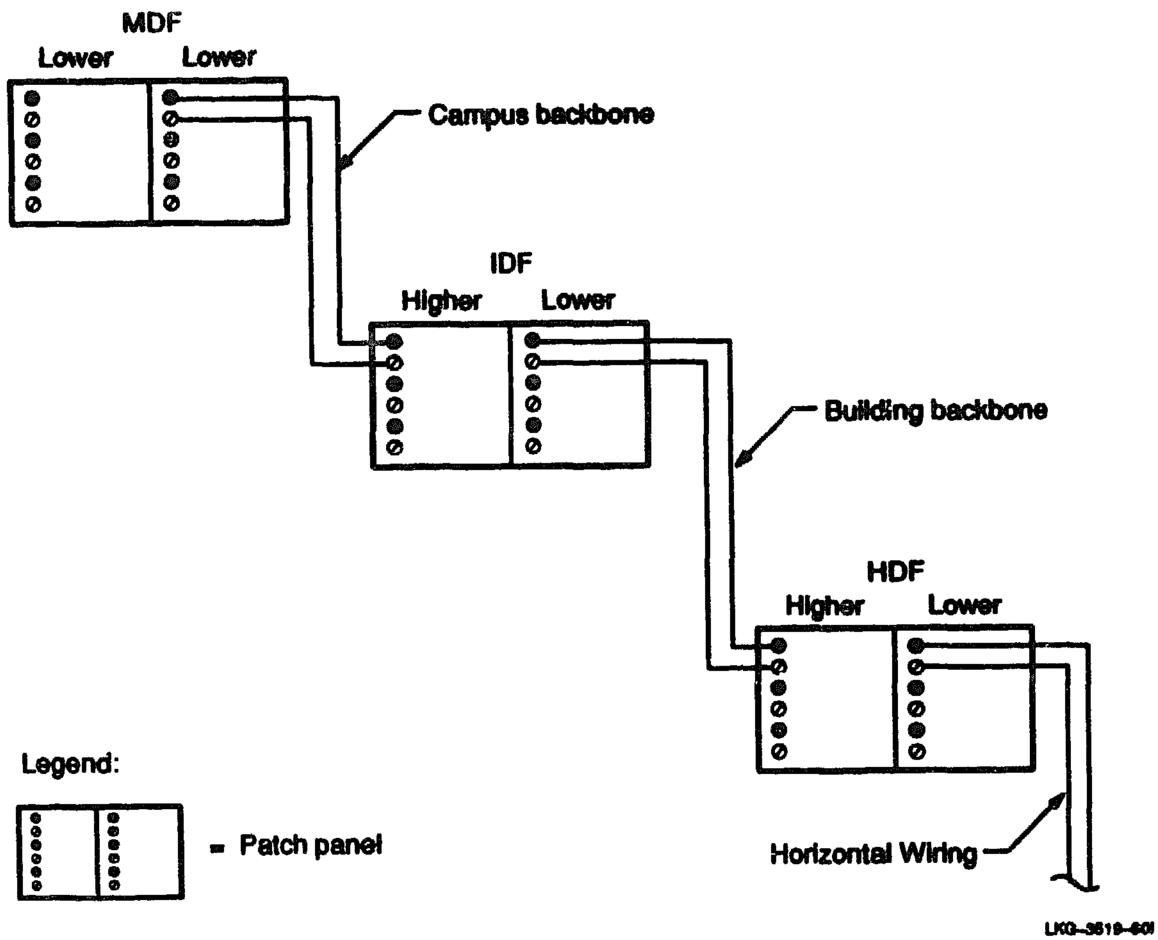
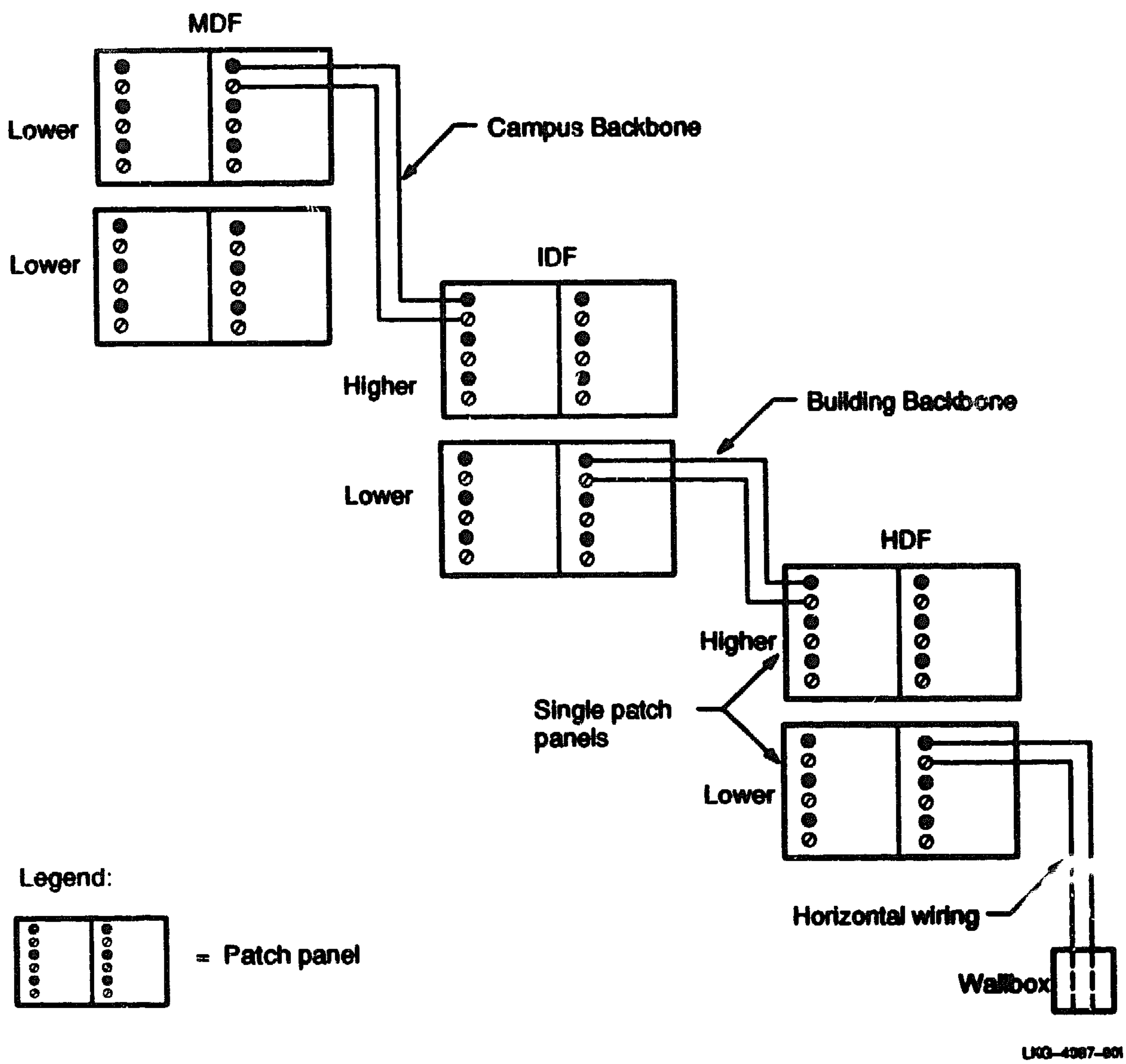


Figure 1–7: Individual Patch Panel Mounting



1.6.2 Labeling the Cables

Use the identification worksheet to determine the correct cable label information, and then transfer this information onto the cable label. Attach the label far enough from the cable end so that it will not be removed from the cable when the cable is stripped for termination.

Each of the cable labels can be color coded to provide easy cable identification (backbone, horizontal, etc.). The label colors are listed in Table 1–1.

Table 1–1: Label Colors

Label Color	Cable Color Description
White	Campus backbone or building backbone
Gray	Horizontal wiring between HDF-to-SDF, HDF-to-ODF, HDF-to-RWDF
Purple	Horizontal wiring between HDF-to-computer rooms, and HDF-to-system common equipment
Blue	Horizontal wiring between HDF-to-wallbox, SDF-to-wallbox, ODF-to-wallbox, RWDF-to-wallbox

1.6.3 Splicing Fiber Cables

Use the splice description worksheet to determine which fiber cables to splice together. Splicing is only performed at the following areas:

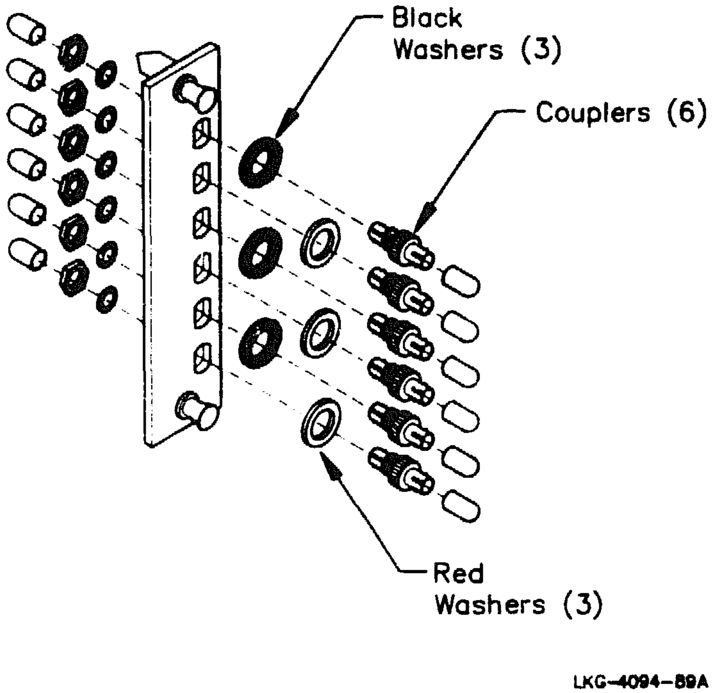
- At a splice closure that will be used for a campus backbone breakout link between multiple cables and a single cable.
- At a distribution frame where a splice shelf will be used to connect incoming fiber cables to pigtail connector cables at a patch panel.
- At a remote wall distribution frame (RWDF), when connecting horizontal wiring to wallbox cables.

The fiber color-to-color relationship cannot always be maintained through the splice: either different-colored fibers will be spliced together or fibers from different-colored bundles will be spliced together.

1.6.4 Preparing the Patch Panels for Fiber-Pair Identification

Each fiber has an odd-number and an even-number fiber (see Table 3–1) and each is identified by the installation of either a red or black washer insert on panel couplers as shown in Figure 1–8. The panel couplers are then installed in the patch panels (termination or combination shelves) as described in Chapter 4.

Figure 1–8: Black and Red Washer Installation on Panel Couplers



1.6.5 Connecting Fibers to the Rear of the Patch Panel

Each distribution frame has at least one patch panel (termination shelf or combination shelf) as shown in Figure 1–9. Coupler panels are installed in each patch panel and terminated connectors (on each behind-the-wall fiber) are installed on the rear of the panel couplers.

Obtain the Distribution Subsystem connection worksheets, which were filled in by the network designer from the *DECconnect System Fiber Optic Planning and Configuration* guide. Use this worksheet to determine where each terminated fiber for each cable is to be connected at each patch panel coupler.

Each coupler at the patch panel is identified by a column letter and row number as shown in Figure 1–10. The information on the Distribution Subsystem connection worksheet provides the installer with a connection map for each patch panel. This connection map indicates by row number and column letter exactly where the connectors on the terminated cable fibers connect to the patch panel coupler.

Figure 1–9: Connecting to the Patch Panel

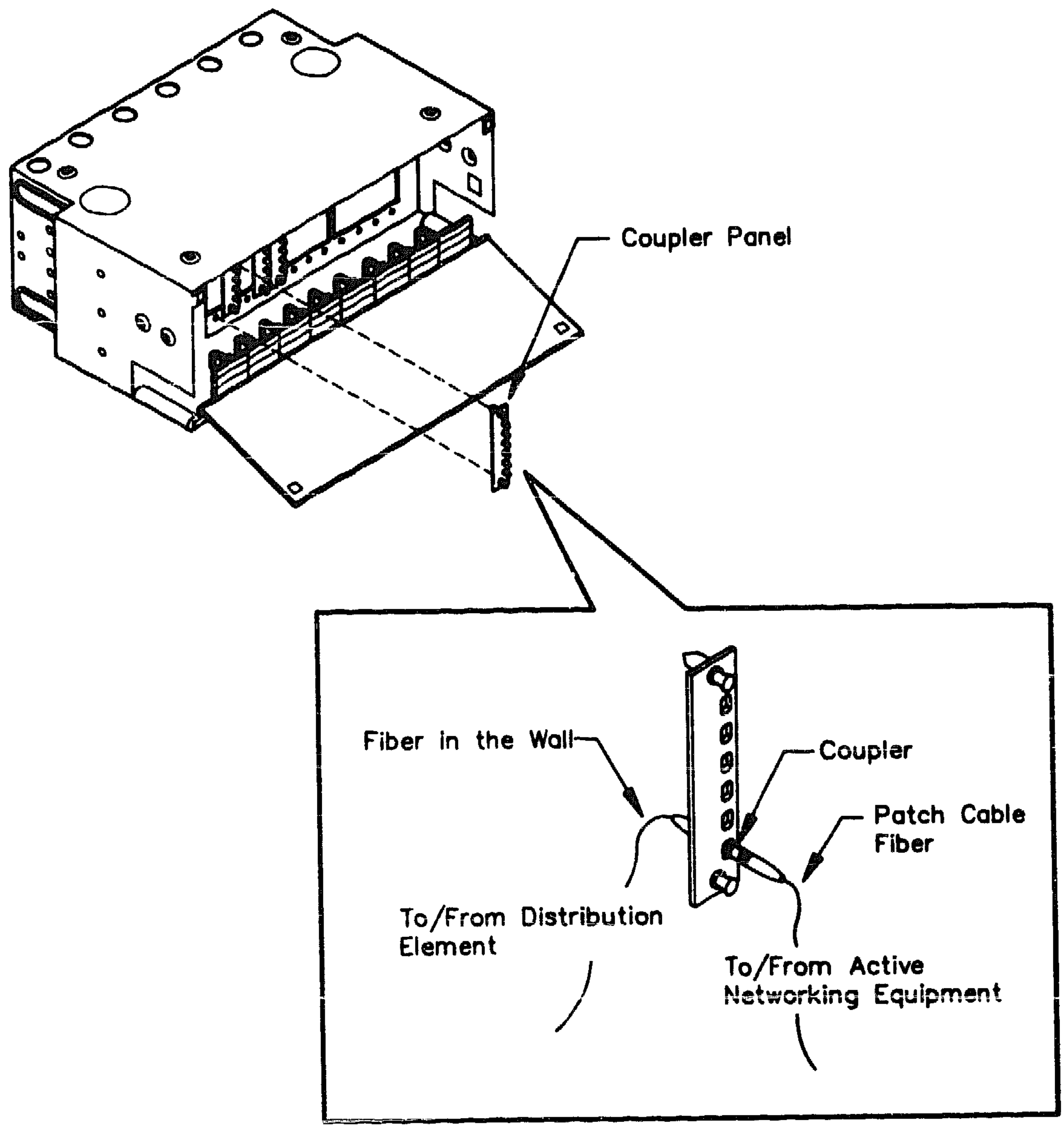
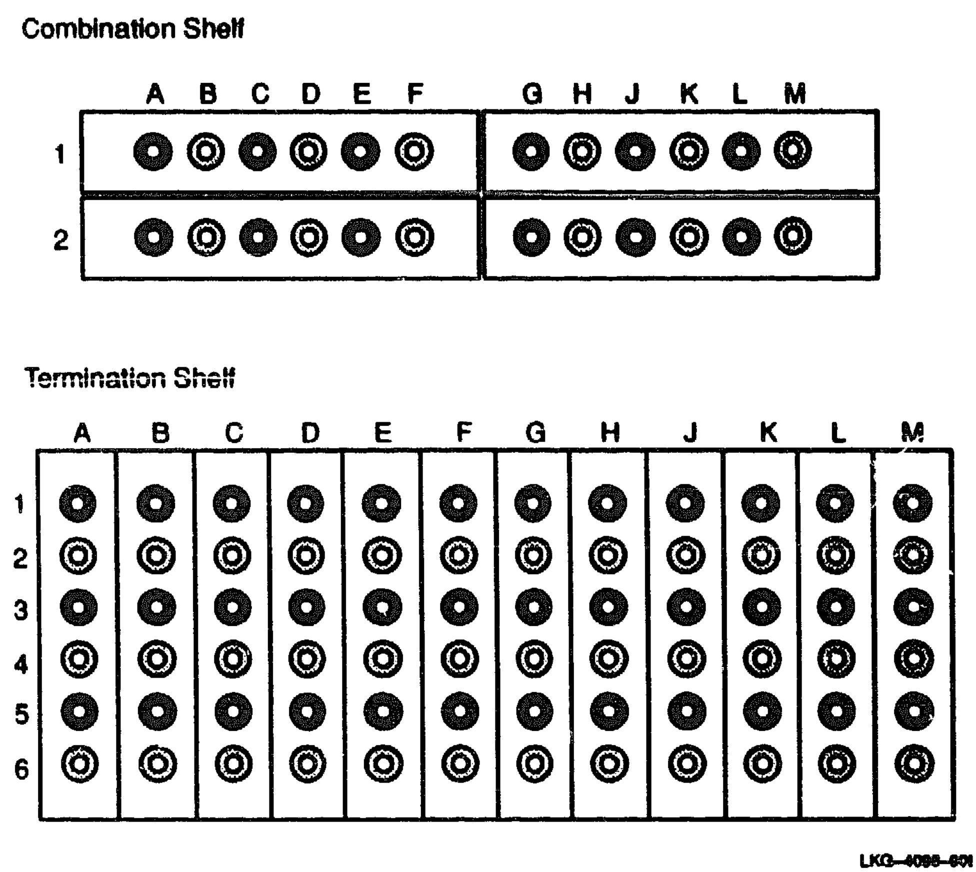


Figure 1–10: Patch Panel Row and Column Numbering



1.6.6 Connecting Patch Cable and Active Equipment to the Patch Panels

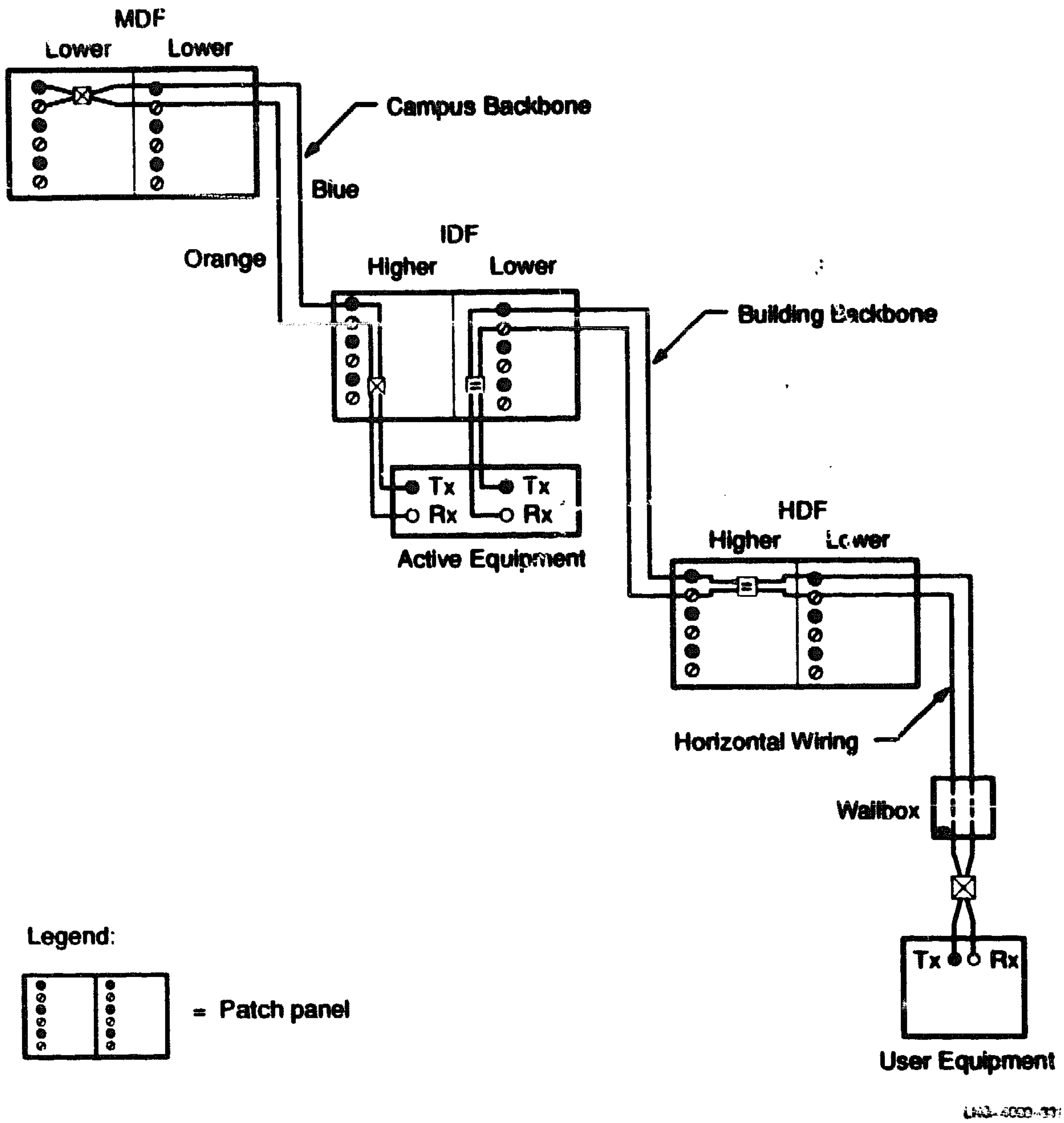
Crossconnect and interconnect patch cables are used to connect each distribution subsystem together and provide connection of active equipment to the patch panel as shown in Figure 1–11. Obtain the crossconnect/interconnect maps which where filled in by the network designer according to the guidelines in Chapter 10 of *DECconnect System Fiber Optic Planning and Configuration* guide. Use these maps to determine where to connect patch cables to the patch panels and the active equipment.

For a complete description of the fiber optic wiring strategy and the crossover connection rules, see Section 4.5 in the *DECconnect System Fiber Optic Planning and Configuration* guide.

NOTE

For connecting active user equipment to the wallbox, see Chapter 6, in the *DECconnect System Fiber Optic Planning and Configuration* guide.

Figure 1–11: Connection Scheme for Higher and Lower Connections



1.6.7 Labeling the Patch Panel

Obtain the connection label maps that were created by the network designer according to the guidelines outlined in the *DECconnect System Fiber Optic Planning and Configuration* guide. Transfer the label on the map to the label on the patch panel (termination shelf and combination shelf) as shown in Figure 1–12 and Figure 1–13. Each label identifies what the panel coupler's ends are terminated to.

The following are sample labels:

M01/4–C/6–a at the IDF Termination Shelf

This label indicates that the identified panel location at the IDF is connected to the MDF in building 1 at patch panel number 4, column C, row 6 and that the fiber-pair letter is a. The fiber-pair letter indicates that the fiber-pair colors are blue or orange (see Table 3–1). Because it is an even row, the even-number fiber is orange.

S102/1–M/3–b at the HDF Termination Shelf

This label indicates that the identified panel location at the HDF is connected to the SDF at patch panel number 1, column M, row 3 and that the fiber-pair letter is b. The fiber-pair letter indicates that the fiber-pair colors are green or brown (see Table 3–1). Because it is an odd row, the odd-number fiber is green.

Figure 1–12: Patch Panel Label (Termination Shelf)

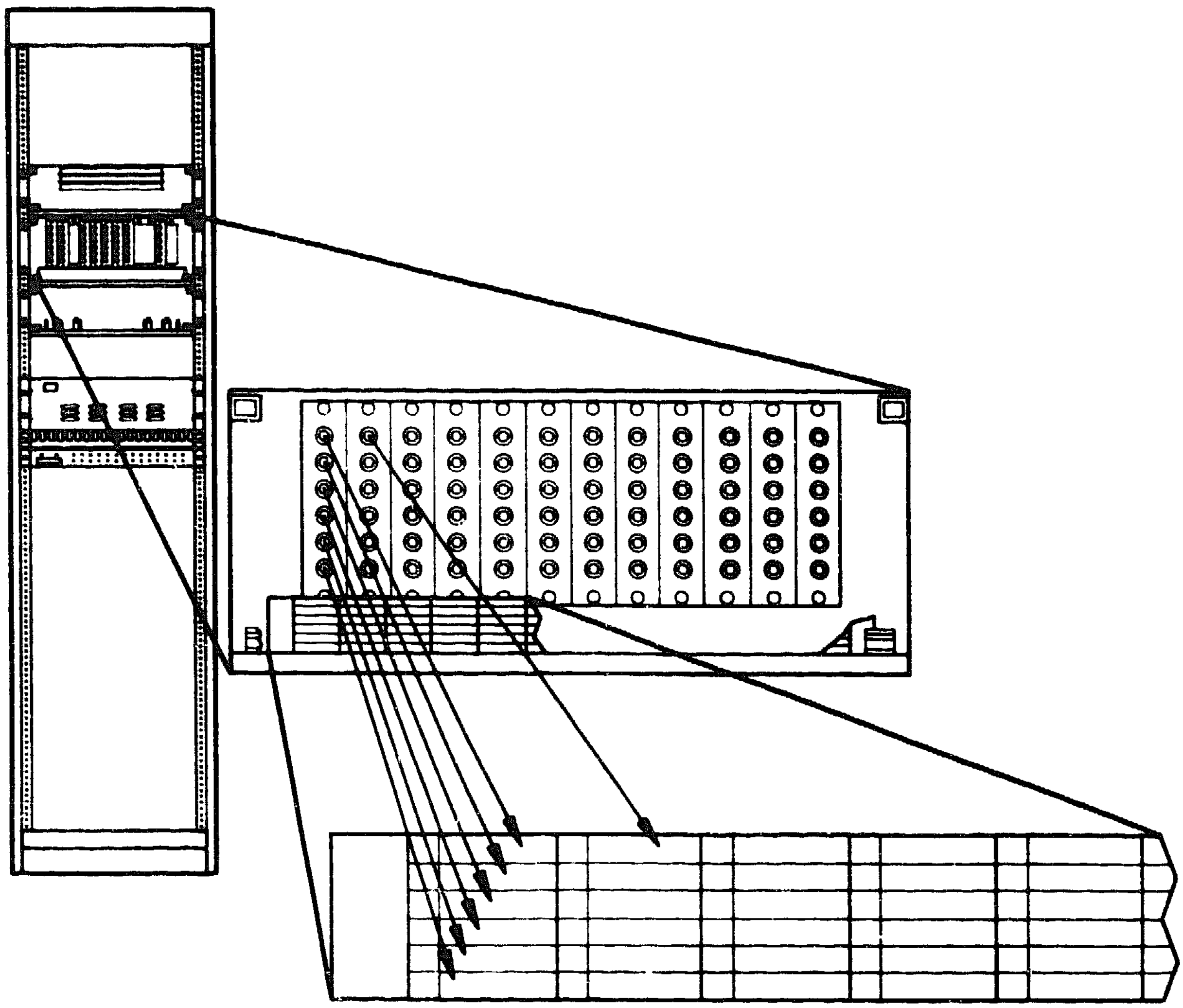


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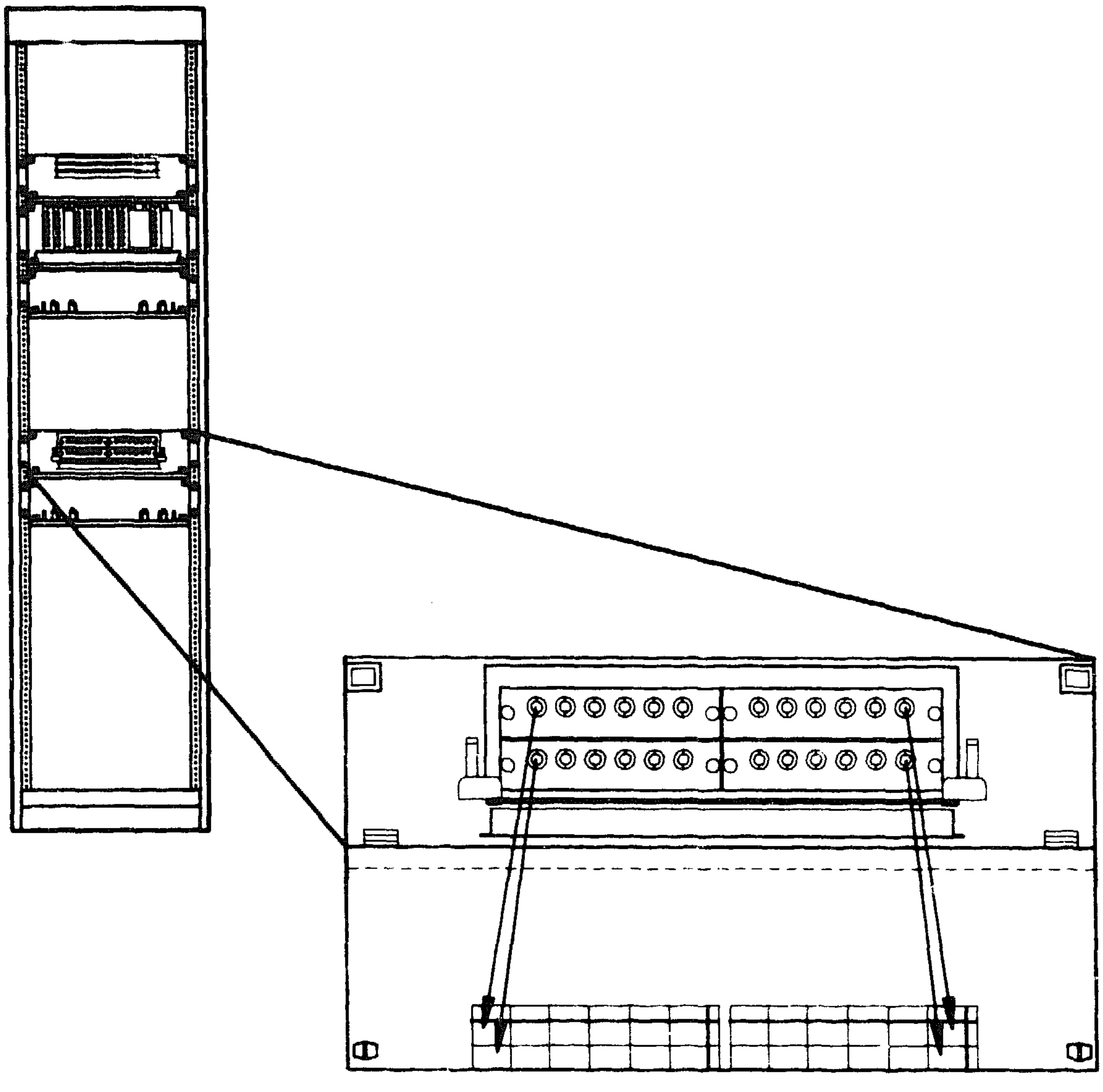
Figure 1–13: Patch Panel Label (Combination Shelf)



1.6.8 Distribution Subsystem Field Color Patch Panel Label

Each connection label map identifies a field color, which is used at the patch panel to identify a higher or lower hierarchical connection point as shown in Figure 1–14. A small color label is applied at each patch panel coupler to identify the higher and lower connection areas. Table 1–2 identifies the distribution subsystem field color coding at each of the distribution frames.

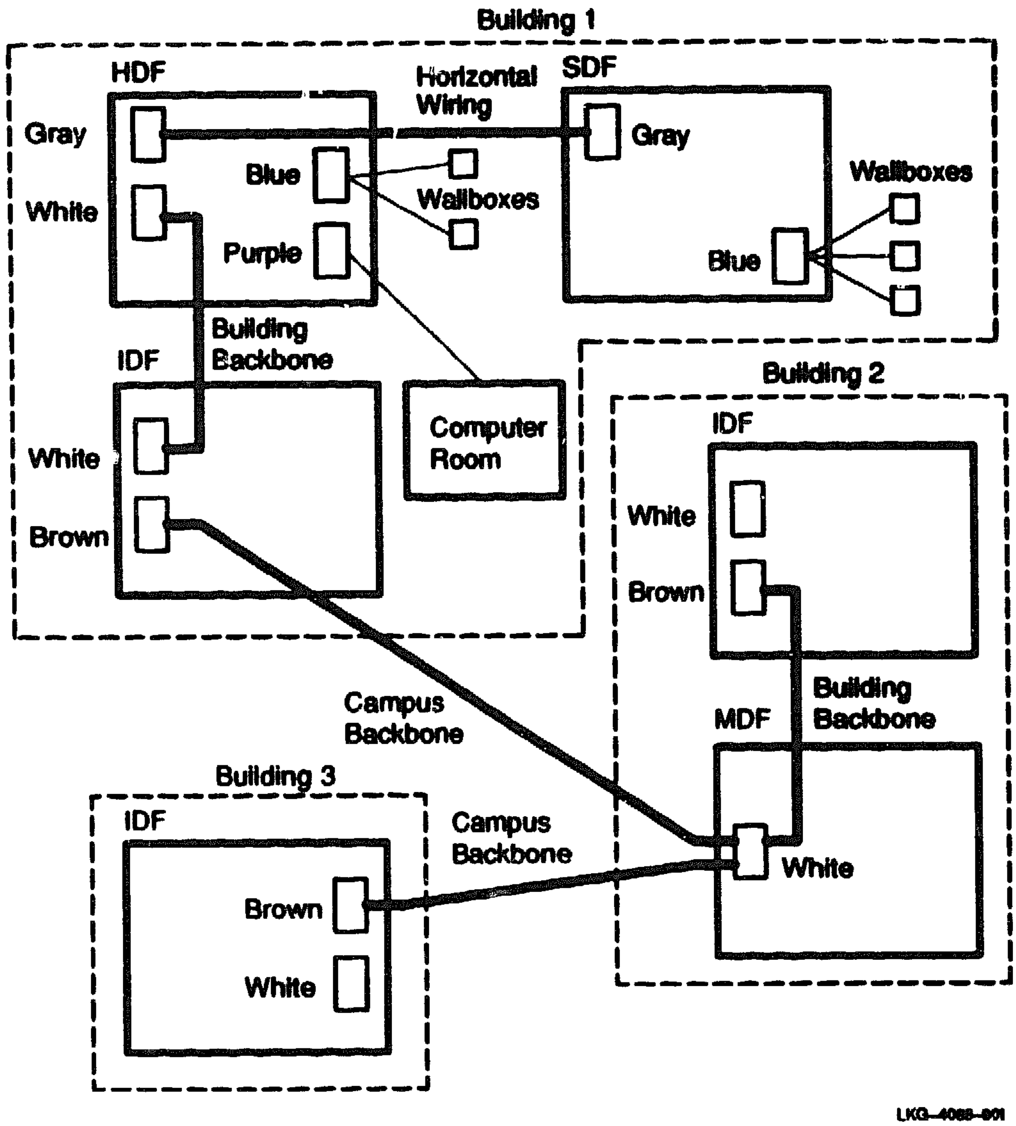
The five colored coded field definitions for use within the distribution subsystems are as follows:

- White field — Campus and building backbone cable connections at the MDF, IDF, and HDF.
- Brown field — The termination field of a campus backbone at an IDF.
- Gray field — Horizontal wiring cable connections between the HDF-to-SDF, HDF-to-ODF, or HDF-to-RWDF.
- Purple field — Horizontal wiring cable connections between the HDF-to-computer rooms, and HDF-to-system common equipment.
- Blue field — Horizontal wiring cable connections between the HDF-to-wallbox. ODF-to-wallbox, or RWDF-to-wallbox.

Table 1–2: Field Color Coding

Distribution Frame	Higher	Lower
MDF	—	White
IDF	Brown	White
HDF	White White White	Gray Purple Blue
SDF	Gray	Blue
ODF	Gray	Blue

Figure 1–14: Distribution Subsystem Field Color



1.6.9 Wallbox Fiber Cable Connections

Each wallbox terminates two fibers; one fiber for transmit, one for receive. The color labeling of the 2.5 mm bayonet ST-type connector is achieved by using black and red bend radius boots. The boots distinguish between fibers in a fiber pair.

- Each fiber is color coded, and each fiber pair is considered to have an odd-numbered color and an even-numbered color (see the color scheme in Table 3–1).
- The black boot connector is terminated to the first color or odd-numbered fiber of the wallbox two-fiber connection. The red boot connector is terminated to the second color or even-numbered fiber.
- The black boot connector is then connected to the 2.5 mm bayonet ST-type connector coupler of the wallbox that is identified by a black dot on the wallbox snap-in connector. The red boot connector is connected to the other 2.5 mm bayonet ST-type connector coupler of the snap-in connector.

See Figure 1–15 for the 2.5 mm bayonet ST-type connections. The FDDI (Fiber Distributed Data Interface) connector coupler for the wallbox has the identical color terminations as the 2.5 mm bayonet ST-type connections (see Figure 1–16).

Obtain the identifier worksheet for the wallbox. This worksheet was created by the network designer according to the guidelines outlined in the *DECconnect System Fiber Optic Planning and Configuration* guide. Use this worksheet to determine the connection of the wallbox fiber optic cables to both the wallbox and to the horizontal wiring subsystem patch panel.

Figure 1–15: Office Wallplate with 2.5 mm Bayonet ST-Type Terminations

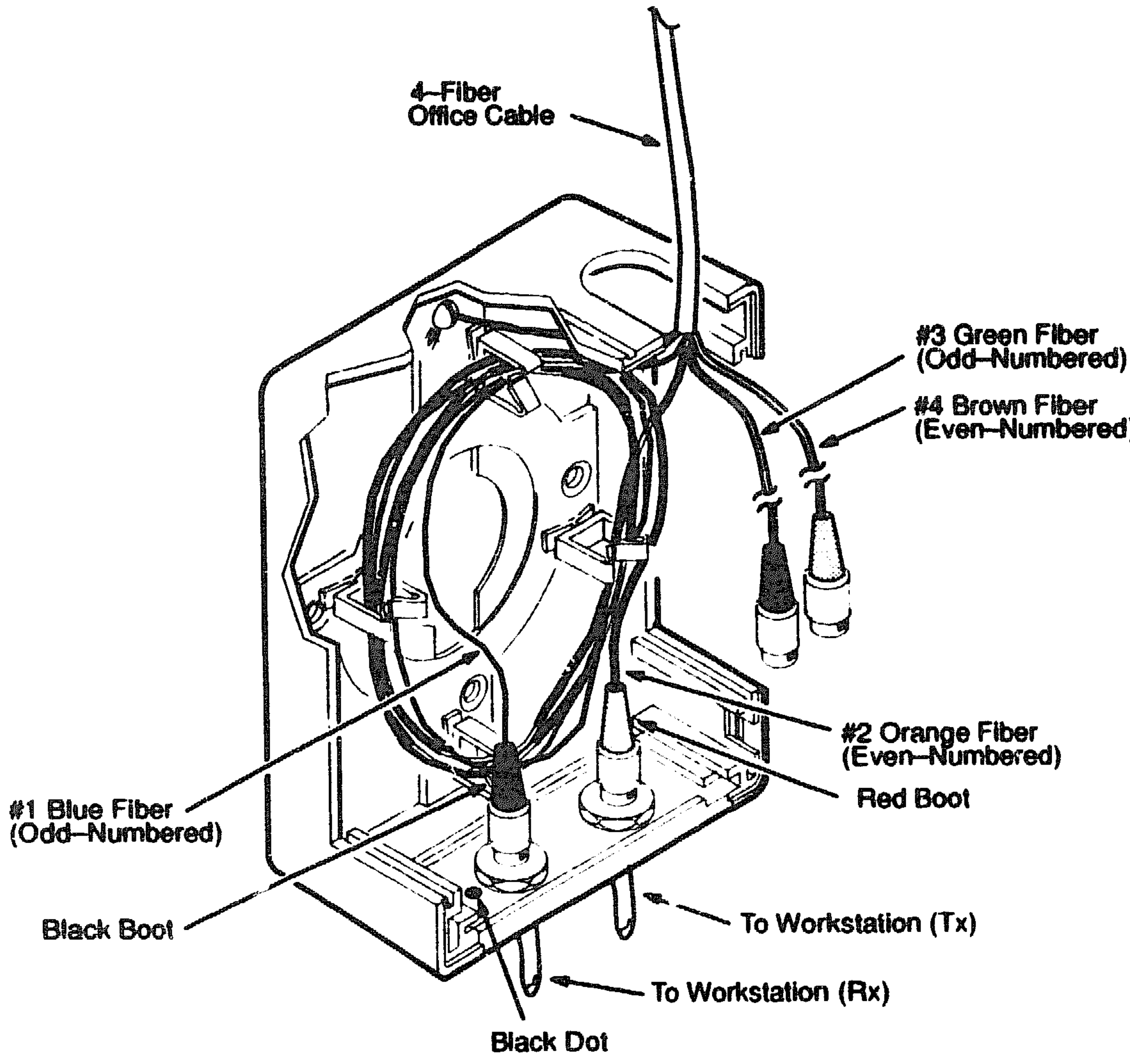
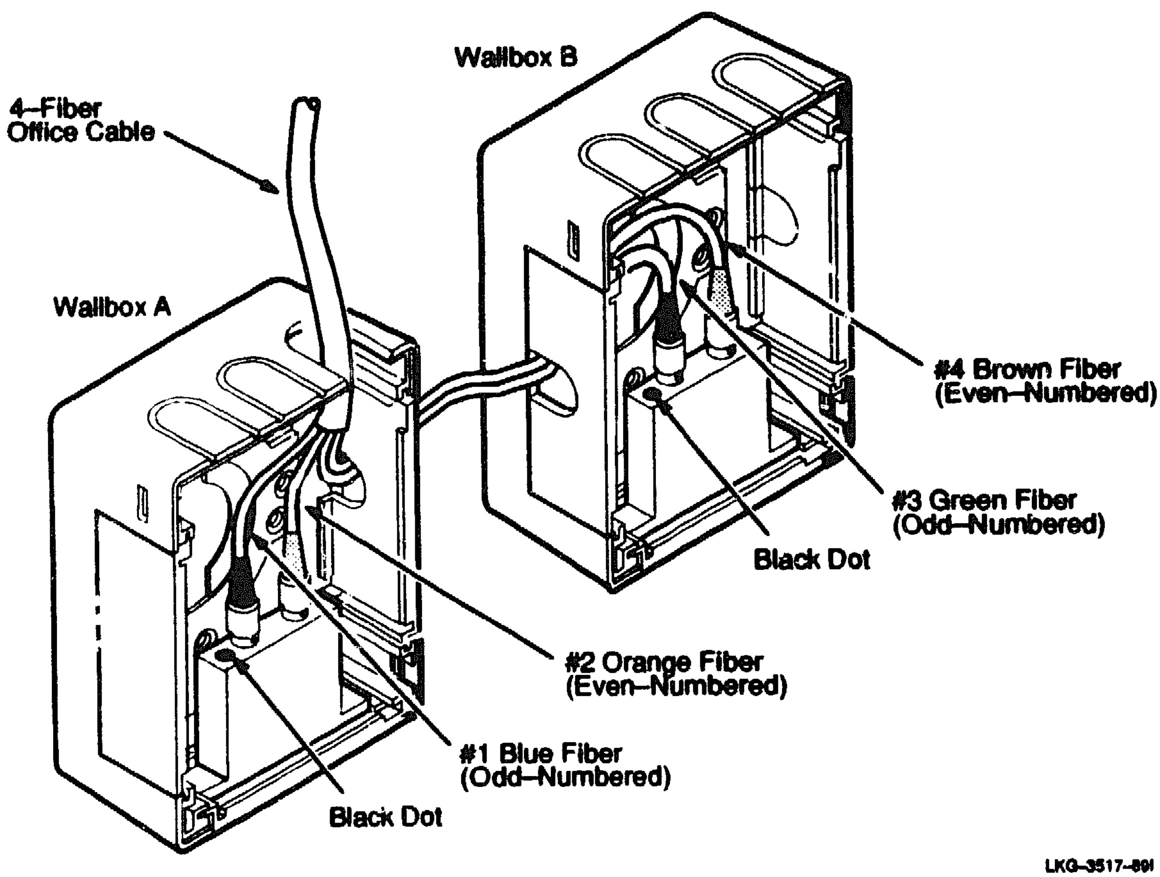


Figure 1–16: Wallboxes with FDDI Connectors



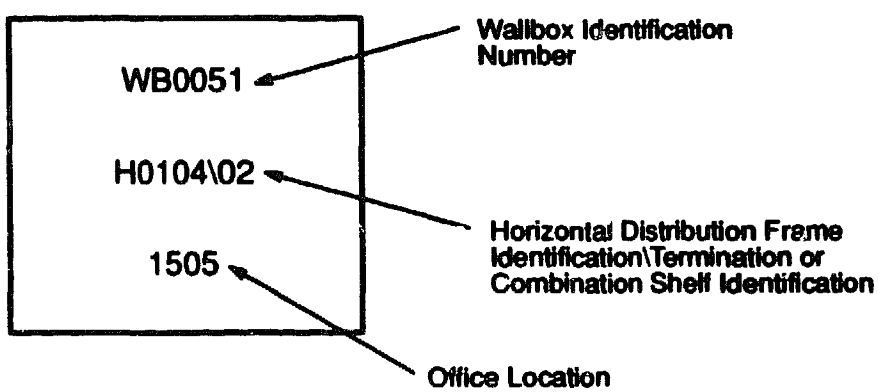
1.6.10 Labeling Fiber Optic Wallboxes

Attach a small white label to the front cover of the wallbox (refer to Section 6.1.7). Look at the label identifier worksheet and enter the following information (see the sample wallbox label in Figure 1–17):

- Wallbox identification number — for example, WB0051 for wallbox 51.
- Distribution frame identifier — where the cable to the wallbox terminates, and the termination or combination shelf identifier where the termination is located – for example, H0104\02 for the HDF on the first floor, zone 4, shelf 02.
- Office location (identification number — for example, 1505).

See the description of labeling in Chapter 4, *DECconnect System Fiber Optic Planning and Configuration* guide.

Figure 1–17: Sample Wallbox Label



1.7 Fiber Optic Cable

The DECconnect System fiber optic structured wiring cable plant recommends 62.5/125 μm size fiber, which meets EIA/TIA 492AAAA requirements. However, the size of the fiber has very little effect on the cable construction. The type of cable construction installed is determined by analysis of the campus environmental and mechanical conditions.

The two major environmental categories are indoor and outdoor. Indoor cables are classified by the National Electrical Code (NEC) as general purpose, plenum, and riser cables.

Outdoor cables are classified in several categories: cables that can be buried directly in the ground without the use of a conduit; cables that must be pulled underground in a conduit; cables installed in a tunnel; cables that must be used under water or in swampy or wetlands environments; and cables that can be strung aerially.

In cable construction, the direct protection of the fiber is accomplished by either a loose-tube or tight-buffered buffering mechanism. The buffering mechanism refers to the way fiber subunit elements of the cable are constructed.

A loose-tube fiber subunit, routinely used outdoors, is created by extrusion of hollow tubes around one or more fibers. These hollow tubes can come filled with a water protective gel.

A tight-buffered fiber subunit construction has more flexibility, allowing tighter bend radii, but offers less protection from cyclic temperature changes and other weather conditions. It is more suitable for indoor cabling.

Slotted-core cables are normally used in outdoor applications only. A typical slotted-core cable has optical fibers inside water-blocked slots in a core. At the center of the core is a tension member. The slots and tension member are enclosed in wrapping tape and an outer sheath.

A typical route can be as simple as a point-to-point link within a single environment, for example, in a conduit within a building. Or it can traverse a long distance passing through several environments and can require the use of several different cable constructions.

Cable is available for each of the indoor and outdoor cable applications. Table 1–3 identifies the primary application and construction of some typical cable types.

Table 1–3: Cable Types: Applications and Construction

Cable Type	Minimum Fire Rating	Application	Construction
Indoor Cable			
General Purpose	OFN*	Horizontal interconnection between rooms, jumper cables	Tight buffered, simplex (1 fiber), duplex (zip-cord), multifiber distribution
Plenum	OFNP*	Horizontal interconnection or between rooms — installed in ceiling airspaces	Tight buffered, simplex (1 fiber), duplex (zip-cord), multifiber distribution
Riser	OFNR*	Vertical interconnection between floors — usually multifiber distribution cables	Same as general purpose cables — long lengths can require extra strength members
Outdoor Cable			
Aerial	N/A	Between buildings — strung on telephone poles that are less than 90.9 meters (300 feet) apart	Loose tube, all dielectric
Direct Buried	N/A	Between buildings — buried directly underground below the frost line	Loose tube, armored dielectric strength member (superior crush and tensile strength), or slotted core
Buried in Conduit (Indoor/Outdoor)	N/A	Run in conduit — buried in the ground below the frost line	Loose tube, dielectric strength member (can be armored, depending on the environment), or slotted core
Underwater	N/A	Install by trenching, ploughing, direct pulling, or floating in position. Used in stream or river crossing, and in lakes and shallow coastal or river installations.	Loose tube, dielectric strength member, (armored) or slotted core

* See National Electrical Code

1.8 National Electrical Code Wiring Classes

NOTE

For installations outside of the U.S. refer to the appropriate local standards.

The National Electrical Code (NEC) is issued by the National Fire Protection Association. The NEC's purpose is to safeguard persons and property from hazards arising from the use of electricity and electrical equipment and conductors. The code is advisory and regulates the installation of electrical equipment and conductors within buildings. The code is updated every three years. The latest version available is from 1990.

Although the code is only advisory, it is routinely adopted by jurisdictions across the United States as part of their local building codes. Some jurisdictions do not adopt the entire code and have local requirements that are different from the NEC. A local jurisdiction's rules always supersede the NEC.

Generally, DECconnect System copper wiring is classed as either Class 2 (CL2) or Class CM wiring.

Class 2 wiring (NEC article 725) is power-limited signaling circuitry whose failure to operate would not introduce a direct fire or life hazard. Class 2 wiring includes low power heating, cooling control circuits, and voice transfer circuits and wiring used for interconnection of electronic data processing and computer equipment. Class 2 cables are marked CL2X, CL2, CL2R, and CL2P, depending on their flame resistance.

Class CM (NEC article 800) covers communications circuits used for telephones and telephone circuits used for data transmission. Class CM cables are marked CMX, CM, CMR, and CMP, depending on their flame resistance. CM types of cable can be used for CL2 applications, but not vice versa.

The NEC also applies to the installation of fiber optic cables when these cables are installed along with electrical cables. Fiber optic cables (NEC article 770) are divided into three types:

- Nonconducting — fiber optic cable containing no metallic members or other electrically-conductive material. Cables of this type are labeled OFN, OFNR, or OFNP, depending on the NEC flame resistance.
- Conducting — fiber optic cable containing electrically-conductive material (such as metallic strength members or vapor barriers) that are not current carrying material. Cables of this type are labeled OFC, OFCR, or OFCP, depending on the NEC flame resistance.

- Hybrid — cable containing both fiber optic and current carrying electrical conductors. These cables are classified as electrical cables in accordance to the type of electrical conductors they contain.

NOTE

This guide describes the installation of Class 2 (CL2) wiring. For international installations, refer to the appropriate national standards.

This guide does not describe installation of Class 1 wiring. Class 1 wiring controls equipment whose failure to operate would introduce a direct fire or life hazard. Class 1 wiring includes wiring that controls fire alarms, nurse call systems, elevators, cranes, conveyers, or other moving equipment.

1.9 Fire Resistance of Cabling

The 1990 NEC divides wiring into four classes. Each class is based on standard flame resistance and flame spread testing. The NEC specifies where each class of cable can be installed. The NEC class must be marked on the cable. In order of increasing strictness, the four NEC wiring classes are as follows:

1. Limited use cables — are marked CMX or CL2X (the lowest flame resistance) and are for use in single and multi-family dwellings only. There are no fiber optic cables in this class.
2. General use cables — are marked CM or CL2. These cables can be installed in offices and rooms, but not behind or through walls or ceilings and not in environmental air handling spaces. Fiber optic cables in this class are marked OFC or OFN.
3. Riser use cables — are marked CMR or CL2R. These cables can be used between floors and in vertical shafts. Fiber optic cables in this class are marked OFCR or OFNR.
4. Plenum use cables — are marked CMP or CL2P (the highest flame resistance). These cables are for use in plenums and air handling spaces. Fiber optic cables in this class are marked OFCP or OFNP.

With flammability ratings, the NEC allows the use of a higher rated cable in a lower rated application. For example, in DECconnect System applications CL2 is recommended for flammability classes CL2X and CL2; and CL2P for CL2R and CL2P. Cable marked CMP, CL2P, OFCP, or OFNP can be used for all four applications.

1.9.1 Environmental Airspace

In many installations, cabling is installed in the space above a suspended ceiling or below a raised floor. These spaces can also act as the return for the building's heating, ventilation, and air conditioning (HVAC) systems. Figure 1–18 shows an example of such an above-ceiling environmental airspace. As shown in the figure, there is no duct work for the air return; therefore, the entire area above the ceiling is considered environmental airspace, or an air handling space. Figure 1–19 shows an example of an above-ceiling nonenvironmental airspace. As shown in the figure, there is duct work for the air return above the ceiling; therefore, the area above the ceiling is considered nonenvironmental airspace.

Figure 1–18: Typical Above-Ceiling Environmental Airspace

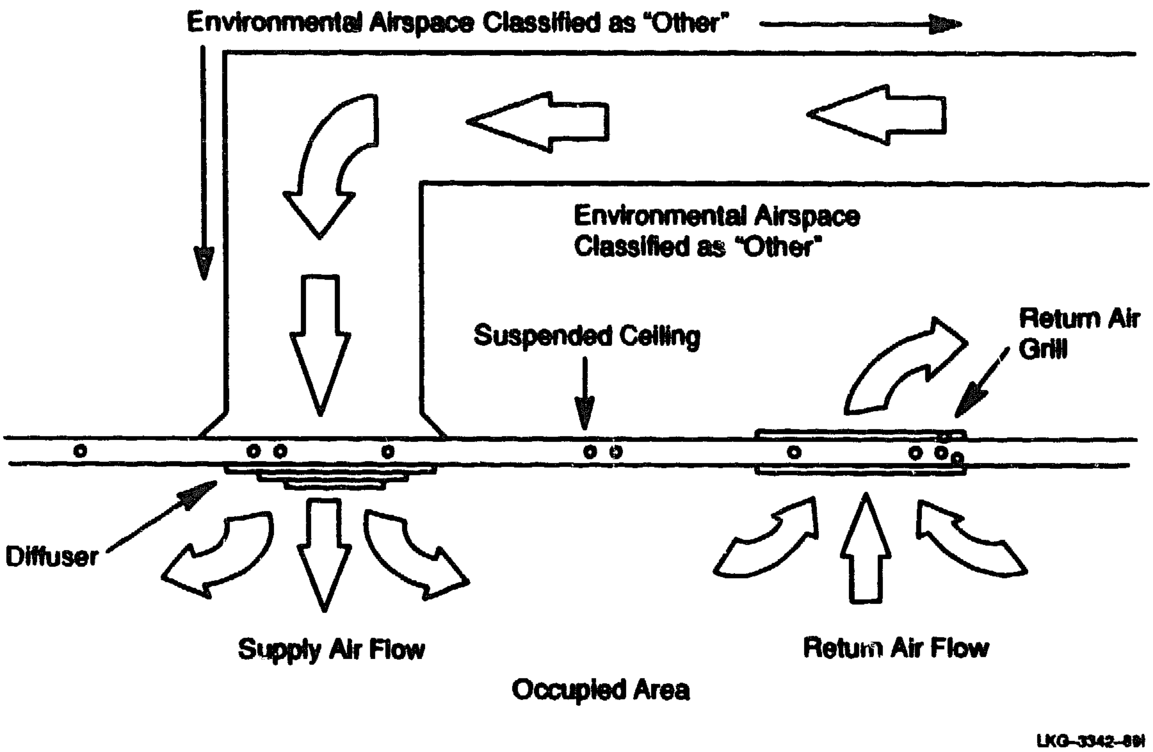
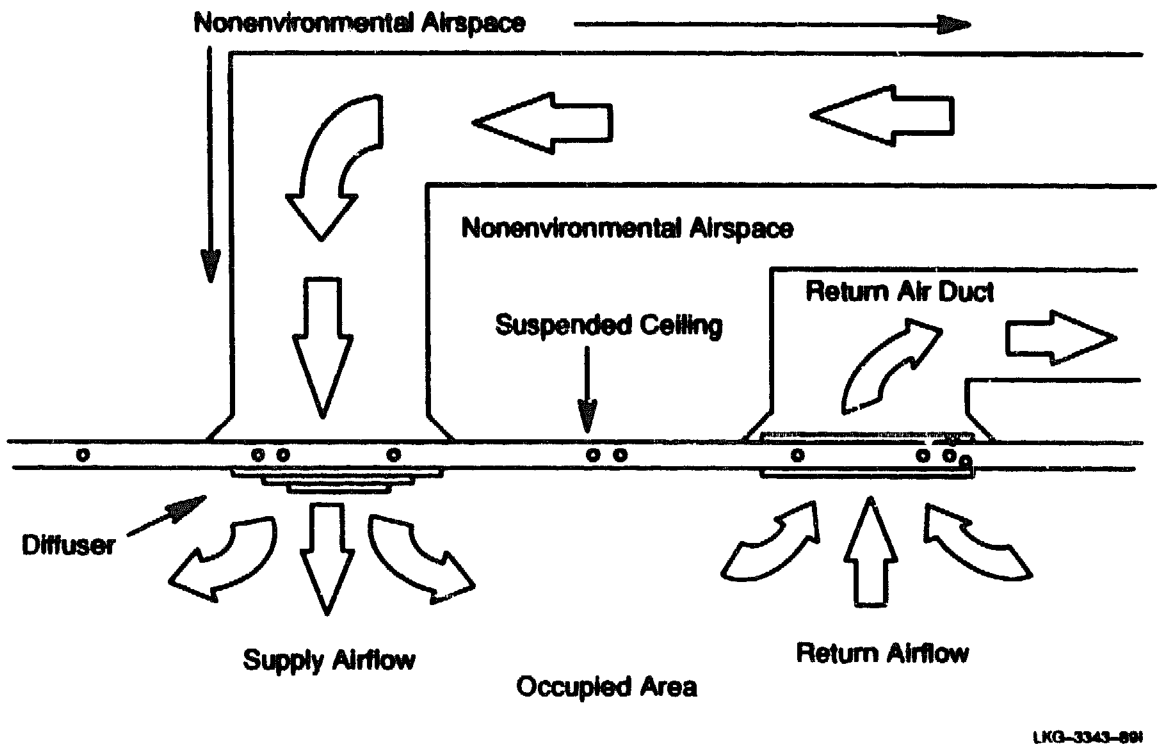


Figure 1–19: Typical Above-Ceiling Nonenvironmental Airspace



1.10 Fire Code Considerations

Any time cabling penetrates walls, partitions, floors, or ceilings that have a fire-resistance rating, the cabling penetration points must be fire-stopped to maintain the fire-resistance rating. There are UL-listed prefabricated fire seals and caulking materials available. If there are any doubts about requirements, consult the local building inspection authorities or the building's architect.

NOTE

> For installations outside of the U.S. refer to the appropriate local standards.

On the floor plans, note any locations where a cable path penetrates a fire wall.

CHAPTER 2

2

Preinstallation Review

2.1 Introduction

This chapter describes the actions to be taken during a preinstallation review of the installation site. A thorough preinstallation review helps ensure a smooth installation. The project manager organizes the review and ensures that all personnel involved in the installation participate, including the network manager.

2.2 Facilities Cabling Installation Plan Review

Review the facilities cabling installation plan, which includes the following:

- Site diagram
- Concept diagram
- Network schematic
- Floor plans
- Worksheets
- Distribution frame layout diagram
- A bill of materials (BOM) for the job
- Any associated drawings and/or floor plans

All documents are developed during the network planning stage.

The site diagram includes:

- For campus distribution (sites with two or more buildings) — a plan set showing the location of the interconnection between the buildings and detailing each building's service entrance (could include cable distances and fiber counts).

The network schematic includes:

- For each floor in each building — a plan set locating all system components, including the backbone distribution, horizontal distribution, and workstation area. Each component (active or passive) must be labeled according to it's location. In some cases, the planning divides large buildings into horizontal zones.

As part of cable plant planning, the location and identification of all system components (such as cables or wallboxes) are marked on the floor plans. Ensure that all system components are labeled on the plans.

2.3 Job Site Tour

Note and discuss any features that are not reflected in the plans or that pose obstacles to the installation. Solve these problems before beginning the installation.

The tour should include the telecommunications contractor, the facilities manager, the plant engineer, security personnel, safety personnel, and other concerned parties.

2.4 Schedule Review

Review scheduling details, including:

- Expected start-up and completion dates for the entire installation.
- Hours during which the installation can proceed.
- Limitations on facility access, or special limitations on access to specific work areas during authorized working hours.

The project manager should also have a chart or timetable detailing intermediate tasks and expected completion dates of those intermediate tasks.

2.5 Network Floor Plans

During installation, cable pullers put labels on each of the components they install and use copies of the network floor plans to record this information. Refer to the labeling overview in Chapter 1 for additional information regarding labels and installation records.

2.5.1 Facilities Changes

Ensure that the plant engineer or facilities manager has reviewed and approved any changes to the facility that are required by the installation.

2.6 Security and Safety

Make certain that security is aware of the planned activity and has approved access of installation personnel to required locations. Confirm that procedures for bringing material into and out of the site are approved. Ensure awareness of any required work area safety procedures.

2.7 Materials Availability

Ensure that all materials specified in the bill of materials are on site, or that they will be delivered prior to the time of installation.

2.8 Permit Verification

The project manager ensures that all required permits (typically electrical wiring and construction permits) are applied for and received.

CHAPTER 3

3 Fiber Optic Cable Installation

3.1 Introduction

This chapter describes how to install a fiber optic cable. This includes information on the installation process and guidelines on how to perform the installation. This chapter assumes that the installation will be perfomed by experienced installers familiar with fiber optic communications.

3.2 The Installation Process

The following paragraphs briefly detail the major elements of a fiber optic installation.

3.2.1 Planning

The successful installation of a structured fiber optic cable plant requires an organized planning strategy. Details on planning and configuring a cable plant are contained in the *DECconnect Fiber Optic Planning and Configuration* guide. Once a detailed site evaluation has been performed, a concept diagram, network schematic, and modified site and floor plans are developed for use by the installers.

The cable construction will be determined primarily by the installation environment. It can also be determined by the required fiber count, as well as by performance considerations. Several high-quality manufacturers of fiber optic cables offer a family of cables to withstand a variety of environmental and mechanical conditions.

Outdoor cables must meet a unique set of requirements to span distances between buildings. Outdoor cables can be buried (directly or in conduit) or strung aerially on telephone poles. The environmental conditions that exist are exposure to weather changes and destructive rodents or machinery.

Indoor cables can be installed separately or with many other cables, in cable trays along ceilings, or even under carpets. The mechanical conditions that exist in these situations include cable bending, hanging, crushing, or twisting.

3.2.2 Cable Installation

The physical installation (including pulling of cables and possible splicing, connector termination, and final certification) is normally provided by a subcontractor. They must be knowledgeable and experienced in fiber optic cable installations, and the related skills and standard associated practices. Specialized installation hardware and equipment is also required for fiber optic cables. The hardware the fiber optic installation subcontractor will use should include pulling winches, protective pulling grips, and equipment for monitoring cable tension and controlling bend radius.

ODTR testing of cable reels before installation is required to ensure that cable was not damaged in shipment.

3.2.3 The One-to-One Wiring Rule

The one-to-one wiring rule requires that the behind-the-wall fiber optic wiring between distribution subsystems maintains a one-to-one relationship. No crossovers can occur in the behind-the-wall wiring.

3.2.4 Cable Installation Verification

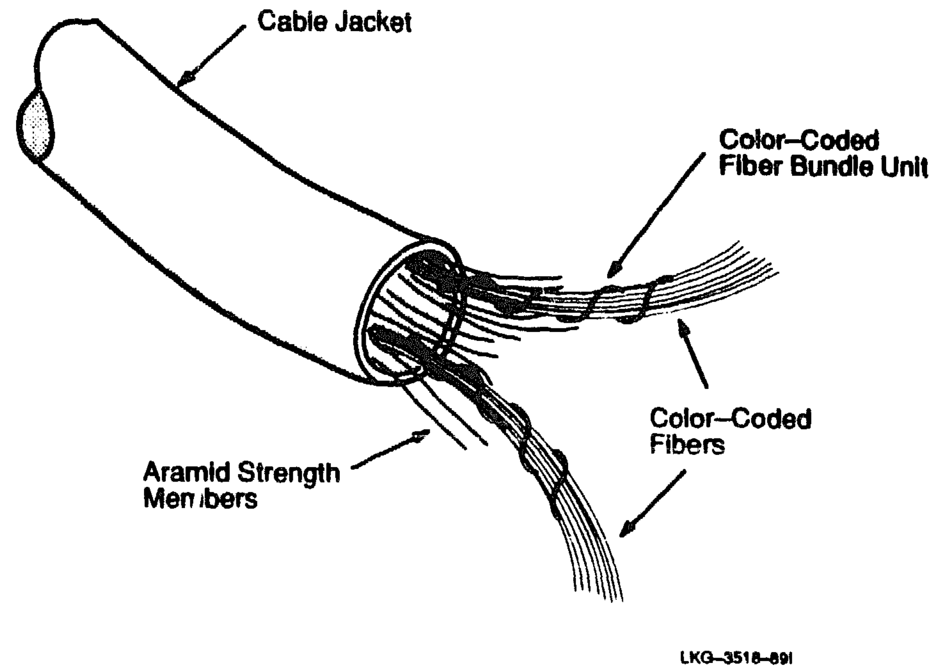
Once the cables are in place, they must be tested and certified to ensure that it meets specification. This requires an end-to-end measurement using a calibrated optical source and an optical power meter. Another required measurement is made with an optical time domain reflectometer (OTDR) (see Chapter 7). Its primary function is to examine splice losses and determine if there are any faults in the cable. It is also used to measure link length. Digital requires using OTDRs that come with printers so that a permanent "signature" (as a printout) of an installed fiber optic cable is created for future reference.

3.3 Fiber Optic Cable Color Codes

This section describes the color code format used for the bundled DECconnect System fiber optic cables (listed in Chapter 4 of *DECconnect System Fiber Optic Planning and Configuration*). The color code format is recommended for all cabling, including outdoor or custom-order fiber optic cables.

Figure 3–1 shows an example of a cable with the recommended fiber cable color code format.

Figure 3–1: Fiber Cable Color Code Construction



3.3.1 Fiber Color Codes

Each DECconnect System fiber optic cable contains an even number of fibers. The fibers are color coded as shown in Table 3–1. This pairing identifies one fiber for transmit and the other fiber for receive. Digital recommends that each unit of fibers be paired as shown in the table.

Table 3–1: Fiber Color Codes

Fiber Number	Pair Letter	Color Code
1	a	Blue
2		Orange
3	b	Green
4		Brown
5	c	Slate
6		White
7	d	Red
8		Black
9	e	Yellow
10		Violet
11*	f	Light blue
12*		Light orange
11**	f	Natural with blue dashes
12**		Natural with orange dashes

* indoor cable only
** outdoor cable only

3.3.2 Unit Color Codes

The fibers are bundled as units. Each unit contains from 1 to 12 fibers. Each unit is color coded. The unit color is identified by a wrapping of colored yarn or by a colored outer protective buffer. The units are color coded as shown in Table 3–2.

Table 3–2: Unit Color Codes

Unit Number	Color Code
1	Blue
2	Orange
3	Green
4	Brown

3.3.3 Standard and Other Fiber Counts

The DECconnect System fiber optic cables are manufactured with a standard fiber count allocated into units. Table 3–3 describes the standard distribution of fiber counts. Table 3–4 describes other fiber count distributions that can be manufactured.

Table 3–3: DECconnect Fiber Counts

Cable Fiber Count	Fibers Allocated to Blue Unit
4	4
6	6
8	8
12	12

Table 3–4: Other Fiber Counts Fiber Distribution

Cable Fiber Count	Number of Units	Allocation of Fibers to Units			
		Blue Unit	Orange Unit	Green Unit	Brown Unit
10	1	10			
16	2	8	8		
14	2	8	6		
18	2	12	6		
20	2	12	8		
22	2	12	10		
24	2	12	12		
26	3	12	8	6	
28	3	12	8	8	
30	3	12	12	6	
32	3	12	12	8	
34	3	12	12	10	
36	3	12	12	12	
38	4	12	12	8	6
40	4	12	12	8	8
42	4	12	12	12	6
44	4	12	12	12	8
46	4	12	12	12	10
48	4	12	12	12	12

3.4 Cable Labeling Process

Each cable will be uniquely identified using the cable labeling method described in detail in Chapter 4 of the *DECconnect System Fiber Optic Planning and Configuration* (EK-DECSY-FP) manual. It is recommended that labeling be done as each cable is pulled, and labels be located at 15.24 meter (50 foot) intervals along the pull route as well as at each cable end. A log book documenting the DECconnect System fiber optic structured wiring fiber installation is required and is crucial to the long-term performance and maintainabilty of the network.

3.4.1 Log Book

After each cable has been labeled, the following information must be recorded in the log book:

- Fiber identification number (fiber label)
- Fiber size and color
- Fiber length

A typical entry would be as follows:

Fiber Label	Fiber Size and Color	Fiber Length	OTDR 850/1300	Corrected Loss 850/1300	Cert. Date	Cable Bandwidth 850/1300	Test Equpt.
B02H02/01	62.5/125	500 M					

As each cable is certified at the completion of the installation, using the procedures described in detail in Chapter 7, the following information is entered into the log book:

- OTDR test at each window (OTDR 850/1300)
- Corrected loss at each window (Corrected Loss 850/1300)
- Certification date
- The cable bandwidth as written in the ordering documentation or manufacturer's specification
- Test equipment used (note, OTDR Identification number)

Fiber Label	Fiber Size and Color	Fiber Length	OTDR 850/1300	Corrected Loss 850/1300	Cert. Date	Cable Bandwidth 850/1300	Test Equpt.
B02H02/01	62.5/125	500 M	1.8/1.3	1.7/1.2	8–14–89	160/500	OTDR/11

A sample log book page is included in Figure 3–2.

Figure 3–2: Log Book Worksheet

Fiber Label	Fiber Size and Color	Fiber Length	OTDR Trace 850/1300	Corrected Cable-Loss 850/1300	Certifica-tion Date	Cable Bandwidth 850/1300	Test Equipment

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3.5 Installation Records

The fiber optic cable must be installed as indicated on the floor plan. Variation between the actual installation and the network floor plan must be noted on the as-built documents.

An as-built document is a record of the actual installation. It consists of additions or deletions to the original floor plans and is used to indicate variations caused by unexpected obstacles, construction changes, and other occurances not detected at the time of the original site survey.

At the comp'etion of the installation, the system log book, including the original cable plant installation plan and the as-built document, are turned over to the network manager.

3.6 Equipment for Fiber Optic Cable Installation

The following is a listing of common tools used for fiber optic cable installations:

- Running line tensiometer with "peak hold" instrumentation — used to monitor the amount of tension on a cable as you pull it.
- Power winch — for pulls in excess of 45.36 kilograms (100 pounds).
- Lubricants — used to reduce the amount of pulling tension on cable being pulled through conduits.
- Woven cable grips — for attaching plenum fiber cable to a pulling rope.

3.7 Guidelines for Installing Fiber Optic Cable

Installation techniques for fiber optic cable are very similar to those for coaxial cable. However, there are some primary and secondary specifications for fiber optic cable that must be considered.

NOTE

The exact value for any primary or secondary specification can vary depending on the cable's fiber size, the type of cable, and the cable manufacturer. If any of the cable's specifications are not known, contact the cable manufacturer to define the specifications before installing the fiber optic cable.

The primary specifications are:

- Bend radius
- Tensile strength
- Maximum vertical rise

The secondary specifications are:

- Crush resistance
- Cyclic flex resistance
- Impact resistance

The following is a list of guidelines for installing fiber optic cables:

- Fiber optic cable has two different minimum bend radius values: the value for when the cable is fully installed and in operation; and the value to be observed while the cable is being installed. Please consult the cable manufacturer for the minimum installation bend radius and the minimum installed bend radius. See Chapter 11 in the *DECconnect System Planning and Configuration* guide for the appropriate installation and installed bend radii.

  To ensure that the minimum bend radius is not exceeded, allow slack at sharp turns in the cable run, and immobilized the cable at the point of the bend. If the bend radius is exceeded, additional loss and/or permanent damage can occur.

- The tensile rating of a cable is the maximum pulling force that can be exerted on the cable, and is usually specified in pounds, or sometimes Newtons. The tension on the cable must be monitored during installation when pulling winches are used.
- After the installation is complete, there should be no tensile forces on the cable. The only exception to this is for riser installations, where the only allowable tensile force on the operating cable is that of its own hanging weight.
- Indoor cables are typically more flexible and lighter in weight. These cables can withstand less tensile force than outdoor cables.
- Because changes in direction increase the tension on a cable, no more than three 90 degree changes are recommended for a single cable installed in conduit without pull boxes.
- Cables running through a vertical riser must be secured at the top of the riser using a split mesh grip, and should be immobilized along the vertical length using cable ties on at least every other floor of the building.

- Cables installed in conduits must be protected from the forces of other cables that can reside there. A conduit should not be filled by more than 50% of its cross-sectional area.

NOTE

> If a conduit run has more than two 90 degree turns, reduce the maximum fill ratio (50%) by 15% for each additional 90 degree turn.

- Never install a cable that has been connectorized at both ends into a conduit. If one end is connectorized, pull the unconnectorized end. Be sure that the connectorized end is not pulled into the conduit.
- The maximum length of the vertical run for any cable is directly related to the maximum cable pulling tension specified by the manufacturer. For example, if the cable's maximum pulling tension is 56.7 kilograms (125 lbs) and the cable weighs 268.7 gram/meter (0.25 pound/foot) then the cable's maximum vertical run is 152.4 meters (500 feet).
- Fiber optic cables are installed in innerduct when they are run through conduit. The innerduct is an extruded, semi--rigid, corrugated plastic duct. It is used to help guide the cable through the conduit and to avoid exceeding the minimum bend radius. The innerduct diameter is between 2.5 centimeters (1.0 inch) and 3.2 centimeters (1.2 inches). The innerduct fill ration is 40%.

3.7.1 General Guidelines for Pulling Cables

- Pull the cable from the equipment room site to the offices.
- When pulling cables, ensure that the minimum bend radius is not exceeded at any point in the process.
- Use a cable-reel stand when unreeling cables longer than 100 meters (330 feet).
- Provide cable support every 3 meters (10 feet) or less.
- Support cable by bar joists, J-hooks, or similar cable support hardware. Do not route cable unducted over (or support cable by) pipes, conduit, cables, grid for suspended ceiling, or other wiring. Use care not to stretch, crimp, compress, or crush the cable.
- Ensure that cable support hardware is mounted directly over the equipment room racks.
- If constraints not shown on the plans are encountered during the installation, contact the project manager to resolve the problems and note the changes on the plans.
- Protect the cable from sharp edges.

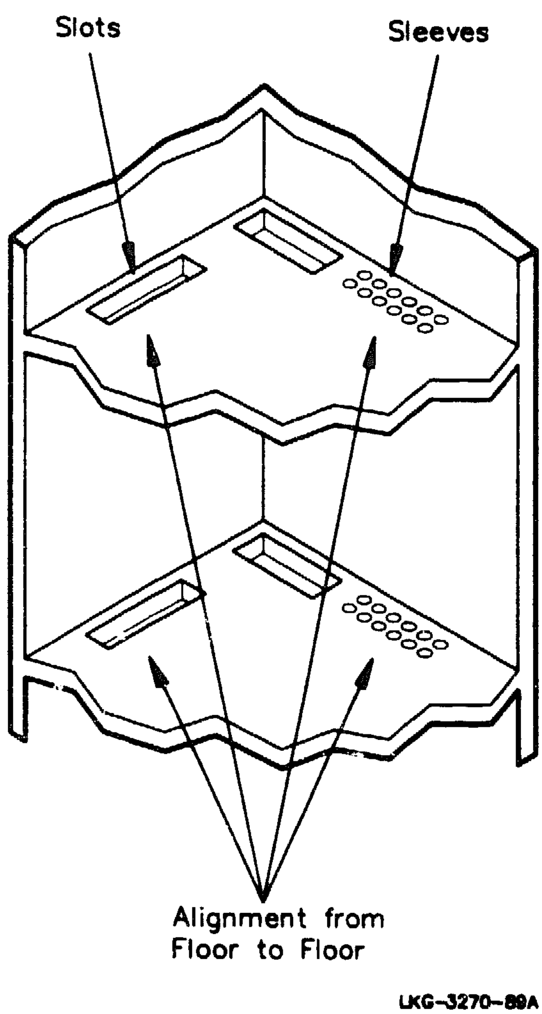
- Seal all openings made for routing cables through fire walls with UL-listed fire barrier caulking or fire seal. Ensure compliance with local fire codes.

3.8 Guidelines for Routing Cable Through Vertical Shafts

In newer construction you will typically find closed shafts or closets that are aligned from floor to floor. Contained within these closets are either 12.5 centimeters (5 inch) or 15 centimeters (6 inch) wide elongated slots or a series of round holes with 10 centimeter (4 inch), 12.5 centimeter (5 inch) or 15 centimeter (6 inch) diameter sleeves as shown in Figure 3–3.

These closed shafts run all the way from the top floor to the basement, so it is relatively easy to run riser cables through many floors.

Figure 3–3: Openings in Closed Shafts



In existing construction, you typically find open shafts without aligned slots or holes. These shafts will contain piping, ducting, and wiring for utility services. Although it is physically possible to use these open shafts, Digital recommends the use of sleeves.

When routing riser cable through vertical shafts over long distances, it is easier to drop the cable from the top floor to the lower levels, than it is to pull the cable upwards.

3.8.1 Installation in Closed Shafts

Survey the work area and if there is existing cable, group it and tie it off, if necessary, to allow clearance for the newly installed cable. When you are ready to drop the cable down the shaft, follow these basic guidelines:

1. Set up the cable reel 9.14 to 12.19 meters (30 to 40 feet) from the opening. This provides better control of the cable once the descent begins and the reel starts turning. Use a reel platform and keep the reel upright throughout the drop. Always position the cable with the end of the cable over the top and facing the shaft. Then when you pull the cable out, it will unreel from the top.
2. Begin turning the reel, pulling the cable off as the reel turns. Be sure that you do not exceed the manufacturer's minimum bend radius of the cable or the tensile loading when unreeling the cable.
3. Guide the cable into the opening. If the opening is small, install a plastic shoe as shown in Figure 3–4 to protect the cable from abrasion. If the opening is large, it is best to use a sheave to keep it straight while being lowered. Set up the sheave directly over the center of the opening as shown in Figure 3–5. Then pull the cable out and loop it over the sheave.
4. Slowly feed the cable off the reel until the person on the floor below can guide it into the opening. Repeat this step at each floor. When the cable has reached the lowest level, allow the slack to accumulate there. However, be sure that the cable does not exceed the minimum bend radius.
5. When all cable slack has been pulled, secure the cable running vertically in the riser as described in Subsection 3.8.2.

Figure 3–4: Using a Plastic Shoe to Guide the Cable

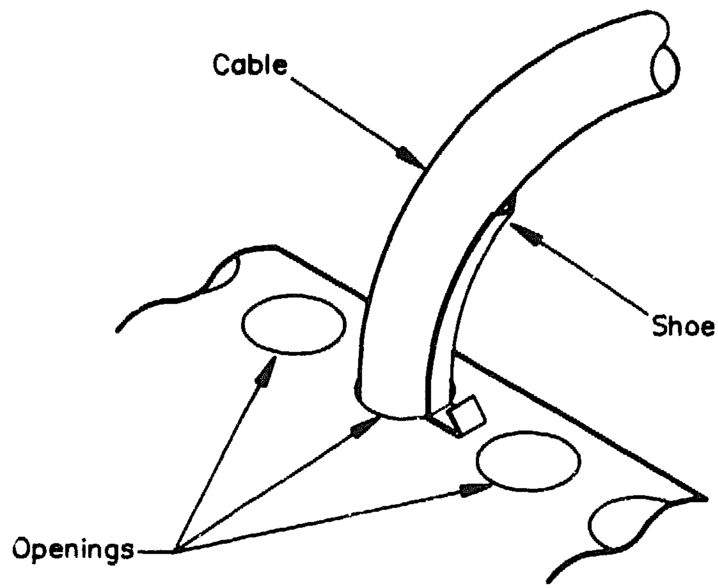
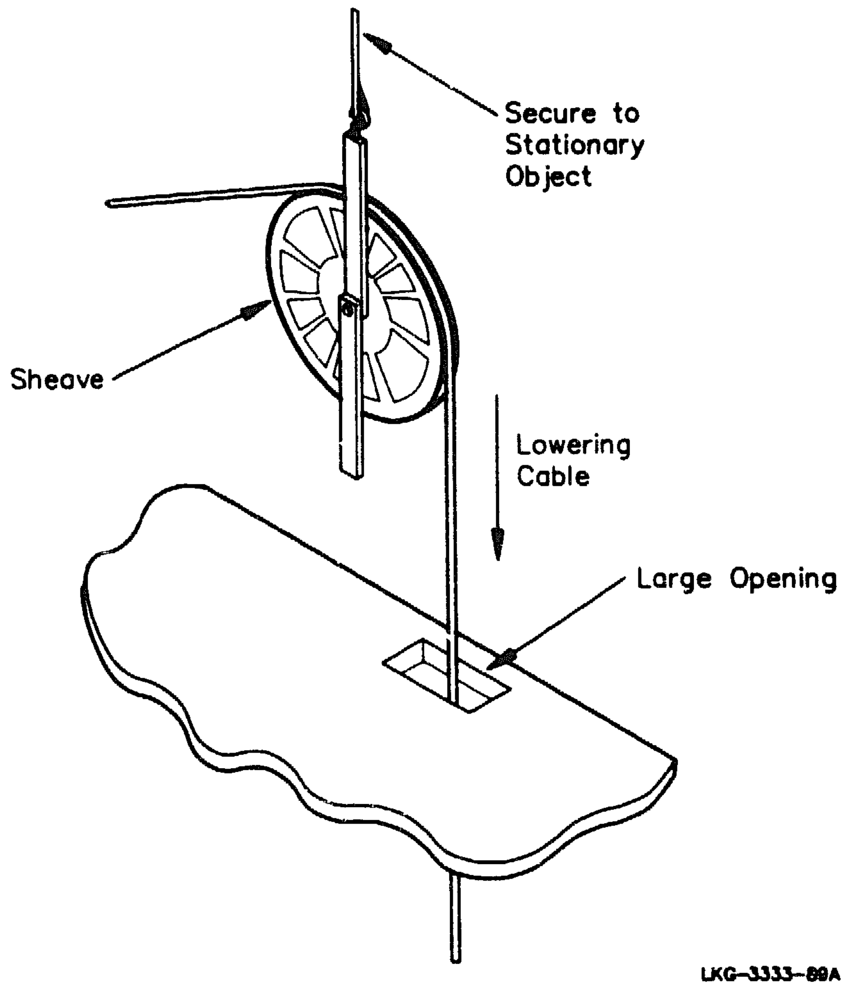


Figure 3–5: Using a Sheave to Guide the Cable



3.8.2 Securing Vertical Cable

When you have lowered or pulled the cable, you must reduce the load on the cable either by supporting it at designated intervals with split mesh cable grips, or by fastening it to the wall with cable ties. These methods are described in the steps that follow.

Split mesh cable grips, shown in Figure 3–6, provide intermediate supports for vertical installation when used at every third floor or every 10 meters (33 feet) of cable run. Use the following steps when installing the split mesh grip:

1. Obtain the proper size of split mesh grip by comparing the cable diameter with the split mesh grip manufacturer's specifications.

2. Raise the cable above the actual terminating point and hold it at this position. Beginning three floors or 10 meters (33 feet) from the cable bottom, install the hardware and position the split mesh grip. Interlace and lock the split mesh grip and cable and then lower the cable slightly to tighten the grip and hold the cable.

3. Continue Step 2 at every third floor or 10 meters (33 feet) until the entire length of cable is secured.

4. Seal all openings made for routing cables through fire walls with UL-listed fire barrier caulking or fire seal. Ensure compliance with local fire codes.

Cable ties, also know as **cable straps**, can provide intermediate supports for vertical installation when used at 5.5 meters (18 foot) intervals. When using this method, you will not need intermediate cable supports (such as split mesh grips) because of the shorter distances.

CAUTION ⚠

> Care must be used when installing cable ties because they can shatter the fibers within the cable if the ties are too tight. To avoid damaging the fibers, make sure you do not constrict the cable jacket when securing the cable tie.

Use the following steps when installing cable ties:

1. Start at the top of the cable run and secure at the first location.

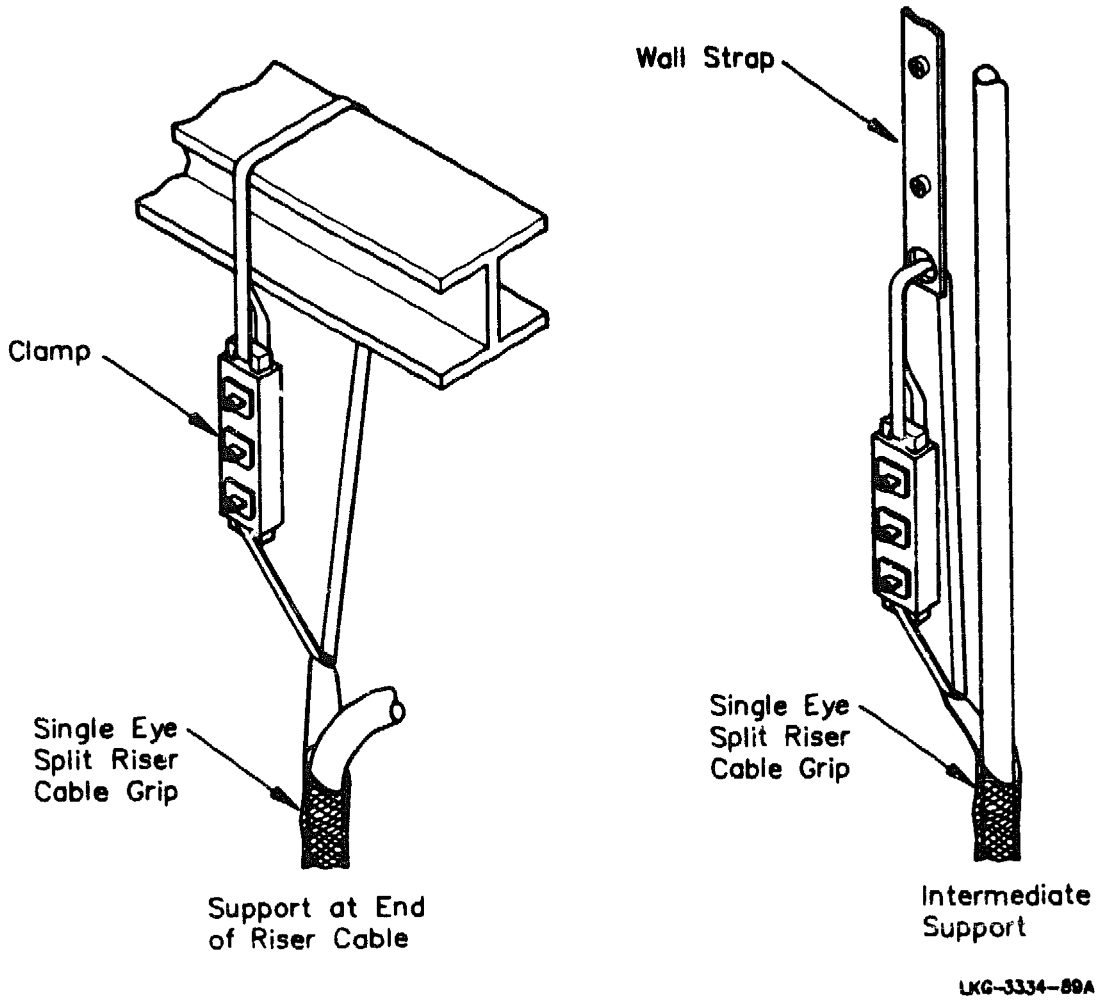
2. Work downward placing ties at the recommend 5.5 meter (18 foot) intervals until the entire cable is secured.

NOTE

> Remove any bends in the cable during the tying operation.

3. Seal all openings made for routing cables through fire walls with UL-listed fire barrier caulking or fire seal. Ensure compliance with local fire codes.

Figure 3–6: Using Split Mesh Grips



3.8.3 Vertical Conduit

When running fiber optic cable through a conduit, that conduit should be dedicated to the use of fiber optic cable. If it is necessary to run fiber optic cable with copper cables, then an innerduct liner should be installed to separate the two mediums.

Whether you run fiber optic cable by itself or in a conduit with other fiber optic cables, attempt to minimize pulling tension and avoid bending the cable beyond the manufacturer's specifications. When installing two or more cables simultaneously, the total maximum tension value is reduced by 20%.

The following is a list of guidelines for installing fiber optic cable in vertical conduit:

- Ensure that the conduit inner diameter is 2.54 centimeters (1 inch) or more.
- Check that conduits or innerducts are clean and unobstructed before installing the cable.
- If possible, pull multiple cables through the cable together. If you must install cables at different times in the same conduit, use a new pulling line for each new cable.
- If you are installing a new cable in an occupied conduit and the measured tension begins to approach the maximum pulling tension before you complete the pull, remove the pulling line and the cable. Then reinsert the pulling line and try again. Sometimes the route of the pulling line in relation to the cables already installed varies, either increasing or decreasing the tension.
- Feed the cable into the conduit entry point to reduce the amount of pulling tension.
- Use a tensiometer on any pull that may exceed 45.5 kilograms (100 pounds). Always use a tensiometer when using a winch.
- Use Kevlar pulling tape when using a power winch. Other tapes may not be strong enough and may break part way through the pull.
- Reduce the pull friction by lubricating cables as well as the conduit or innerduct. Use only approved industry lubricants, other lubricant types may actually increase the pulling tension. Never use petroleum grease.
- Pull the cable at a steady rate (preferably 22.7 meters [75 feet] per minute) and avoid stopping once you have begun pulling, unless the pulling tension approaches the maximum limit. Never allow the peak pulling tension to exceed the recommended pulling tension.
- Never pull a wire cable (to be used as a future fish line) into the duct or conduit at the same time you are pulling a fiber cable.

To route cable through vertical conduit, perform the following steps:

1. Determine whether a pulling tape is installed the full length of the duct. If there is no existing line and the conduit is empty, first use a snake to run a fish line the full length of the duct, to serve as a leader for pulling in the wire rope or pulling tape.

   If the conduit already contains one or more cables, install a new pulling line using a fish line. This will minimize the possibility of entanglement with the existing cables.

You can install the new line in one of three ways:

- The fish line can be pushed into the conduit.
- Twine can be tied to a piece of cork or sponge (or similar material) and blown into the conduit using compressed air.
- Twine can be tied to a piece of cork or sponge (or similar material) and vacuumed into the conduit from the exit point.

2. Cover any conduit exit or entry points with bushings, if necessary, to protect the cable sheath from rubbing against sharp edges.
3. Tie the pulling line directly to the cable using the cable's Kevlar yarn as follows:
   - Remove 30 centimeters (12 inches) of cable jacket from the cable end.
   - Separate the Kevlar from the fibers, twist the Kevlar yarn, and tape the ends with electrical tape.
   - Cut off the fibers and center strength member flush with the end of the jacketed cable. Be careful not to cut the Kevlar yarn.
   - Attach the Kevlar yarns to the pulling line or tape with a bowline knot.
   - Cut off any excess Kevlar yarn and use duct or electrical tape to spiral wrap the knot and the end of the cable. Make sure that there are no rough edges that could cause friction when the cable is pulled.
4. If possible, pull the cable by hand, if not perform the steps listed below, which describe pulling with a winch. Seal all openings made for routing cables through fire walls with UL-listed fire barrier caulking or fire seal. Ensure compliance with local fire codes.

The primary piece of equipment used in pulling cable up through shafts is a portable electric winch. Whatever machine you use, you should thoroughly familiarize yourself with its operation before attempting to pull the cable.

To pull cable with an electric winch, perform the following steps:

1. Set up the winch according to the manufacturer's instructions.
2. Thread the line through the winch.
3. Turn on the winch and lower a pulling line down through the floor openings. It may help to attach a weight to the line and have workers at strategic locations guide the line through the openings.
4. Turn the winch off.

5. Attach the cable to the winch. The method of attachment is determined by the type of winch and the available equipment.

6. Turn the winch on and slowly feed the cable up through the innerduct, conduit, closet, or opening.

CAUTION ⚠

> When pulling cable never allow the peak tension to exceed the recommended pulling tension.

7. Monitor the pulling tension with a running line tensiometer. If necessary, lubricate the cable and the innerduct or conduit.

8. When the cable end reaches the floor where the winch is located, turn off the winch.

9. Secure the cable as described in Subsection 3.8.2 and plug any openings as described in Step 4.

10. When the cable is secure, release it from the winch.

3.9 Routing Cable Through Horizontal Conduit

If you must run a cable in a conduit, either because you are installing non-plenum fiber in a plenum area or because you want to protect the cable from damage, be sure to follow the guidelines below and the instructions that follow.

The following is a list of guidelines for installing fiber optic cable in horizontal conduit:

- Ensure that the conduit inner diameter is 2.54 centimeters (1 inch) or more.
- Check that conduits or innerducts are clean and unobstructed before installing the cable.
- Be sure that the cable enters the end of the duct or conduit nearest the curved sections of the duct or conduit.
- Feed the cable into the conduit entry point to reduce the amount of pulling tension.
- Use a tensiometer on any pull that may exceed 45.4 kilograms (100 pounds). Always use a tensiometer when using a winch.
- Most long pulls are difficult because there is rarely, if ever, a run of conduit that is perfectly straight. Even when no major turns are involved, lengths of conduit may settle, installed cables may be kinked, and innerduct within the conduit may be twisted. This means that the amount of friction you will encounter may be higher than you can predict just by looking at the conduit.

Reduce the pull friction by cleaning and lubricating cables at the conduit entry point. Never use petroleum grease. Use only approved industry lubricants, other lubricant types may actually increase the pulling tension. If you are using a winch, lubricate the pull rope and the entire conduit system.

- Never pull a wire cable (to be used as a future fish line) into the duct or conduit at the same time you are pulling a fiber cable.
- Never install a cable that has been connectorized at both ends into a conduit. If one end is connectorized, pull the unconnectorized end. Be sure that the connectorized end is not pulled into the conduit.
- Never string cable or innerduct through ring supports or allow it to sag between horizontal supports.
- Dedicate a conduit to the use of fiber cables. If the cables must be run in conduit with copper cables, an innerduct should be installed in the large conduit to separate the copper from the fiber optic cable.
- Limit the number of 90 degree bends (minimum conduit bend radius of 15.24 centimeters (6 inches). If at all possible, do not pull cables through more than four 90 degree bends. If the conduit run contains more than four bends, be sure to provide intermediate points (pull boxes) at every fourth 90 degree bend, so you can help pull the cable through.
- Avoid tight pulls or tugs against sharp corners so you can minimize pulling tension during the installation and reduce the possibility of broken fibers. If cables must be installed around the sharp edges of frameworks, racks, or cabinetry, you should always cover the edges with protective material (for example, split tubing).

To route cable through horizontal conduit, perform the following steps:

1. Determine whether a pulling tape is installed the full length of the duct. If there is no existing line and the conduit is empty, first install a steel fish line the full length of the duct, to serve as a leader for pulling in the wire rope or pulling tape. You can install the new line in one of three ways:
   - The fish line can be pushed into the conduit.
   - Twine can be tied to a piece of cork or sponge (or similar material) and blown into the conduit using compressed air.
   - Twine can be tied to a piece of cork or sponge (or similar material) and vacuumed into the conduit from the exit point.
2. Cover any conduit exit or entry points with bushings, if necessary, to protect the cable sheath from rubbing against sharp edges.
3. Attach the pulling line to the cable using the following method:

- Pull the cable end through the open bail of the smallest available wire mesh pulling grip that will fit over the cable.
- Tie the pulling line directly to the cable, using the cable's Kevlar strength members.
- Pull the cable through the wire mesh grip and tie the Kevlar to the grip.

4. To prepare and attach the cable:
   - Remove approximately 20 to 25 centimeters (8 to 10 inches) of cable jacket from the cable end.
   - Cut off the fibers and center strength member flush with the end of the jacketed cable. Be careful not to cut the Kevlar yarn.
   - Securely tie and double knot the Kevlar yarn to the wire mesh grip.
   - Cover the point at which the cable meets the pulling line with electrical or duct tape. Make sure that there are no rough edges that could cause friction when the cable is pulled.
5. Start pulling the cable and monitor the pulling tension with the tensiometer. Never allow the peak tension to exceed the recommended pulling tension. If necessary, lubricate the innerduct or conduit with a recommended lubricant.

CAUTION ⚠

When pulling cable through conduit, be careful not to exceed the minimum bend radius of the cable.

6. If pull boxes have been installed at any points in the conduit runs, pull the cable to the first pull box and out into a coil on the floor. Then feed the cable back into the remaining portion of the conduit run. Repeat this procedure at every pull box.

3.10 Routing Cable Through Ceilings

In many sites, such as one-story manufacturing buildings, riser cable may be routed horizontally, above the ceiling. The method for running cable will vary from building to building depending on the type of ceiling installed and the type of cable used. Follow these guidelines:

- Support cable by bar joists, J-hooks, or similar cable support hardware. Do not route cable unducted over (or support cable by) pipes, conduit, cables, grid for suspended ceiling, or other wiring.
- Use care not to stretch, crimp, compress, or crush the cable.

3.11 Routing Cable Through Flooring

The task of routing cable through underfloor duct systems is not much different or more complex than routing cable through ceilings. The difficulty is in determining where the paths for cable are and selecting the best path to take. Generally the information is contained in the building plans, which can be obtained by the architect, building contractor, engineer, or maintenance superintendant.

If plans are not available, you can make a visual inspection of the area and check for the locations of junction boxes, headerducts, and service fittings. Their locations will help you understand the system layout.

Junction boxes are openings in the duct system that give access to cable running in underfloor ducts. They have round metal cap covers, which may be visible as circular metal disks in the floor, or be partially concealed by carpet or tile with only a round metal edge showing. In either case, the cap will be secured with screws, which you can remove as needed to route the cable. If you can find one junction box, you can tell which way cables are being run and locate other junction boxes. Once you have located several junction boxes, you can determine how the ducts run and consequently how to route the cable.

NOTE

> You will often find a junction box in a corridor near a closet. Check the closet for the direction the cables are feeding.

A **headerduct** is the main component of a **trenchduct**. Unlike a junction box, a headerduct is rectangular. It is typically located near a closet and secured with screws. Removing the panels and observing the cable runs will help you analyze the system.

Service fittings are actually holes in the cellular floor duct, which means they are covered with concrete. To access them, you have to break through the thin layer of concrete, then remove the covering cap. To locate these fittings, check for what the builders refer to as "marker screws" on boards. These are simply screws, set in the floor at the heads of lines of ducts. In some cases, the fittings will have marker screws directly above them (fittings will be on either 12 inch or 24 inch centers. If not, you can use an electronic device called an insert finder to locate them. The device is passed across the line and detects the zinc that fittings are commonly made of.

In some cases, the fittings will be in use, and you can find out where others are by measuring the distance between them and using this distance to determine where others might be.

In new buildings, determining where the paths are should not be a problem. Even when construction has passed to the point where the paths are not obvious, you should be able to obtain a plan that indicates the location of ducts and junction boxes in the system.

When the duct or conduit is straight enough and short enough, a snake can be used. To route cable through flooring using a snake, as described in the following steps:

1. Open junction boxes along the desired path.
2. Push a snake through the first junction box back towards the origin point. For example, the headerduct or closet.
3. Tie and tape the cable to the end of the snake,
4. Pull the snake through to a junction box. Be sure to pull enough slack through to reach you destination. You do not want to damage the cable by pulling it around a sharp corner.
5. Disconnect the line.
6. Repeat this procedure to get the cable through the remaining junction boxes until you reach your destination.

When the distance is long or twisted, or you have several cables to pull, then a pulling line is preferred. To route cable through flooring using a pulling line, use the following steps:

1. Run the snake back from the junction box back to the starting point.
2. Secure the pulling line to the snake.
3. Pull the line to the first junction box.
4. Run the snake through the next junction box back to your present location.
5. Secure the pulling line to it and pull it through.
6. Repeat this procedure until the pulling line is through to the destination.
7. Secure the cable to the pulling line.
8. Pull the cable(s) through to the destination all at once.

Working with **computer flooring** is not difficult. You can use a plunging device to lift panels, or if fasteners are used, use a tool or other readily available tool. To route cable, you can use a snake or a pulling line. One technique for running a pulling line is to roll a ball of pulling line under the floor in the direction of the pull. As you hold the loose end the ball will unravel and pay out the line.

3.12 Verifying Cable Routing

The telecommunications contractor and project manager must inspect and verify the installation of all cables. Any problems discovered during this verification must be resolved before proceeding with the remainder of the installation.

Completion of the verification in this section is not an acceptance of the installed cabling. The cabling is accepted during the total facilities cabling certification procedures described in Chapter 7.

Verify the installation of the cables by visually inspecting that:

- The cable label is installed.
- The cable is properly supported.
- The cable is undamaged — no kinks or chafed areas.
- The cable is properly routed — no bends tighter than the minimum bend radius.
- The cable installation is fully documented.

No optical measurement of the cable is performed at this time. This measurement is done by the installer or Digital Field Service at the completion of the installation.

3.13 Fiber Optic Cable Splicing and Connector Termination

After the cables are routed, they must be spliced or terminated. The best way to terminate a cable is to perform field connector termination. This requires skill because the fiber must be epoxied to the connector and the end face of the fiber must be polished to achieve the best possible transmission and lowest loss. Connectors are described in Section 4.

Connectors can also be installed by splicing pigtails onto the cable ends. Pigtail splicing can be done to simplify the termination process, but it is not recommended because the splice creates additional loss. If this method is used, the splice must be accounted for when planning the system loss budget. Connector pigtails are described in Section 4.

Cable splicing or pigtail installation should occur in a splice closure such as a splice shelf, combination shelf, or appropriate fiber transition enclosure. These contain rings to secure the incoming and outgoing cable, and a fiber organizer tray to separate and immobilize the unprotected fibers and mechanical splices.

When multifiber cables are terminated they often require a unit splitter kit. These kits include tubing to protect the exposed fibers. Core blocking, unit splitter and buffering details are contained in Appendix B.

CHAPTER 4

4

Fiber Optic Passive Equipment Installation

This chapter describes the fiber optic passive equipment and provides installation guidelines. The *DECconnect System Fiber Optic Planning and Configuration* guide contains ordering information for all Digital equipment discussed in this chapter.

4.1 Connectors

Optical parameters of the cable connectors and connector couplers comply with the DECconnect System specifications outlined in Chapter 5 of the *DECconnect System Fiber Optic Planning and Configuration* guide. (Note: the 2.5 mm bayonet connector is an ST-type connector.) The primary connection devices used with the DECconnect System fiber optic structured wiring are:

- 2.5 mm bayonet ST-type connector
- 2.5 mm bayonet ST-type connector coupler
- FDDI connector

4.1.1 Tools for Connector Installation

The H8102-AA 2.5 mm Bayonet ST-Type Connector Termination Tool Kit contains all the tools needed to mount the connectors provided in the Field Installable 2.5 mm Bayonet ST-Type Connector Kit (H3114-FA). A 220 Vac version is also available (H8102-AC). The tool kit is used with the 2.5 mm Bayonet ST-Type Connector Consumables Kit (H8102-AB).

The 2.5 mm Bayonet ST-Type Connector Termination Tool Kit (H8102-AA) contains the following:

- Inspection microscope (with light)
- Eye loupe
- Curing oven
- Fiber cleaving tool
- Glass plate
- Polishing tool
- Insertion tool
- Crimping tool
- Cable stripping tool
- Scissors
- Carrying case

The 2.5 mm Bayonet ST-Type Connector Consumables Kit (H8102-AB) contains the following:

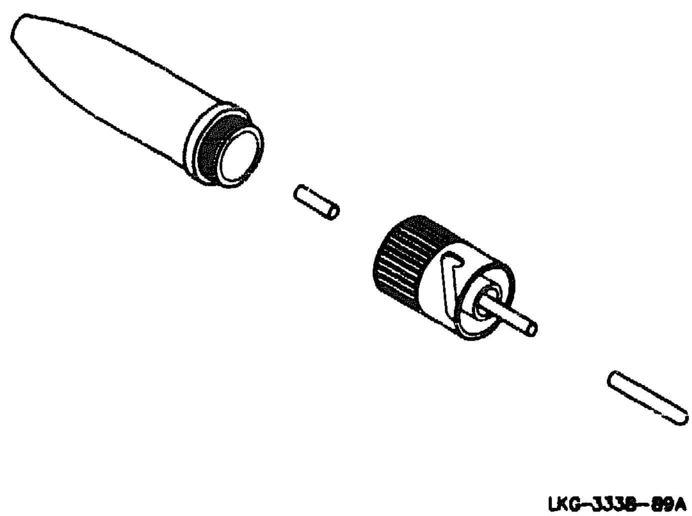
- 5 µm polishing paper
- 1 µm polishing paper
- Epoxy packets
- Wipes
- Syringes
- Mixing pad
- Dispensing tips

The H8102-AB Consumables Kit contains the necessary materials to terminate one-hundred 2.5 mm bayonet ST-type connectors.

4.1.2 2.5 mm Bayonet ST-Type Connector and 2.5 mm Bayonet ST-Type Connector Pigtail

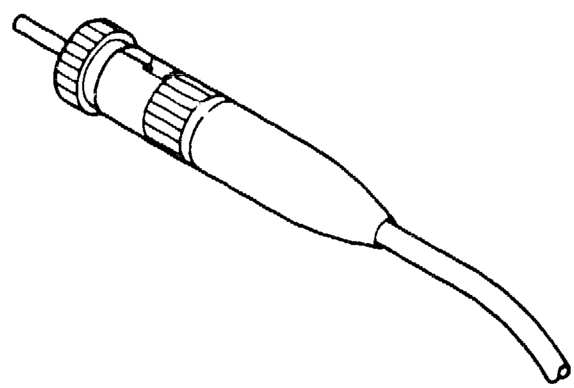
The typical 2.5 mm bayonet ST-type connector contained in the Field Installable 2.5 mm Bayonet Fiber Optic Connector Kit (H3114-FA) contains six connectors; 3 connectors with black boots and 3 connectors with red boots) and is used in cable-to-cable or cable-to-equipment applications. It provides high performance, low cost and easy field mounting in a rugged compact package. The connector consists of a connector assembly, dust cover, crimp eyelet, and a cable strain relief boot (available in red or black). A typical connector is shown in Figure 4–1.

Figure 4–1: 2.5 mm Bayonet ST-Type Connector



The 2.5 mm bayonet ST-type connector pigtail (H3118-FA is a preconnectorized 2.5 mm bayonet ST-type connector and 62.5/125 µm tight buffered cable (3 meter [12 foot] length) suitable for splice applications. A typical splice pigtail is shown in Figure 4–2.

Figure 4–2: 2.5 mm Bayonet ST-Type Connector Pigtail



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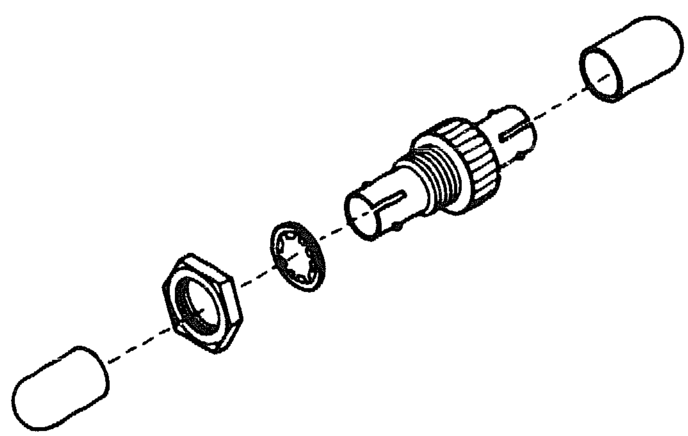
4.1.3 2.5 mm Bayonet ST-Type Connector Coupler

The 2.5 mm bayonet connector coupler contained in the 2.5 mm Bayonet ST-Type Connector Coupler Kit (H3114-FC, Quantity 12) is used in termination shelves, combination shelves and interconnection units. It mates with 2.5 mm bayonet ST-type connectors (H3114-FA), and is comprised of a coupler, washer, nut, and dual dust covers. A typical coupler is shown in Figure 4–3. The nut used measures one-half inch over the flats.

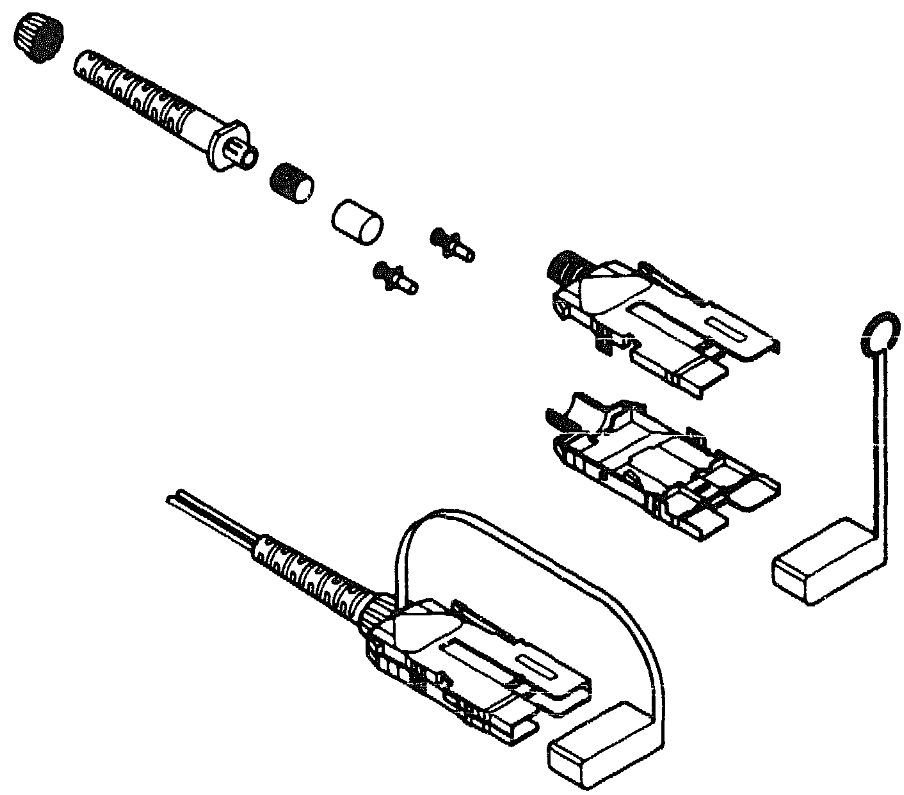
Figure 4–3: 2.5 mm Bayonet ST-Type Connector Coupler



4.1.4 FDDI Connector

The FDDI connector has field-programmable keying and is supplied with an integral dust cover. A typical connector is shown in Figure 4–4.

Figure 4–4: FDDI Connector



Typical connector, actual connector may differ.

4.1.5 2.5 mm Bayonet ST-Type Connector and Connector Pigtail Installation Guidelines

The following briefly describes the use of the 2.5 mm ST-Type Bayonet Connector for field connectorization and for splicing pigtails.

4.1.5.1 2.5 mm Bayonet ST-Type Connector Field Connector Termination

The following is the process for field connector termination. Complete connector termination instructions are included with the H8102-AA 2.5 mm Bayonet ST-Type Connector Termination Tool Kit. These tool kit instructions contain procedures for connector terminating both light and heavy duty cable.

WARNING ⚠

Non-connected optical connectors may emit radiation if the far end is coupled with a working laser or LED (light emitting diode). Do not view the fiber or connector with an optical instrument until there is absolute verification that the fiber is disconnected from the laser or LED source and will remain so until the activity is complete. Reference U.S. OSHA CFR 1910.147 — Control of Hazardous Energy Sources (Lockout/Tagout) or local regulations which may supercede.

WARNING ⚠

The epoxy adhesive is a skin and eye irritant. Use safety glasses at all times and wear appropriate gloves to prevent skin contact.

WARNING ⚠

Always wear safety glasses and follow safety procedures when splicing or terminating fibers with connectors. The cleaved glass fiber can penetrate the skin or become embedded in the eye.

When installing a 2.5 mm bayonet ST-type connector, the strain relief (or PVC tubing) and crimp eyelet are slid onto the cable, the cable is stripped to the appropriate size, and the clad fiber exposed. The fiber cladding is then removed to expose the bare fiber.

Adhesive is then loaded into the connector assembly and the fiber inserted. The cable is trimmed and a crimping tool is used to crimp the eyelet and secure the cable. The strain relief (or PVC tubing) is slid up onto the connector to provide additional cable protection. The assembled connector is then heat cured in an oven.

When the connector has cured, the exposed bare fiber is then cleaved and polished.

A dust cover is then installed to protect the fiber surface from contamination until the connector is used.

4.1.5.2 2.5 mm Bayonet ST-Type Connector Pigtail Splicing

The following briefly detail the process for splicing pigtails. Complete splicing details are included with the H3114-FD Splice Tool Kit, which is used in conjunction with the H3114-FG Splice Kit.

Mechanical splicing (described in Section 4.2) consists of preparing the cable and fiber, inserting the fiber into the splice mechanism, and securing the splice position.

4.2 Splice

The mechanical splice (H3114-FG) is a joining device used to align and clamp fibers end-to-end along a precision vee groove. The splice is simple, compact, and easy to use. It will accommodate fiber with 250 µm coating or 900 µm buffer.

WARNING ⚠

The coupling gel is a minor eye irritant. Use safety glasses at all times to prevent contact with the eyes.

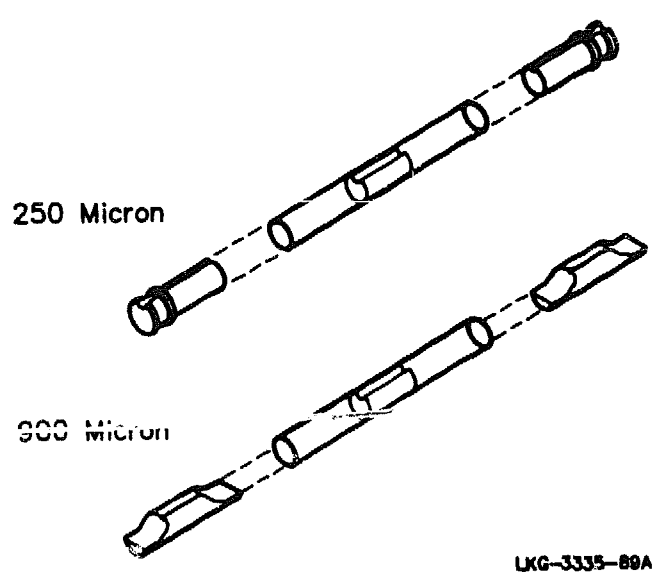
WARNING ⚠

Always wear safety glasses and follow safety procedures when splicing or terminating fibers with connectors. The cleaved glass fiber can penetrate the skin or become embedded in the eye.

The splice assembly consists of a transparent tubular body, a ceramic mandrel with a vee groove, and two sets of strain relief chocks.

Mechanical splicing consists of preparing the cable and fiber, inserting the fiber into the splice mechanism, optimizing the splice alignment, and securing the splice position. Complete splicing details are included with the H3114-FD Splice Tool Kit, which is used in conjunction with the H3114-FG Splice Kit. The mechanical splice is shown in Figure 4–5.

Figure 4–5: The Mechanical Splice

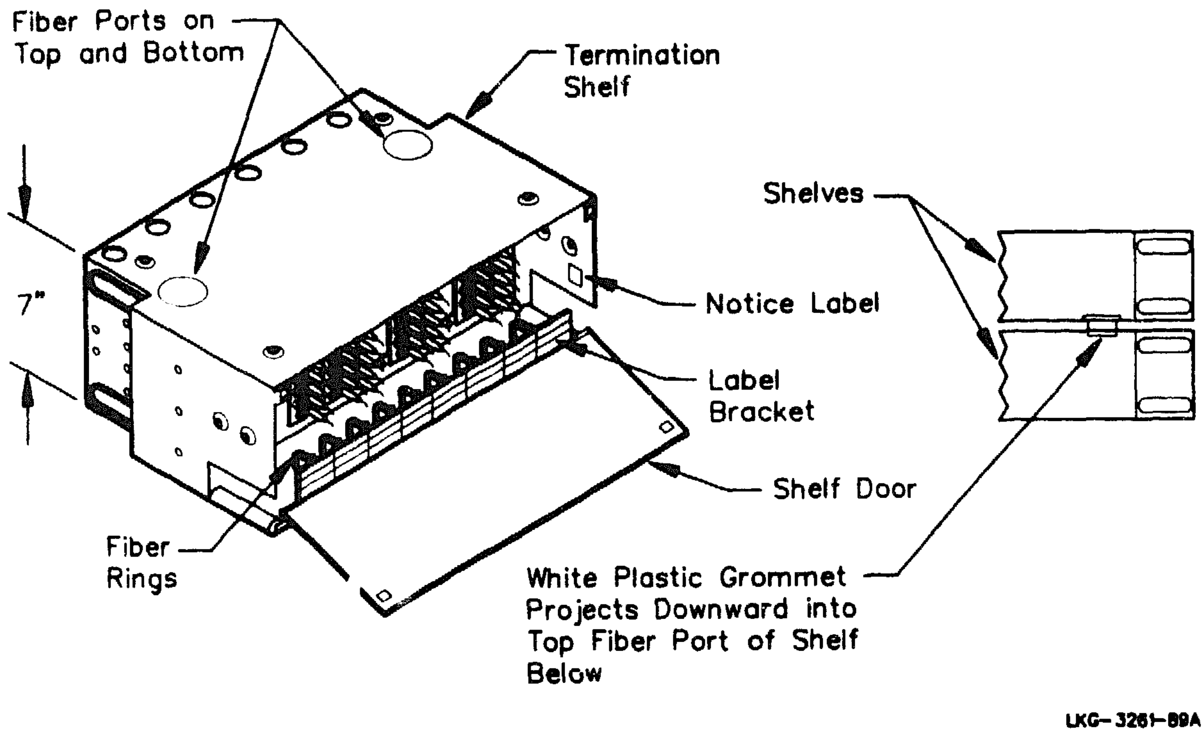


4.3 Termination Shelf Installation

The termination shelf, shown in Figure 4–6, is used for the termination of buffered indoor cables and direct termination of outdoor cables. The shelf is 17.8 centimeters (7 inches) high, 43.2 centimeters (17 inches) wide and 28 centimeters (11 inches) deep. Clamp brackets are used to secure buffered indoor cables or for securing up to four outdoor cables. The shelf also has provisions for storing buffered fiber slack while maintaining a minimum bend radius of 3.8 centimeters (1.5 inches). The standard mounting panel can mount up to 12 connector panels each containing six connector couplers, for a termination capability of 72 fibers. Fiber jumpers are routed in a trough that is equipped with fiber rings for strain relief. The shelf also provides a blank label for identifying fiber terminations

With the brackets supplied, the termination shelf can be mounted in an H9646 Office Communications Cabinet (OCC), Satellite Equipment Room (SER) 19-inch rack (H3120), or in 23-inch standard telecommunications racks.

Figure 4–6: The Termination Shelf



4.3.1 Preparation

The termination shelf has a number of small items that must be installed prior to rack or wall mounting. The installation will proceed faster if you assemble the shelf on a clean, flat work surface.

To prepare the termination shelf for installation, perform the following steps:

1. Unpack the termination shelf and verify that all parts are available by comparing the kit contents with the packing list. The items include the following:

   - Mounting brackets (2 sets)
   - Fiber rings
   - Termination label
   - Laser notice label
   - Cable clamp brackets
   - White plastic grommets

- Black rubber grommets
- Miscellaneous screws and nuts
- Connector panels (quantity: 12)

The following items may be required but not supplied:

- 2.5 mm bayonet ST-type connector couplers
- Core blocking and unit splitter for outdoor cable
- Cable clamps

2. Rotate the front door fasteners 1/4 turn and tilt open the shelf front door.
3. Apply the termination label to the label bracket and the laser notice label to either inside shelf wall.
4. Remove the front door. Do not reinstall the door until the shelf has been rack or wall mounted and the cable installation is complete. Then record the termination information
5. Rotate the rear door fasteners 1/4 turn and tilt open the shelf door. Remove the rear door. Do not reinstall the door until the shelf has been rack mounted and the cable installation is complete.
6. Snap the 11 fiber rings into the rear of the shelf (refer to Figure 4–12 for their location).
7. Snap the front fiber rings (shown in Figure 4–6) into place, or install them following the connector panel installation in Section 4.3.4.
8. If fibers are to be routed to adjacent shelves, remove either the top or bottom fiber port plugs as shown in Figure 4–6 (this will depend on the cable routing). Install the white plastic grommets in the fiber ports so that they project downward.

4.3.2 Rack Mounting Bracket Installation

Two types of mounting brackets are included with the shelf. One set is used specifically to recess mount the shelf in an Office Communications Cabinet (H9646-EA) or in a 19-inch SER rack (H3120). A second set has multiple holes and can be rotated for use in 19-inch or 23-inch racks.

To install the rack mounting brackets perform the following:

Position and attach each mounting bracket using the appropriate mounting holes using two 12-24 by 1/2 inch screws (with captive lock washers) and 12-24 nuts. Figure 4–7 details an extended 19-inch rack installation typically used in equipment rooms, while Figure 4–8 details a recessed 19-inch rack installation typically used in Office Communications Cabinets.

Figure 4–7: Rack Mounting Bracket Installation (Extended)

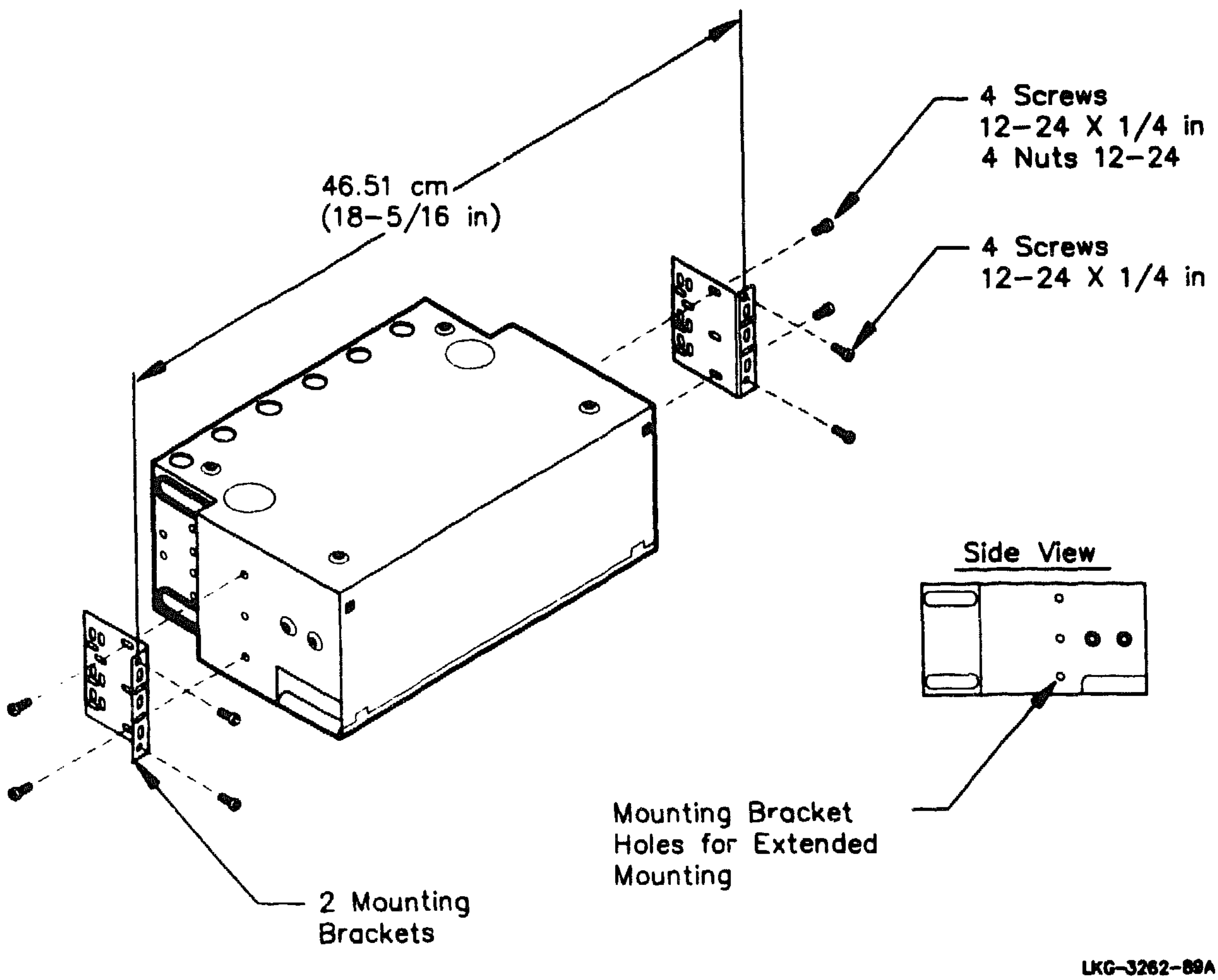
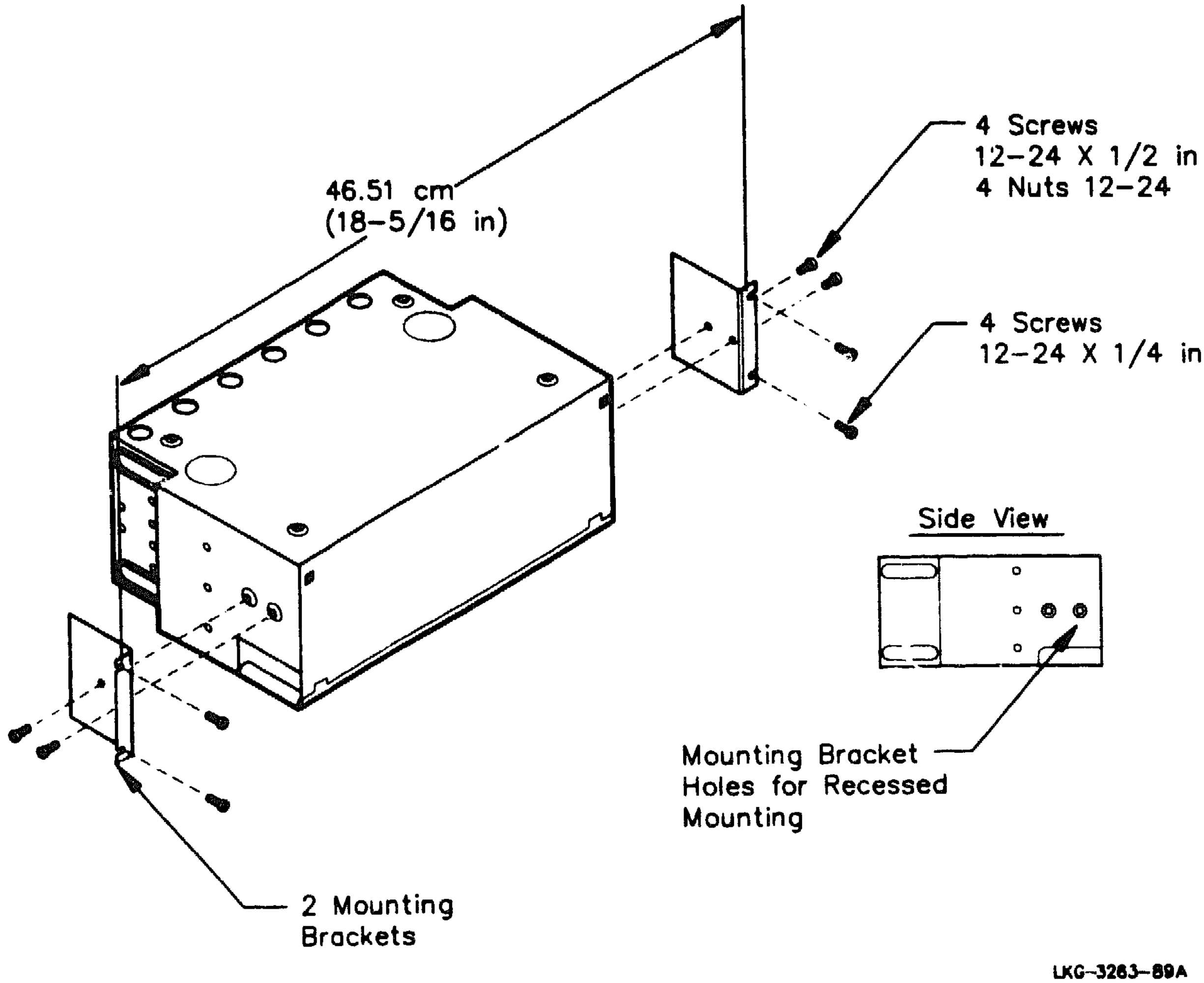


Figure 4–8: Rack Mounting Bracket Installation (Recessed)



4.3.3 Cable Clamp Bracket and Grommet Installation

To install the cable clamp brackets and black rubber grommets refer to Figure 4–9 or Figure 4–10 (depending on whether cable is routed from the top or the bottom), and perform the following steps:

1. Position and install each cable clamp to the sides of the shelf using two 10-24 by 3/8 inch screws and 10-24 nuts.
2. Snap the black rubber grommets (one on each side) into the fiber entry slots that are to be used.

Figure 4–9: Cable Clamp Bracket and Black Rubber Grommet Installation (Top Cable Entry)

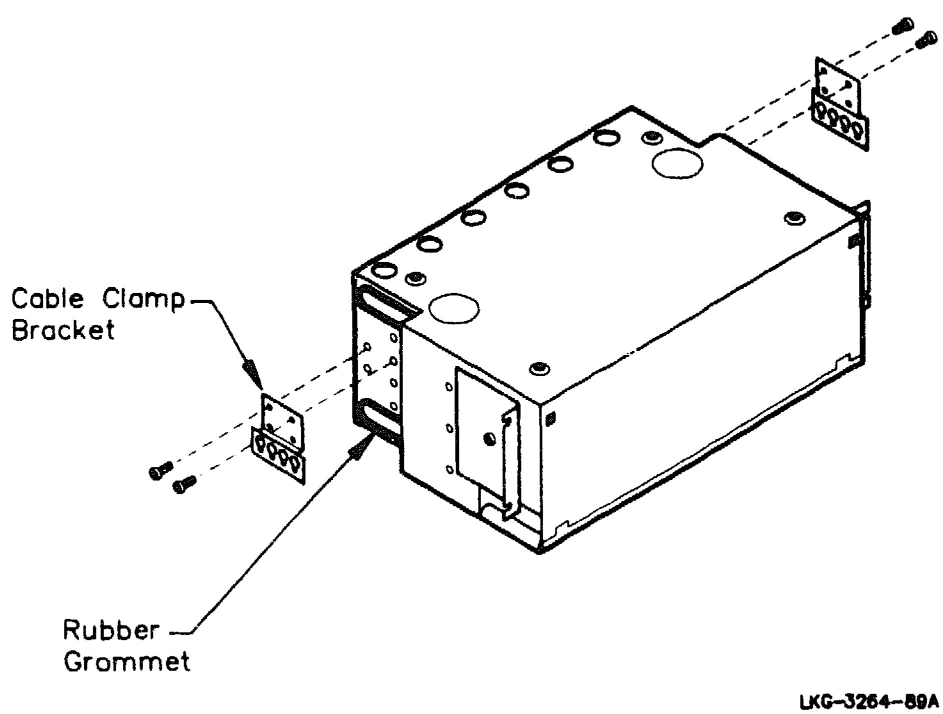
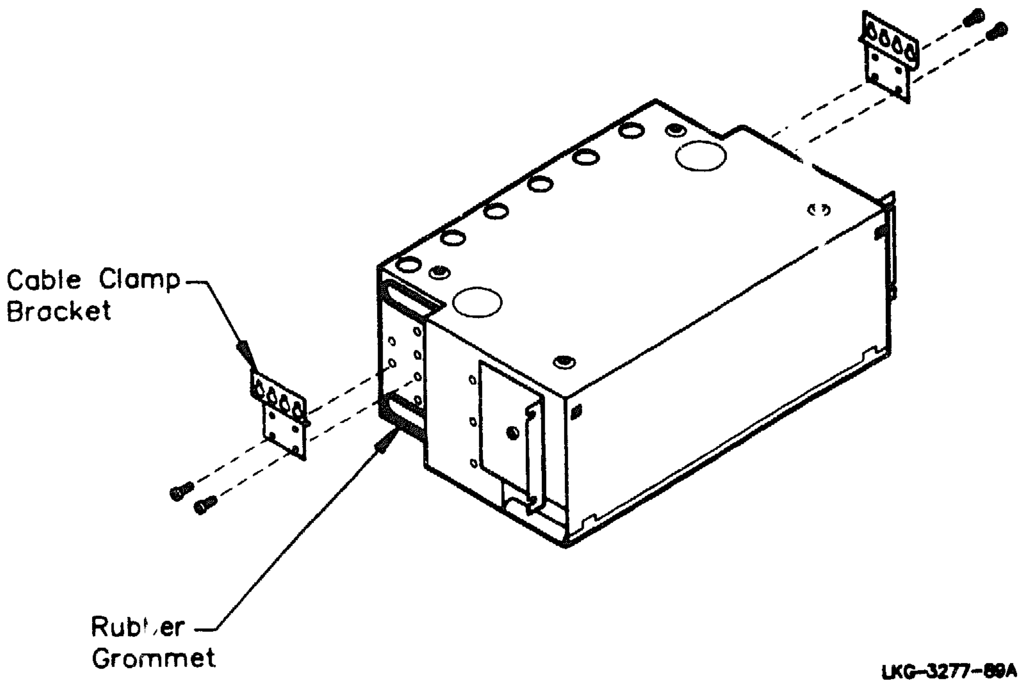


Figure 4–10: Cable Clamp Bracket and Black Rubber Grommet Installation (Bottom Cable Entry)

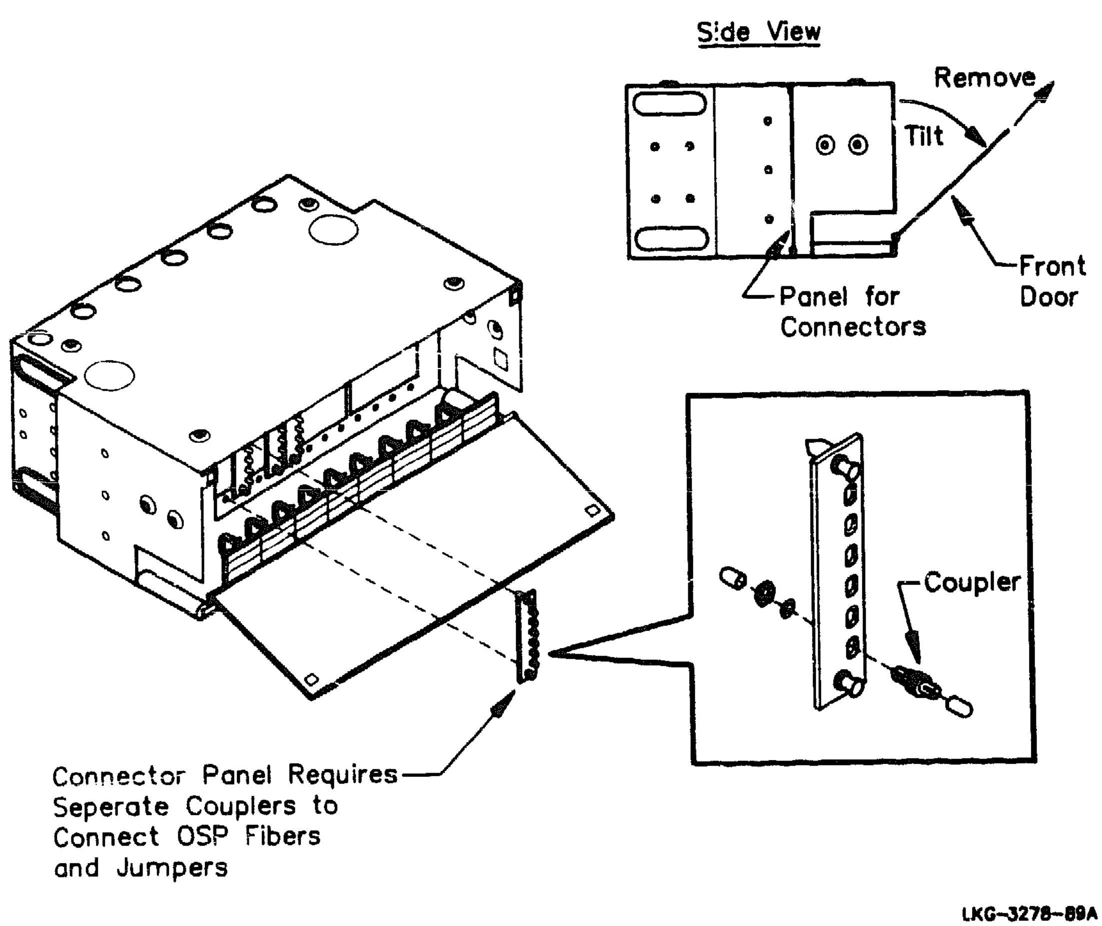


4.3.4 Connector Panel Installation

To install connector panels, refer to Figure 4–11 and perfom the following steps:

1. Install couplers into the connector panels (or use preloaded coupler panels H3114-FF'). Use a red or black marker or an optional installable plastic washer as described in Section 1.6.3.2.
2. Peel the backing from the connector panel labels, align them with the couplers, and press them onto the panels. (Note: this may be already installed.)
3. Install the connector panels in the shelf by partially pulling out the white plungers on each connector panel, aligning the plungers with the holes on the connector panel door, and then pushing the plungers in to secure the panel.

Figure 4–11: Connector Panel Installation



4.3.5 Indoor Buffered Fiber Cable Installation

Access to the termination shelf interior may be limited if the shelf is rack mounted. Some installations will have provisions for front, side, and rear access while others will have limited access, typically from the front.

In the installations with unlimited access, the connector panels can be left in the connector panel door and connectorized fibers routed and coupled easily by lowering the rear shelf door. For front access installations, the connector panel door must be removed and moved to the front door position to allow access to the rear of the shelf. After the fibers have been routed and the connectors coupled, the slack fiber is managed and the connector panel door is then moved back to the original position.

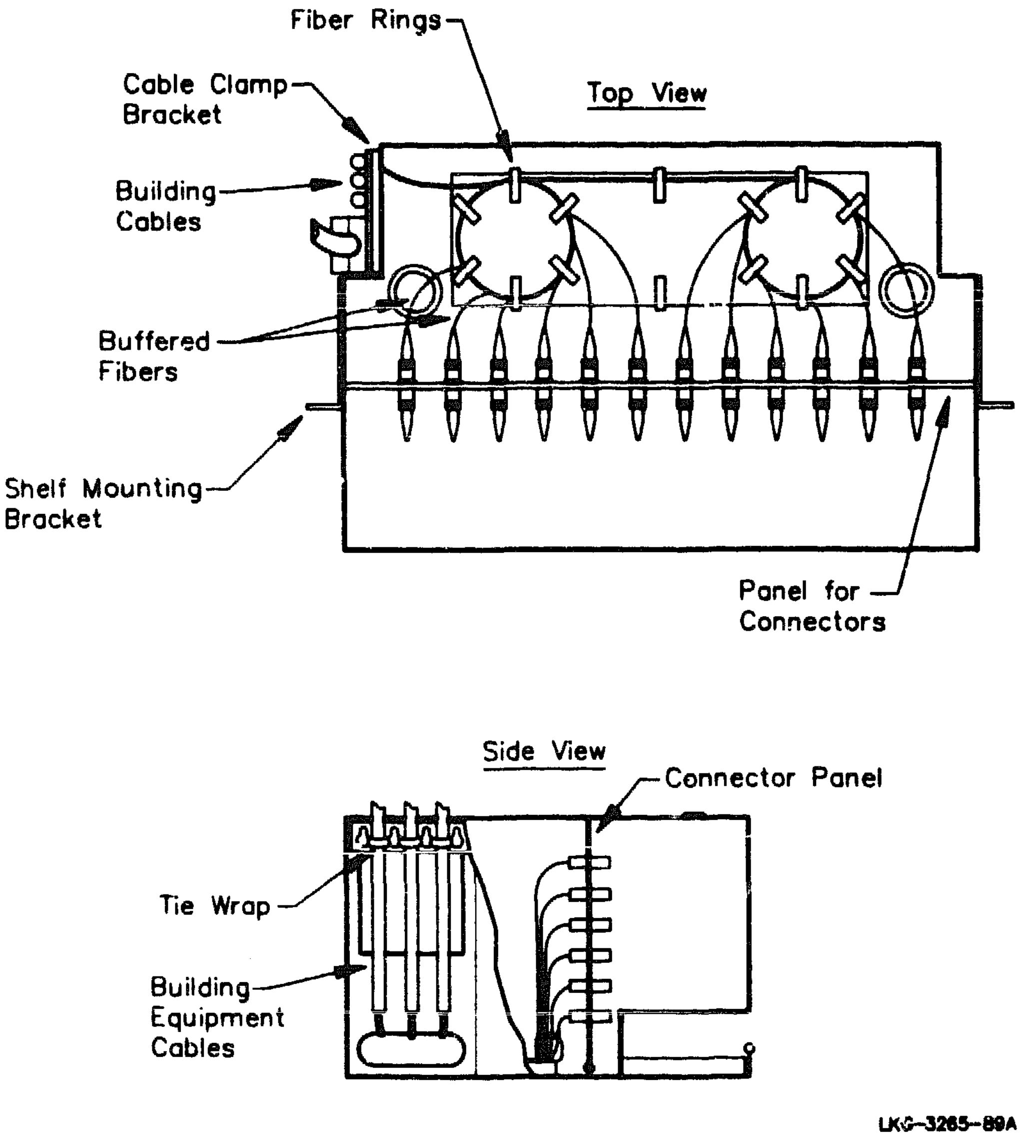
To install indoor buffered fiber cable to a termination shelf with unlimited access, refer to Figure 4–12 and perform the following steps:

NOTE

When using tie wraps to secure buffered fibers to the shelf do not cinch the tie wraps. Over-tightening of the cable can damage the fibers. Use only enough pressure to hold the cable in position.

1. Install the shelf in the rack using two 12-24 by 1/4 inch screws for each mounting bracket.
2. Loosely secure (tie wrap) buffered fiber cables to the cable clamp bracket on the shelf.
3. Route the buffered fibers into the shelf storing fiber rings as shown in Figure 4–12.
4. Connectorize the buffered fibers and couple to the rear of the connector panel.

Figure 4–12: Indoor Buffered Fiber Cable Installation (Termination Shelves with Unlimited Access)



4.3.6 Outdoor Cable Installation

Outdoor cable will always be clamped at the rear of the shelf with cable routing into the shelf from the top or the bottom. To install outdoor cable to termination shelves, refer to Figure 4–13 or Figure 4–14 (depending on whether the cable is routed from the top or the bottom) and perform the following steps:

1. Install the shelf in the rack using two 12-24 by 1/4 inch screws for each mounting bracket.
2. Remove the cable outer sheath, perform core tube blocking, and install a unit splitter and cable buffering as described in Appendix B.
3. Install the cable clamp into the cable clamp bracket on the rear of the termination shelf. Refer to the procedures provided with the cable clamp bracket for details on assembling the clamp.
4. Secure the cable to the cable clamp bracket and ground the cable to the rack.
5. Route the cable fibers into the shelf for connectorization and coupling to the connector panels.

Figure 4–13: Outdoor Cable Installation (Top Cable Entry)

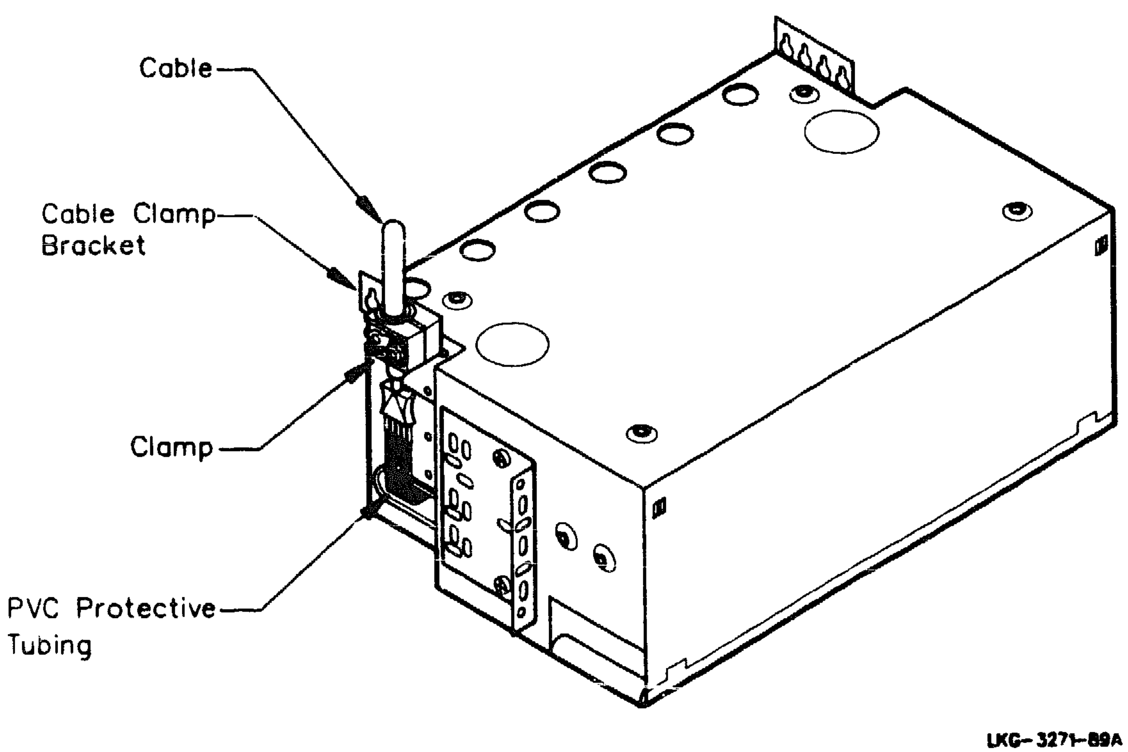
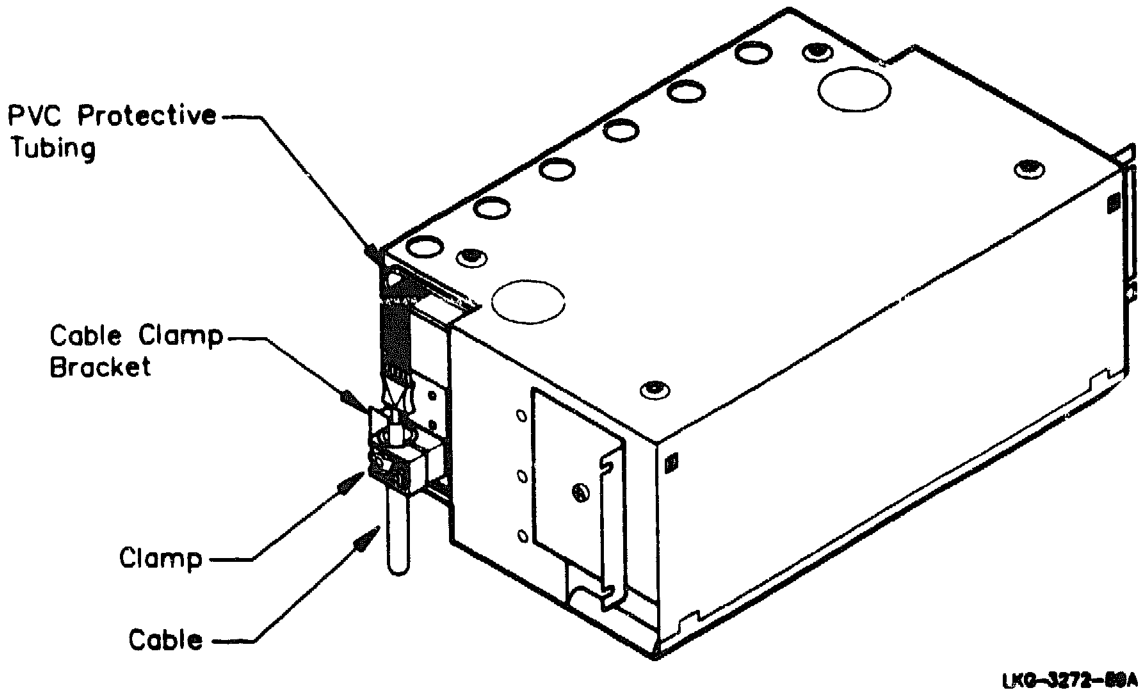


Figure 4–14: Outdoor Cable Installation (Bottom Cable Entry)



4.3.7 Termination Shelf Wall Mount Installation

The termination shelf can be used in wall mount applications using the brackets supplied. Wall mounting limits access to the front of the shelf. To install the termination shelf wall mount bracket and cable clamp bracket refer to Figure 4–15 and perform the following steps:

1. Install both the mounting bracket and the cable clamp bracket to the side of the shelf using three 12-24 by 1/2 inch screws (with captive lock washers) and 12-24 nuts. Select the cable routing (top or bottom) to determine the clamp alignment before installing. Two screws go through both brackets, while the third screw goes through the mounting bracket only. Repeat for the opposite side shelf.

2. Install the shelf to the wall surface with two fasteners (locally obtained) per mounting bracket. The fasteners should be appropriate for the wall surface.

For buffered fiber cable installation, loosely secure (tie wrap) the cables to the cable clamp bracket on the shelf.

For outdoor cable installation refer to Figure 4–16 and Figure 4–17 and perform the following steps:

1. Remove the cable outer sheath, perform core tube blocking, and install a unit splitter and cable buffering as described in Appendix B.
2. Install the cable clamp into the cable clamp bracket on the rear of the termination shelf. Refer to the procedures provided with the cable clamp bracket for details on assembling the clamp.
3. Secure the cable to the cable clamp bracket and ground the cable.
4. Route the cable fibers into the shelf for connectorization and coupling to the connector panels.

Figure 4–15: Wall Mount Bracket and Cable Clamp Bracket Installation

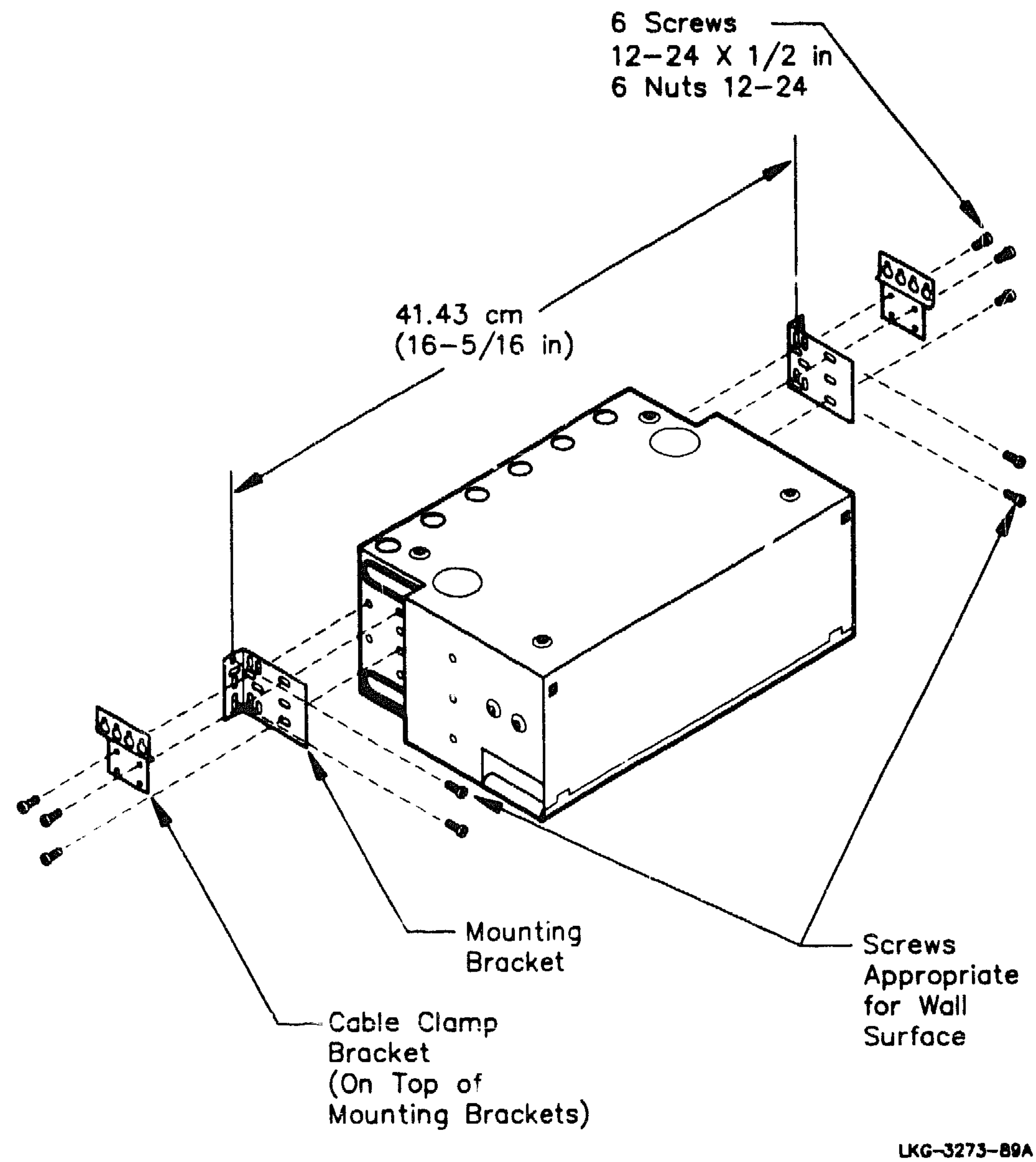


Figure 4–16: Outdoor Cable Installation (Top Entry)

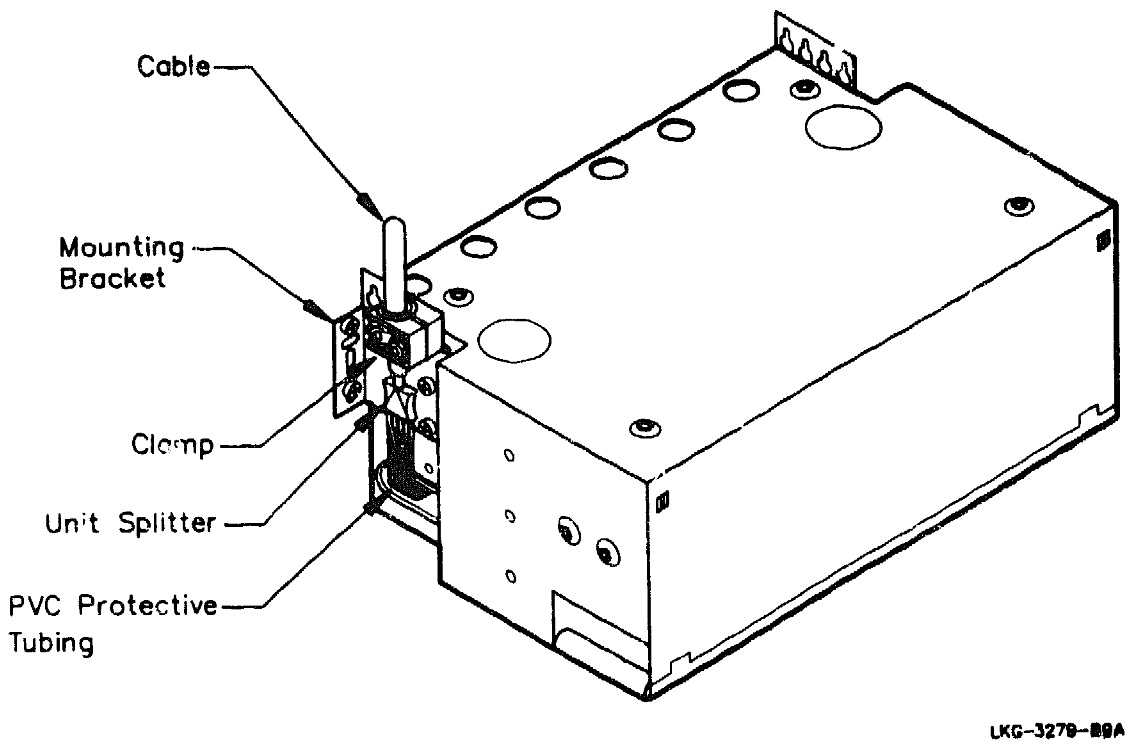
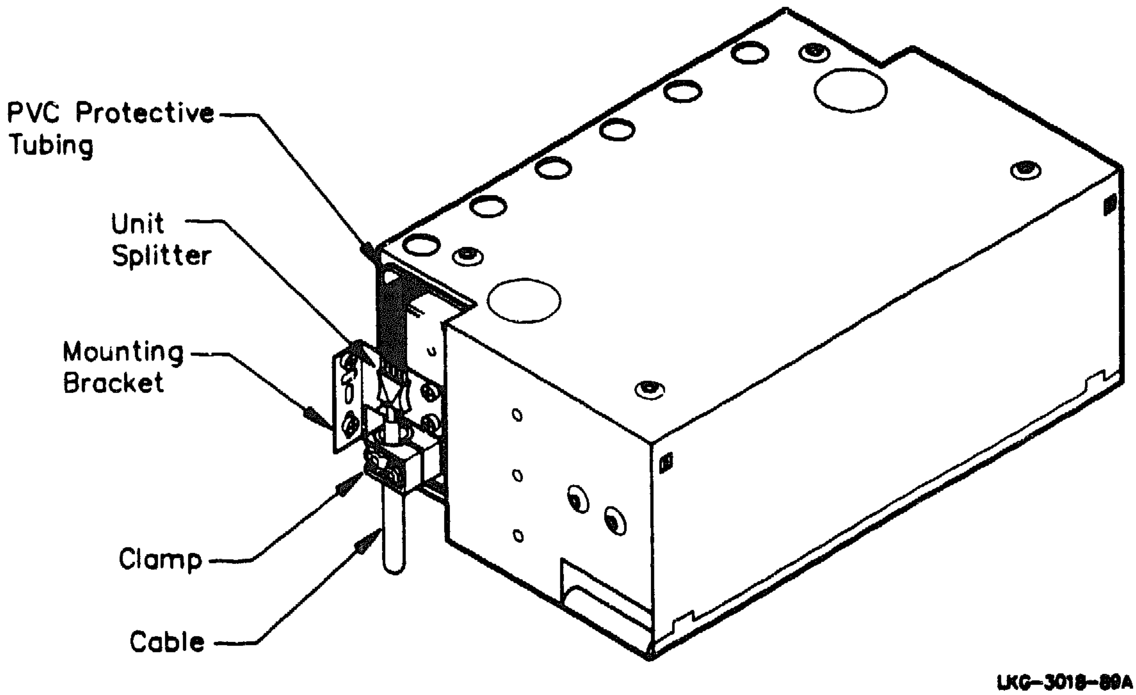


Figure 4–17: Outdoor Cable Installation (Bottom Entry)

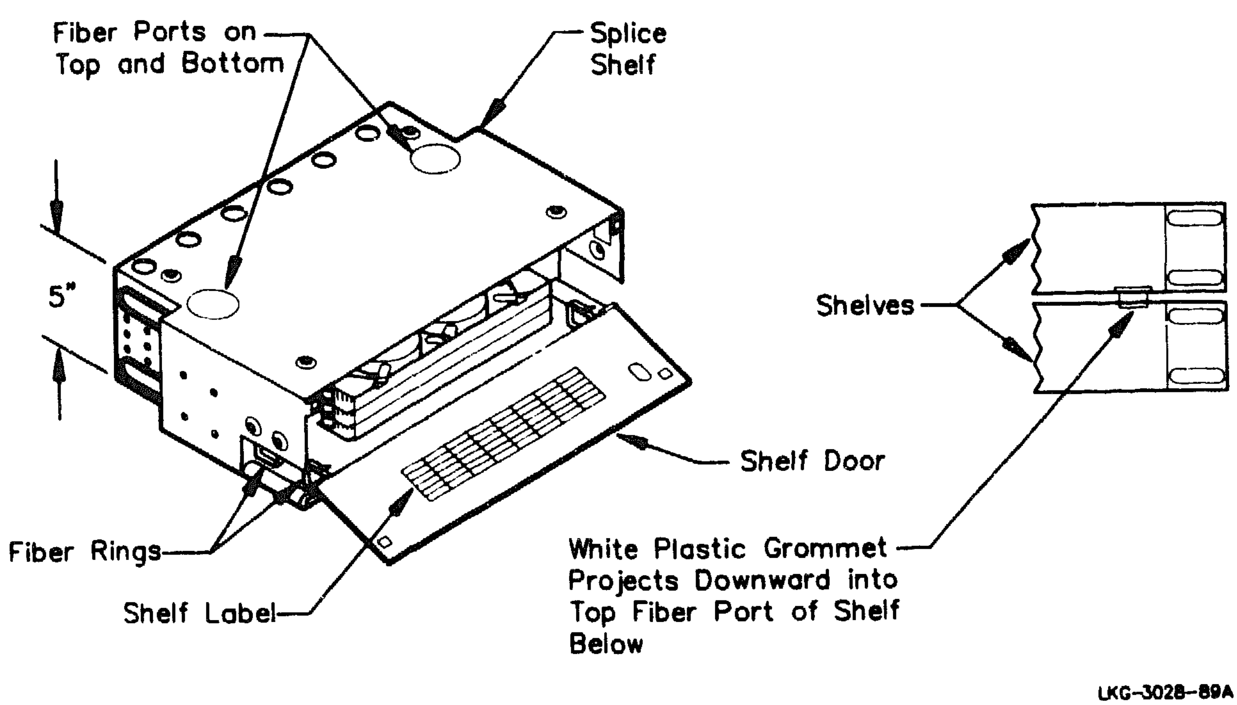


4.4 Splice Shelf Installation

The splice shelf, shown in Figure 4–18, is used to mount up to three splice organizers in a shelf that is 12.7 centimeters (5 inches) high, 43.18 centimeters (17 inches) wide, and 27.94 centimeters (11 inches) deep. The shelf is typically used in splice only applications to store individual splices. Up to four outdoor cable clamps can be secured to a shelf. Fiber splices are identified on a label attached to the inside of the shelf door.

With the brackets supplied, the splice shelf can be mounted in an H9646 Office Communications Cabinet (OCC), Satellite Equipment Room (SER) 19-inch rack (H3120), or in 23-inch standard telecommunications racks.

Figure 4–18: The Splice Shelf



4.4.1 Preparation

The splice shelf has a number of small items that must be installed prior to rack or wall mounting. The installation will proceed faster if you assemble the shelf on a clean flat work surface.

To prepare the splice shelf for installation, perform the following steps:

1. Unpack the splice shelf and verify that all parts are available by comparing the kit contents with the packing list. The items include the following:
   - Miscellaneous screws and nuts
   - Mounting brackets (2 sets)
   - Fiber rings
   - Splice label
   - Cable clamp brackets
   - White plastic grommets
   - Black rubber grommets
2. Rotate the front door fasteners 1/4 turn, tilt open the shelf front door.
3. Apply the splice label to the inner side of the door.
4. Position and snap the fiber rings into the front and back of the shelf (as shown in Figure 4–26).
5. If fibers are to be routed to adjacent shelves, remove either the top or bottom fiber port plugs (shown in Figure 4–18). Install white plastic grommets in the fiber ports, so that they project downward.
6. Return the front door to the closed position and rotate the fasteners 1/4 turn to secure.

4.4.2 Rack Mounting Bracket Installation

Two types of mounting brackets are included with the shelf. One set is used specifically to recess mount the shelf in an Office Communications Cabinet. A second set has multiple holes and can be rotated for use in 19-inch, and 23-inch racks.

To install the rack mounting brackets perform the following:

Position and attach each mounting bracket using the appropriate mounting holes using two 12-24 by 1/2 inch screws (with captive lock washers) and 12-24 nuts. Figure 4–19 details an extended 19-inch rack installation typically used in equipment rooms, while Figure 4–20 details a recessed 19-inch rack installation typically used in Office Communications Cabinets.

Figure 4–19: Rack Mounting Bracket Installation (Extended)

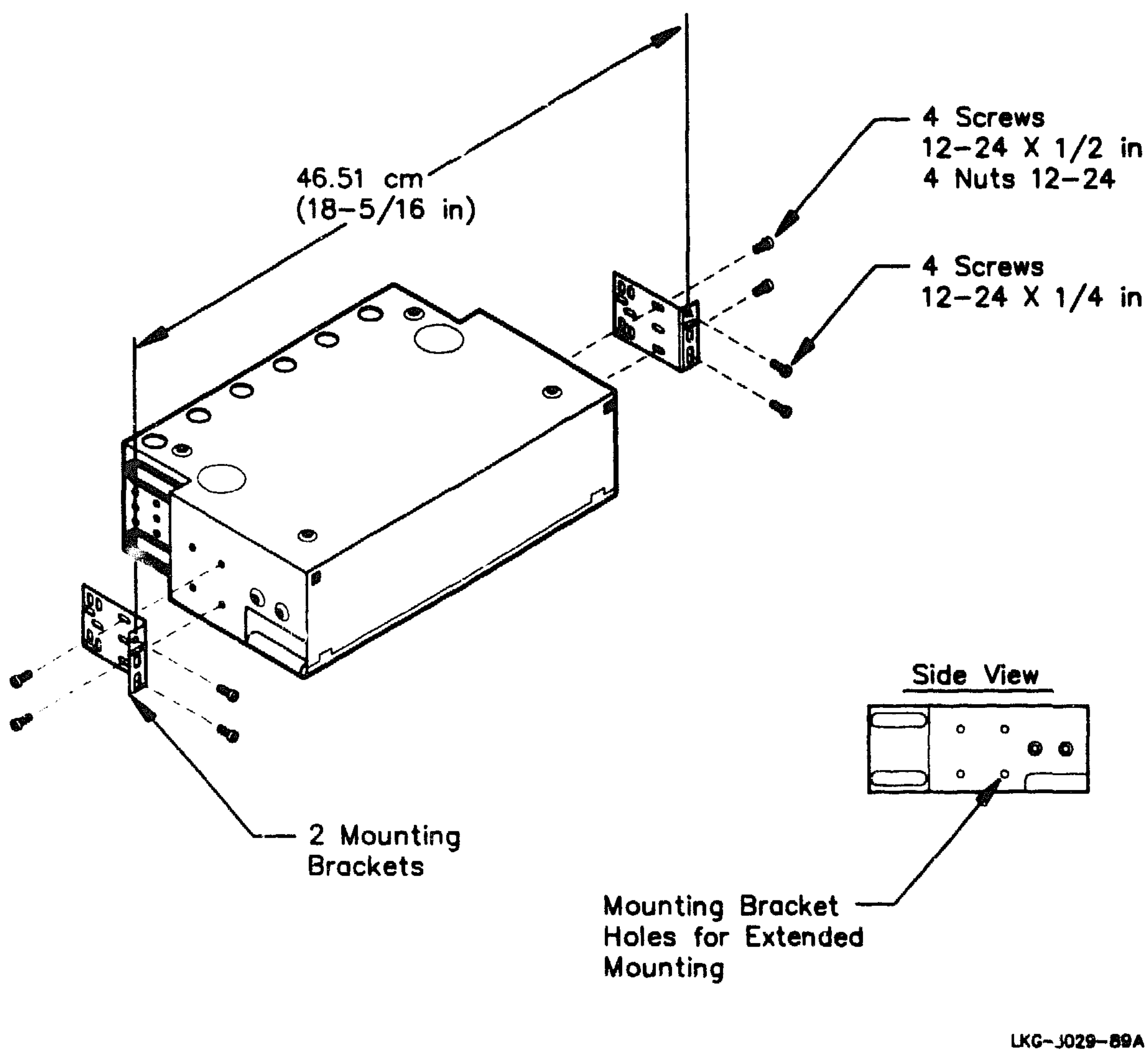
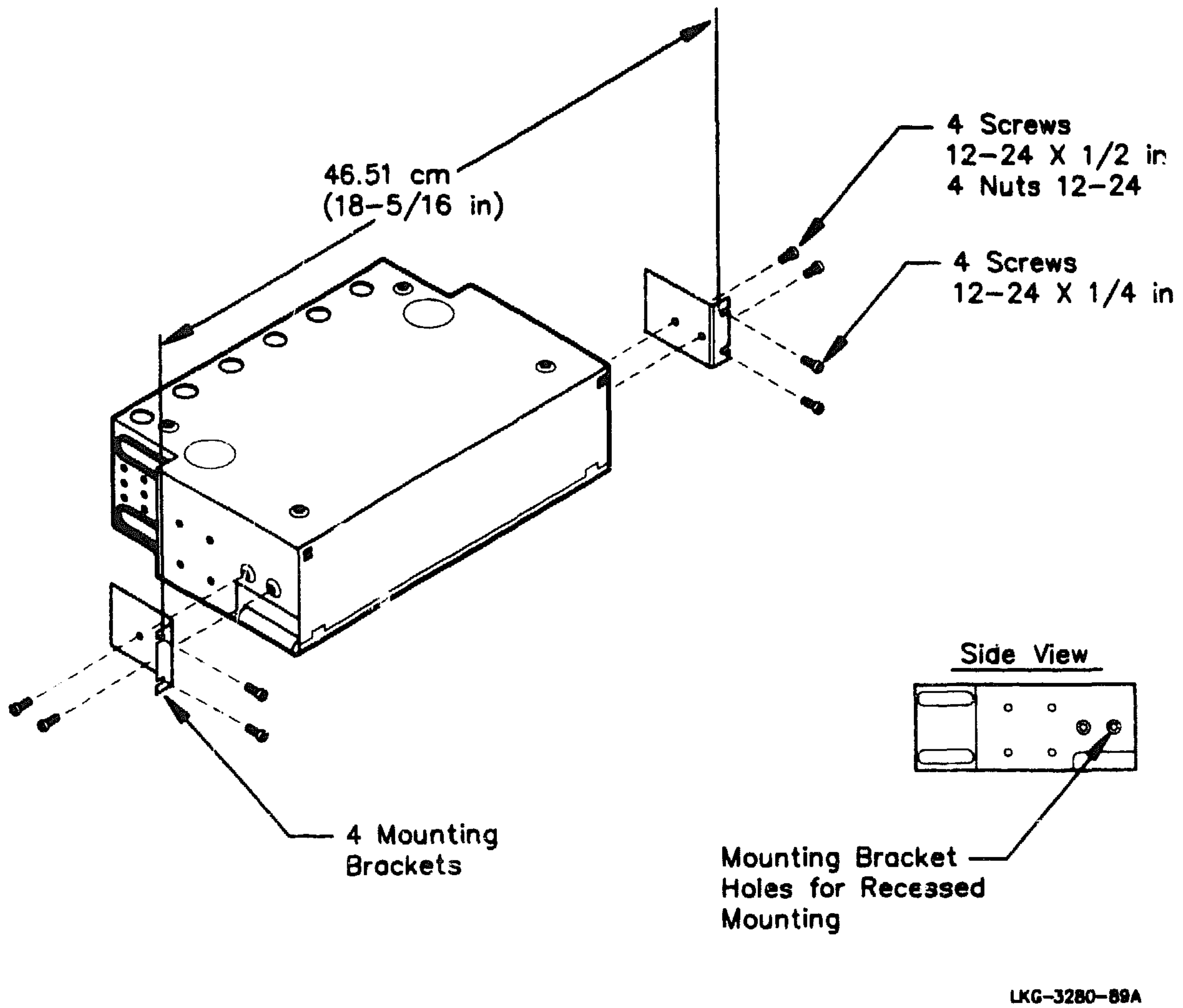


Figure 4–20: Rack Mounting Bracket Installation (Recessed)



4.4.3 Cable Clamp Bracket and Grommet Installation

To install the cable clamp brackets and black rubber grommets refer to Figure 4–21 or Figure 4–22 (depending on whether the cable is routed from the top or bottom), and perform the following steps:

1. Position and install each cable clamp to the sides of the shelf using two 10-24 by 3/8 inch screws and 10-24 nuts as shown in Figure 4–21.

2. Snap the black rubber grommets (one on each side) into the fiber entry slots that are to be used.

Figure 4–21: Cable Clamp Bracket and Black Rubber Installation (Top Cable Entry)

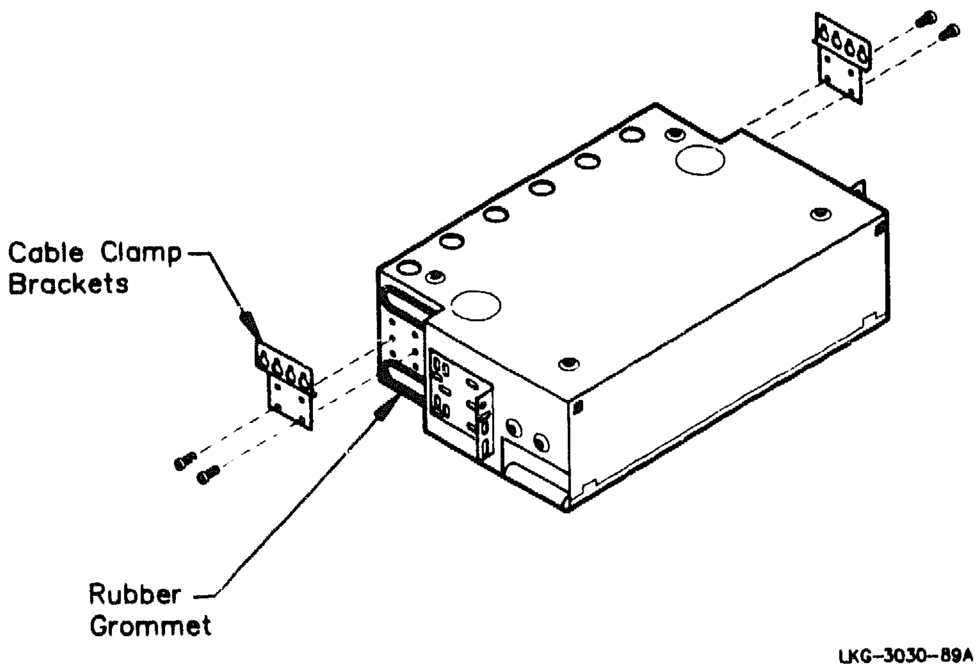
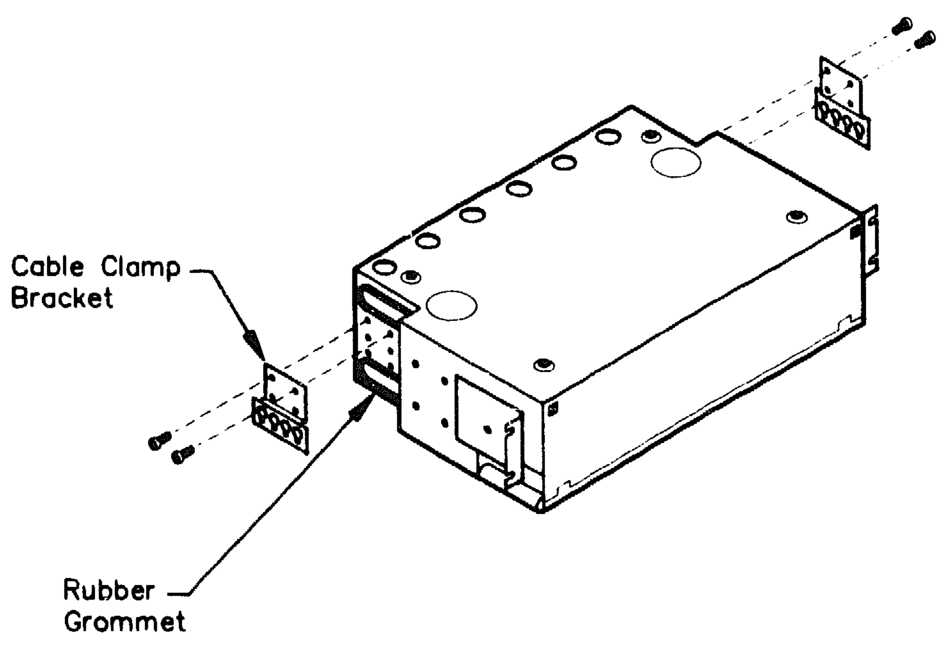


Figure 4–22: Cable Clamp Bracket and Black Rubber Installation (Bottom Cable Entry)

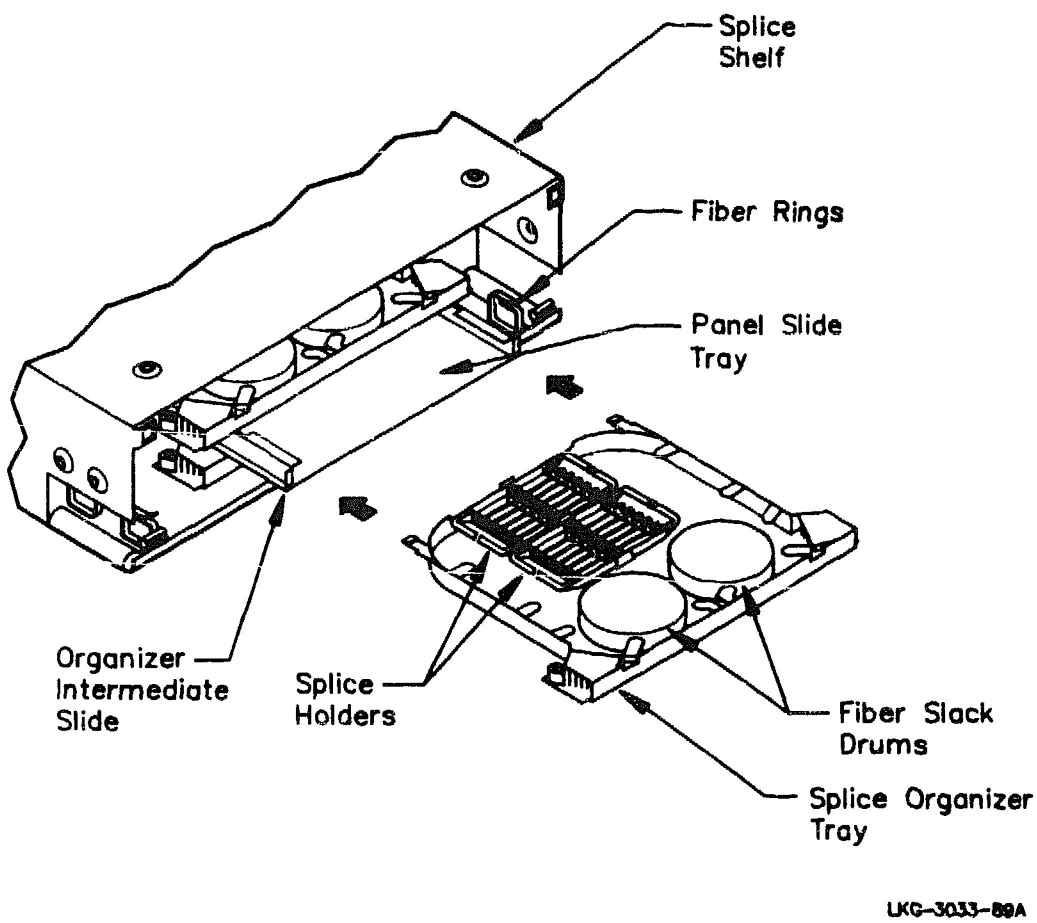


4.4.4 Splice Organizer Installation

A splice organizer is shown in Figure 4–23. To install the organizer into the splice shelf perform the following steps:

1. Rotate the front door fasteners 1/4 turn and tilt open the shelf front door.
2. Insert the organizer intermediate slide into the splice shelf.
3. Depress the tabs on the rear of the splice organizer tray, insert into the intermediate slide, and push the tray into the shelf.
4. Repeat Steps 2 and 3 for the remaining splice organizer trays.

Figure 4–23: Splice Organizer Installation



4.4.5 Outdoor Cable Installation

To install outdoor cable in the splice shelf, refer to Figure 4–24 or Figure 4–25 (depending on whether the cable is routed from the top or the bottom) and perform Steps 1–4:

1. Install the shelf in the rack using two 12-24 by 1/4 inch screws for each mounting bracket.
2. Remove the cable outer sheath, perform core tube blocking, and install a unit splitter and cable buffering as described in Appendix B.
3. Secure the cable to the cable clamp bracket and ground the cable to the rack.
4. Route the cable fibers into the shelf for splicing.

Figure 4–24: Outdoor Cable Installation (Top Cable Entry)

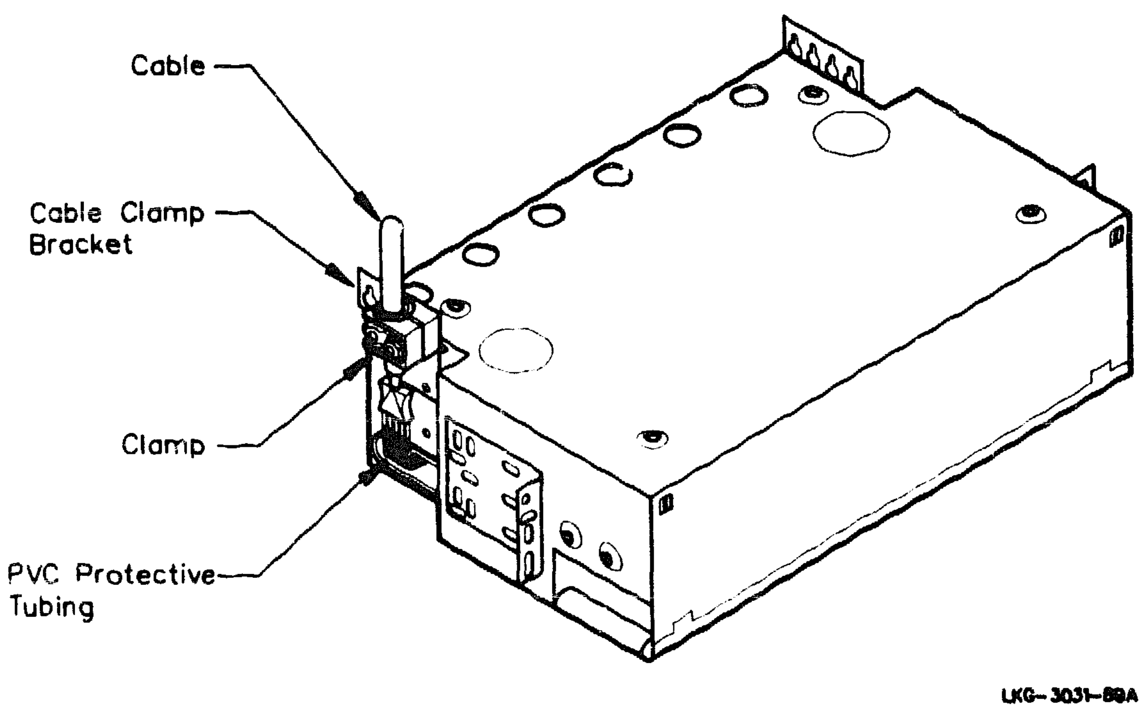
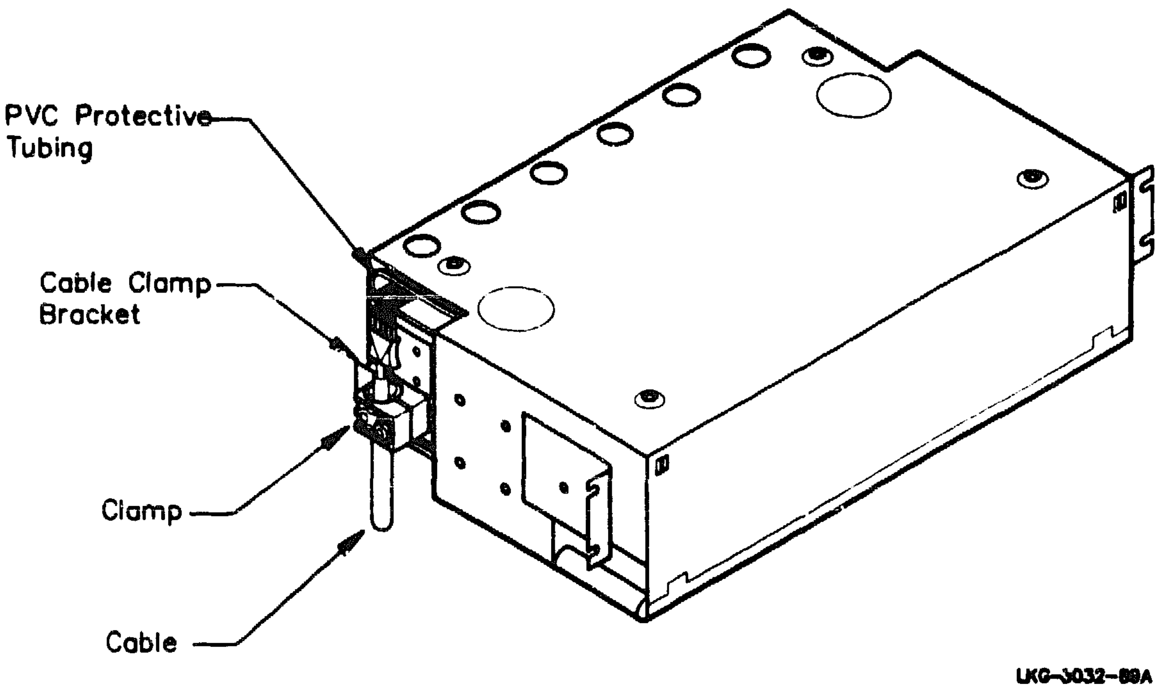


Figure 4–25: Outdoor Cable Installation (Bottom Cable Entry)



4.4.6 Outdoor Cable Fiber Splicing

To splice outdoor cable refer to Figure 4–26 and follow the procedures described below.

To splice with the organizer installed, perform the following steps:

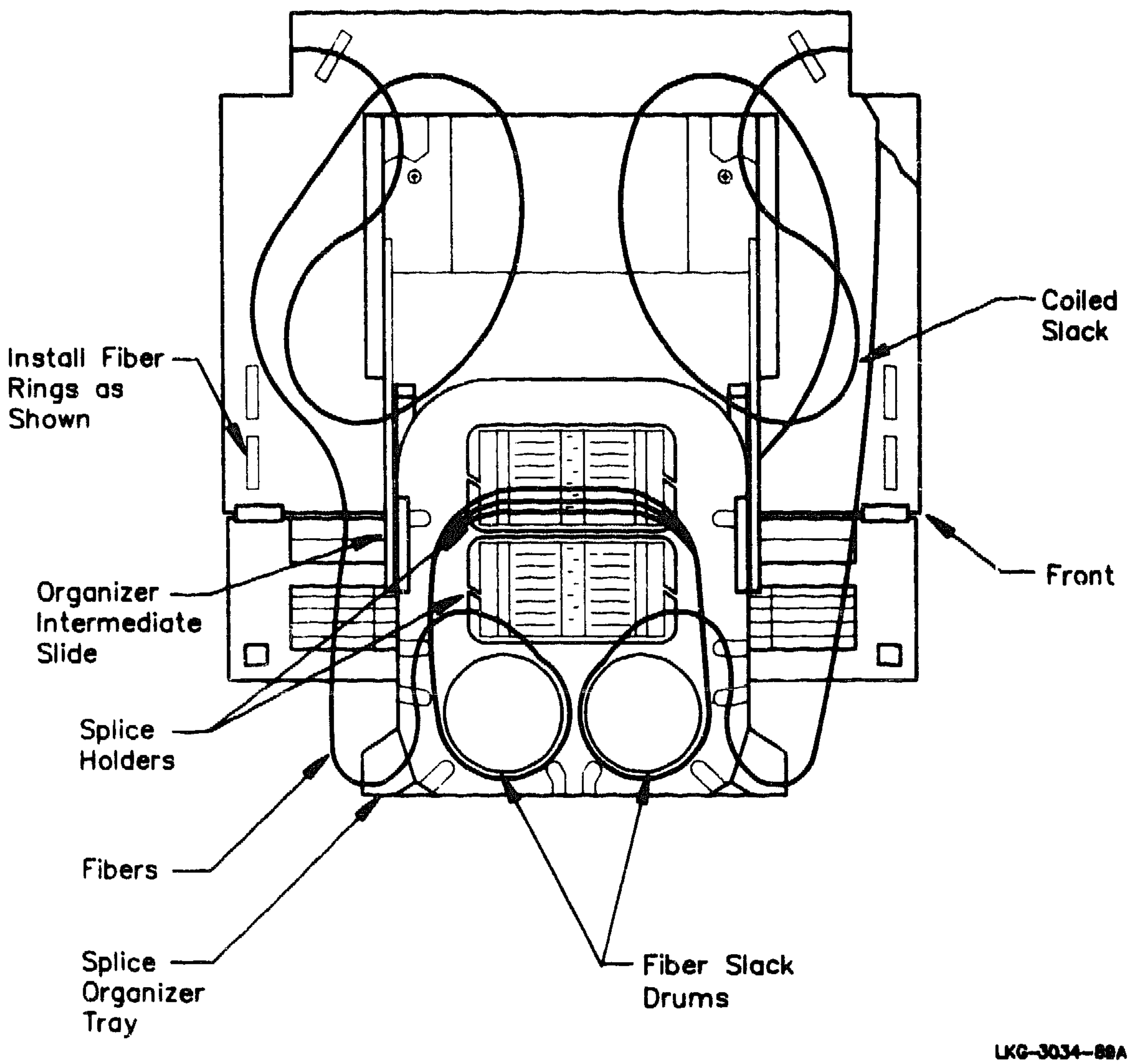
1. Obtain the appropriate splice material for the splicing method being used.
2. Pull the splice organizer tray out to the "stop" position.
3. Remove the left and right entrance covers.
4. Splice the fibers, place the splices into the holders, and coil two loose turns of excess fiber slack around the fiber drums in the tray.
5. Reinstall the left and right entrance covers.
6. Slide the splice organizer tray back into the shelf.
7. Carefully coil and store excess fiber slack into the bottom of the splice shelf.

To splice with the organizer removed from the shelf, perform the following steps:

1. Obtain the appropriate splice material for the splicing method being used.
2. Pull the splice organizer tray out to the "stop" position. Press down the rear tabs on the splice organizer tray and remove it from the intermediate slide.
3. Remove the left and right entrance covers.
4. Splice the fibers, place the splices into the holders, and coil two loose turns of excess fiber slack around the fiber drums in the tray.
5. Reinstall the left and right entrance covers.
6. Depress the tabs on the rear of the splice organizer tray, insert into the intermediate slides, and push into the shelf.
7. Carefully coil and store excess fiber slack into the bottom of the splice shelf.

This completes the installation.

Figure 4–26: Splice Shelf Outdoor Cable Fiber Splicing

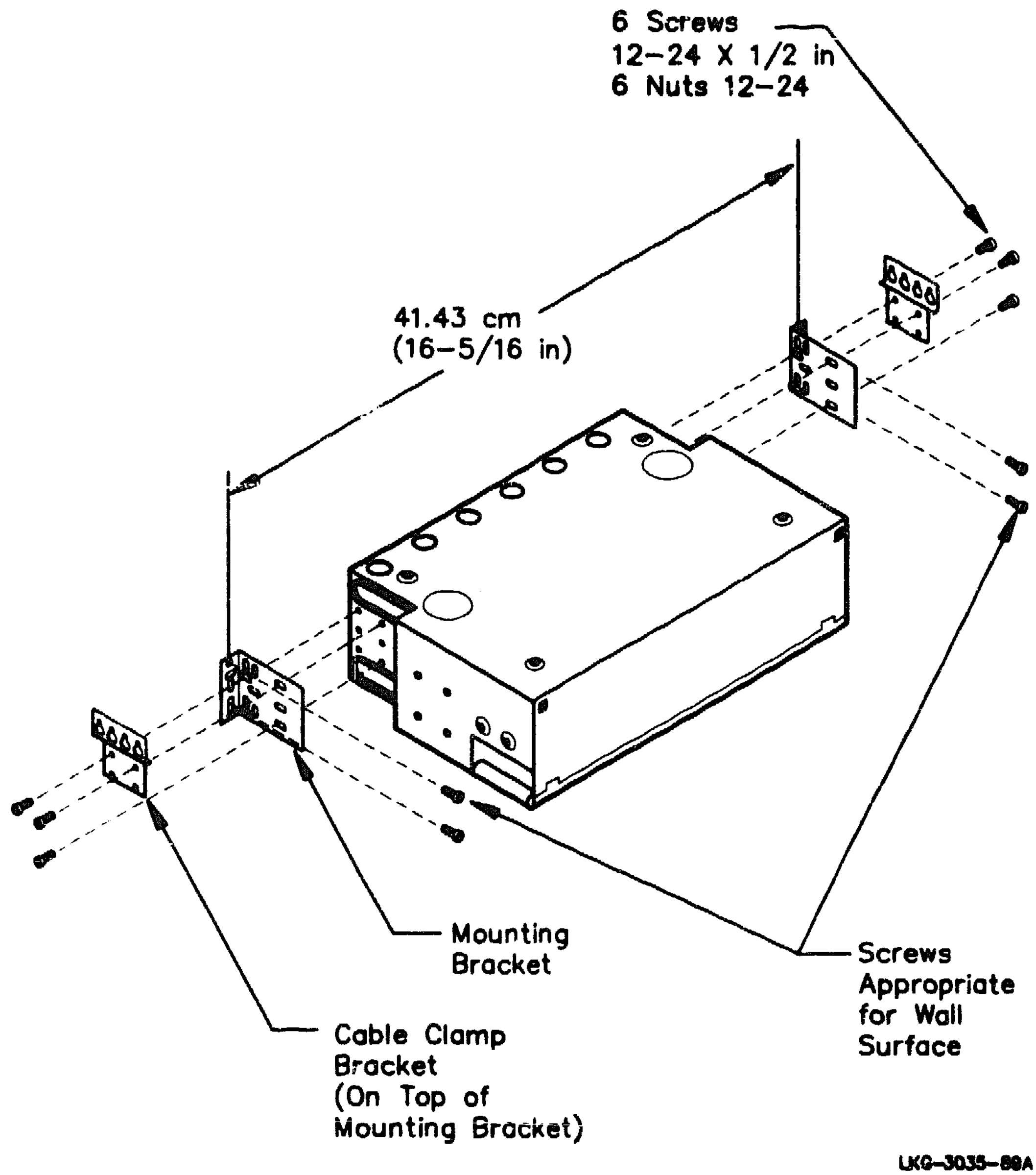


4.4.7 Splice Shelf Wall Mount Installation

The splice shelf can be wall mounted using the brackets supplied. To wall mount the splice shelf, refer to Figure 4–27 and perform the following steps:

1. Position and attach the shelf mounting bracket and cable clamp bracket to the side of the shelf with three 12-24 by 1/2 inch screws (with captive lockwashers) and 12-24 nuts. Select the cable routing (top or bottom) to determine the clamp alignment before installing. Two screws go through both brackets while the third screw goes through the mounting bracket only. Repeat the same procedure for the opposite side.
2. Install the shelf to the wall surface with two fasteners (locally obtained) per mounting bracket. Fasteners should be appropriate for the wall surface.
3. Snap the black rubber grommets into the fiber entry slots to be used.
4. Install the splice organizer tray and prepare and clamp cables as described in Sections 4.4.4 through 4.4.6.

Figure 4–27: Wall Mount Bracket and Cable Clamp Bracket Installation

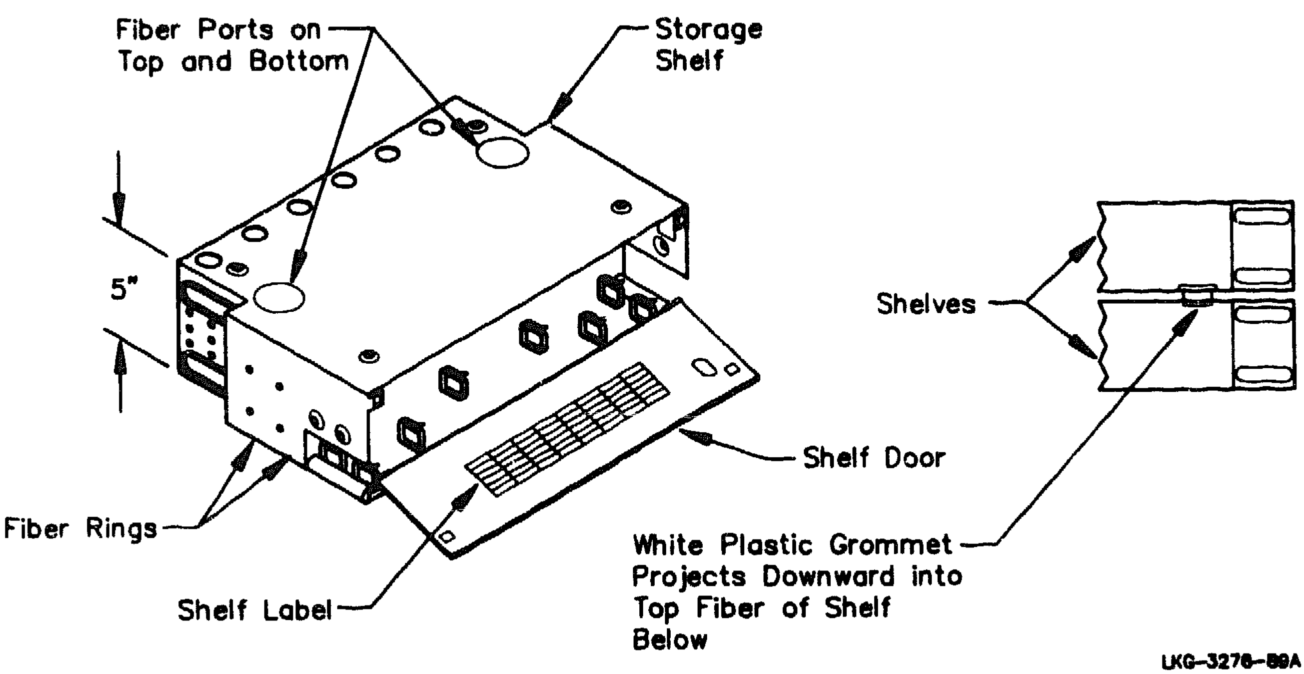


4.5 Storage Shelf Installation

The storage shelf, shown in Figure 4–28, is used to store slack in preassembled crossconnect jumper cables, or to take up slack in buffered cables routed from equipment, or outdoor cables. The shelf is 12.7 centimeters (5 inches) high, 43.18 centimeters (17 inches) wide, and 25.4 centimeters (11 inches) deep. Jumper cable slack can be coiled in the storage shelf and retained with fiber rings provided with the shelf.

With the brackets supplied, the storage shelf can be mounted in an H9646 Office Communications Cabinet (OCC), Satellite Equipment Room (SER) 19-inch rack (H3120), or in 23-inch standard telecommunications racks.

Figure 4–28: The Storage Shelf



4.5.1 Preparation

The storage shelf has a number of small items that must be installed prior to rack or wall mounting. The installation will proceed faster if you assemble the shelf on a clean flat work surface.

To prepare the storage shelf for installation, perform the following steps:

1. Unpack the storage shelf and verify that all parts are available by comparing the kit contents with the packing list. The items include the following:

   - Miscellaneous screws and nuts
   - Mounting brackets (2 sets)
   - Fiber rings
   - Storage label
   - Laser notice label
   - Cable clamp brackets
   - White plastic grommets
   - Black rubber grommets

2. Rotate the front door fasteners 1/4 turn, tilt open the shelf front door, and apply the storage label to the inner side of the door.

3. Position and snap the fiber rings into the front and back of the shelf (as shown in Figure 4–33).

4. If fibers are to be routed to adjacent shelves, remove the top or bottom fiber port plugs (shown in Figure 4–28). Install white plastic grommets in the fiber ports, so that they project downward.

5. Return the front door to the closed position and rotate the fasteners 1/4 turn to secure.

4.5.2 Storage Shelf Rack Installation

To install the shelf mounting brackets perform the following:

Position and attach each mounting bracket using the appropriate mounting holes using two 12-24 by 1/2 inch screws (with captive lock washers) and 12-24 nuts. Figure 4–29 details an extended 19-inch rack installation typically used in equipment rooms, while Figure 4–30 details a recessed 19-inch rack installation typically used in Office Communications Cabinets.

Figure 4–29: Rack Mounting Bracket Installation (Extended)

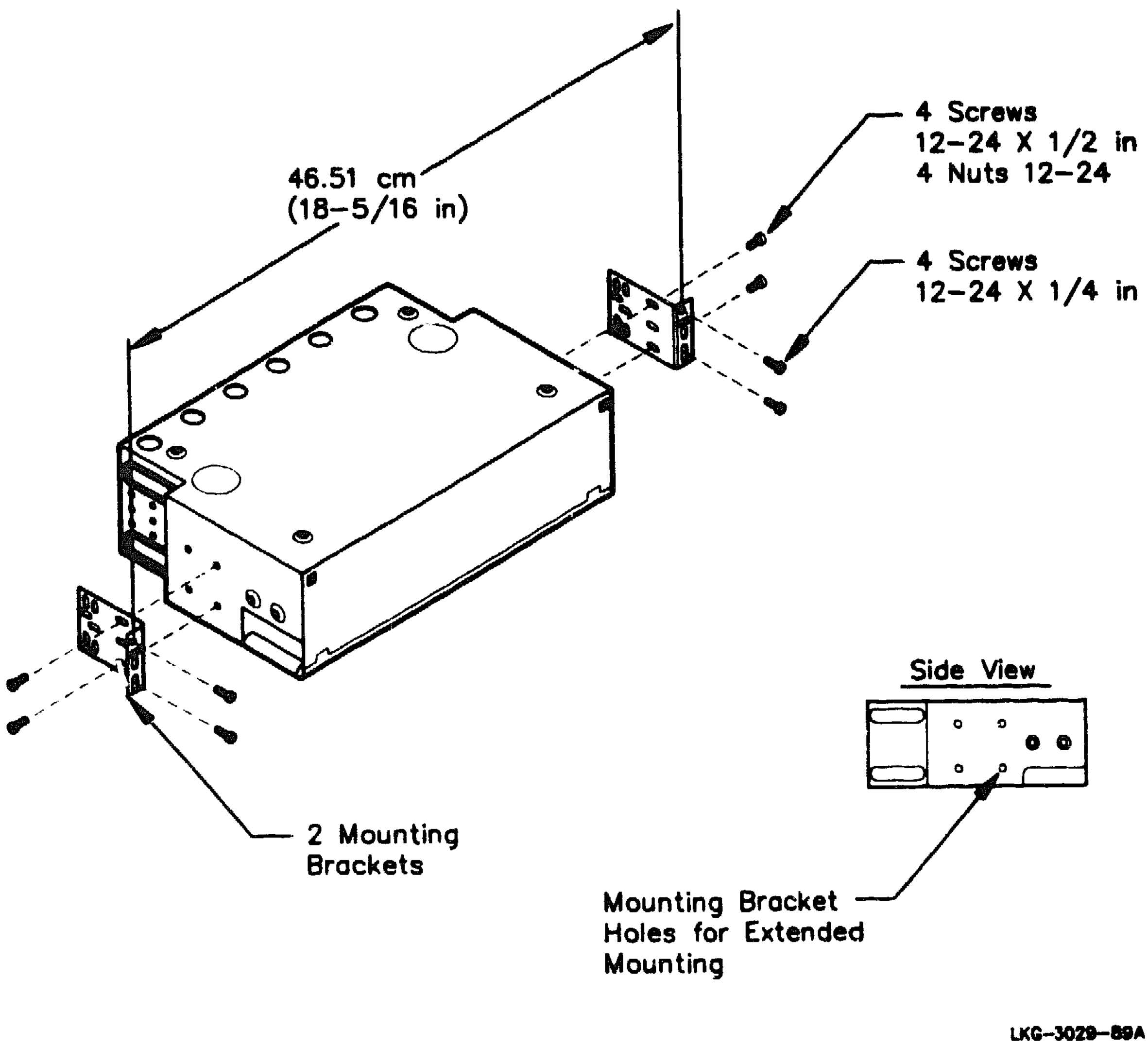
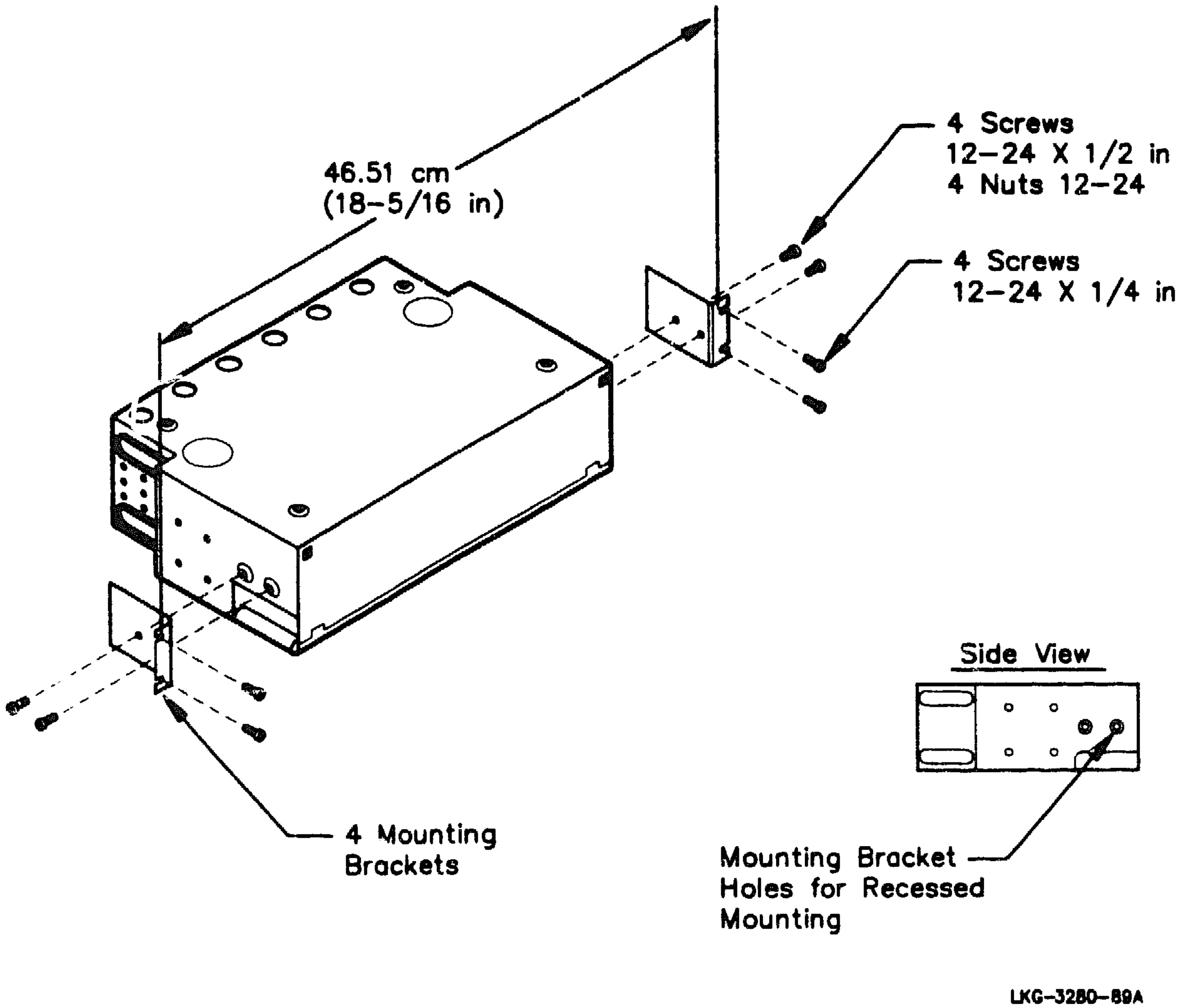


Figure 4–30: Rack Mounting Bracket Installation (Recessed)



4.5.3 Storage Shelf Cable Clamp Bracket and Grommet Installation

To install the cable clamp brackets and black rubber grommets refer to Figure 4–31 or Figure 4–32 (depending on whether the cable is routed from the top or bottom), and perform the following steps:

1. Position and install each cable clamp to the sides of the shelf using two 10-24 by 3/8 inch screws and 10-24 nuts as shown in Figure 4–31.
2. Snap the black rubber grommets (one on each side) into the fiber entry slots that are to be used.

Figure 4–31: Cable Clamp Bracket and Black Rubber Grommet Installation (Top Cable Entry)

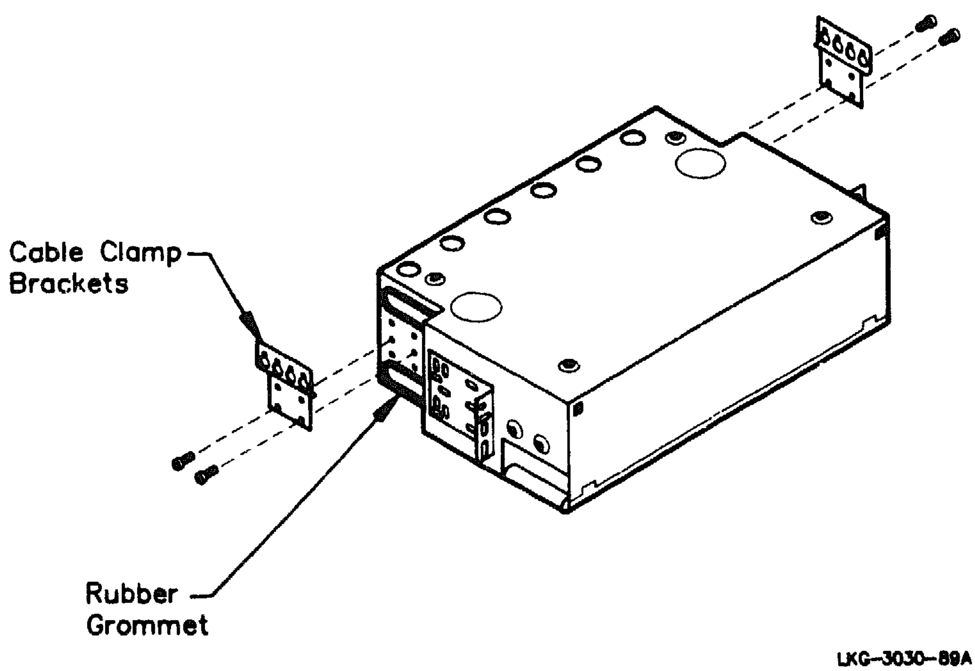
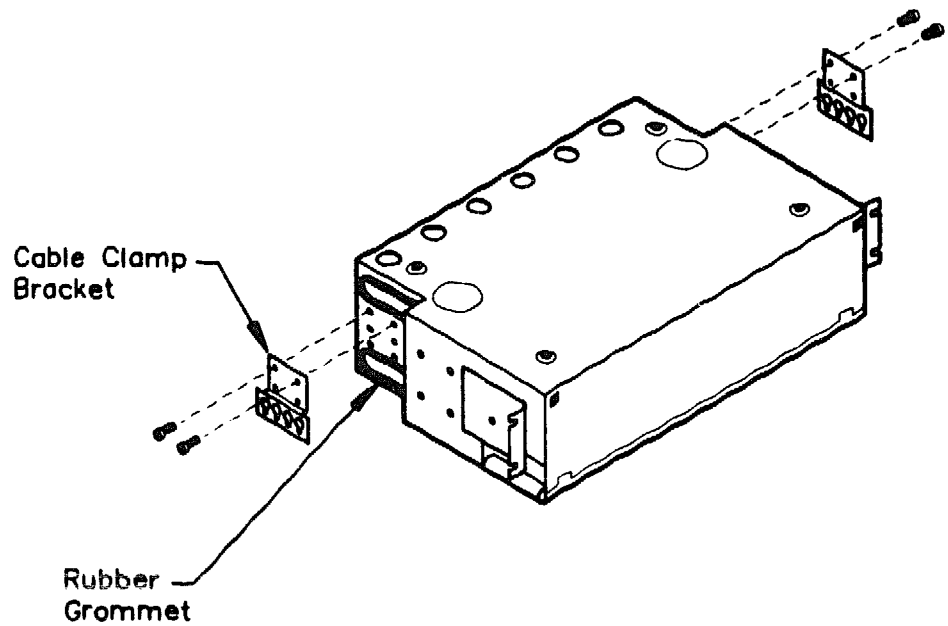


Figure 4–32: Cable Clamp Bracket and Black Rubber Grommet Installation (Bottom Cable Entry)

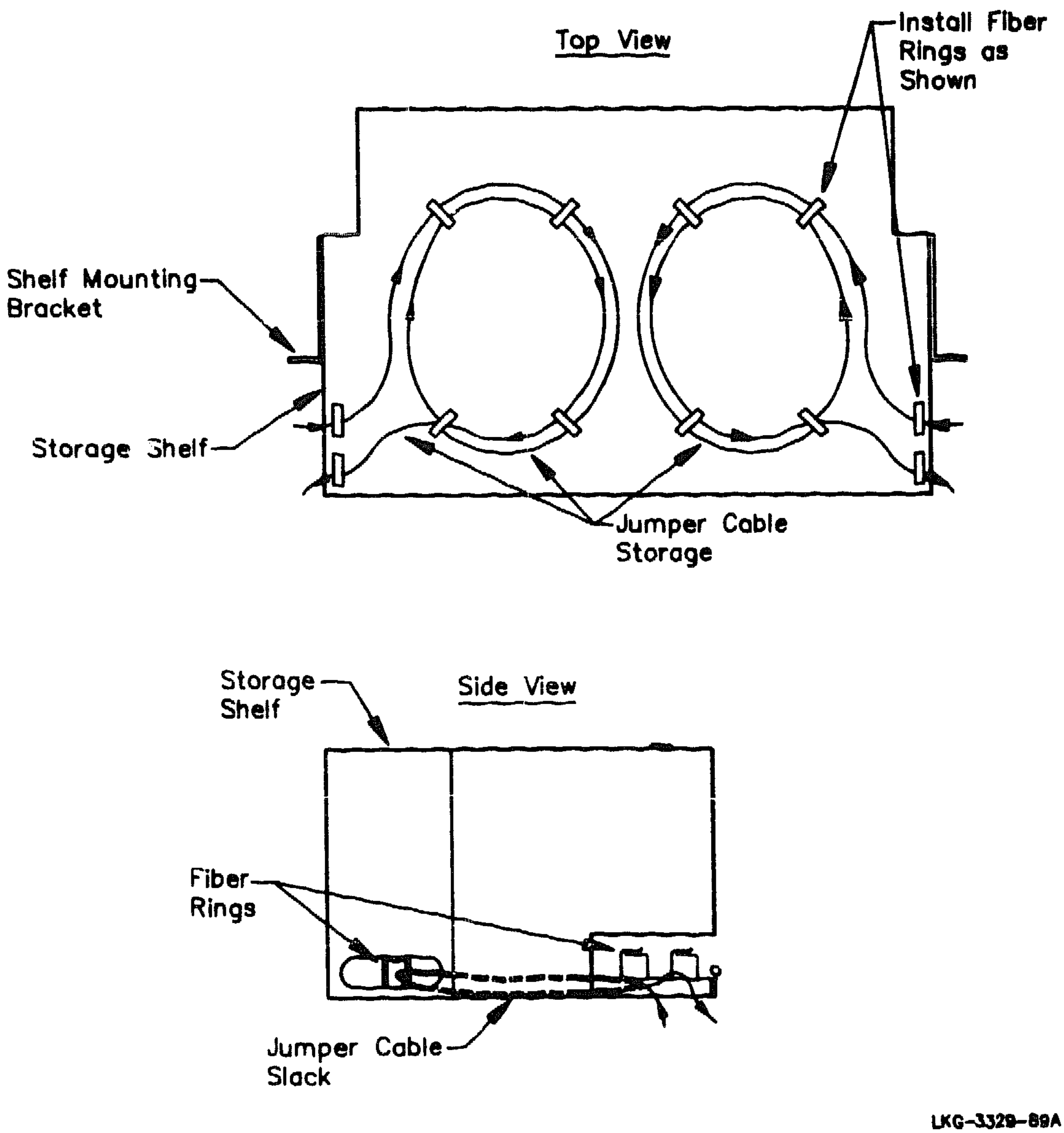


4.5.4 Storing Excess Jumper Cable Slack

To store excess jumper cable slack, refer to Figure 4–33 and perform the following:

Route jumper cable through the fiber rings for storage. Cables may be routed through either side.

Figure 4–33: Storing Excess Jumper Cable

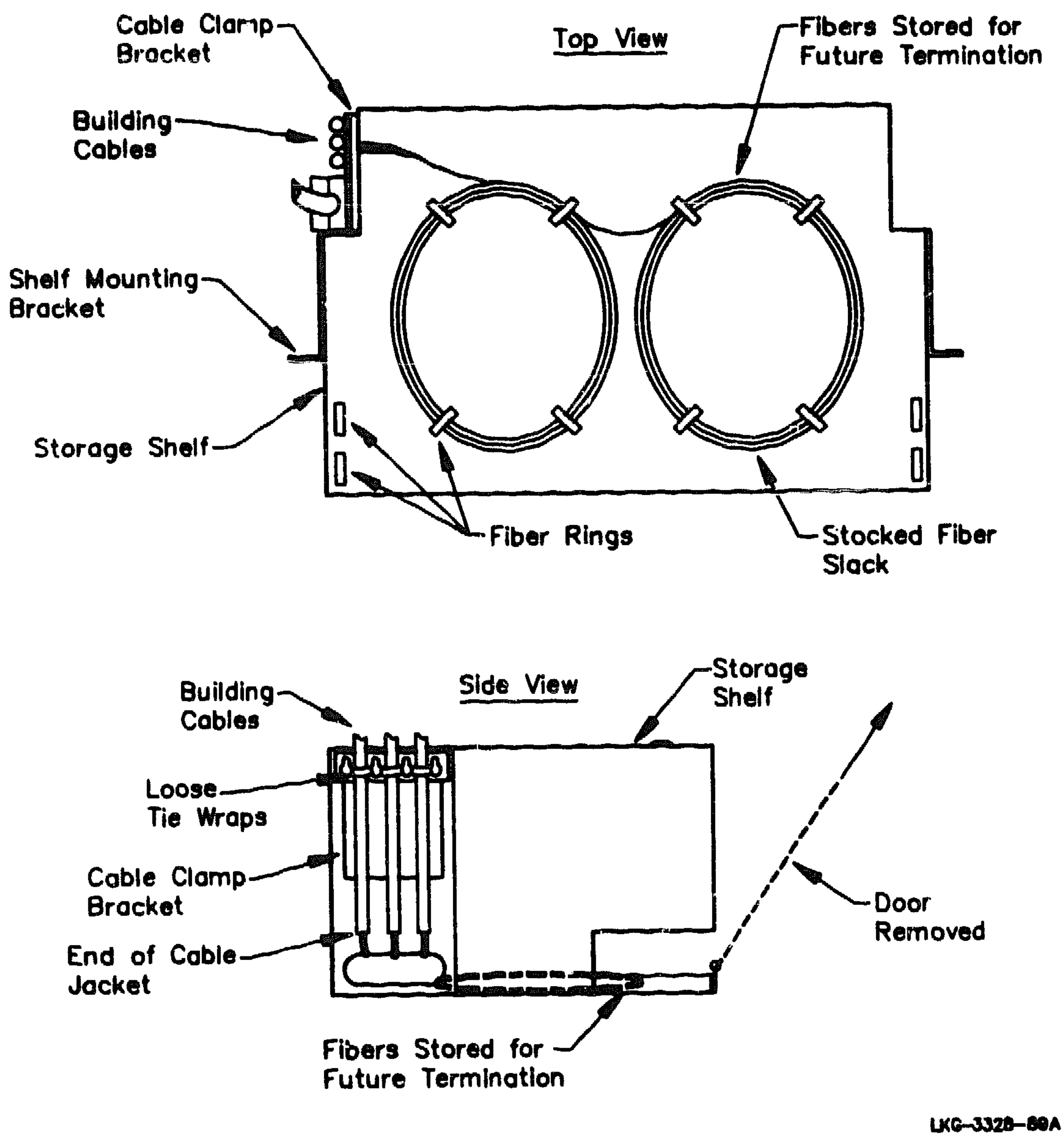


4.5.5 Securing Indoor Cables and Storing Slack

To store indoor cable slack, refer to Figure 4–34 and perform the following steps:

1. Route and loosely secure (tie wrap) the indoor cables to cable retainers and cable brackets on the rack as shown in Figure 4–34.
2. Loosely secure (tie wrap) indoor cables to the cable clamp bracket on the shelf.
3. Route the fibers into the shelf and store fiber slack and/or fibers for future use as shown in Figure 4–34.

Figure 4–34: Securing Indoor Cable and Storing Slack



4.5.6 Storage Shelf Wall Mount Installation

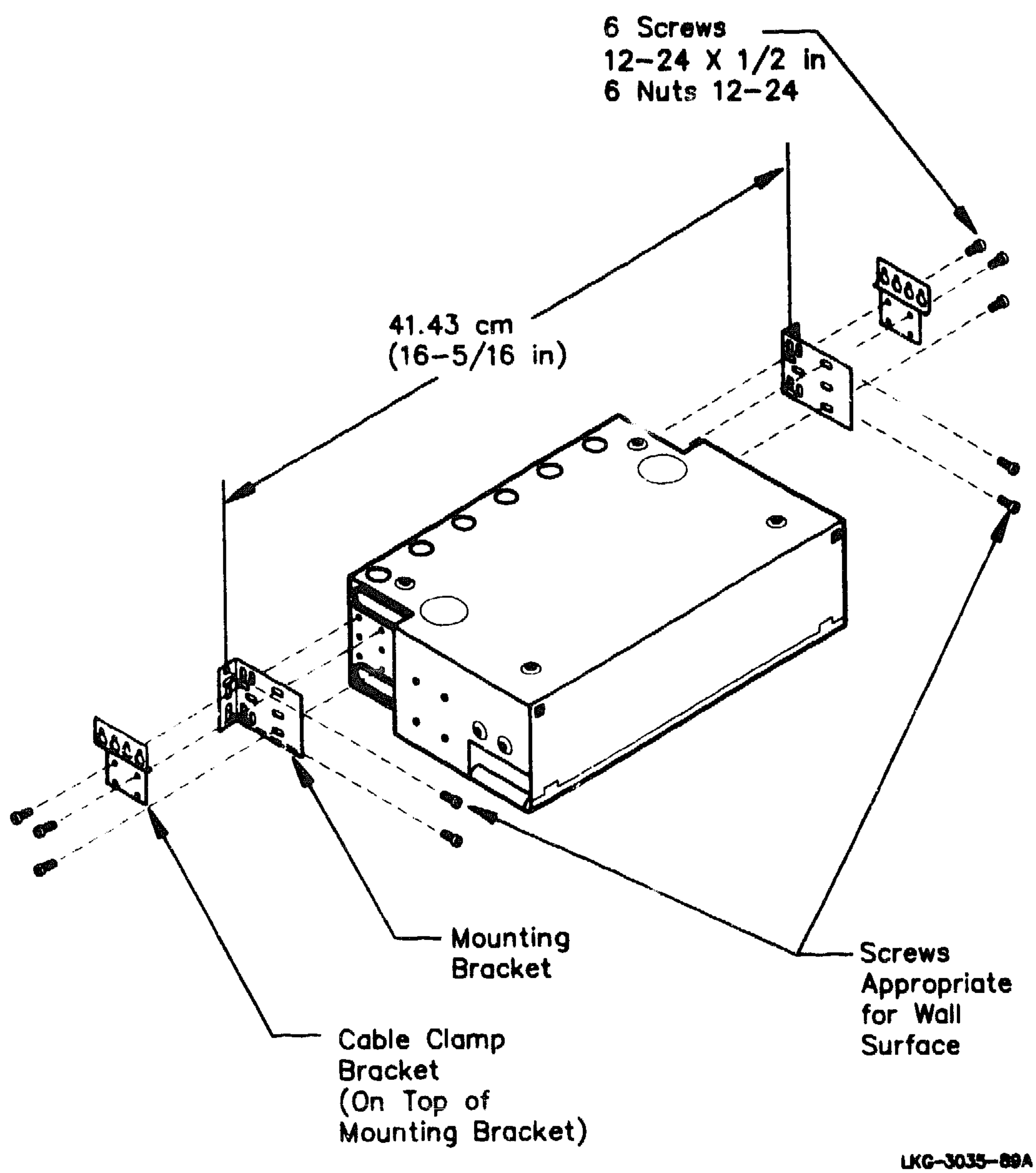
To wall mount the storage shelf, refer to Figure 4–35 and perform the following steps:

1. Position and attach the shelf mounting bracket and cable clamp bracket to the side of the shelf with three 12-24 by 1/2 inch screws (with captive lockwashers) and 12-24 nuts. Select the cable routing (top or bottom) to determine the clamp alignment before installing. Two screws go through both brackets while the third screw goes through the mounting bracket only. Repeat the same procedure for the opposite side.

2. Install the shelf to the wall surface with two fasteners (locally obtained) per mounting bracket. Fasteners should be appropriate for the wall surface.

3. Snap the black rubber grommets into the fiber entry slots to be used.

Figure 4–35: Storage Shelf Wall Mount Bracket and Cable Clamp Bracket Installation

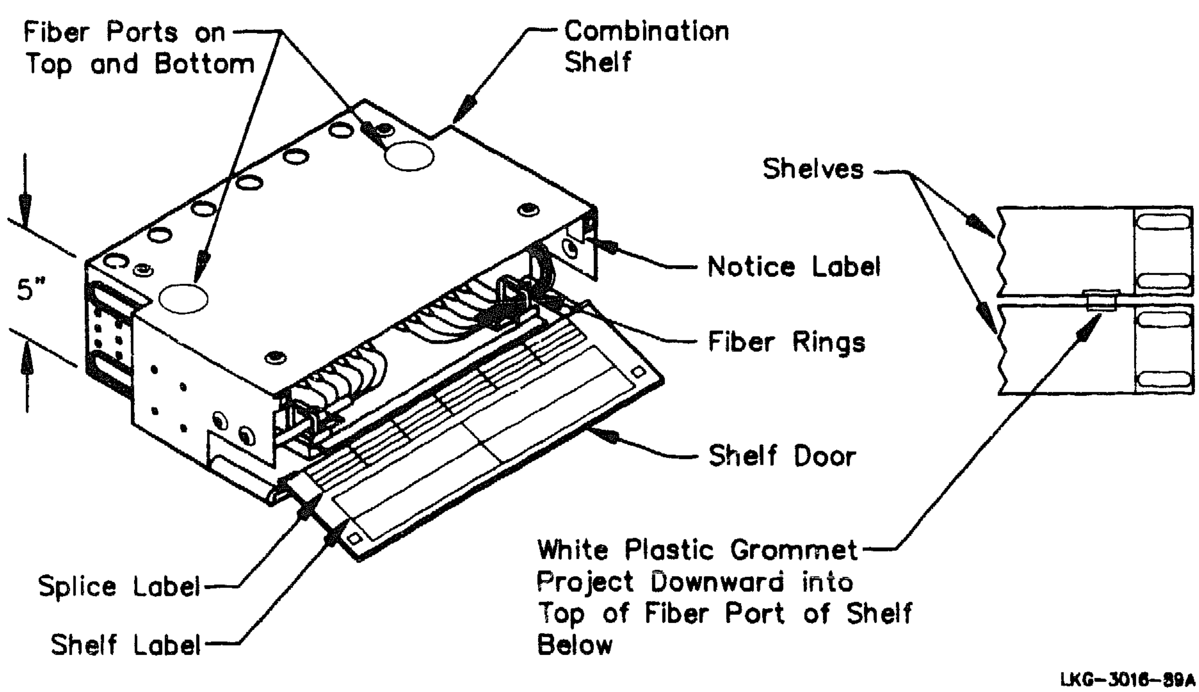


4.6 Combination Shelf Installation

The combination shelf, shown in Figure 4–36, is used for a combination of splicing and termination of outdoor cables and has a capacity of 24 fibers. The shelf is 12.7 centimeters (5 inches) high, 43.18 centimeters (17 inches) wide, and 27.94 centimeters (11 inches) deep. Clamp brackets are used to secure buffered cables or for securing up to four outdoor cables. A shelf housing is used to mount one splice organizer. Up to four connector panels, each containing six connector couplers may be mounted on a panel, which slides out of the shelf for easy access. Fiber rings are used to organize and provide strain relief for fibers.

With the brackets supplied, the combination shelf can be mounted in an H9646 Office Communications Cabinet (OCC), Satellite Equipment Room (SER) 19-inch rack (H3120), or in 23-inch standard telecommunications racks.

Figure 4–36: The Combination Shelf



4.6.1 Preparation

The combination shelf has a number of small items that must be installed prior to rack or wall mounting. The installation will proceed faster if you assemble the shelf on a clean flat work surface. To prepare the combination shelf for installation, perform the following steps:

1. Unpack the combination shelf and verify that all parts are available by comparing the kit contents with the packing list, and check for optional items to be used during this particular installation.

   The items include the following:

   - Miscellaneous screws and nuts
   - Mounting brackets (2 sets)
   - Fiber rings
   - Shelf label
   - Notice label
   - Cable clamp brackets
   - White plastic grommets
   - Black rubber grommets
   - Miscellaneous screws and nuts
   - Connector panels (quantity: 4)

   The following items are required but not supplied:

   - 2.5 mm bayonet ST-type connector couplers
   - Core blocking and unit splitter for outdoor cable

2. Rotate the front door fasteners 1/4 turn and tilt open the shelf front door.

3. Apply the shelf labels to the inner side of the door and the notice label to either inside wall or shelf.

4. Position and snap the fiber rings into the front and back of the shelf (as shown in Figure 4–44).

5. If fibers are to be routed to adjacent shelves, remove the top or bottom fiber port plugs (shown in Figure 4–36). Install white plastic grommets in the fiber ports, so that they project downward.

6. Return the front door to the closed position and rotate the fasteners 1/4 turn to secure.

4.6.2 Rack Mounting Bracket Installation

To install the racks mounting brackets refer to Figure 4–37 and perform the following:

Position and attach each mounting bracket using the appropriate mounting holes using two 12-24 by 1/2 inch screws (with captive lock washers) and 12-24 nuts. Figure 4–37 details an extended 19-inch rack installation typically used in equipment rooms, while Figure 4–38 details a recessed 19-inch rack installation typically used in Office Communications Cabinets.

Figure 4–37: Rack Mounting Bracket Installation (Extended)

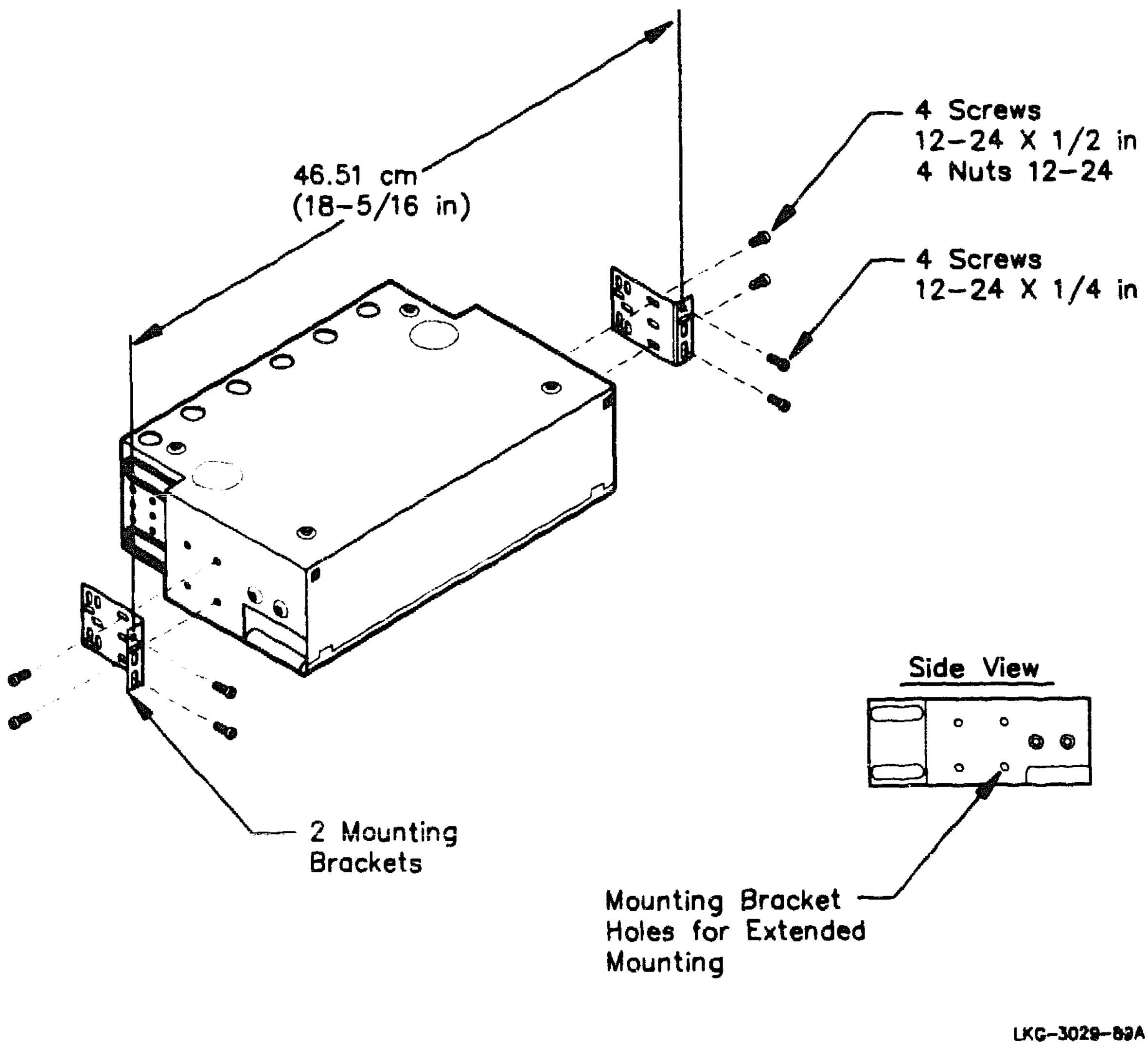
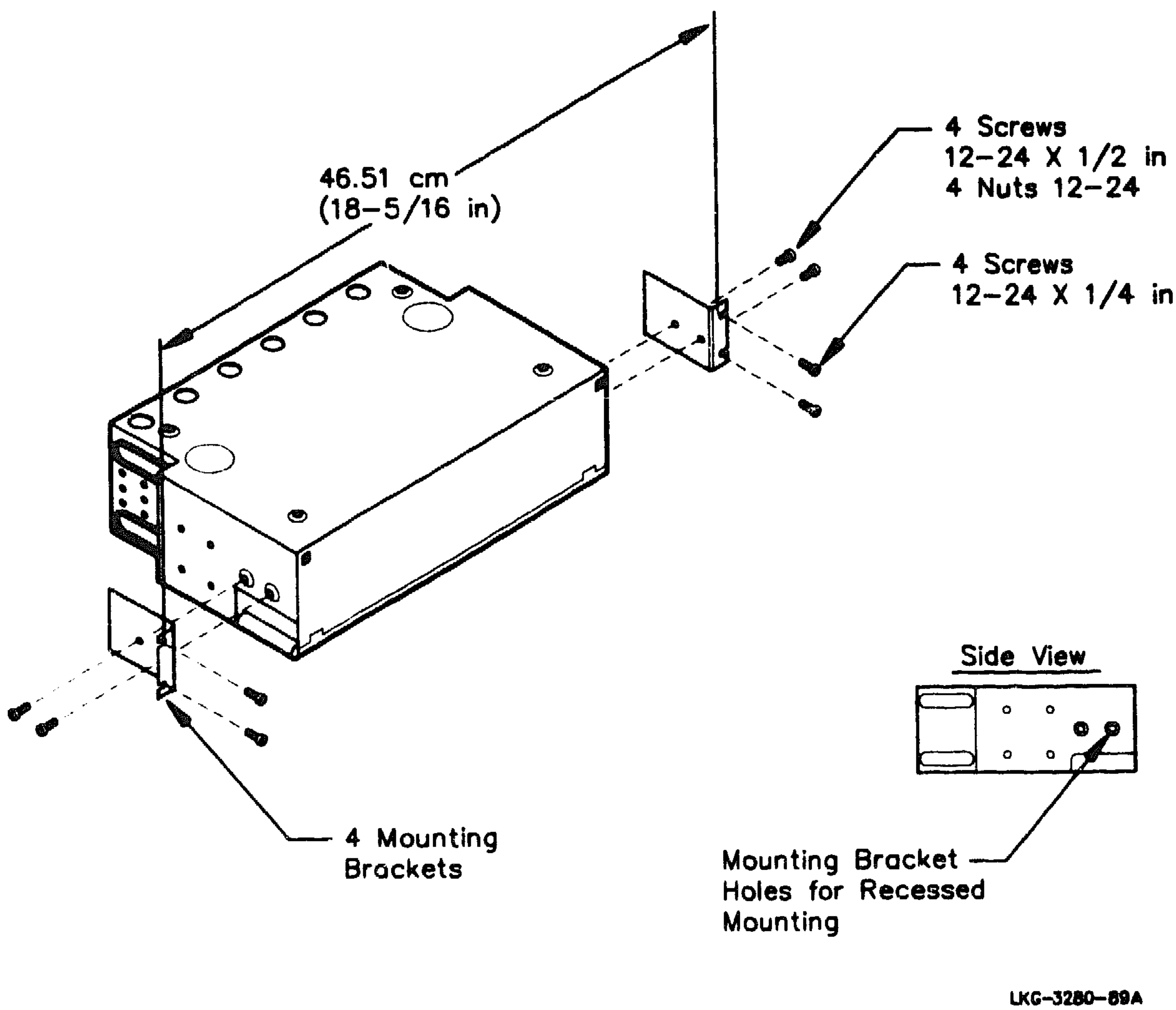


Figure 4–38: Rack Mounting Bracket Installation (Recessed)



4.6.3 Combination Shelf Cable Clamp Bracket and Grommet Installation

To install the cable clamp brackets and black rubber grommets refer to Figure 4–39 or Figure 4–40 (depending on whether cable is routed from the top or bottom), and perform the following steps:

1. Position and install each cable clamp to the sides of the shelf using two 10-24 by 3/8 inch screws and 10-24 nuts as shown in Figure 4–39.
2. Snap the black rubber grommets (one on each side) into the fiber entry slots that are to be used.

Figure 4–39: Cable Clamp Bracket and Black Rubber Grommet Installation (Top Cable Entry)

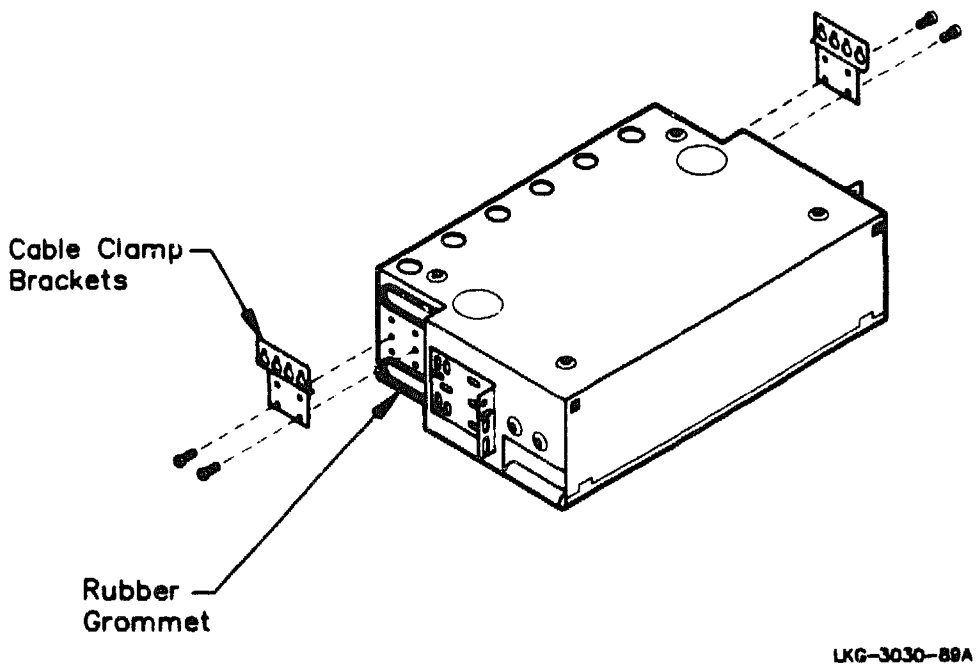
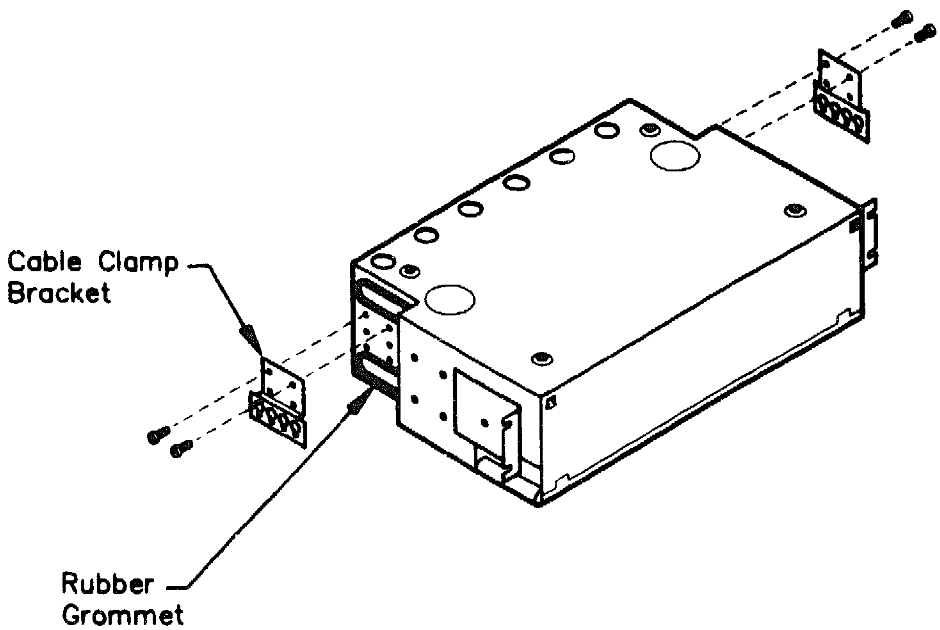


Figure 4–40: Cable Clamp Bracket and Black Rubber Grommet Installation (Bottom Cable Entry)

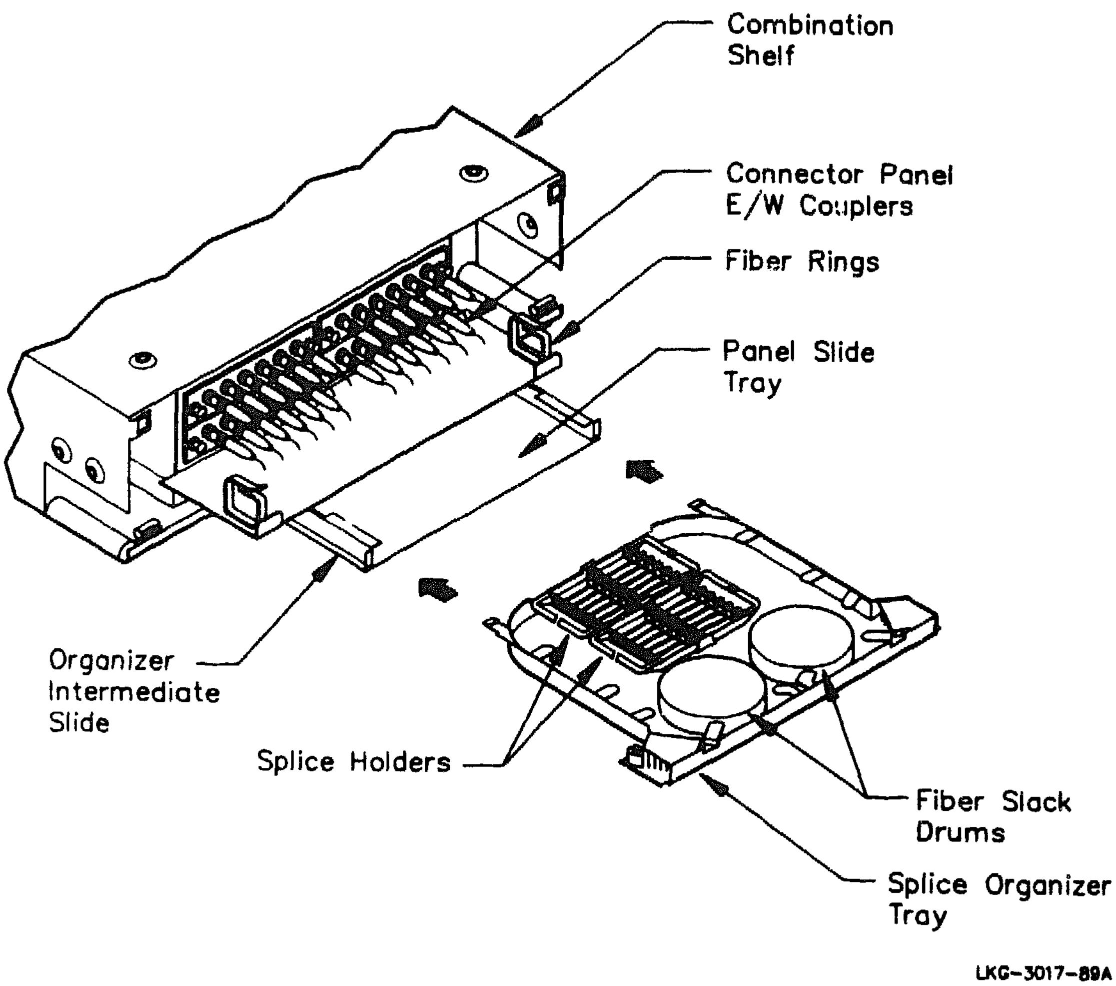


4.6.4 Connector Panel and Splice Organizer Installation

To install the combination shelf connector panels and splice organizer refer to Figure 4–41 and perform the following steps:

1. Rotate the front door fasteners 1/4 turn. Tilt the front door to align with the slots in the hinges and remove the front door.
2. Install couplers into the connector panels (or use preloaded coupler panels H3114-FH). Use a red or black marker or an optional installable plastic washer as described in Section 1.6.3.2.
3. Peel the backing from the connector panel labels, align them with the couplers, and press them onto the panels.
4. Install the connector panels in the shelf. These can be more easily installed with the panel slide tray pulled out of the shelf.
5. Insert the organizer intermediate slide into the shelf.
6. Depress the tabs on the rear of the splice organizer tray, insert them into the intermediate slide, and push the slide into the shelf.

Figure 4–41: Connector Panel and Splice Organizer Installation



4.6.5 Combination Shelf Outdoor Cable Installation

To install outdoor cable in the combination shelf, refer to Figure 4–42 and Figure 4–43 and perform the following steps:

1. Install the shelf in the rack using two 12-24 by 1/4 inch screws for each mounting bracket.
2. Remove the cable outer sheath, perform core tube blocking, and install a unit splitter and cable buffering as described in Appendix B.
3. Install the cable clamp into the cable clamp bracket on the rear of the termination shelf. Refer to the procedures provided with the cable clamp bracket for details on assembling the clamp.
4. Secure and ground the cables to the cable clamp bracket and the rack.
5. Route the cable fibers into the shelf for buffering, connectorization and splicing.

Figure 4–42: Outdoor Cable Installation (Top Cable Entry)

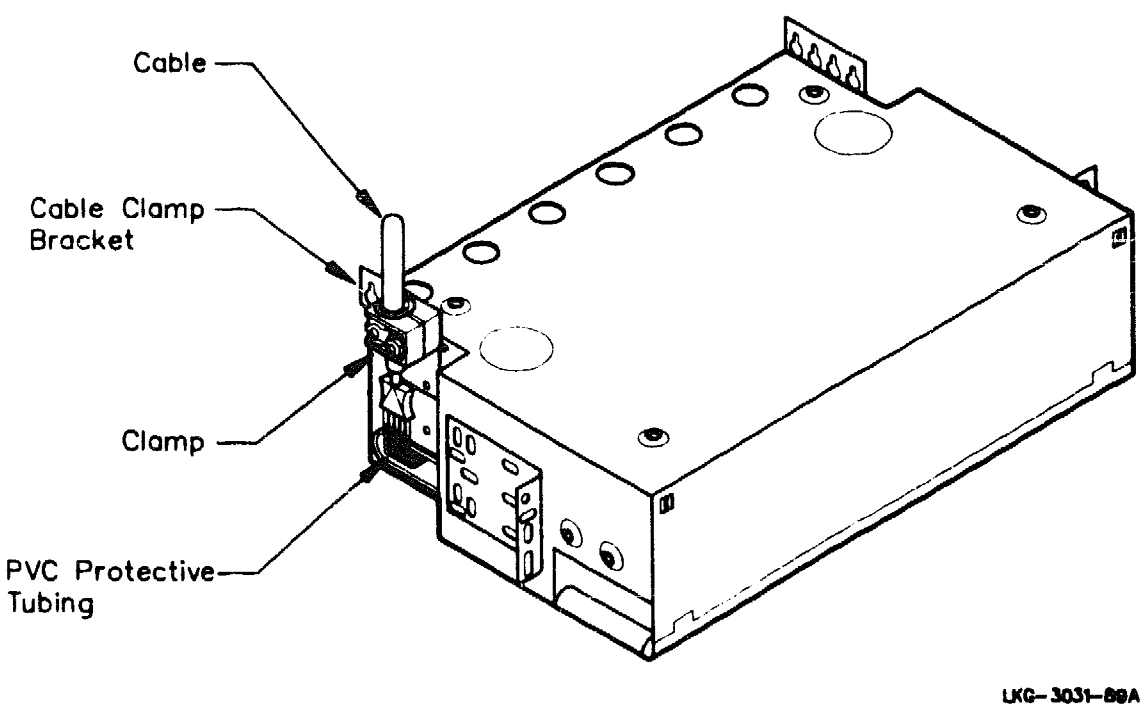
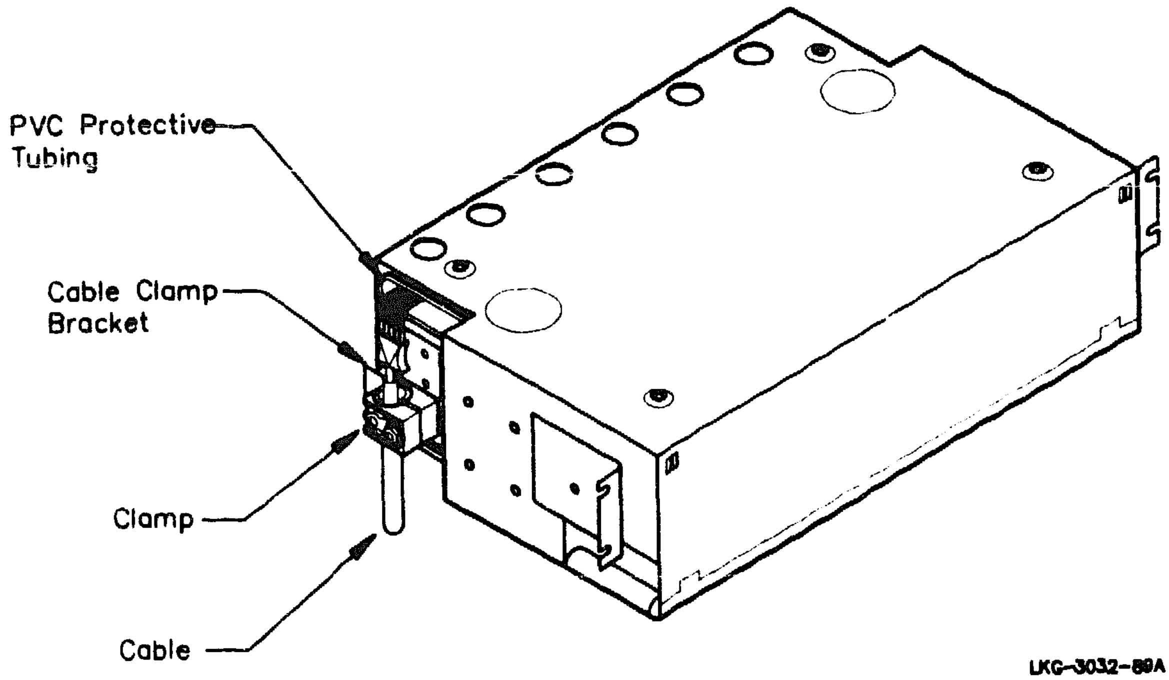


Figure 4–43: Outdoor Cable Installation (Bottom Cable Entry)

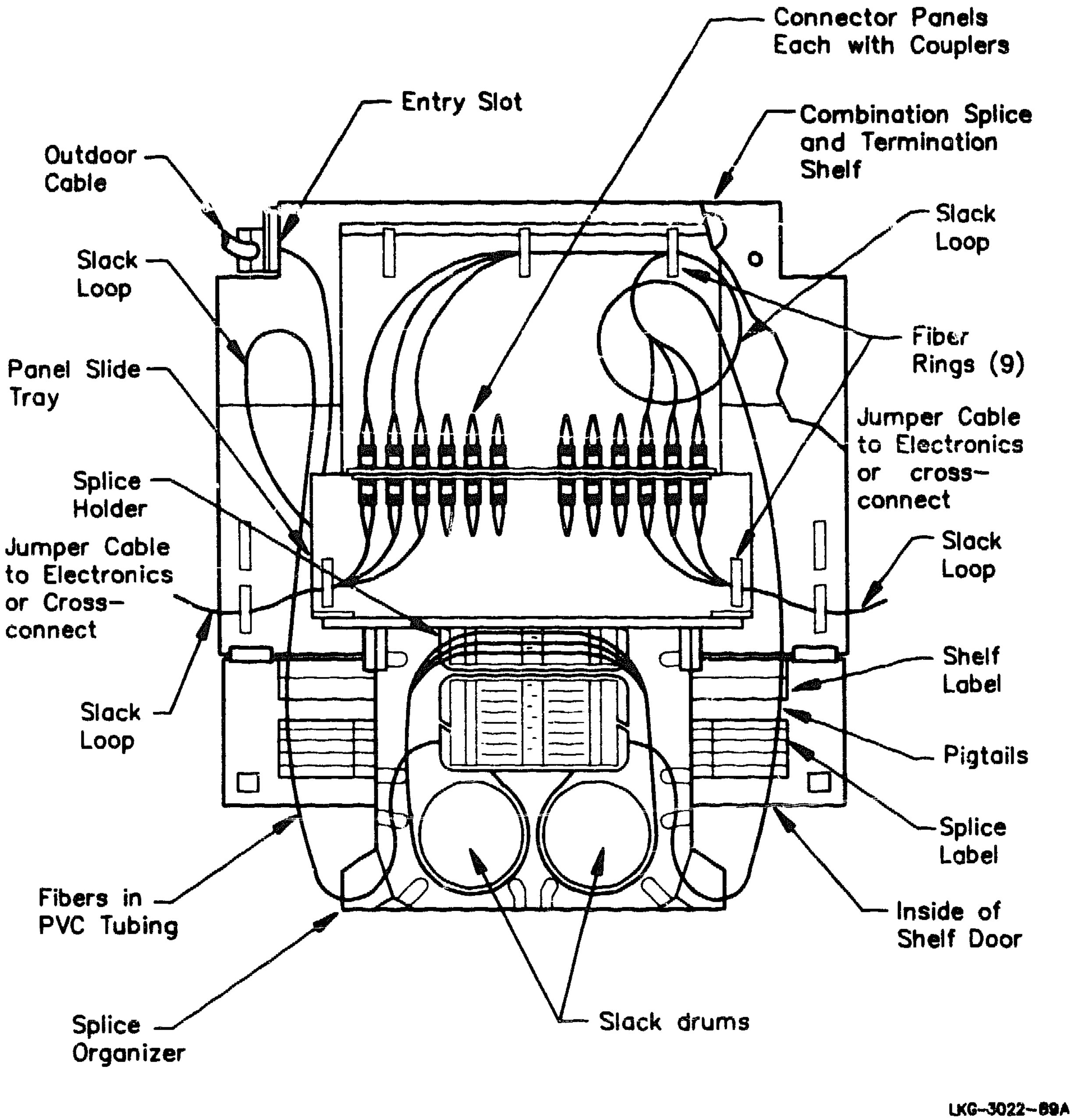


4.6.6 Combination Shelf Splicing and Fiber Connection

To splice and connect outdoor cable to the combination shelf, refer to Figure 4–44 and perform the following steps:

1. From the entry slot, route the outdoor cable fibers alongside the splice organizer, making a slack loop to allow the organizer to easily slide in and out. The fibers can then be routed into the splice organizer or terminated at the rear of the connector panel.
2. Connect pigtail connectors to the rear of the connector panels. Route the pigtails as shown, leaving slack so that the organizer and connector panel shelf slide easily.
3. Splice the outdoor cable to the pigtails and place in the splice holders.
4. Loosely wrap two turns of fiber around the slack drum on the splice organizer. Slide the splice organizer tray into the intermediate slide.

Figure 4–44: Combination Shelf Splicing and Fiber Connection

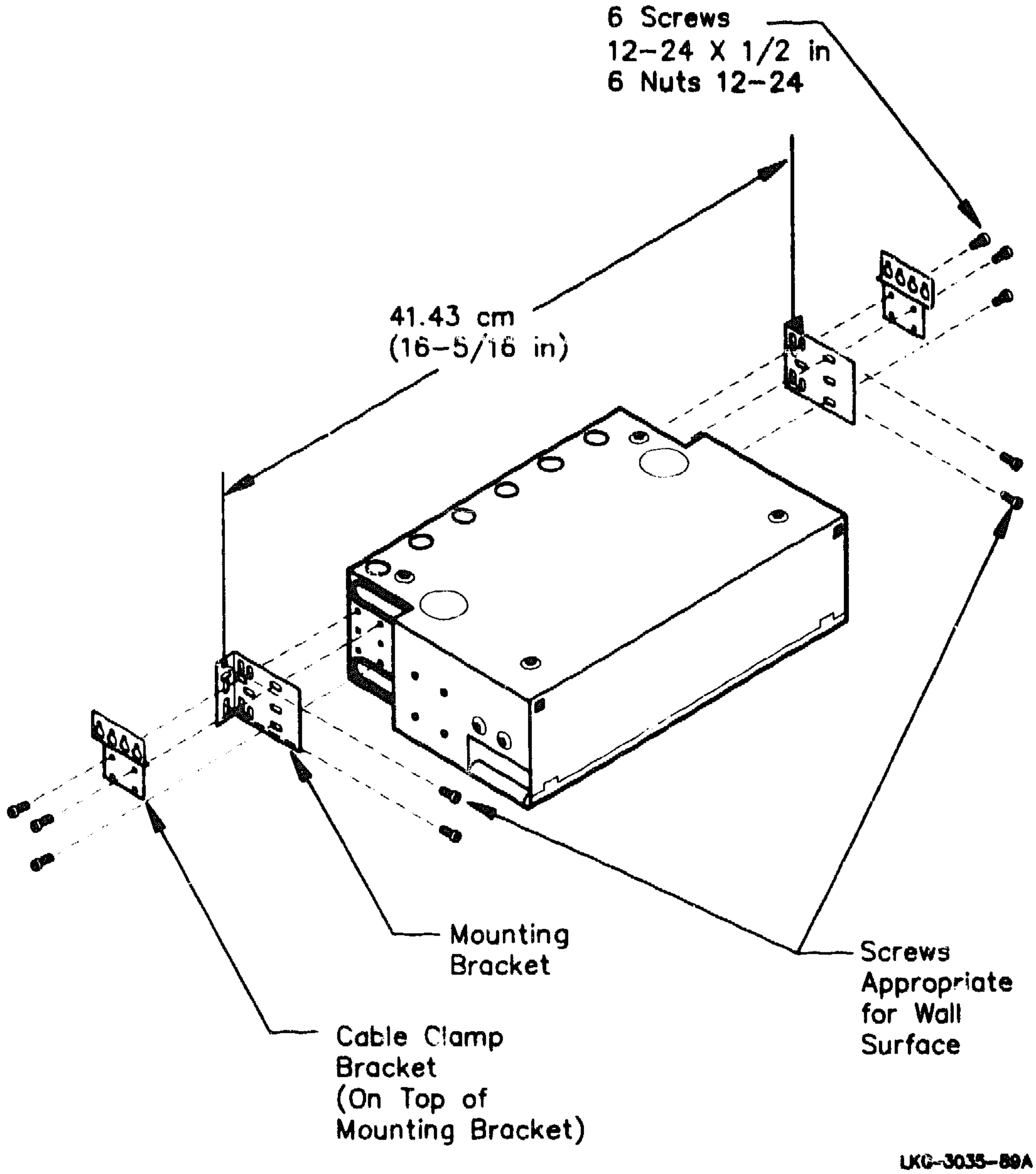


4.6.7 Combination Shelf Wall Mount Installation

To wall mount the combination shelf, refer to Figure 4–45 and perform the following steps:

1. Position and attach the shelf mounting bracket and cable clamp bracket to the side of the shelf with three 12-24 by 1/2 inch screws (with captive lockwashers) and 12-24 nuts. Select the cable routing (top or bottom) to determine the clamp alignment before installing. Two screws go through both brackets while the third screw goes through the mounting bracket only. Repeat the same procedure for the opposite side.
2. Install the shelf to the wall surface with two fasteners (locally obtained) per mounting bracket. Fasteners should be appropriate for the wall surface.
3. Snap the black rubber grommets into the fiber entry slots to be used.
4. Install the cable clamps and cable as described in Section 4.6.5.

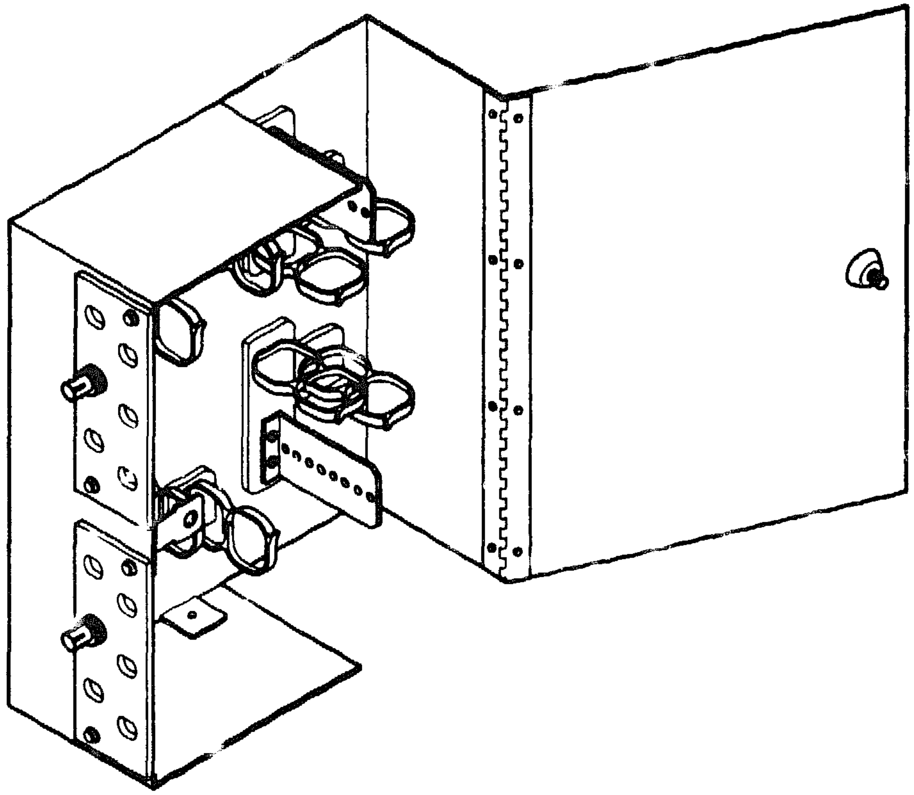
Figure 4–45: Wall Mount Bracket and Cable Clamp Bracket Installation



4.7 Remote Wall Enclosure for Fiber

The remote wall enclosure for fiber shown in Figure 4–46 is a wall mountable unit designed for storage, termination, and splicing of fiber optic cable. It is used for low fiber count installations and applications where rack installations are not practical or desirable. The unit is 22.23 centimeters (8-3/4 inches) high, 19.11 centimeters (7-5/8 inches) wide, and 7.62 centimeters (3 inches) deep. The unit contains eight fiber rings for fiber storage and two 6-capacity connector panels. A splice adapter kit is optional. The units can be gang mounted for large installations.

Figure 4–46: Remote Wall Enclosure for Fiber



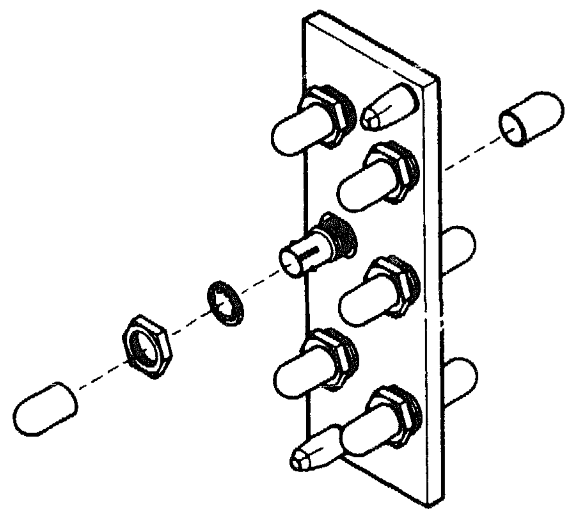
4.7.1 Installation

To assemble for cable termination and storage, perform the following steps:

1. Position the interconnect unit so that the hinge is to your left and the front cover opens towards you.
2. Place the label included with the interconnect unit on the outside front cover.

3. Remove the red plastic cap plugs on the 2.5 mm bayonet ST-type connector couplers (H3114-FC, not supplied) and install the couplers in the connector panels. Secure them in position by screwing on the locknuts that are included with the couplers as shown in Figure 4–47.

Figure 4–47: Installing the 2.5 mm Bayonet ST-Type Connector Couplers



4. If the couplers are not being used immediately, reinstall the red plastic cap plugs.

5. Prepare the connector panels for installation by pulling out the plunger of each quick-connect fastener until you hear a click.

6. Install the connector panels in the interconnect unit by aligning the quick-connect fasteners with the holes. Push in the plungers to secure the connector panel.

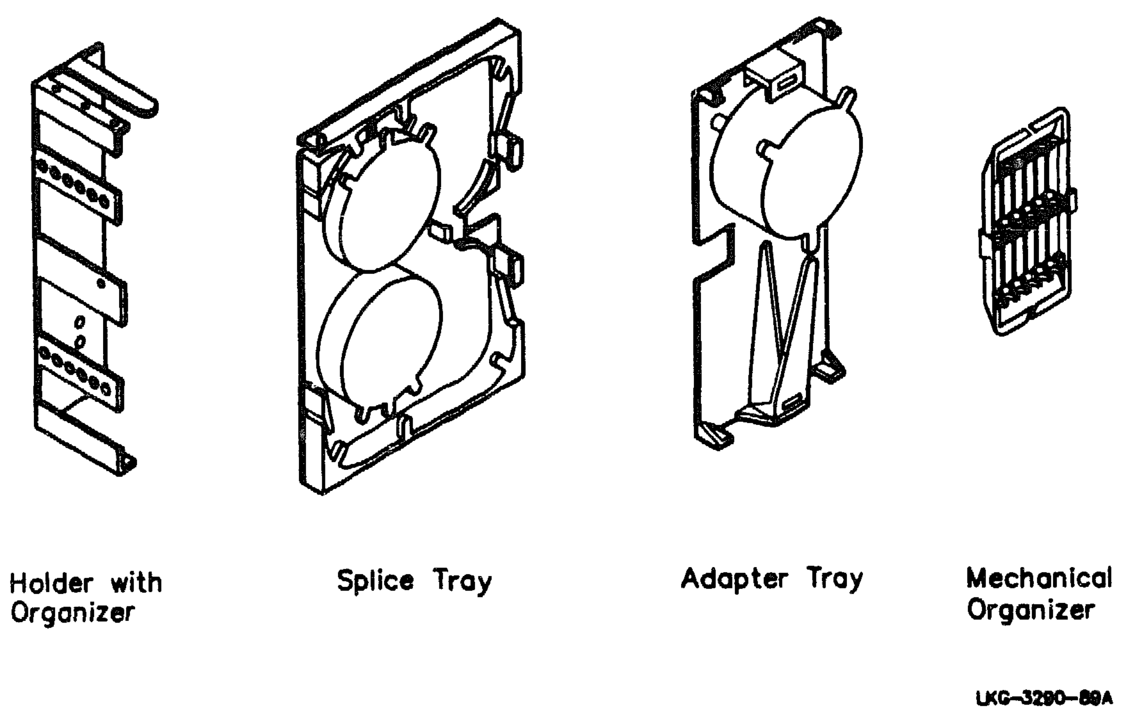
7. Secure the unit to a plywood backboard at the desired location using the four wood screws included with the unit.

4.7.2 Splice Adapter Kit Installation

To add an optional splice adapter kit and prepare the remote wall enclosure fcr fiber for cable splicing, termination, and storage perform the steps below. The splice adapter kit items are displayed in Figure 4–48.

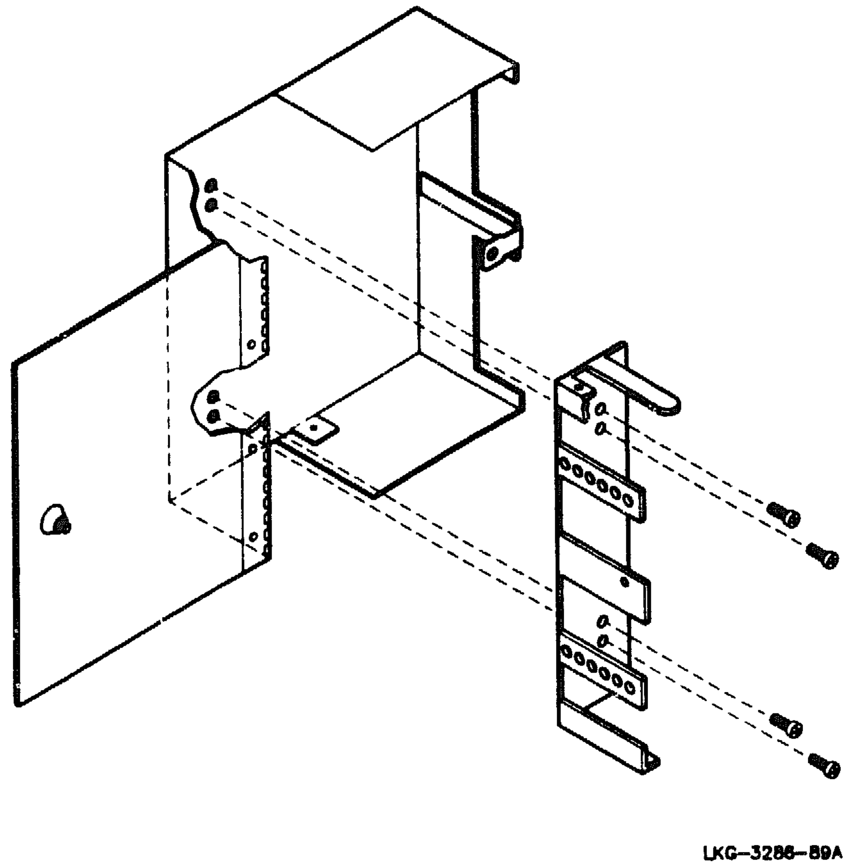
1. Remove the plastic split rings.
2. Remove the two metal brackets.
3. Remove the connector panels, however, they will be reinstalled later.
4. If not done previously, secure the unit to a plywood backboard at the desired location using the four wood screws included with the unit.

Figure 4–48: Splice Adapter Kit



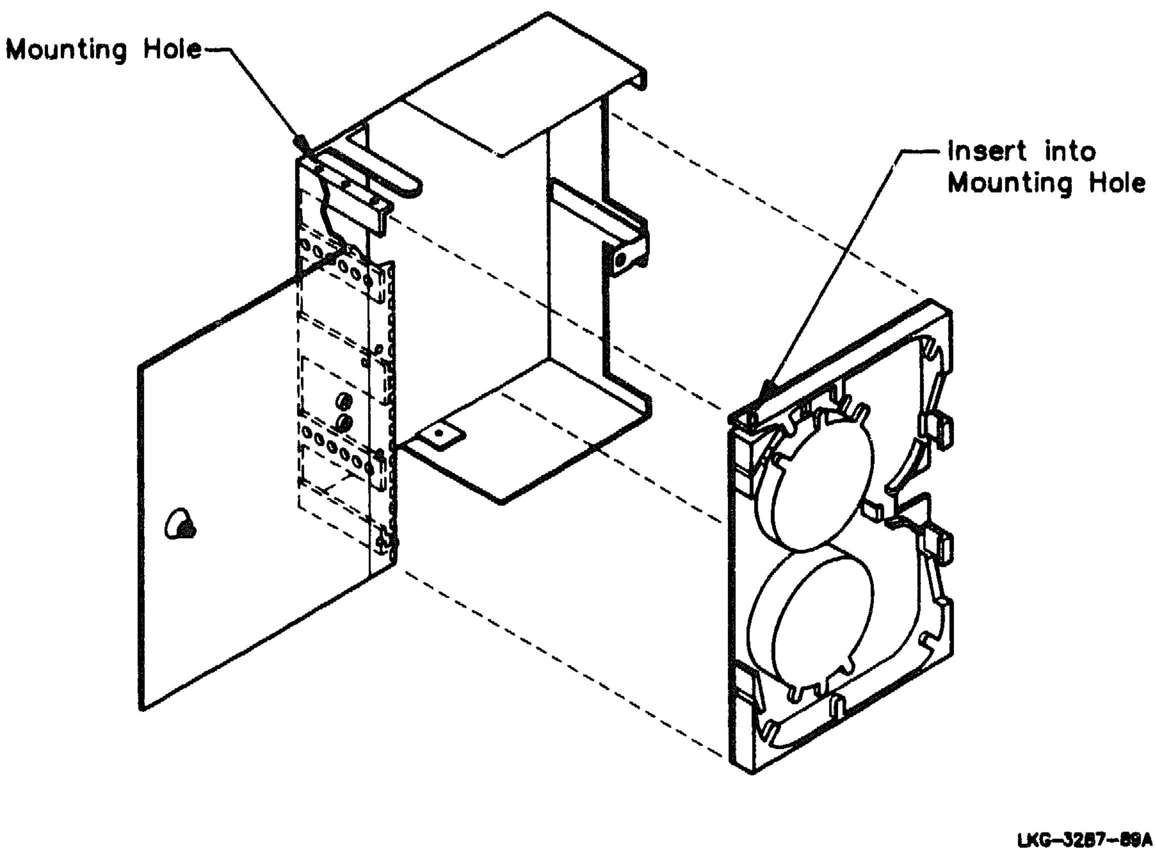
5. Install the holder as shown in Figure 4–49, and secure with the four screws included.

Figure 4–49: Installing the Splice Tray and Adapter Tray Holder



6. Insert the splice tray unit as shown in Figure 4–50, by positioning the splice tray's lower mounting tab into the lowest hole of the holder's lower mounting flange. Insert the splice tray's upper mounting tab into the lowest hole of the holder's upper mounting flange by gently pressing down on the spring-loaded tab.

Figure 4–50: Installing the Splice Tray



7. Prepare the cable end. Allow for 1.53 meters (60 inches) of slack fiber and leave 10.16 centimeters (4 inches) of inner tubing from the cable sheath.

8. Install a cable clamp above the interconnect unit and attach the cable's metal strength member to the clamp.

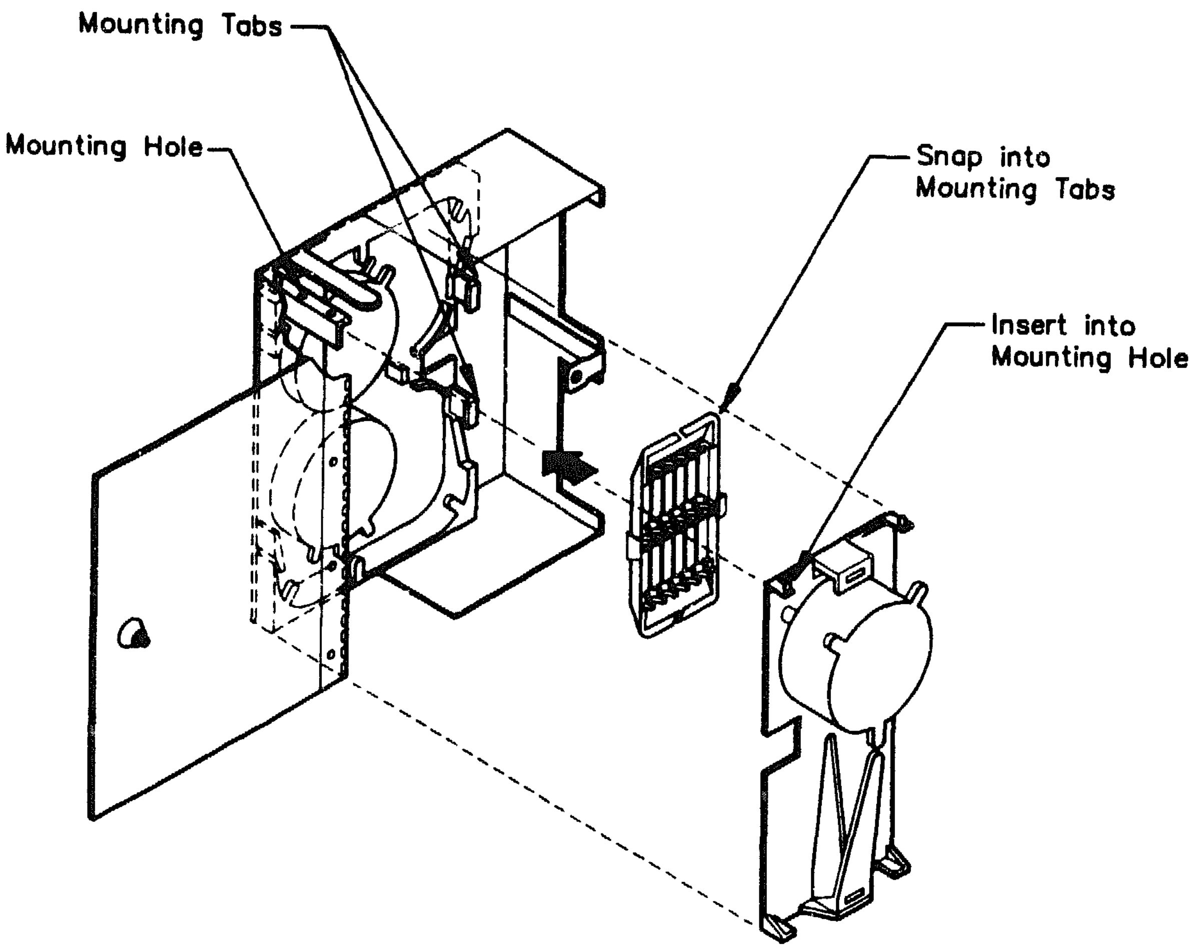
9. Cut a length of white PVC tubing long enough to reach from the cable end to 2.54 centimeters (1 inch) inside the splice tray's cable slot as shown in Figure 4–51.

10. Insert a maximum of 12 fibers into the cut length of PVC tubing. Slide the tubing up over the fibers to the butt end of the cable.

11. Place the PVC tubing into the splice tray's entry slot. The tubing must extend 2.54 centimeters (1 inch) into the entry slot.

12. Install the splice organizer onto the splice tray as shown in Figure 4–51, by inserting the organizer under the tray's two mounting tabs. Gently press the opposite side of the organizer under the tray's single mounting tab to secure the organizer.

Figure 4–51: Preparing and Installing Cable and the Splice Organizer

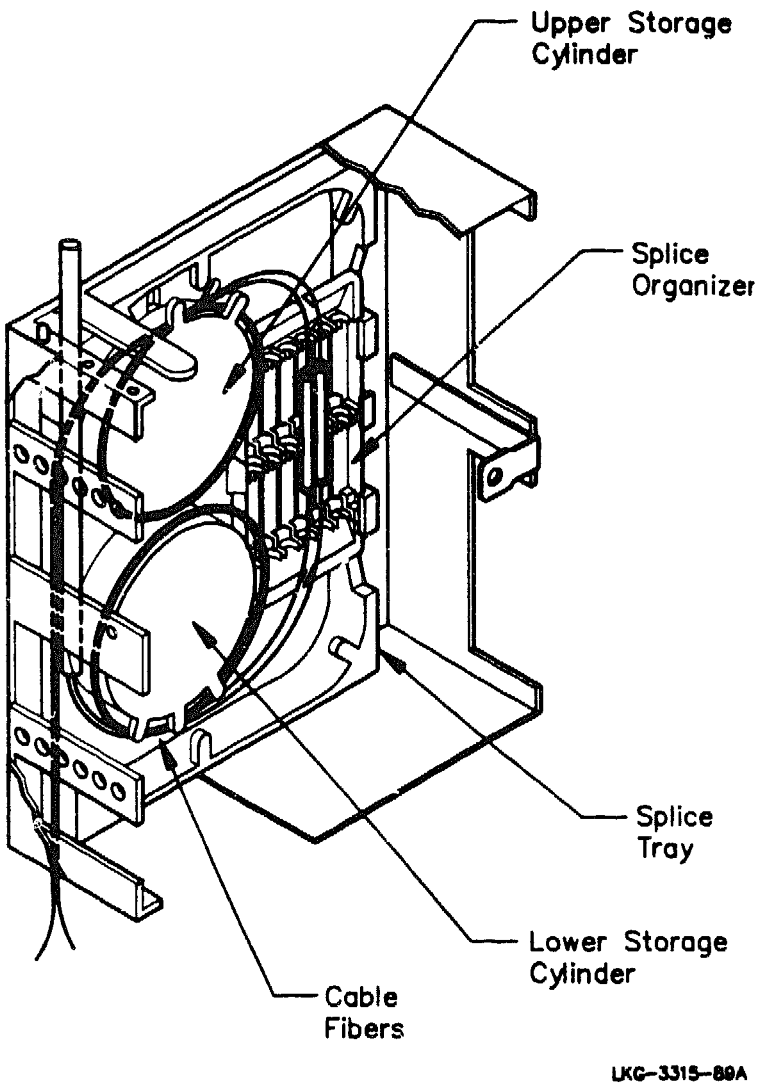


13. Splice the fiber pigtails and cable fibers. Store the completed splices in the splice organizer and install the organizer cover.

14. Starting at the PVC end of the cable fiber, wrap the fiber around the lower storage cylinder of the splice tray in a counterclockwise direction.

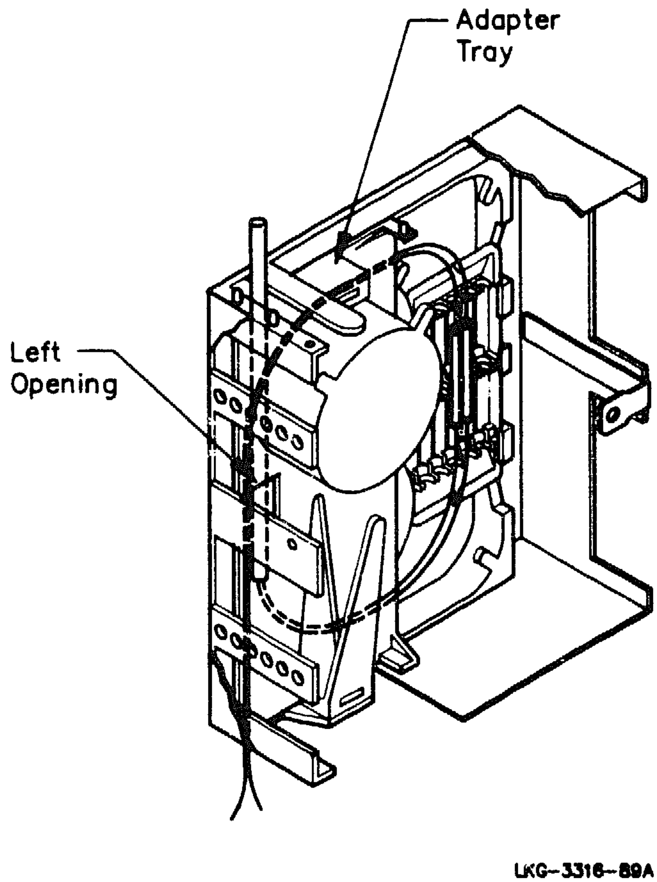
15. Starting at the splice end of the pigtails, store two large slack loops around the upper storage cylinder of the splice tray in a counterclockwise direction. Refer to Figure 4–52.

Figure 4–52: Storing Slack Fibers



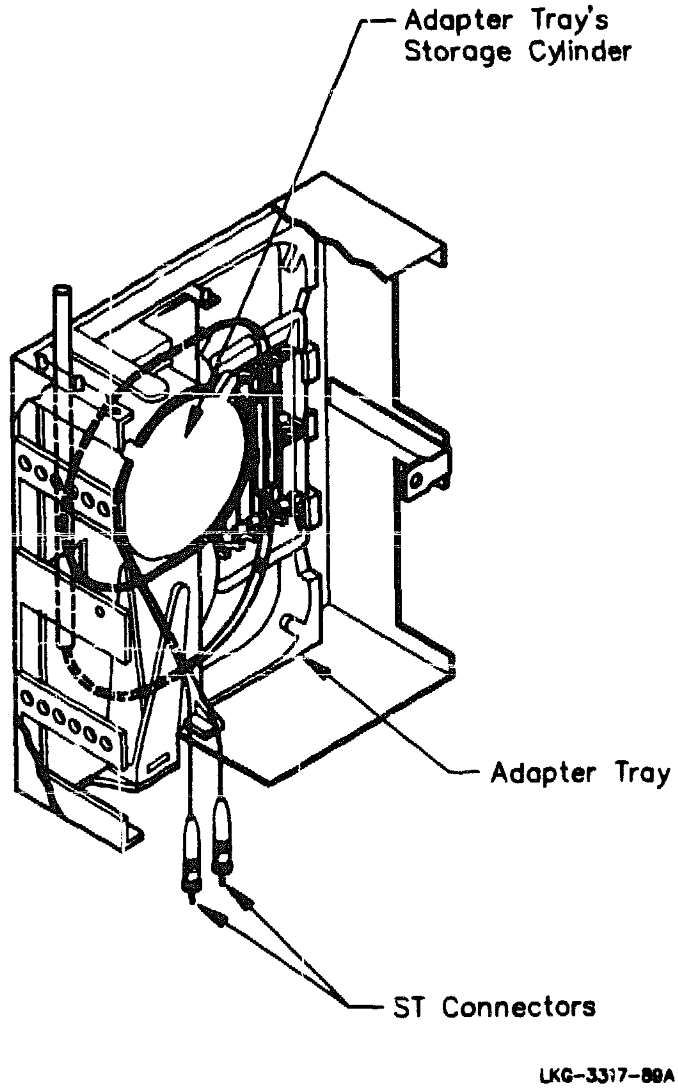
16. Insert the adapter tray's lower mounting tab into the lowest visible hole in the holder's lower mounting flange as shown in Figure 4–53.
17. Insert the pigtail fibers through the adapter tray's left opening.
18. Insert the adapter tray's upper mounting tab into the lowest visible hole in the holder's upper mounting flange by gently pressing down on the tab.

Figure 4–53: Installing the Adapter Tray



19. Store the slack fiber around the adapter trays storage cylinder in a counterclockwise direction as shown in Figure 4–54.

Figure 4–54: Storing Slack Pigtails



20. If previously removed, reinstall the connector panels, and connect the pigtails to the couplers.

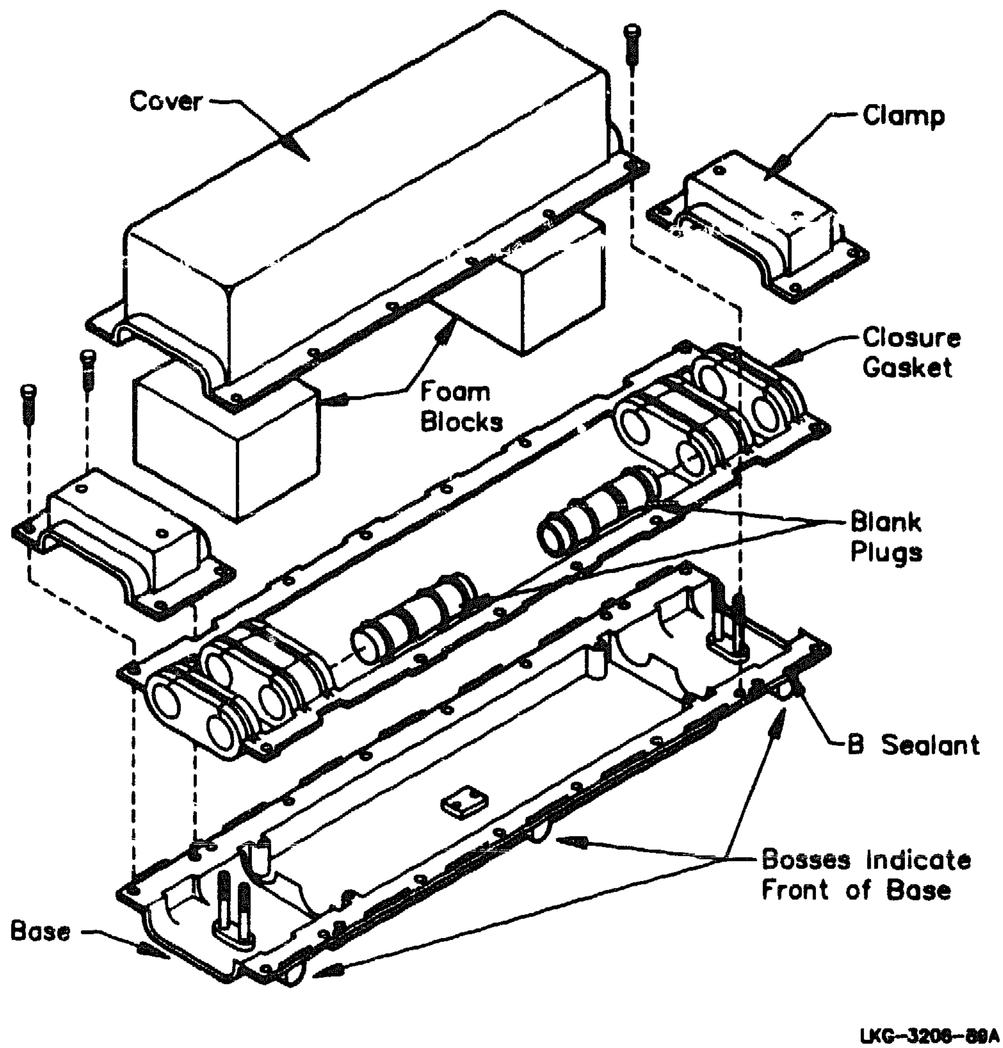
4.8 Fiber Transition Enclosure

The fiber transition enclosure, shown in Figure 4–55, is a sealable unit used for joining and splicing outdoor fiber optic cables. It is used in building entrance and non-corrosive aerial applications. An optional waterproofing housing is available for buried and underground applications.

The enclosure consists of a base, cover, cable clamps, and grommets and can contain a splice organizer with splice trays. The unit is approximately 57.15 centimeters (22.5 inches) long, 13.97 centimeters (5-1/2 inches) wide, and 12.7 centimeters (5 inches) high and can be wall or rack mounted. The enclosure can accommodate four cables, two at each end, and up to 72 mechanical splices.

Installation consists of cable preparation, closure preparation, grounding, cable installation, splicing, closure assembly and, if applicable, waterproof housing installation.

Figure 4–55: Fiber Transition Enclosure



4.8.1 Cable Preparation

Although cable preparation varies according to cable type and installation environment, there are basic steps that will be common to all enclosure installations. These steps are:

1. Setting up the work area and gathering the tools required.
2. Opening the cable sheath to gain access to the fibers, and preparing the fibers for the installation.
3. Bundling the strength wires and setting them up in a grommet and grip assembly.

Detailed instructions on preparing specific cable types are included with the enclosure. For details on ordering grommet kits for use with the fiber transition enclosure, refer to the *DECconnect System Fiber Optic Planning and Configuration* guide (EK-DECSY-FP).

4.8.2 Enclosure Preparation

Once you have prepared the cable prepare the enclosure as follows:

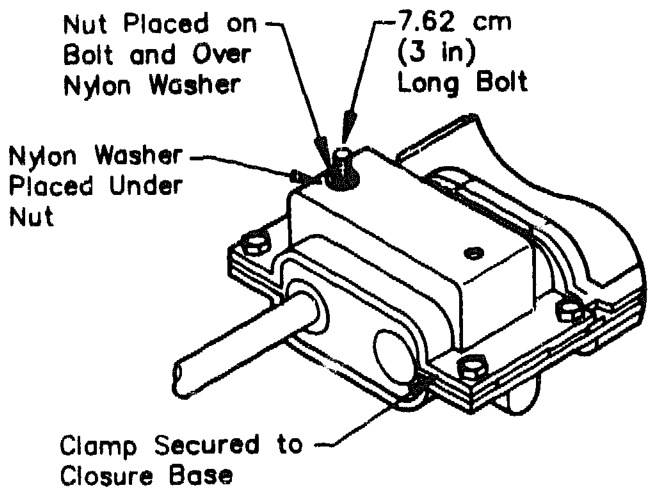
1. Open the split ports and applying sealant.
2. Seal the ports not used with blank plugs.
3. Apply sealant to the closure base.

4.8.3 Grounding

External grounding is sometimes required to isolate the cable's metallic sheath from enclosure. This is for protection against harmful voltages. The procedure consists of:

1. Using a longer bolt, shown in Figure 4–56, which will extend through the enclosure cover.
2. Attaching a ground wire.
3. Connecting the ground wire to a properly installed ground.
4. For a properly installed ground, consult the section on Grounding, Bonding, and Electrical Proctection in the *BICSI Telecommunications Distribution Methods Manual*. See the reference to this manual in Appendix A.

Figure 4-56: Ground Bolt Used In Cable Installation



4.8.4 Cable Installation

One the cables and enclosure have been prepared, cable installation is as follows:

1. Route the cables into the enclosure split ports.
2. Place the grip assembly into the enclosure base.
3. Clamp the cable to the enclosure.
4. Seal the cable ends.

4.8.5 Splicing

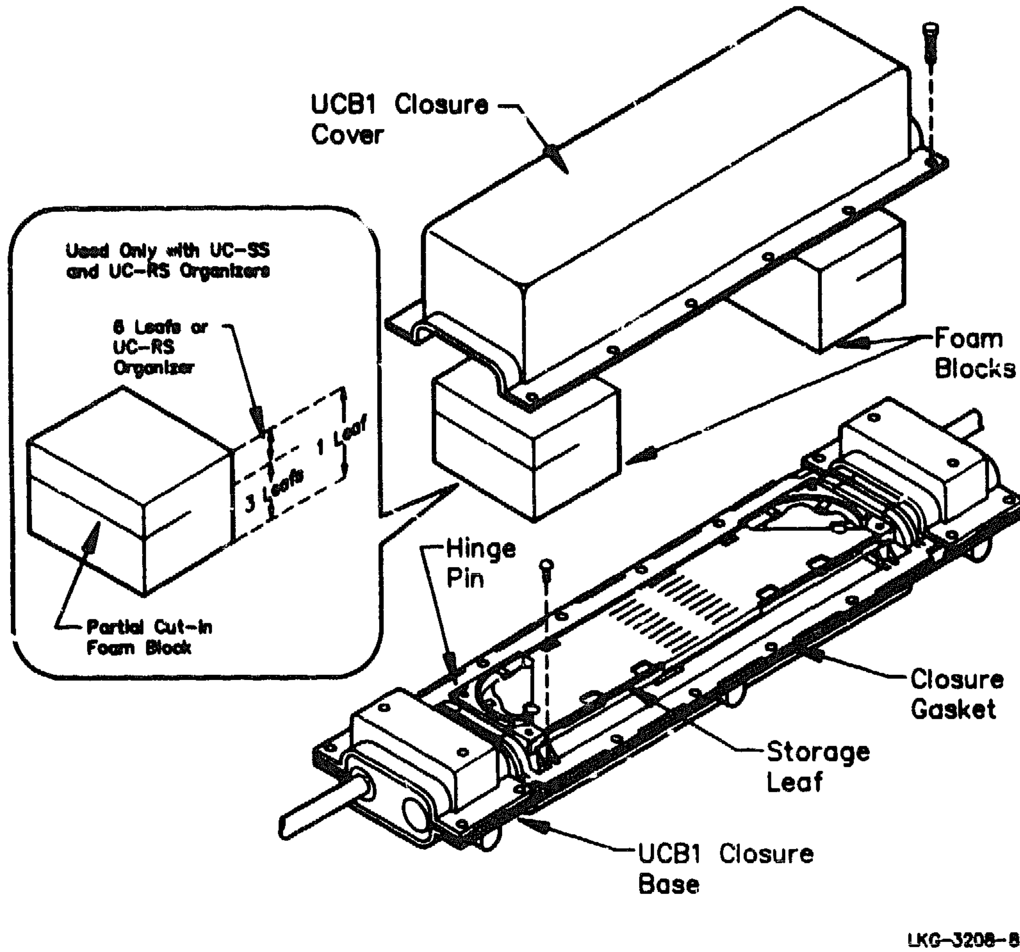
After installing the cable, you will then splice the cable using the appropriate splicing arrangement. Follow the splicing instructions for the splice method and organizer tray selected.

4.8.6 Securing the Cover

Refer to Figure 4-57 and secure the enclosure cover as follows:

1. Place a small portion of foam block in each cover, sizing the foam as required.
2. Apply sealant to the underside of the cover.
3. Bolt the cover to the base.

Figure 4–57: Securing the Enclosure Cover



4.8.7 Waterproofing

Follow the installation instructions included with the environmenta' enclosure selected.

CHAPTER 5

5

Rack Installation

This chapter contains the guidelines for installing equipment in 19-inch and 23-inch racks and in an office distribution frame.

5.1 Guidelines for 19-Inch Rack (H3120, 86-Inch) Installations

This section describes how to install passive equipment, how to install active and passive equipment together, and how to install and route cable (cable management) in the 19-inch (H3120, 86-inch) rack.

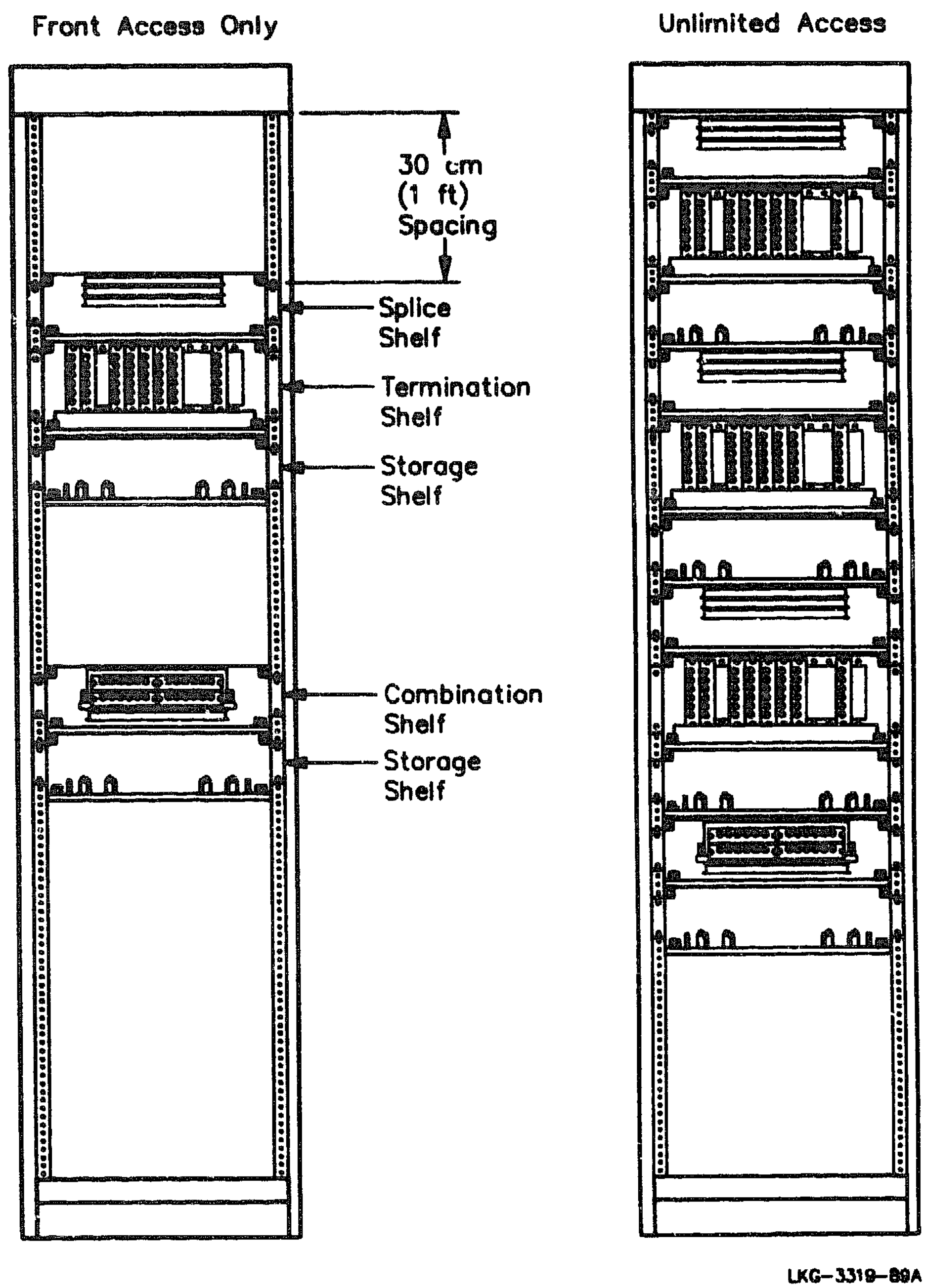
5.1.1 Passive Equipment

The following are guidelines for installing passive equipment (termination, splice, storage and combination shelves) in 19-inch equipment racks. Refer to Figure 5–1 for a typical installation using these guidelines.

- Plan the cable clamp locations in advance and allow room for access. Route all cable from the top and on the left side. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.
- For front access only racks, leave 30 centimeters (12 inches) of space at the top of the rack for routing cable. Also leave 30 centimeters (12 inches) of space above shelves with outdoor cable clamps.
- Mount all shelves in the extended position.

- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf, and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- In front access-only installations, separate logical groups by 30 centimeters (12 inches) of space to allow access. Otherwise it will be difficult to install the cable clamps, or wire ties.
- Install splice shelves above termination shelves to maintain the top-down cable routing.
- Install storage shelves below termination shelves to store fiber and jumper cables.

Figure 5–1: 19-Inch Rack (H3120, 86-Inch) Passive Installation

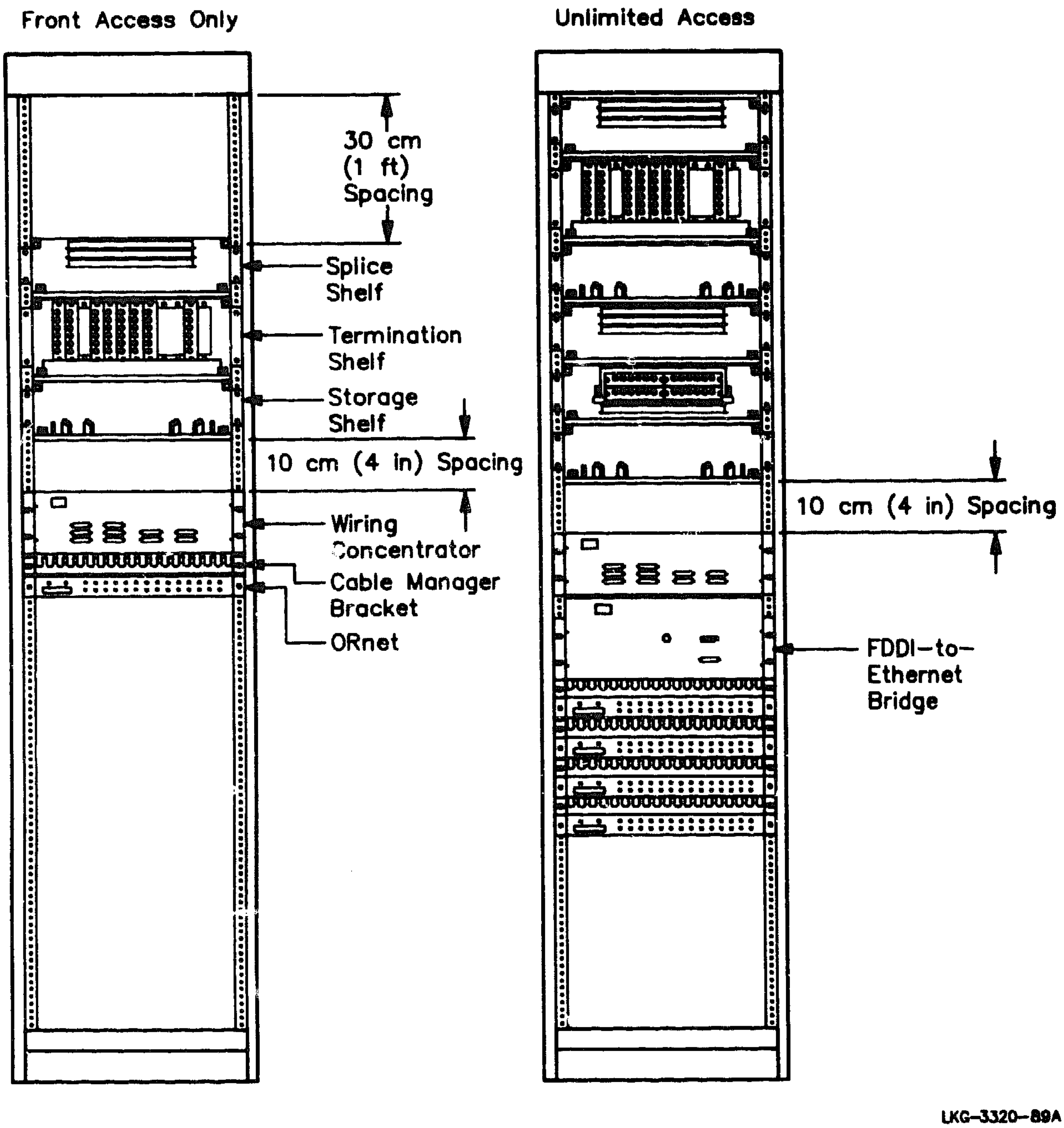


5.1.2 19-Inch Rack (H3120, 86-Inch) Passive and Active Installation

The following are guidelines for installing passive and active equipment together in a 19-inch equipment rack. Refer to Figure 5–2 for a typical installation using these guidelines.

- For stability, mount the lighter passive equipment in the top portion of the rack and the heavier active equipment in the lower portion of the rack.
- Plan the cable clamp locations in advance and allow room for access. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.
- For front access-only racks, leave 30 centimeters (12 inches) of space at the top of the rack for routing cable. Also leave 30 centimeters (12 inches) of space above shelves with outdoor cable clamps.
- Never mount active equipment directly below passive equipment. Leave 10 centimeters (4 inches) of space to allow for outdoor cable clamping.
- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- Mount active equipment recessed to protect patch cable connectors from accidental contact. Mount passive equipment extended, to facilitate cable routing.

Figure 5–2: 19-Inch Rack (H3120, 86-Inch) Passive and Active Installation



5.1.3 19-Inch Rack (H3120, 86-Inch) Cable Management

The following are guidelines for installing outdoor or indoor cable in 19-inch equipment racks and to route slack. Refer to Figure 5–3 for a typical installation using these guidelines.

- Maintain minimum fiber bend radii at all times.
- Route all cable into the rack from the top.
- In front access-only installations, outdoor cable clamping requires 30 centimeters of space (12 inches) above the clamping area.
- Use cable clamps and unit splitters, and perform core blocking and buffering on all outdoor cable. Follow the cable preparation, grounding, and clamp assembly procedures included with the cable clamp hardware.
- Wire tie indoor cable to the openings on the cable clamp brackets. Use only slight pressure when installing wire ties, excessive tightening will damage fibers.
- Install cable manager raceways (wiring duct, Digital specification number 12-26262-01; wiring duct cover, Digital specifiction number 12-26261-01) around the outside front of the racks to route fiber and jumper cable slack as shown in Figure 5–4. Use double-sided tape (Digital specification number 36-23858-02) to secure the raceway to the rack. Break off raceway tabs to create openings for routing. Reinstall raceway covers when the installation is complete.
- Cable manage excess fiber slack and jumper cable slack in the storage shelves, then route to the destination using the cable manager. Try to minimize the amount of fiber stored in the storage shelves by routing most of the cable along the raceway.
- Use cable manager brackets to route patchcords. Refer to Figure 5–5. Patchcord ends can be neatly stored when recessed into the cable manager bushings.

Figure 5–3: 19-Inch Rack (H3120, 86-Inch) Outdoor Cable Management

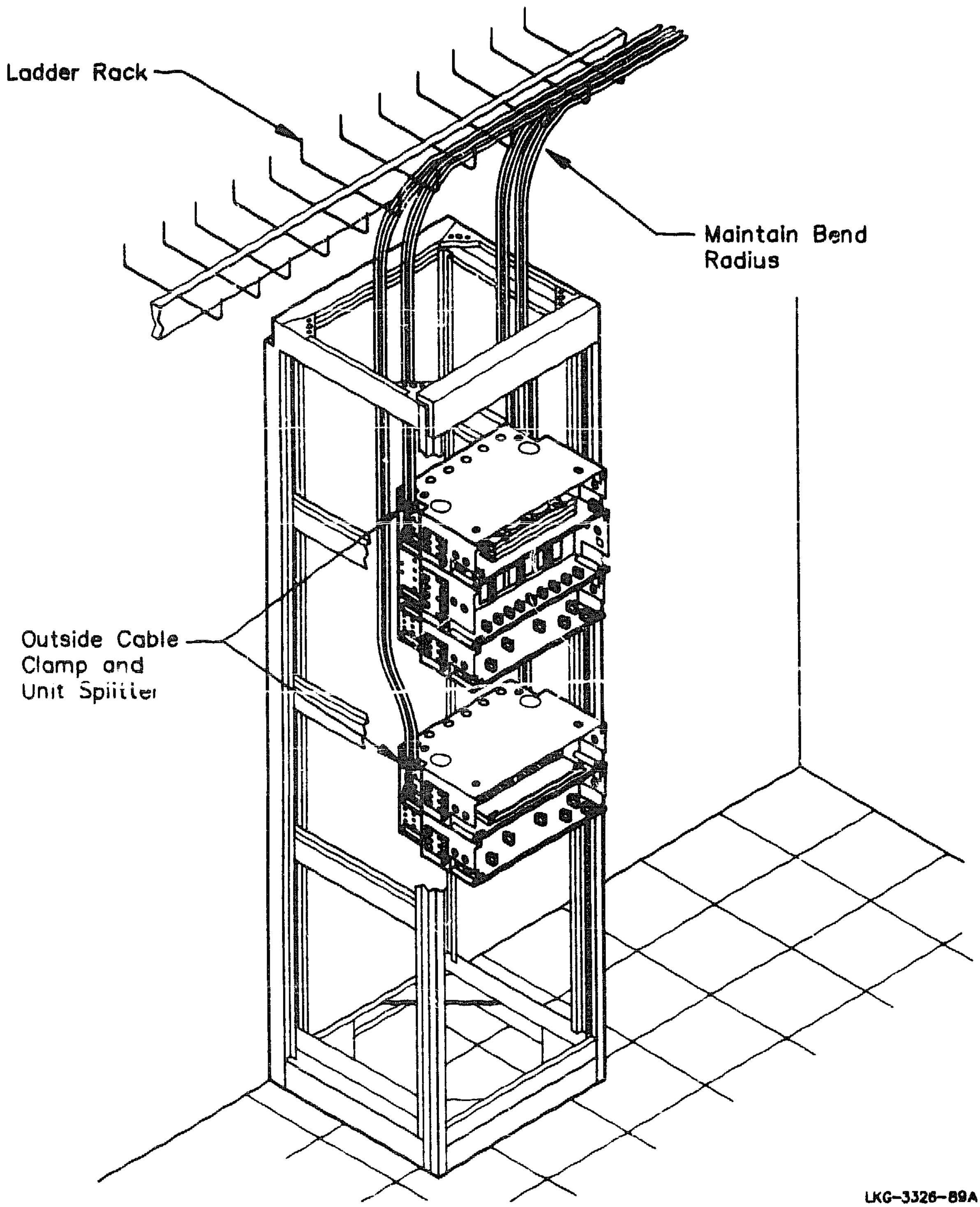


Figure 5–4: 19-inch Rack (H3120, 86-inch) Cable Management Raceway Installation

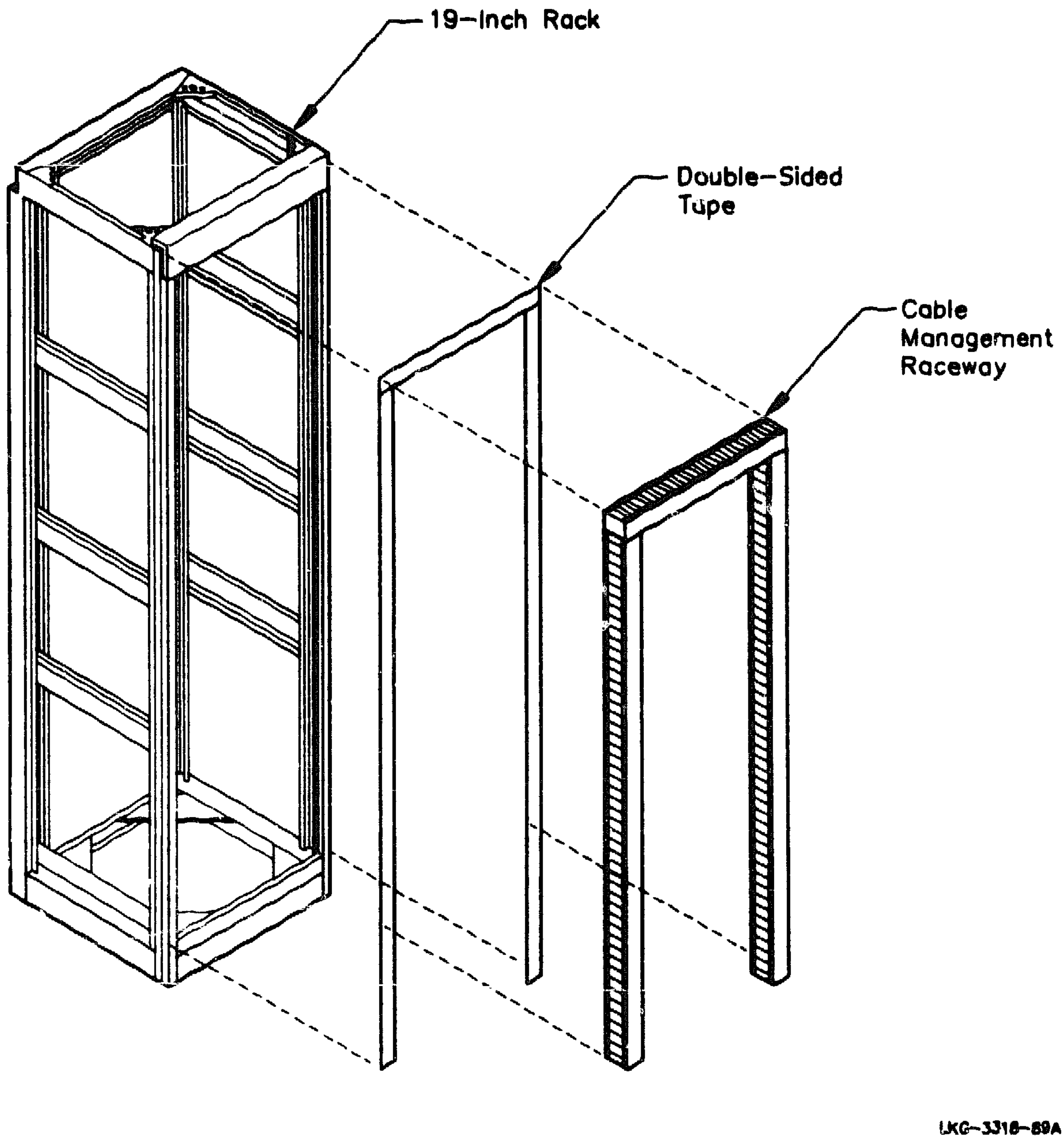
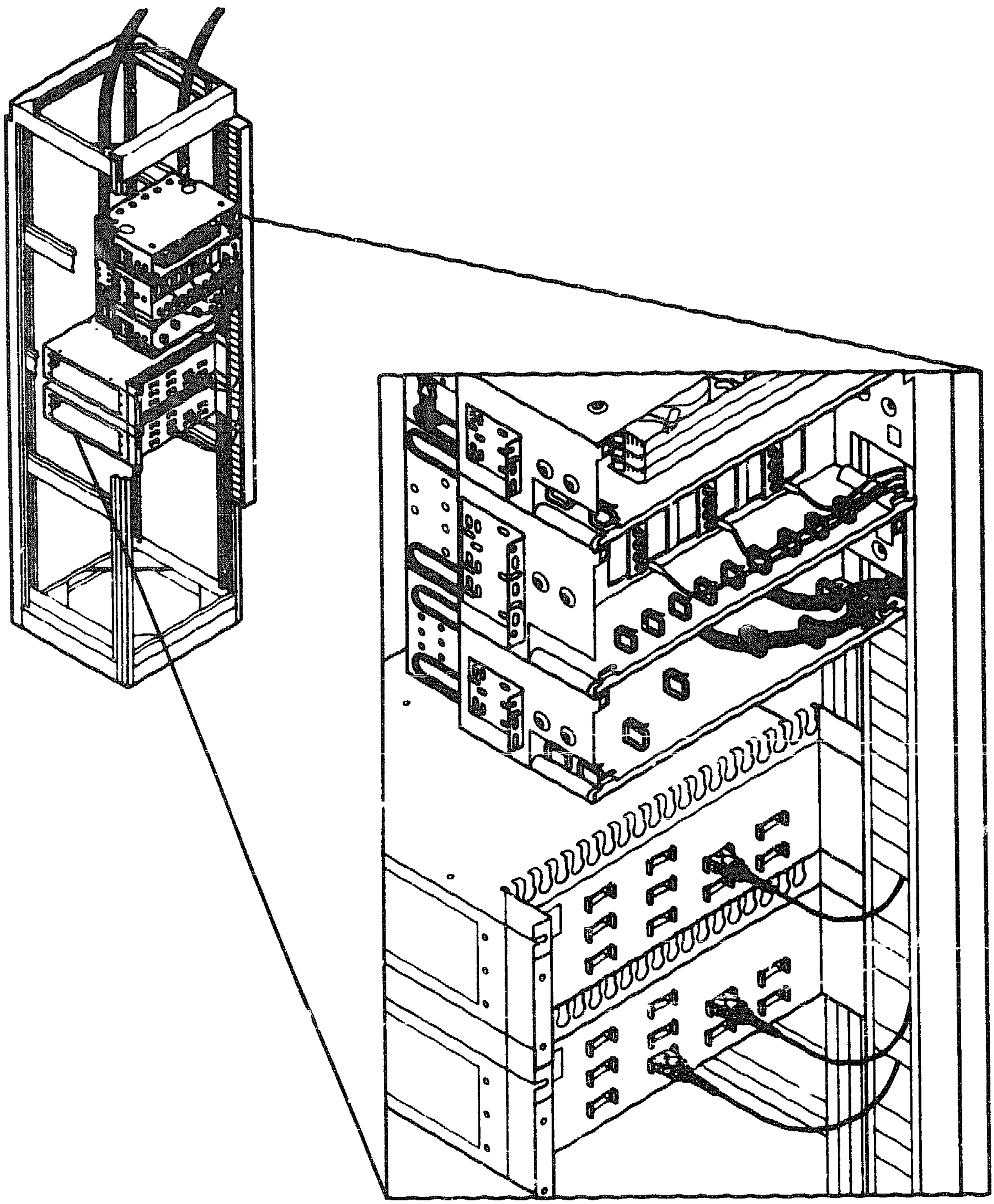


Figure 5–5: 19-Inch Rack (H3120, 86-Inch) Patch Cable Management



5.2 Guidelines for 19-Inch Rack (H3130, 72-Inch) Installations

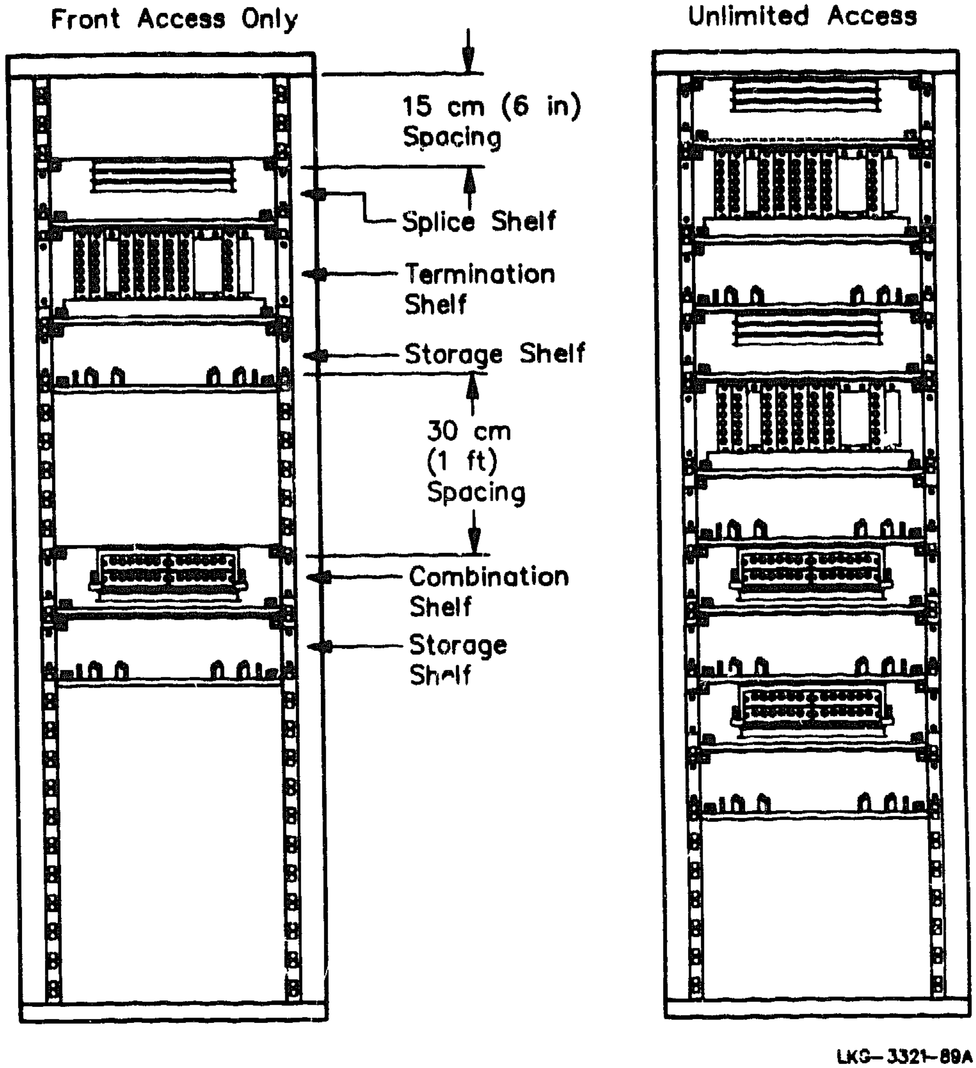
This section describes how to install passive equipment, how to install active and passive equipment together, and how to install and route cable (cable management) in 19-inch (H3130, 72-inch) equipment racks.

5.2.1 Passive Equipment

The following are guidelines for installing passive equipment (termination, splice, storage and combination shelves) in 19-inch (H3130) equipment racks. Refer to Figure 5–6 for a typical installation using these guidelines.

- Plan the cable clamp locations in advance and allow room for access. Route all cable from the top. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.
- For front access-only racks, leave 15 centimeters (6 inches) of space at the top of the rack for routing cable. Also leave 30 centimeters (12 inches) of space above shelves with outdoor cable clamps.
- Mount all shelves in the recessed position.
- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- Install splice shelves above termination shelves to maintain the top-down cable routing.
- Install storage shelves below termination shelves to store fiber and jumper cables.

Figure 5–6: 19-Inch Rack (H3130, 72-Inch) Passive Installation

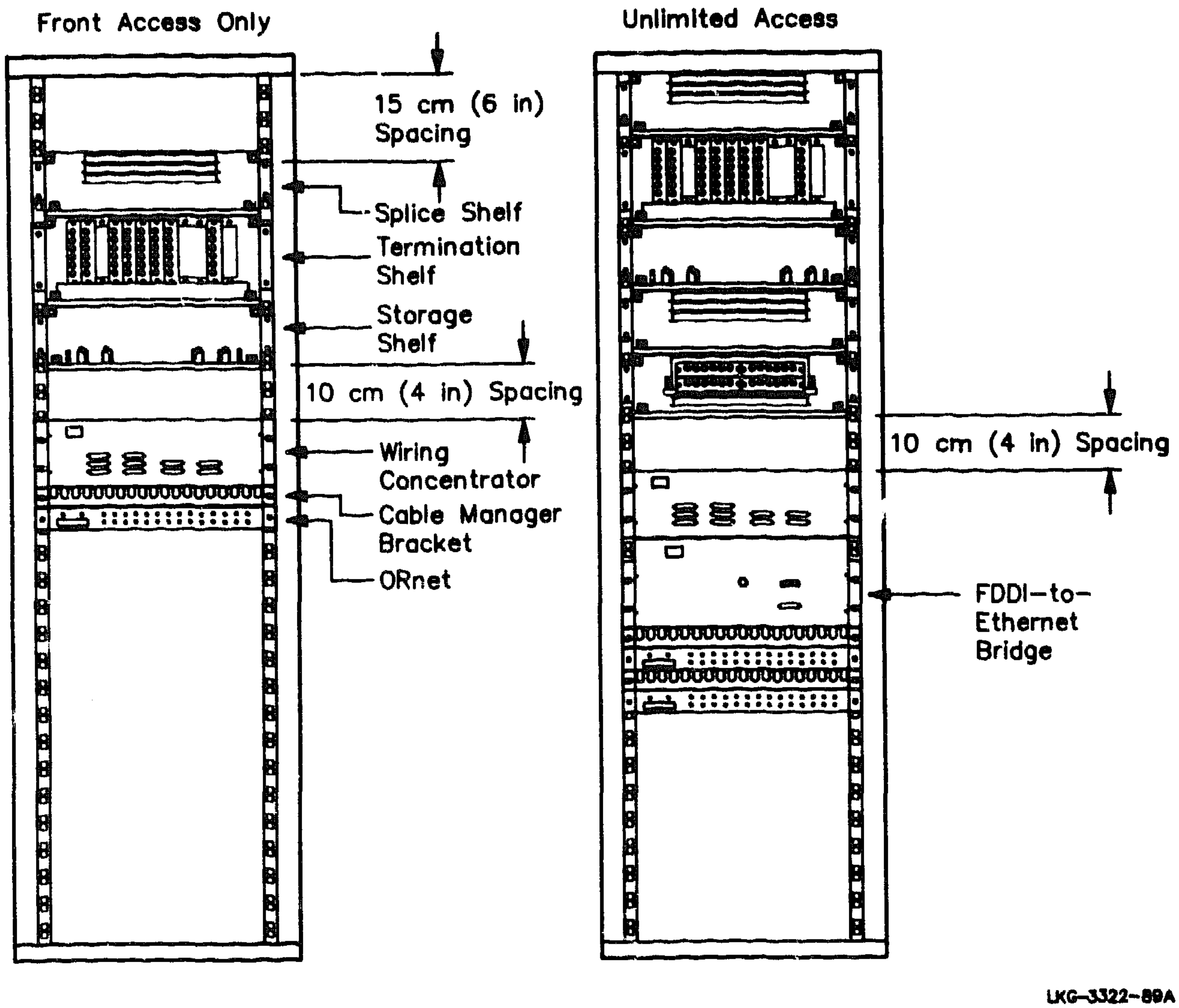


5.2.2 19-Inch Rack (H3130, 72-Inch) Passive and Active Installation

The following guidelines are for installing passive and active equipment together in 19-inch (H3130, 72-inch) equipment racks. Refer to Figure 5–7 for a typical installation using these guidelines.

- For stability, mount the lighter passive equipment in the top portion of the rack and the heavier active equipment in the lower portion of the rack.
- Plan the cable clamp locations in advance and allow room for access. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.
- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- For front access-only racks, leave 15 centimeters (6 inches) of space at the top of the rack for routing cable. Also leave 30 centimeters (12 inches) of space above shelves with outdoor cable clamps.
- Never mount active equipment directly below passive equipment. Leave 10 centimeters (4 inches) of space to allow for outdoor cable clamping.
- Mount active equipment recessed, to protect patch cable connectors from accidental contact. Mount passive equipment extended, to facilitate cable routing.

Figure 5–7: 19-Inch Rack (H3130, 72-Inch) Passive and Active Installation



5.2.3 19-inch Rack (H3130, 72-inch) Cable Management

The following guidelines are for installing outdoor or indoor cable in 19-inch equipment racks and to route slack. Figure 5–8 shows a typical installation using these guidelines. Figure 5–9 shows patch cable management.

- Maintain the minimum fiber bend radii at all times.
- Route all cable into the rack from the top.
- Use cable clamps and unit splitters, and perform core blocking and buffering on all outdoor cable. Follow the cable preparation, grounding, and clamp assembly procedures included with the cable clamp hardware.
- Wire tie indoor cable to the openings on the cable clamp brackets. Use only slight pressure when installing wire ties, excessive tightening will damage fibers.
- Cable manage excess fiber slack and jumper cables slack in the storage shelves then route to the destination.
- Use cable manager brackets to route patchcords. Patchcord ends can be neatly stored when recessed into the cable manager bushings.

Figure 5–8: 19-Inch Rack (H3130, 72-Inch) Cable Management

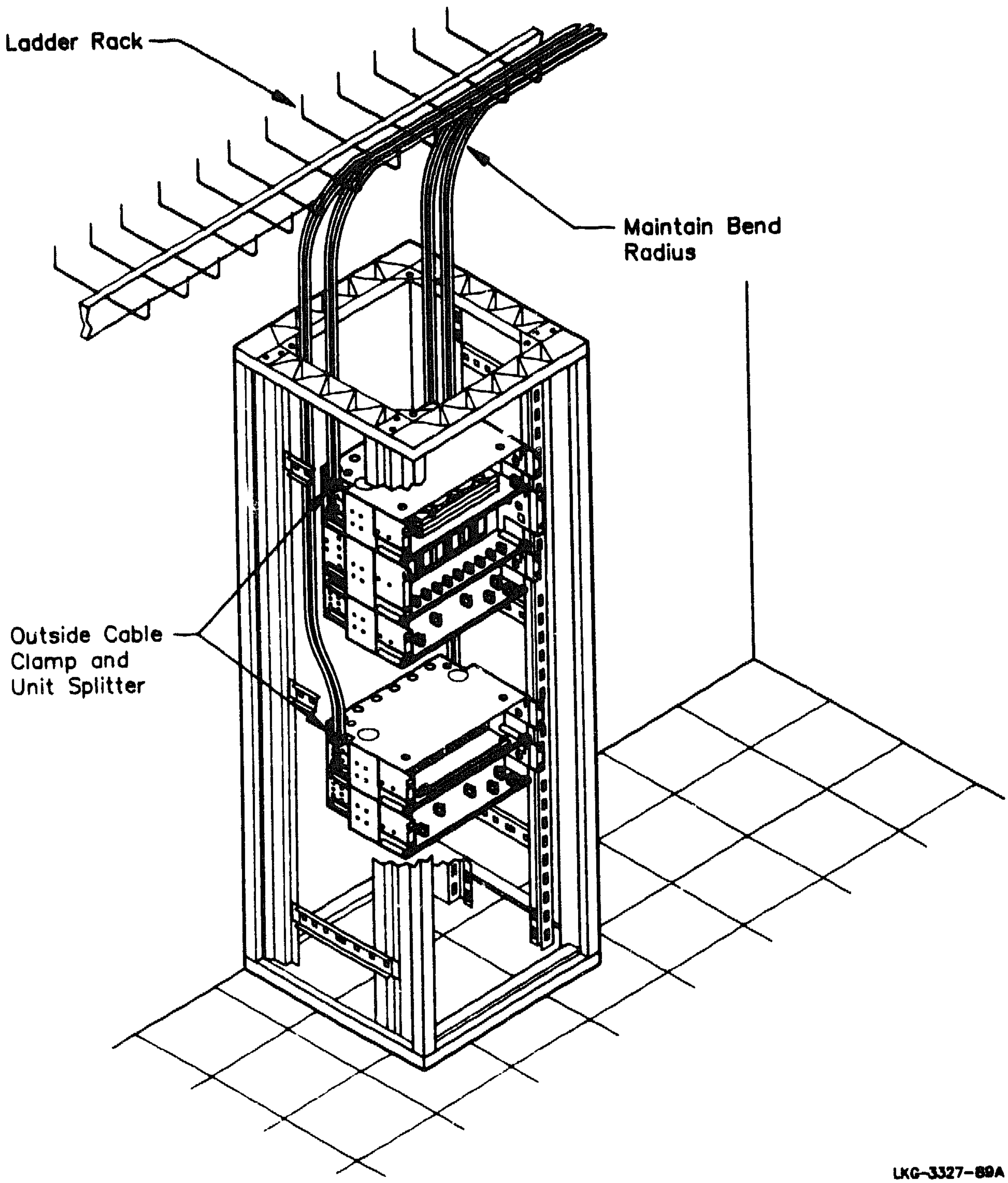
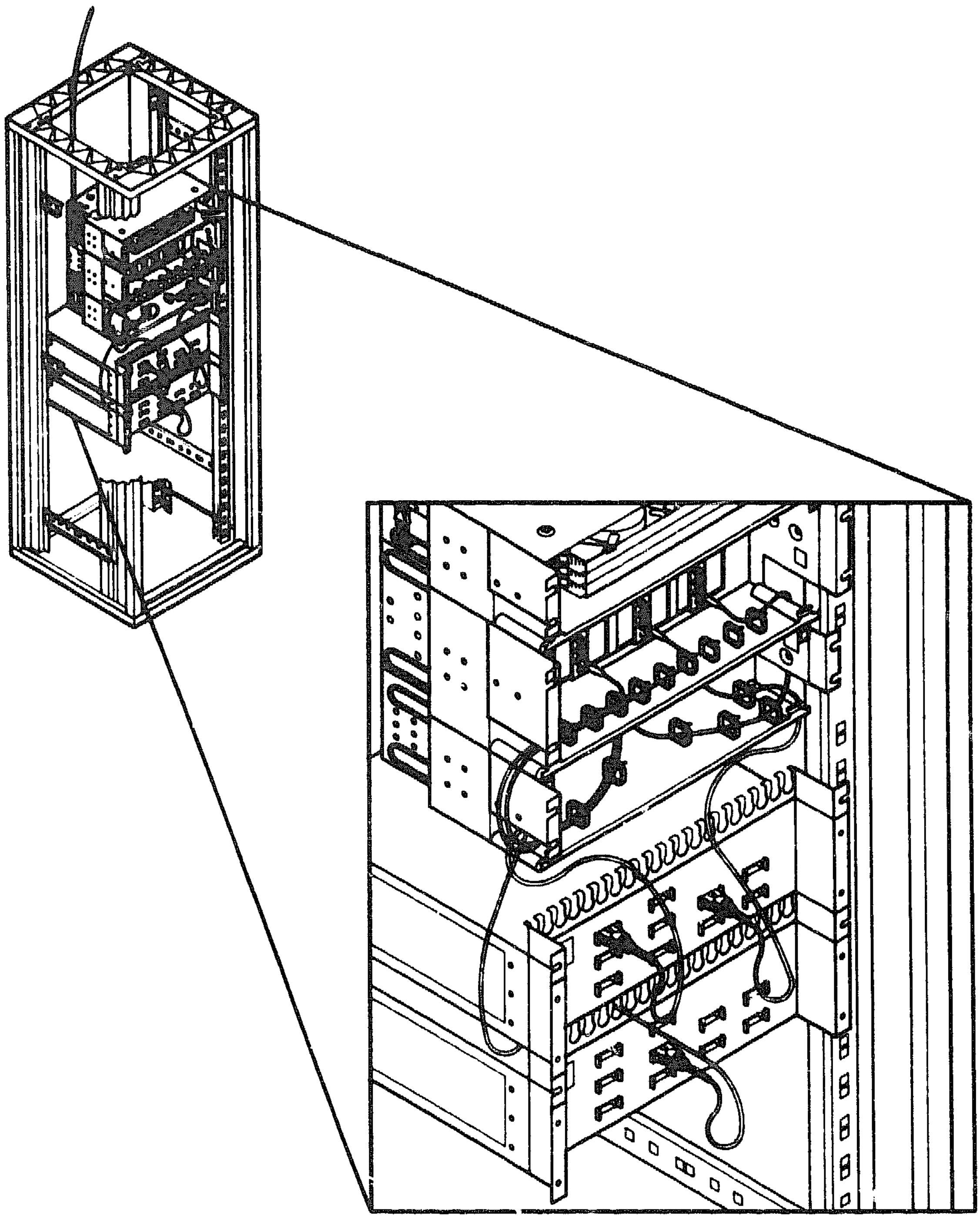


Figure 5–9: 19-Inch Rack (H3130, 72-Inch) Patch Cable Management



5.3 Guidelines for Installing Passive Hardware in a 23-Inch Rack

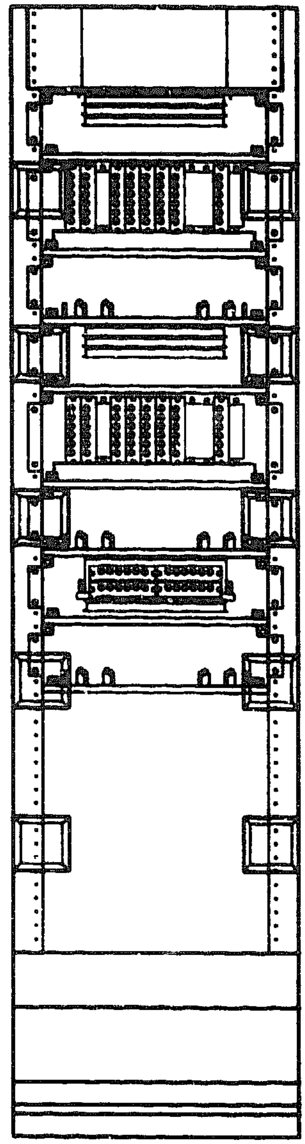
This section describes how to install passive equipment, how to install active and passive equipment together, and how to install and route cable (cable management) in 23-inch racks.

5.3.1 Passive Equipment

The following are guidelines for installing passive equipment (termination, splice, storage and combination shelves) in 23-inch equipment racks. Refer to Figure 5–10 for a typical installation using these guidelines.

- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf, and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- Install splice shelves above termination shelves to maintain the top-down cable routing.
- Install storage shelves below termination shelves to store fiber and jumper cables.

Figure 5–10: 23-Inch Rack Passive Installation



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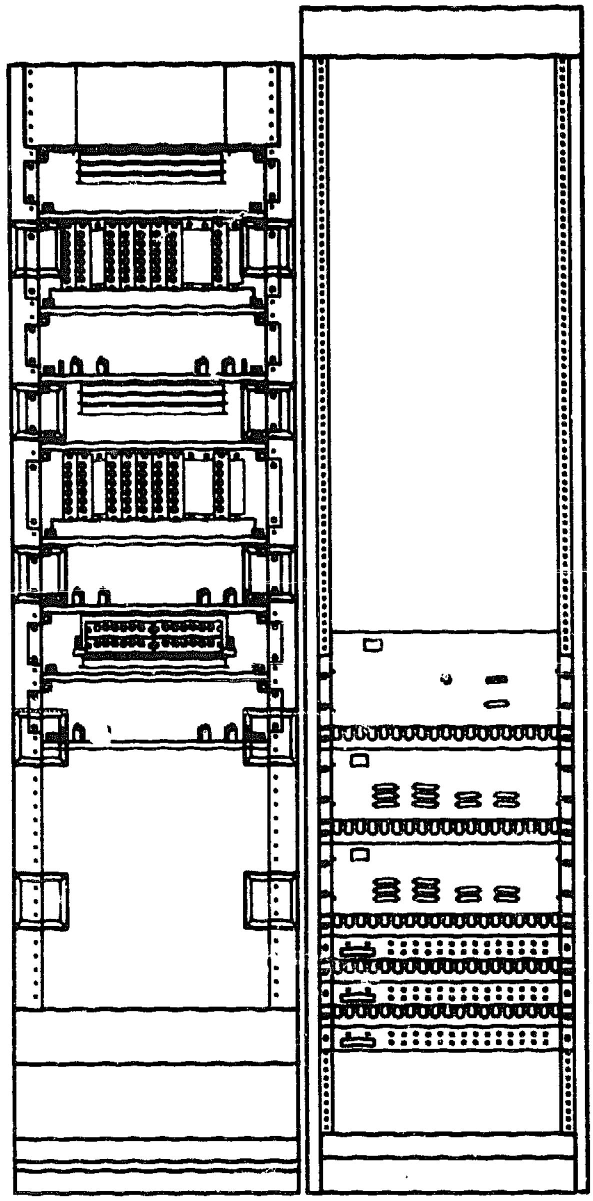
5.3.2 23-Inch Rack Passive and 19-Inch Active Installation

The following are guidelines for installing passive and active equipment together in a 23-inch and 19-inch equipment racks. Refer to Figure 5–11 for a typical installation using these guidelines.

- All passive equipment must be installed in the 23-inch rack, and all active (or an active-passive mix) must be installed in the 19-inch rack.
- Follow the guidelines for passive installation as described in Section 5.3.1.
- Follow the guidelines for active and passive installations as described in Section 5.1 and Section 5.2.

Figure 5–11: 23-Inch Rack Passive and 19-Inch (H3120, 86-Inch) Rack Active Installation



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5.3.3 23-Inch Rack Cable Management

The following guidelines are for installing outdoor or indoor cable in 23-inch equipment racks and to route slack. Refer to Figure 5–12 for a typical installation using these guidelines.

- Maintain minimum bend radii at all times.
- Route all cable into the rack from the top.
- Use cable clamps and unit splitters, and perform core blocking and buffering on all outdoor cable. Follow the cable preparation, grounding, and clamp assembly procedures included with the cable clamp hardware.
- Wire tie indoor cable to the openings on the cable clamp brackets. Use only slight pressure when installing wire ties, excessive tightening will damage fibers.
- Cable manage excess fiber slack and jumper cables slack in the storage shelves.
- In 23-inch and 19-inch (H3120, 86-inch) mixed rack installations, route the cable through the 19-inch rack cable management raceway to the top of the 23-inch rack as shown in Figure 5–13.

Figure 5–12: 23-Inch Rack Cable Management

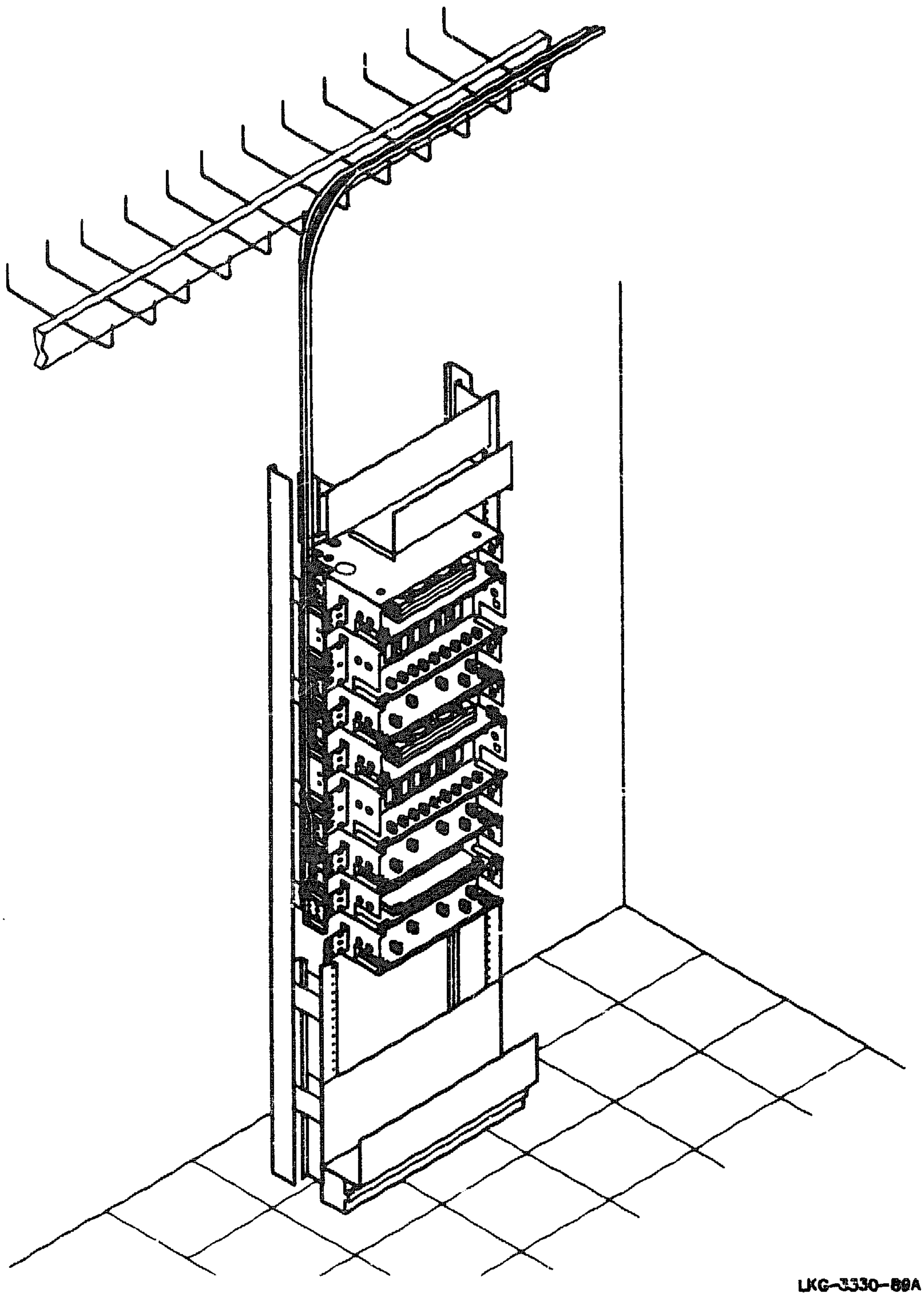
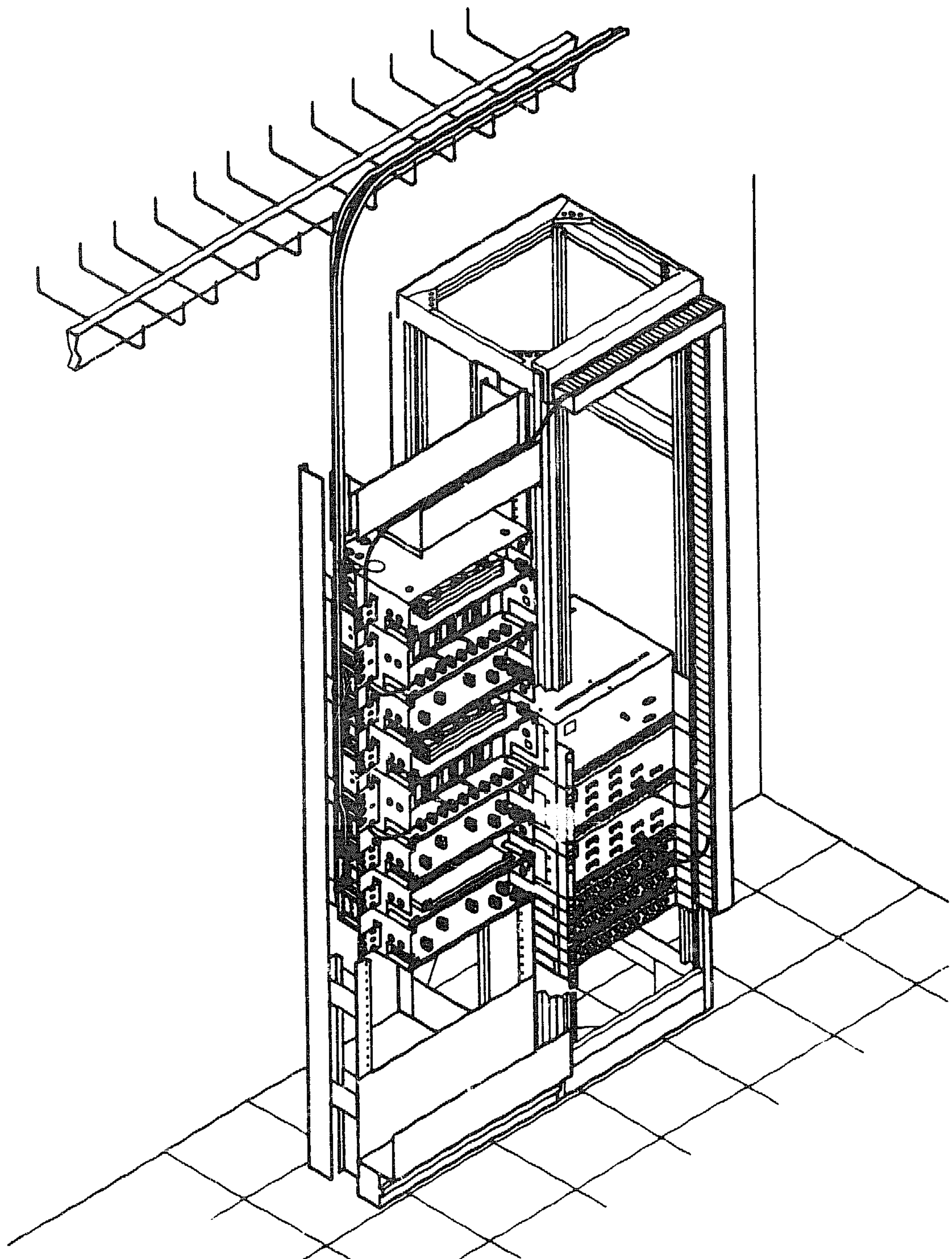


Figure 5–13: 23-Inch Rack and 19-Inch (H3120, 86-Inch) Rack Cable Management



5.4 Guidelines for Installing Passive Hardware in an Office Distribution Frame

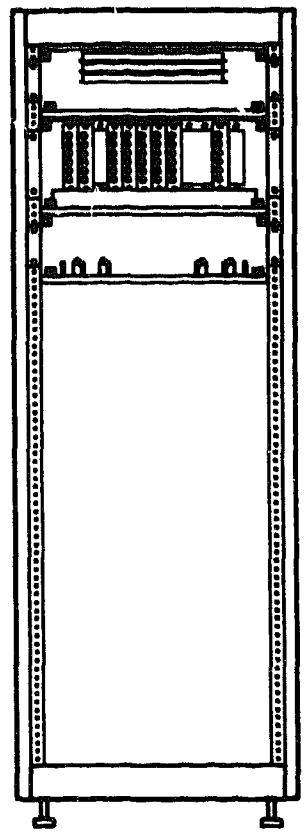
This section describes how to install passive equipment, how to install active and passive equipment together, and how to install and route cable (cable management) in an office distribution frame.

5.4.1 Passive Equipment

The following guidelines are for installing passive equipment (termination, splice, storage and combination shelves) in an office distribution frame (ODF). Refer to Figure 5–14 for a typical installation using these guidelines.

- Plan the cable clamp locations in advance and allow room for access. Route all cable from the bottom. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.
- Mount all shelves in the recessed position.
- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- Install splice shelves above termination shelves to maintain the top-down cable routing.
- Install storage shelves below termination shelves to store fiber and jumper cables.
- Route fibers in from the bottom of the cabinet.

Figure 5–14: Office Distribution Frame Passive Installation



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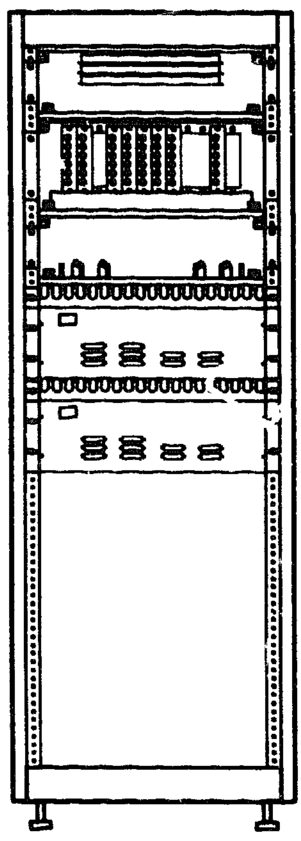
5.4.2 Office Distribution Frame Passive and Active Installation

The following guidelines describe installing passive and active equipment together in an office distribution frame. Refer to Figure 5–15 for a typical installation using these guidelines.

- For stability, mount the lighter passive equipment in the top portion of the rack and the heavier active equipment in the lower portion of the rack.
- Plan the cable clamp locations in advance and allow room for access. Mount the clamps after the shelves are installed in the rack.
- When using a single rack, keep fiber optic equipment separate from copper equipment. Intermingling will cause problems when installing cable clamps and in routing patchcords.

- Install shelves in logical groups. That is, all shelves using the same cable fibers should be located together. For example, a splice shelf, termination shelf, and associated storage shelf should have cable routing grommets installed, and should be mounted above each other.
- For front access-only racks, leave 15 centimeters (6 inches) of space at the top of the rack for routing cable. Also leave 30 centimeters (12 inches) of space above shelves with outdoor cable clamps.
- Never mount active equipment directly below passive equipment. Leave 10 centimeters (4 inches) of space to allow for outdoor cable clamping.
- Mount all equipment recessed.

Figure 5–15: Office Distribution Frame Passive and Active Installation

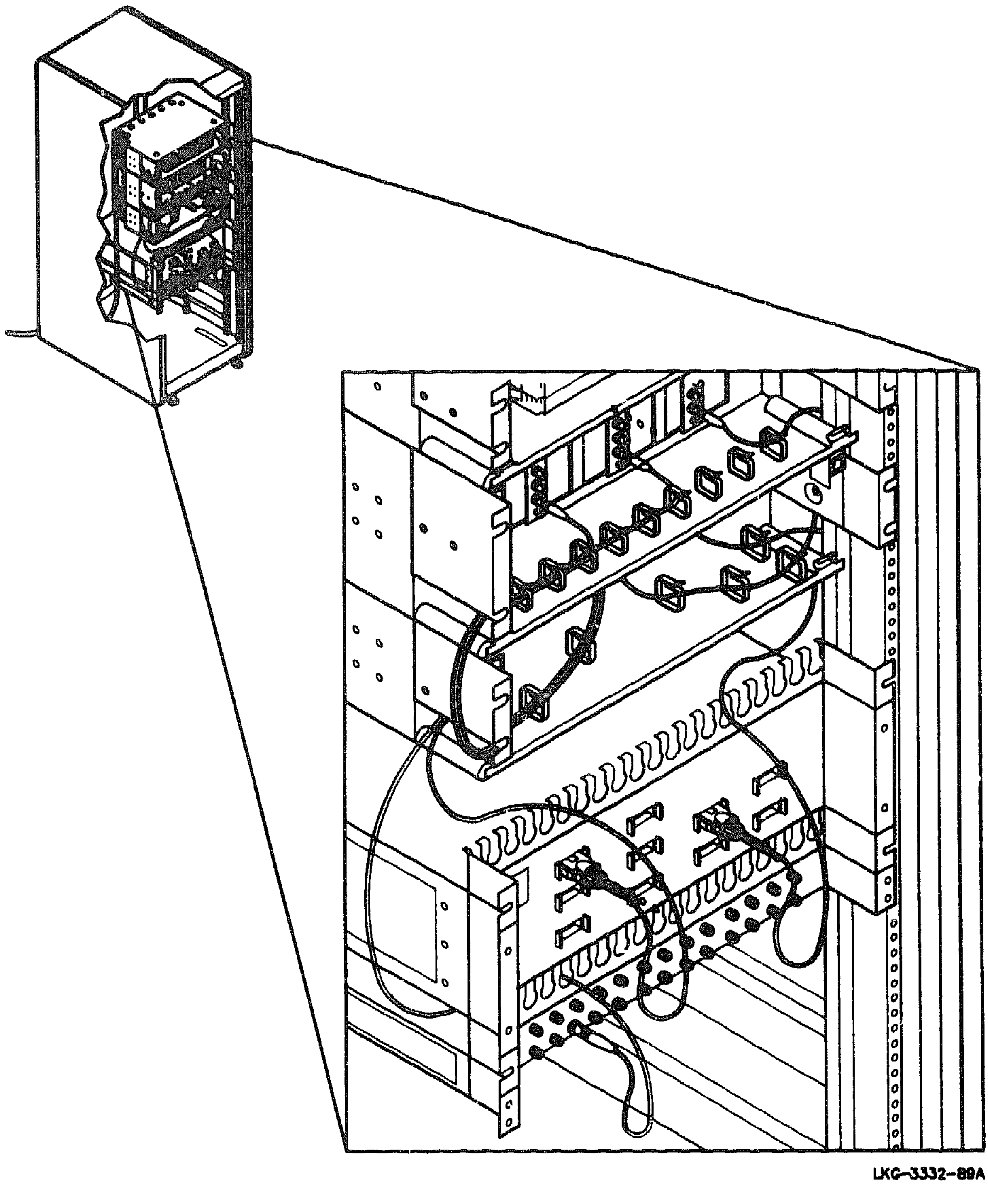


5.4.3 Office Distribution Frame Cable Management

The following guidelines are for installing outdoor or indoor cable in an office distribution frame. Refer to Figure 5–16 for a typical installation using these guidelines.

- Maintain minimum fiber bend radii at all times.
- Route all cable into the rack from the bottom.
- Use cable clamps and unit splitters, and perform core blocking and buffering on all outdoor cable. Follow the cable preparation, grounding, and clamp assembly procedures included with the cable clamp hardware.
- Wire tie indoor cable to the openings on the cable clamp brackets. Use only slight pressure when installing wire ties, excessive tightening will damage fibers.
- Cable manage excess fiber slack and jumper cables slack in the storage shelves then route to the destination.
- Use cable manager brackets to route patchcords. Patchcord ends can be neatly stored when recessed into the cable manager bushings.
- Remove rack side panels for easier patch cable routing.
- Take up excess patch cable slack using the storage shelf, or by allowing the slack to hang in large loops along the inside of the ODF.

Figure 5–16: Office Distribution Frame Cable Management



5.5 Preparing the Equipment Room for Rack Installation

This section describes how to install lag bolt anchors in the equipment room floor. These anchors allow the use of lag bolts in bolting the racks to the floor.

5.5.1 Preparing the Equipment Room Floor

The exact size of the lag bolts needed to bolt a rack to the equipment room floor depends on the rack that is to be installed. Digital Equipment Corporation's 86-inch racks require four 3/8 inch by 5 inch lag bolts. In general, this size lag bolt should satisfy the requirements of any rack manufacturer.

The lag bolts are screwed into expanding lag screw anchors. A Rawl lag shield (Rawlplug Company, New Rochelle, NY, 10802, catalog number 1151) is an acceptable lag screw anchor for the 3/8 inch by 5 inch lag bolts. Digital does not supply the lag bolts or the anchors. These items can be purchased at a local hardware store.

Each rack will require four lag bolt anchors. Exactly where those anchors are located on the floor will depend on the position of the racks within the equipment room and the hole pattern in the bottom of the racks (for the lag bolts). Different racks will have different rack hole patterns. It may be necessary to physically measure the racks to be installed to determine the actual lag bolt anchor pattern.

To install the Rawl lag shield (1151), drill a 5/8 inch by 1 and 3/4 inch hole in the concrete at the locations required by the rack to be installed. Insert the anchors until they are flush with the floor surface.

Figure 5–17 shows a sample floor hole pattern for a single rack configuration using 72-inch racks, while Figure 5–18 shows a sample floor hole pattern for a dual-rack configuration using 72-inch racks. These figures are supplied as examples only. The actual pattern can be different for the racks that will be installed. Figure 5–19 shows the floor hole pattern needed for Digital's 86-inch racks.

Figure 5–17: Sample Floor Hole Pattern for Single 72-Inch Rack Configuration

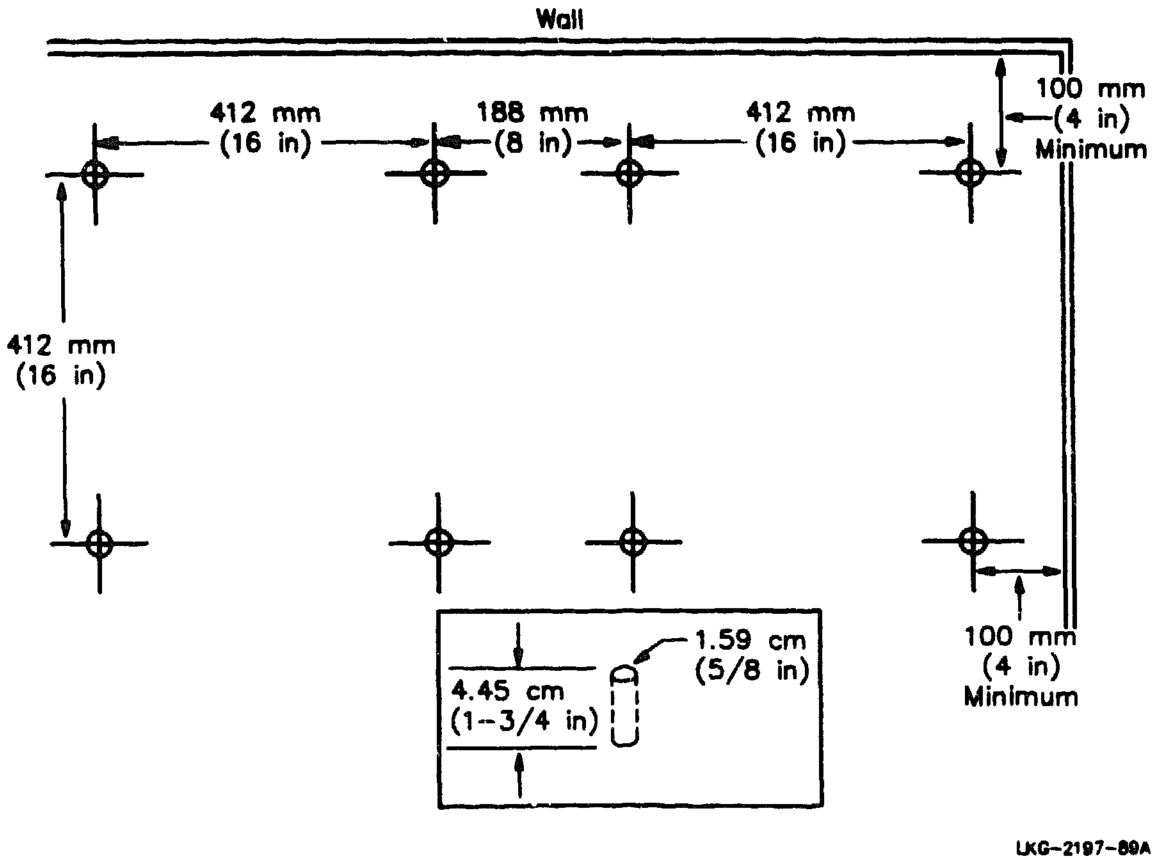


Figure 5–18: Sample Floor Hole Pattern for Dual 72-Inch Rack Configuration

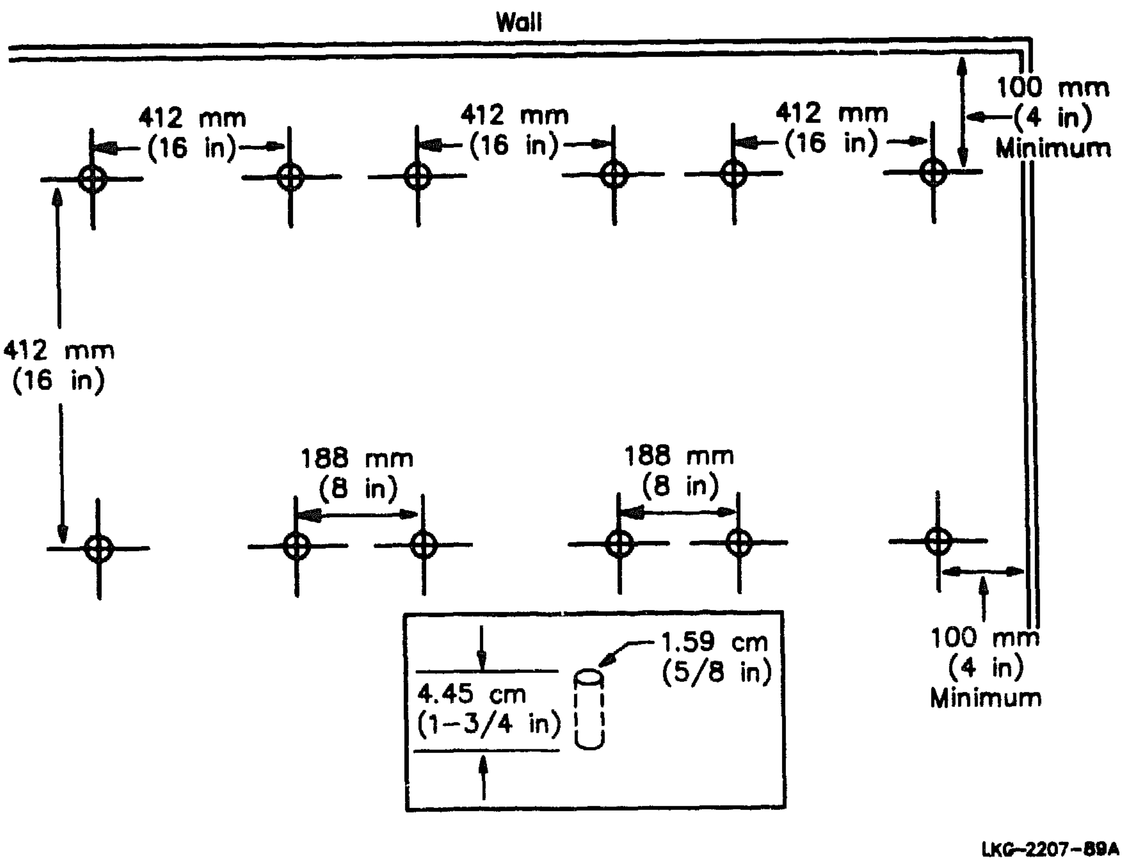
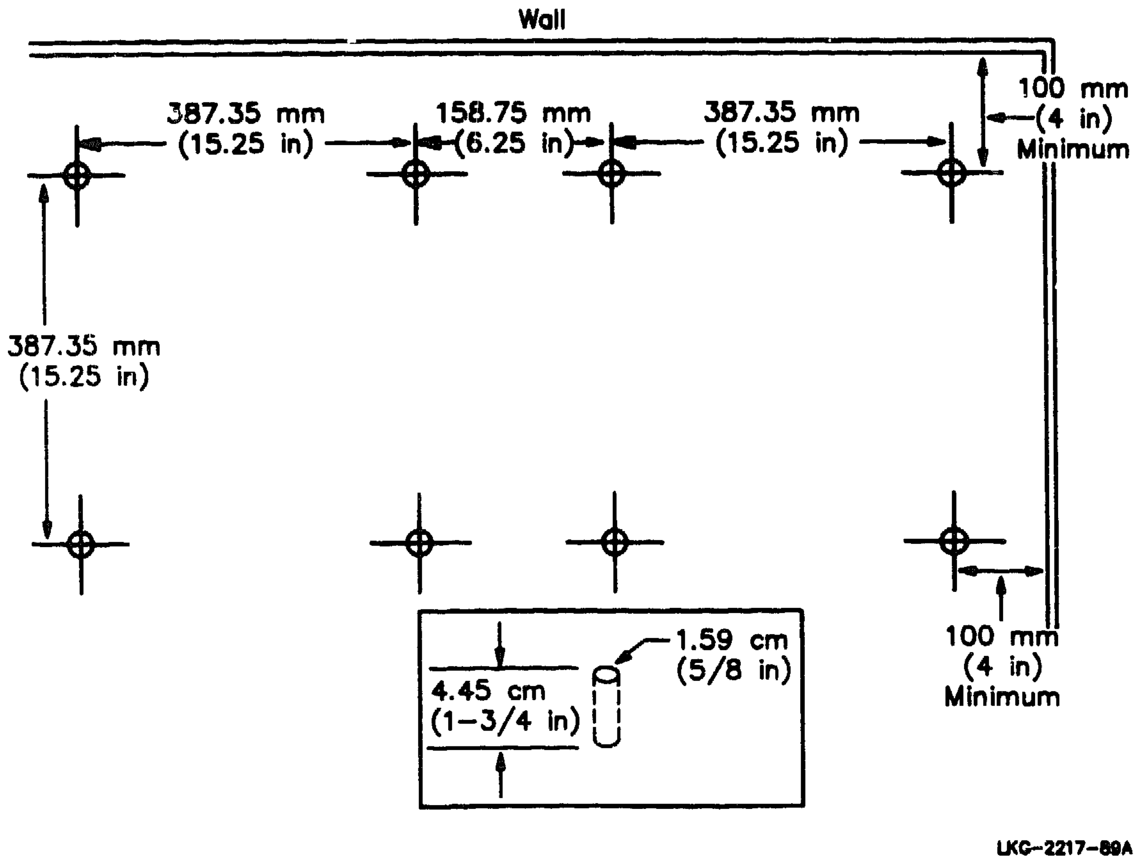


Figure 5–19: Floor Hole Pattern for 86-Inch Rack Configuration



CHAPTER 6

6

Wallbox Installation

6.1 Modular Office Wallbox Kits

The modular office wallbox (see Figure 6–1) provides a network connection point for office communication equipment. The wallbox is a plastic enclosure, 10.16 centimeters (4 inches) high, 7.52 centimeters (3 inches) wide and 4.75 centimeters (1 and 7/8 inches) deep, designed to accept various network receptacles as shown in Figure 6–2.

The wallbox is used in fiber-only or copper-only applications. Fiber and copper wiring should not be installed in a single wallbox, but multiple wallbox fiber-copper wiring installations, shown in Figure 6–5 are possible. The wallbox design allows it to be oriented horizontally or vertically. It can be mounted using the predrilled U.S. and European hole patterns, to accomodate installation on an existing electrical box in the wall.

The modular wallbox kits are:

- H3111-GA — Kit of 8 wallboxes, color: Digital Grey
- H3111-GB — Kit of 8 wallboxes, color: White
- H3111-GC — Kit of 8 wallboxes, color: Ivory

Table 6–1 lists the components and the quantity of each component that each wallbox kit contains.

Table 6–1: Wallbox Kit Contents

Component	Kit Quantity
Modular wallboxes (cover and base)	8
Installation instructions	1
Fiber routing rings	32 (4 per wallbox)
Dual bezels	16 (2 per wallbox)
Blank bezels	16 (2 per wallbox)
Blank hole plug	8 (1 per wallbox)
Metric mounting screws	16 (2 per wallbox)
U.S. mounting screws	16 (2 per wallbox)
Sheet of labels	1 (contains 8 labels)
Plastic label protector	8 (1 per wallbox)
Wall mounting back	8 (1 per wallbox)
Velcro strips	16 (2 per wallbox)

Figure 6–1: H3111-GA/GB/GC Modular Wallbox

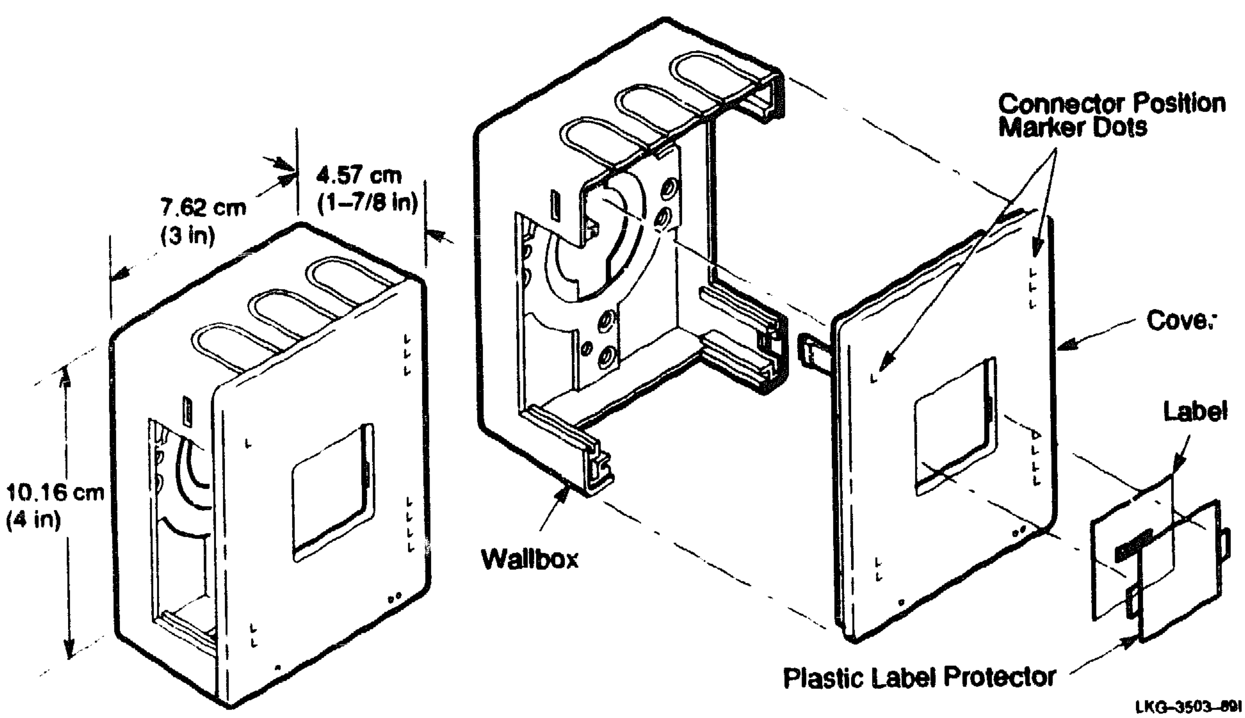
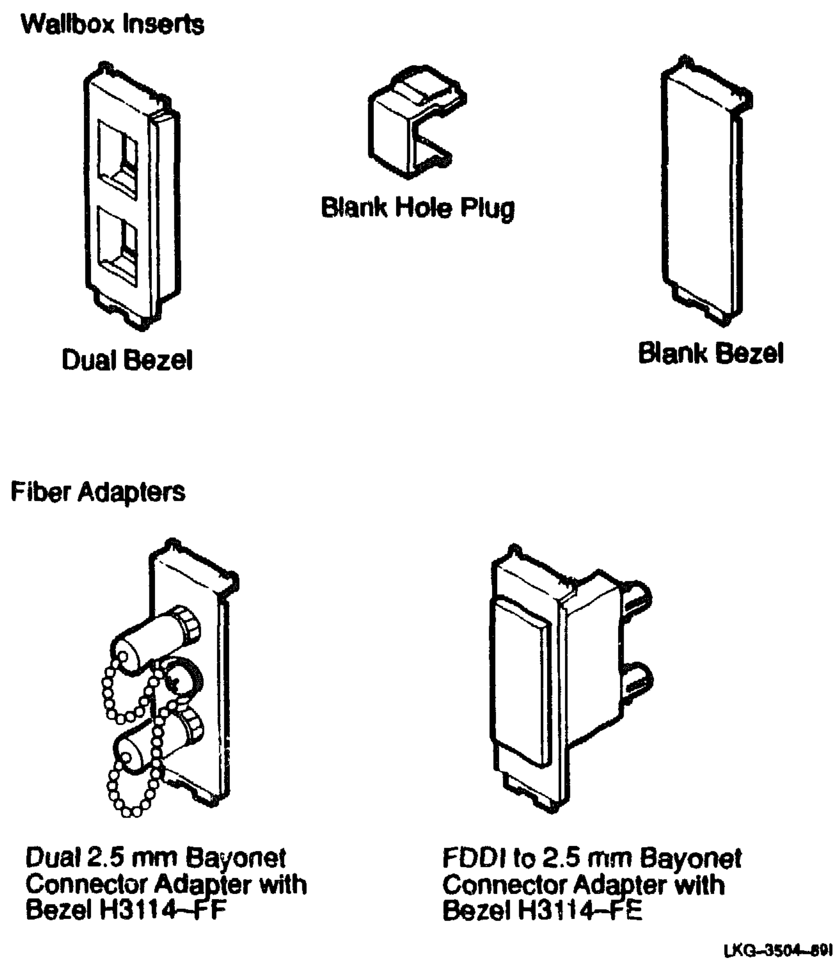


Figure 6–2: Available Connectors and Inserts



6.1.1 Fiber Optic Cable Connection

The following tools are needed to install 2.5 mm bayonet ST-type connectors (refer to J3114-FA) on fiber optic cable:

- 2.5 mm Bayonet ST-type Connector Termination Tool Kit H8102-AA (110 volt) or H8102-AC (220 volt)
- 2.5 mm Bayonet ST-type Connector Consumables Kit (H8102-AB)
- 2.5 mm Bayonet ST-type Connector Kit containing six connectors (H3114-FA)
- Razor knife
- Diagonal cutters

- Flat-blade screwdriver

Refer to the installation instructions in the 2.5 mm Bayonet ST-type Connector Termination Tool Kit (H8102-AA/AC) for details on field termination.

6.1.2 Mounting Options

Figure 6–3, Figure 6–4, and Figure 6–5, show some typical mounting options.

Figure 6–3 shows the FDDI to 2.5 mm bayonet ST-type connector adapter bezel installed in the modular wallbox. The fiber adapter bezels should always be installed in the bottom slot of the wallbox to allow adequate room for the fiber's minimum bend radius requirement.

Always install the 2.5 mm bayonet ST-type connector with the black bend bend radius boot to the connector barrel with the black dot on the adapter bezel.

Always install the 2.5 mm bayonet ST-type connector with the red bend bend radius boot to the other connector barrel.

Figure 6–4 shows the 2.5 mm bayonet ST-type connector adapter bezel installed in the wallbox and the proper fiber cable routing for storage in the wallbox.

Always install the 2.5 mm bayonet ST-type connector with the black bend bend radius boot to the connector barrel with the black dot on the adapter bezel.

Always install the 2.5 mm bayonet ST-type connector with the red bend bend radius boot to the other connector barrel.

Figure 6–3: Fiber-Only Installation (FDDI)

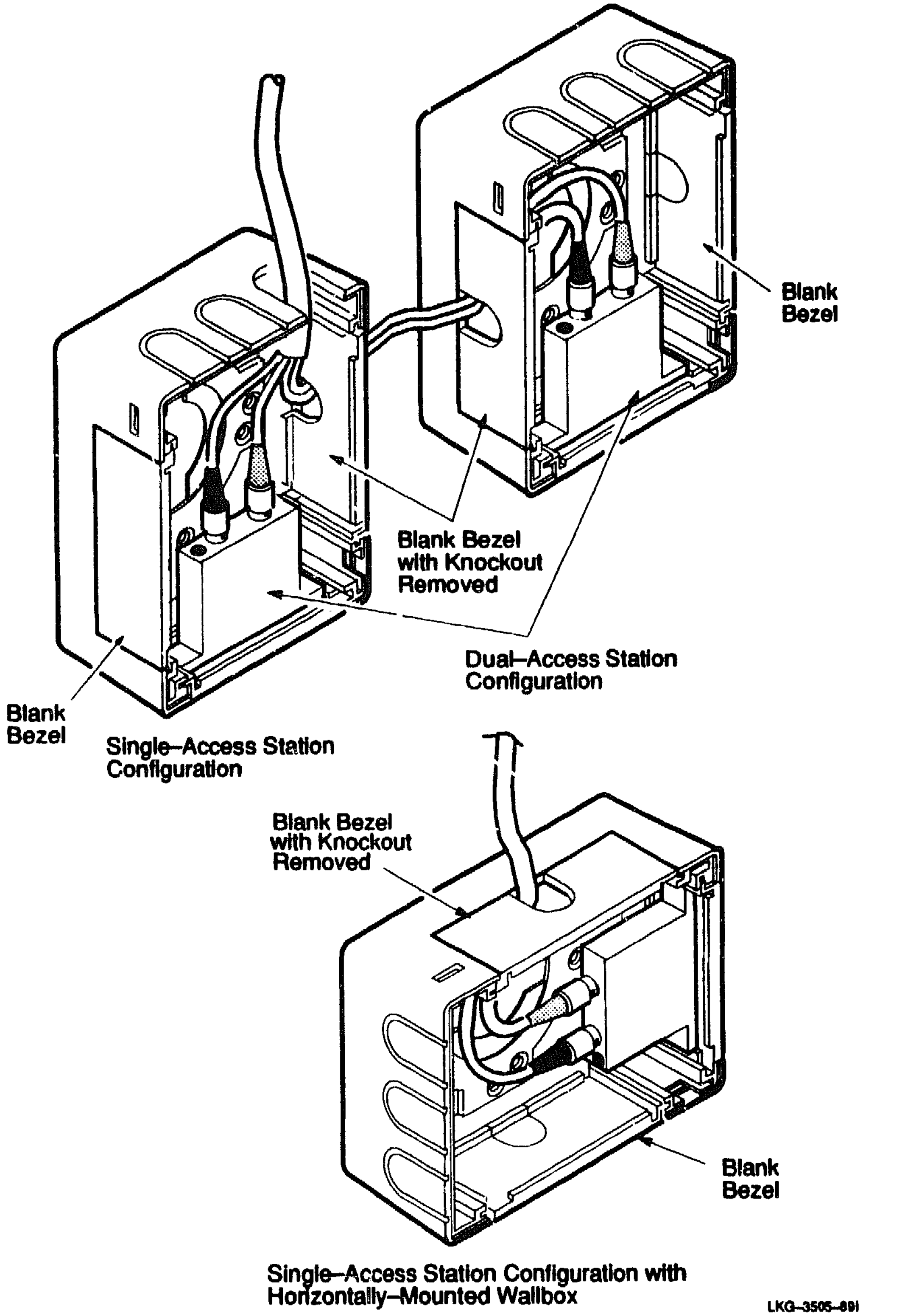


Figure 6–4: Fiber-Only Installation (2.5 mm Bayonet ST-Type Connector) and Fiber Cable Wallbox Storage

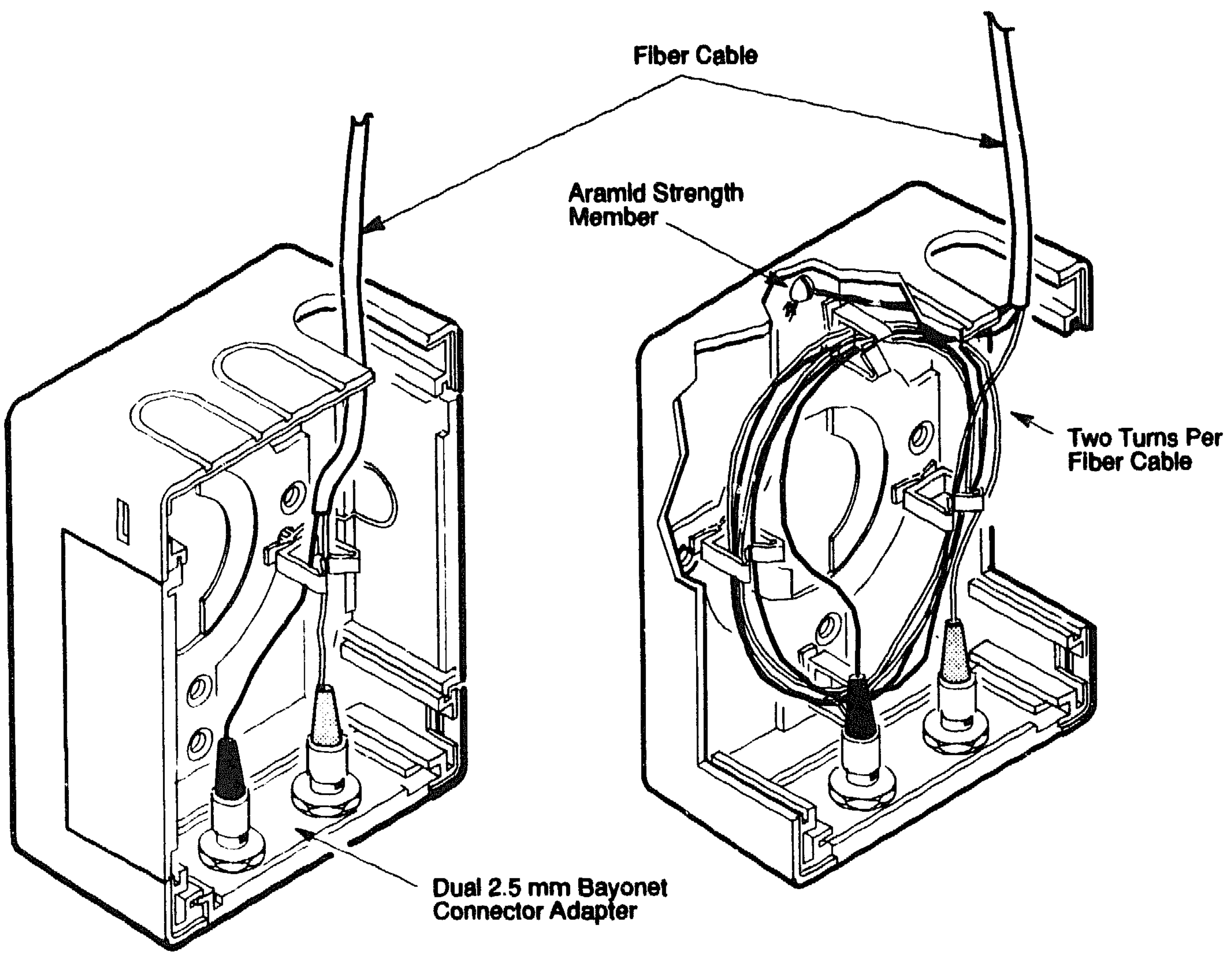
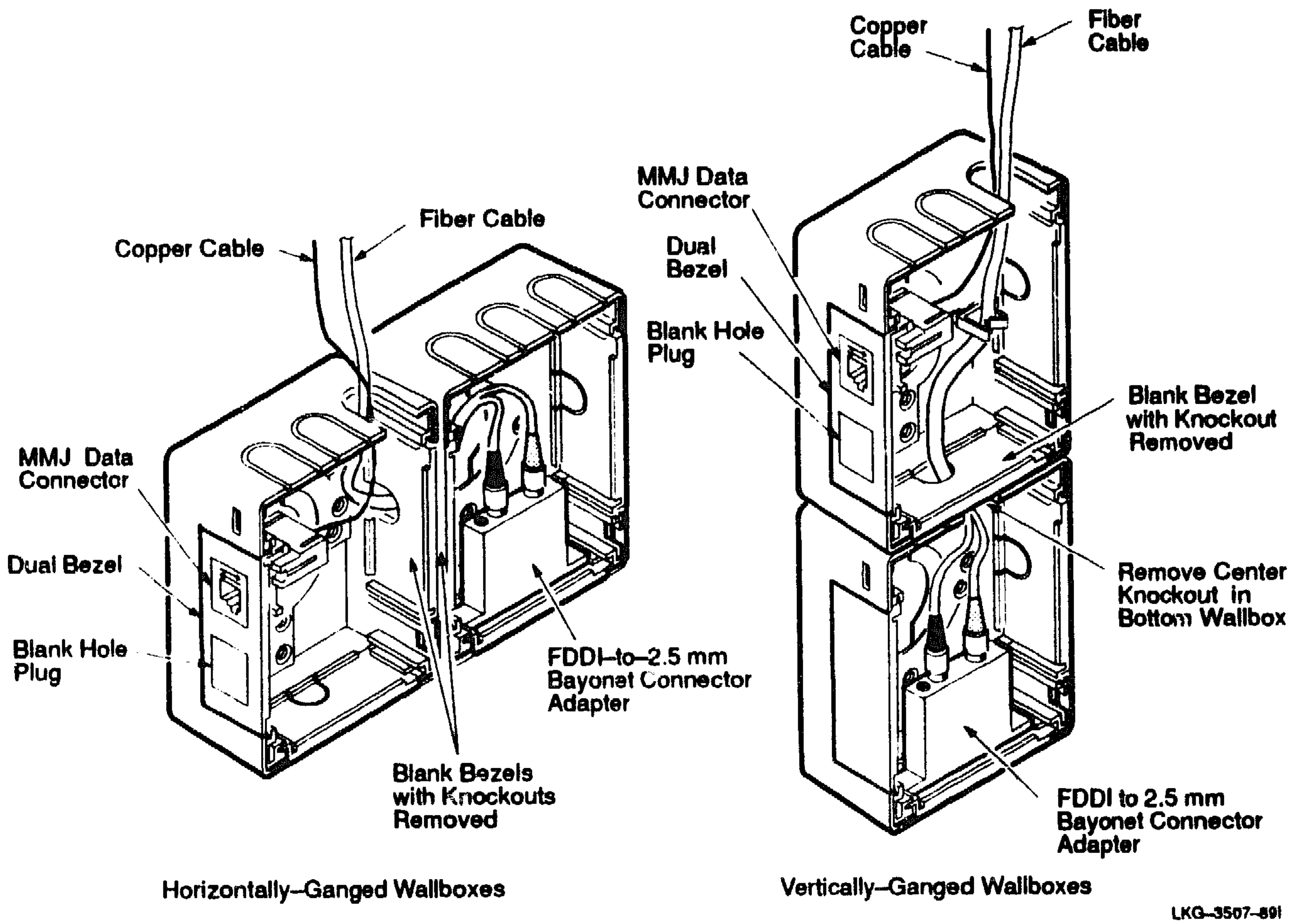


Figure 6–5 shows fiber and copper connectors installed in horizontally and vertically ganged modular wallboxes. In the horizontally ganged wallboxes, only one side slot is available in each wallbox for installing connectors. If two side slots are needed for connectors, the wallboxes should be vertically ganged.

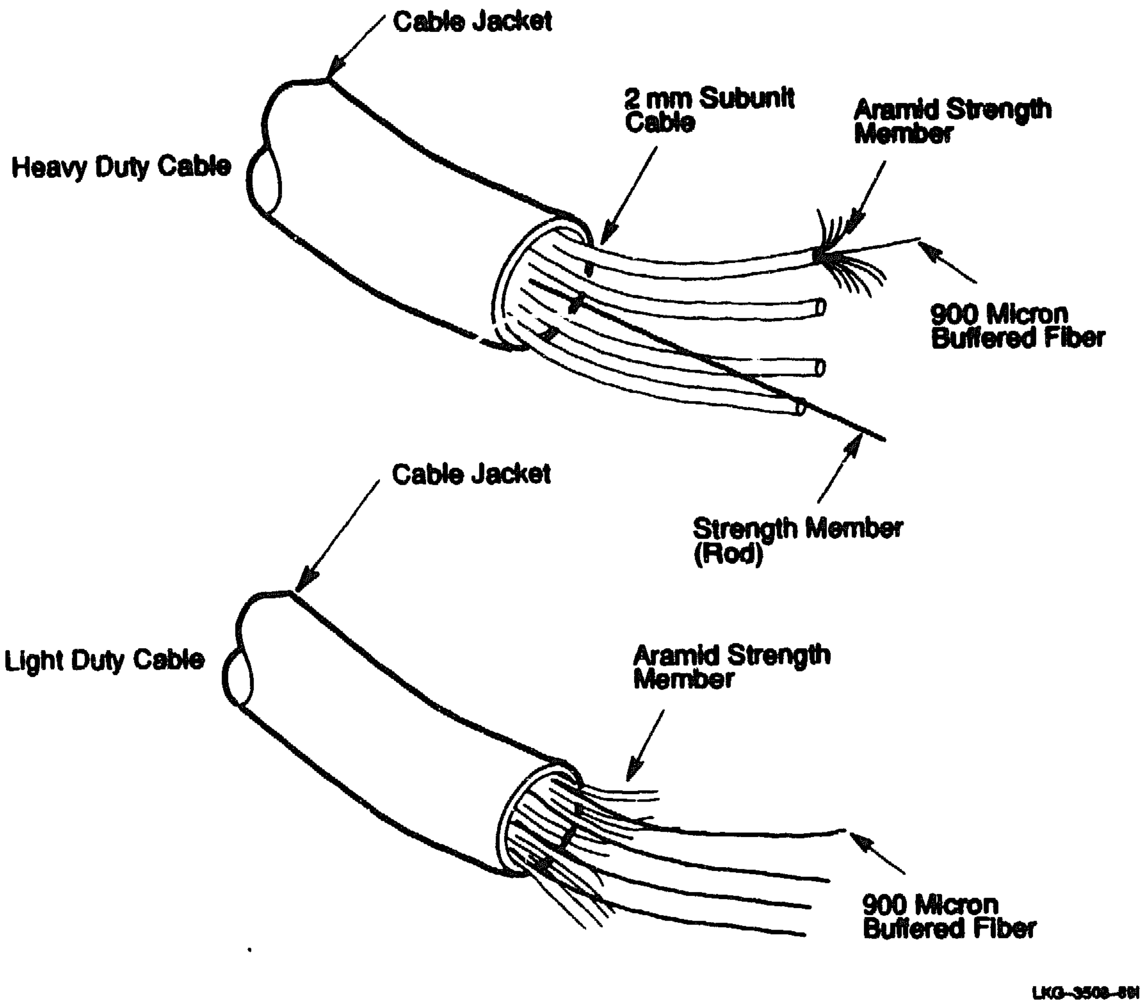
Figure 6–5: Copper-Fiber Installation



6.1.3 Preparing Fiber Optic Cable for Wallbox Mounting

The wallbox accommodates the two styles of fiber optic cable that are specified for use in the DECconnect System fiber optic structured wiring, as well as other typical industry designs. For simplification, the two major styles are referred to as light duty cable and heavy duty cable. Figure 6–6 shows the structural differences between the light duty and heavy duty cable.

Figure 6–6: Light and Heavy Duty Cable Structure



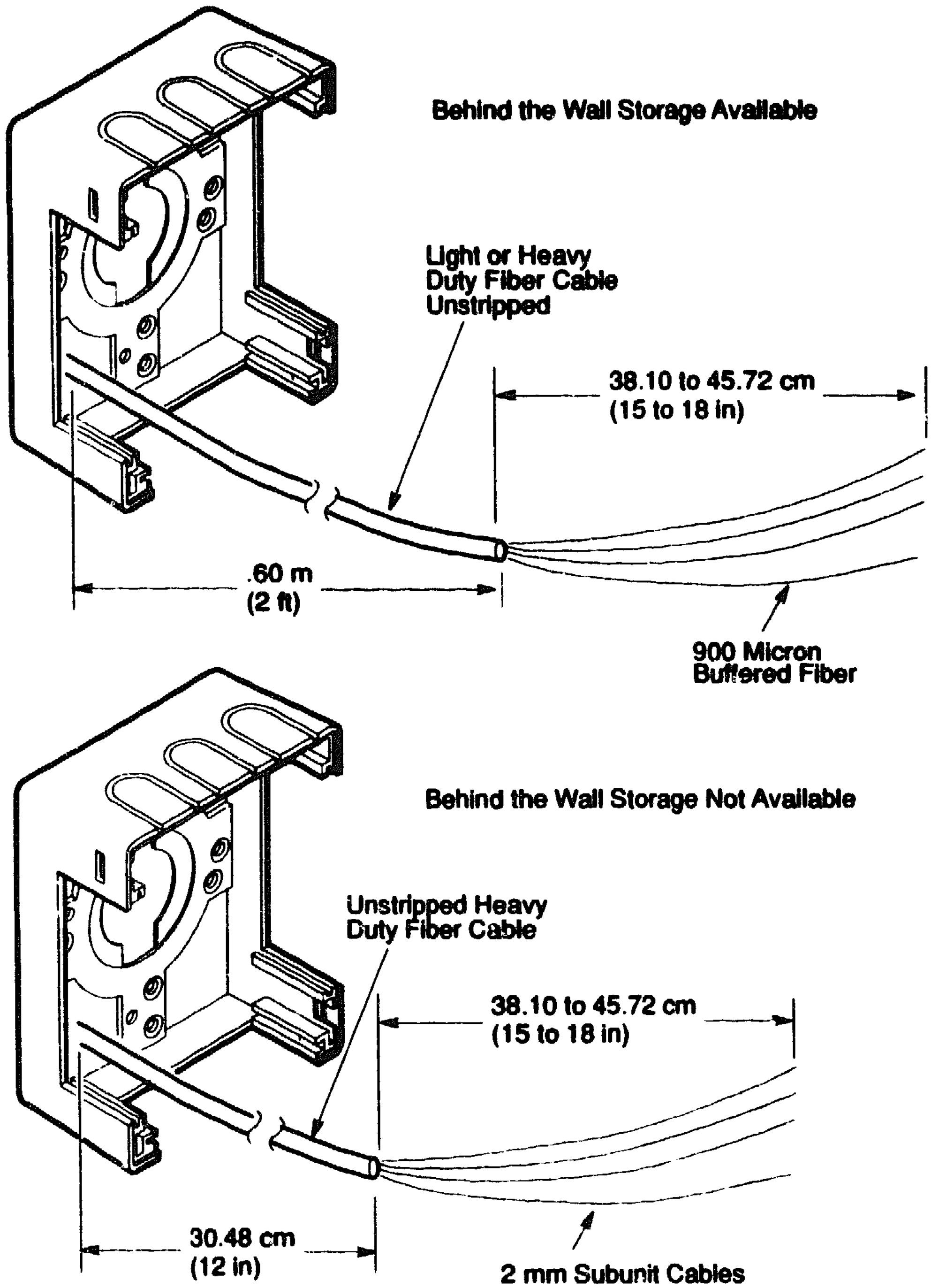
Although termination techniques vary from connector supplier to supplier, 30 centimeters (15 inches) to 45 centimeters (18 inches) of either the 900 micron buffered fiber or the breakout subunit cable must be free from the overall cable jacket to allow proper connector installation.

Figure 6–7 shows the cable style and length requirements when behind-the-wall cable storage is available for two feet of unstripped fiber cable and when behind-the-wall cable storage is not available.

NOTE

If behind-the-wall cable storage is not available, the use of heavy duty fiber cable, as shown is Figure 6–7, is recommended.

Figure 6–7: Fiber Cable Style and Length Requirements



Note: In ganged wallboxes installations, add 10.16 cm (4 in) to unstripped cable length for routing to second wallbox

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6.1.3.1 Light Duty Cable Preparation

Use the following procedure to prepare light duty fiber optic cable:

1. Strip off approximately 30 centimeters (15 inches) to 45 centimeters (18 inches) of outer the cable jacket using a razor knife.
2. Twist the aramid strength members together, then pull them back and tape them to the outer cable jacket. NOTE: masking tape works well.
3. Slip the black bend bend radius boot (included with the connector kits) onto the odd colored fiber and the red bend bend radius boot onto the even colored fiber. See the color codes in Table 6–2.
4. Terminate the 2.5 mm bayonet ST-type connectors to the individual 900 micron buffered fibers by referring to the installation instructions in the 2.5 mm Bayonet ST-type Connector Termination Tool Kit (H8102-AA).

6.1.3.2 Heavy Duty Cable Preparation

Use the following procedure to prepare heavy duty fiber optic cable:

1. Strip off approximately 30 centimeters (15 inches) to 45 centimeters (18 inches) of the outer cable jacket using a razor knife.
2. Cut off the strength member rod where it comes out of the outer cable jacket.
3. Slip the black bend bend radius boot (included with the connector kits) onto the odd colored fiber and the red bend bend radius boot onto the even colored fiber. See the color codes in Table 6–2.
4. Terminate the 2.5 mm bayonet ST-type connectors to the individual breakout 2 mm subunit cables by referring to the installation instructions in the 2.5 mm Bayonet ST-Type Connector Termination Tool Kit (H8102-AA/AC). See the color codes in Table 6–2.

Table 6–2: Fiber Color Codes

Fiber Number	Pair Letter	Color Code
1	a	Blue
2		Orange
3	b	Green
4		Brown

6.1.4 Wallbox Mounting Methods

The two mounting methods described in this document are hardwall mounting and modular furniture mounting.

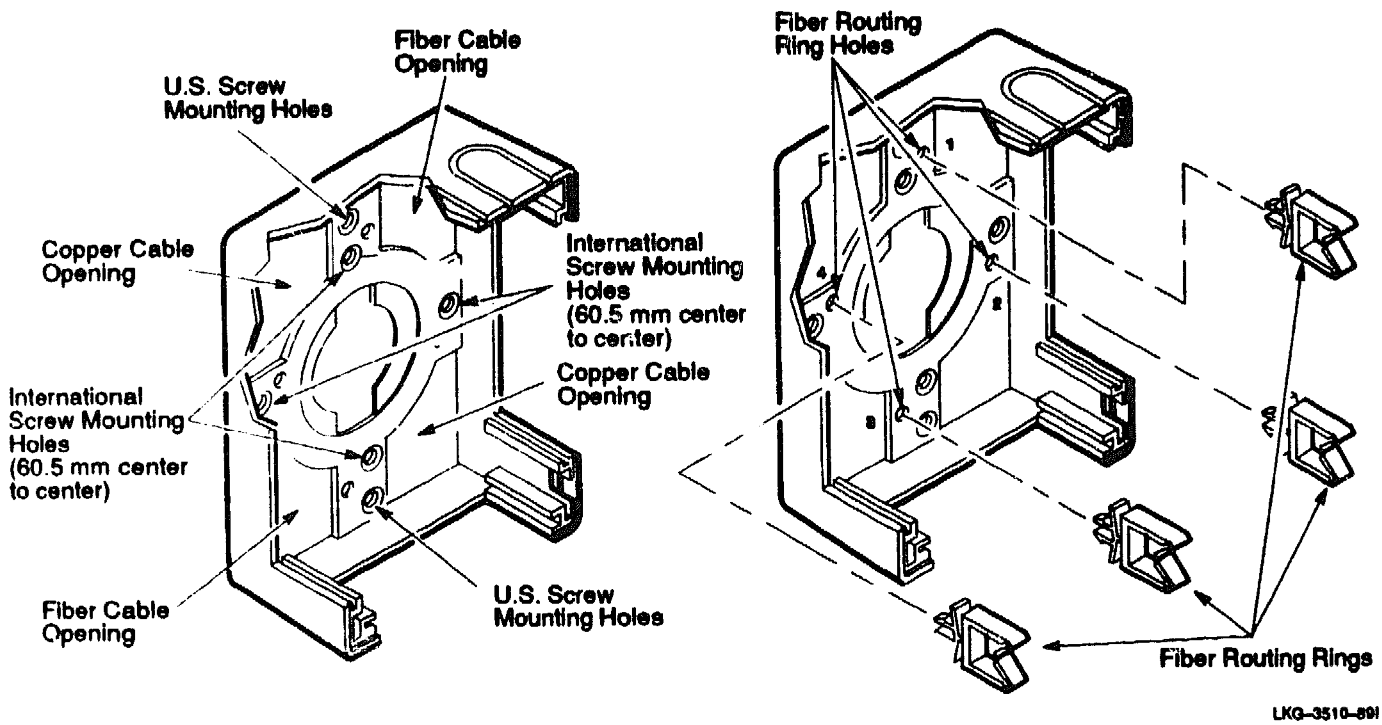
Hardwall mounting is characterized by a preinstalled electrical box in the wall. The cable is behind the wall and is frequently in a conduit stub. The cable enters the wallbox directly through the openings in the rear of the wallbox and cable storage must be done within the wallbox.

Modular furniture mounting is characterized by the cable entering the wallbox through the knockouts located on the top of the wallbox. Excess cable can often be stored in the modular walls or raceways.

6.1.5 Hardwall Mounting and Cable Routing

There are four openings in the rear of the wallbox that allow cable entry when the wallbox is hardwall mounted. Two of the openings are designed for copper cable entry and the other two openings are designed for fiber cable entry (see Figure 6–8).

Figure 6–8: Wallbox Rear Cable Openings, Screw Mounting Holes, and Fiber Routing Ring Holes



For hardwall mounting, perform the following to mount the wallbox and route the cable:

1. Ensure that all copper and/or fiber cables are properly connectorized.

NOTE

The daisy-chain connector (H3114-AA) can only be installed after all wire routing has been completed.

2. Feed the connectorized copper and/or fiber cable(s) coming out of the electrical box through the correct opening(s) in the rear of the wallbox (see Figure 6–8).
3. Attach the wallbox to the electrical box with two screws through the correct screw mounting holes (see Figure 6–8).
4. If fiber cable is being installed, insert the necessary fiber routing ring(s) in the fiber routing ring hole(s) (see Figure 6–8) and route the fiber cable through them (see Figure 6–4).
5. Go to Section 6.1.7 to install the correct bezels and the front cover on the modular wallbox.

If ganged wallboxes are being hardwall mounted, refer to Figure 6–9 and Figure 6–10 and perform the following steps:

1. Attach the second wallbox to the wall, in either the horizontal or vertical configuration, using the screws, wall mounting back, or Velcro strips (see Figure 6–9).
2. Route the copper or fiber cable from the first wallbox to the second wallbox (see Figure 6–10 for the correct routing path for the horizontal and vertical ganged configurations).
3. If fiber cable is being routed to the second wallbox, insert the necessary fiber routing ring(s) in the fiber routing ring hole(s) in the second wallbox (see Figure 6–8) and route the fiber cable through them.
4. Go to Section 6.1.7 to install the correct bezels and the front cover on the ganged modular wallbox.

Figure 6–9: Attaching the Wall Mounting Back and Velcro Strips

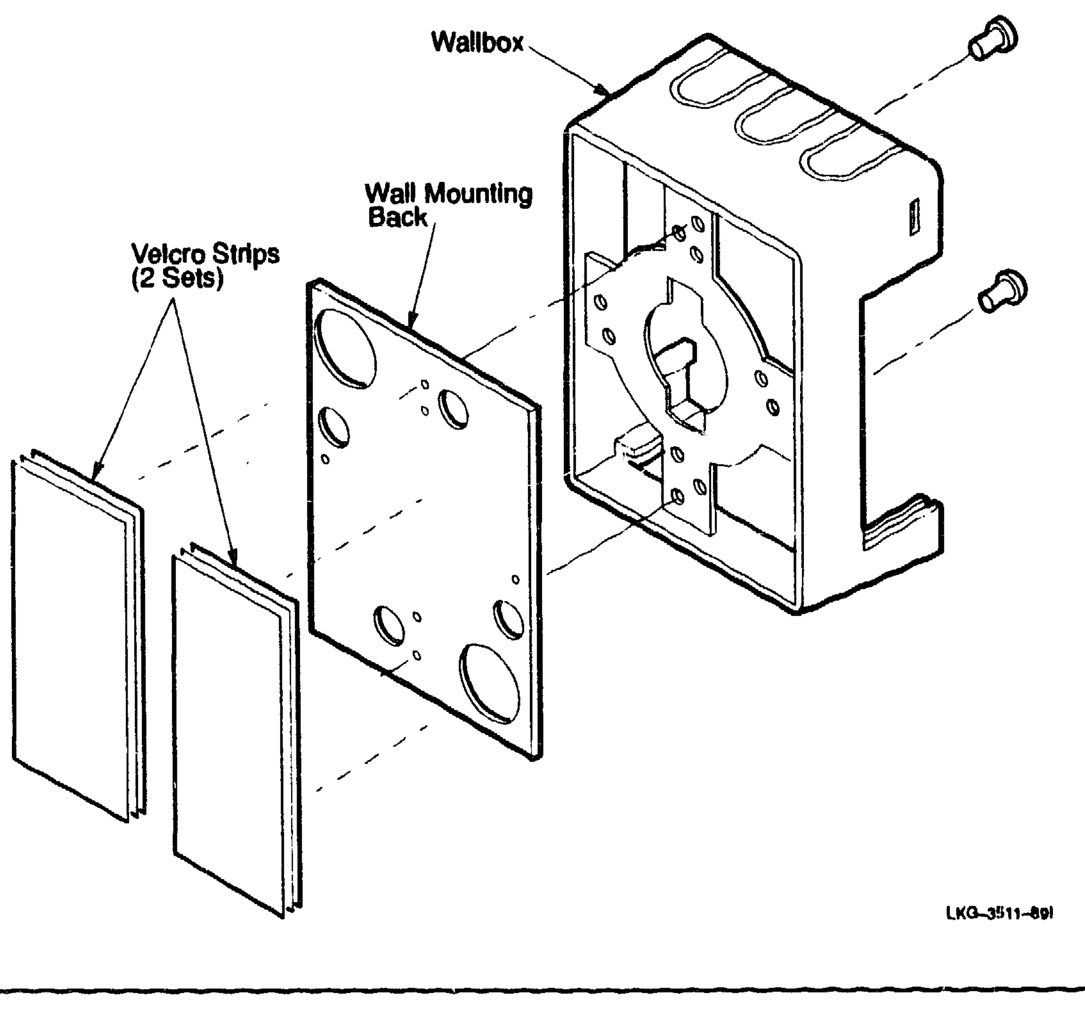
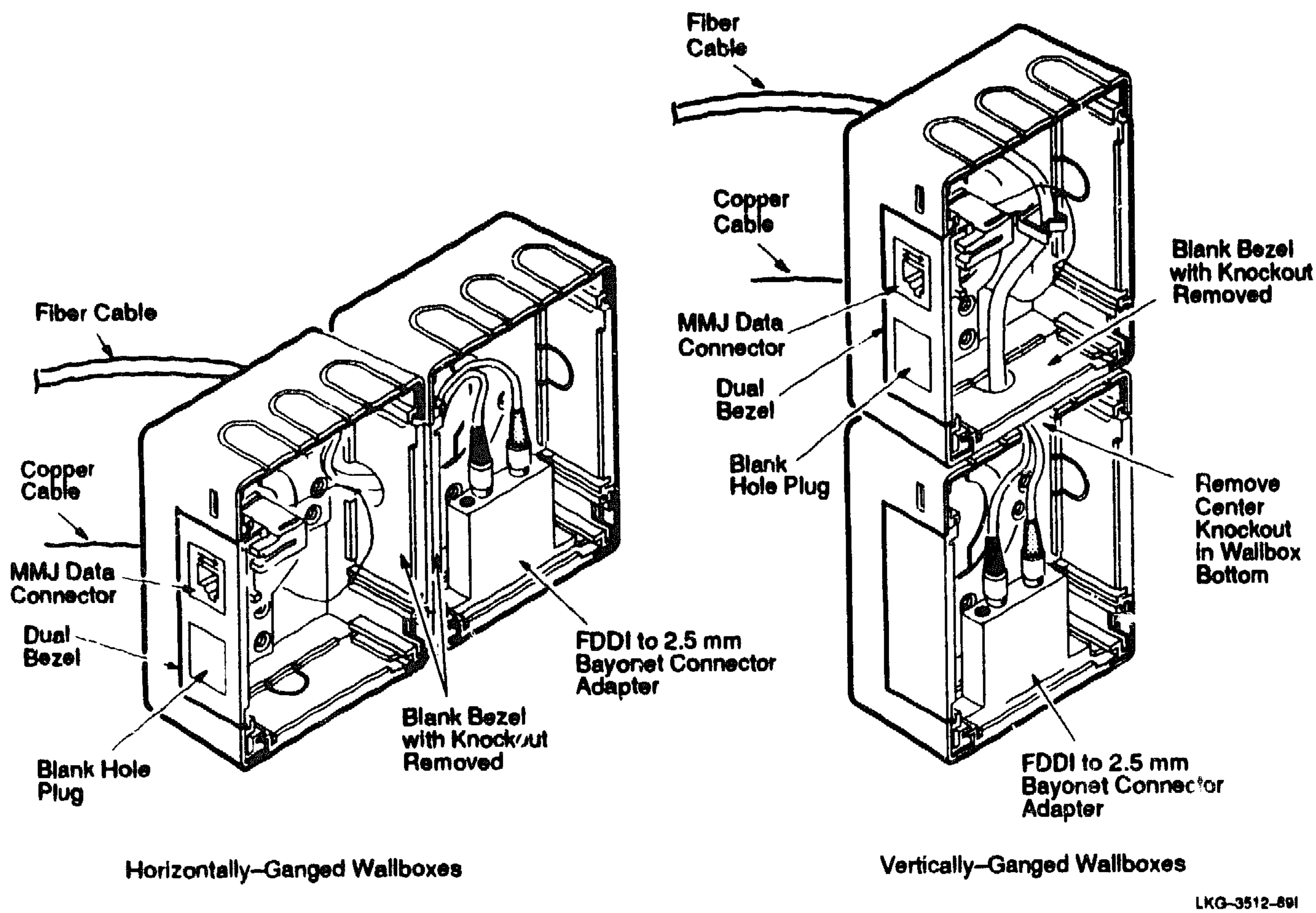


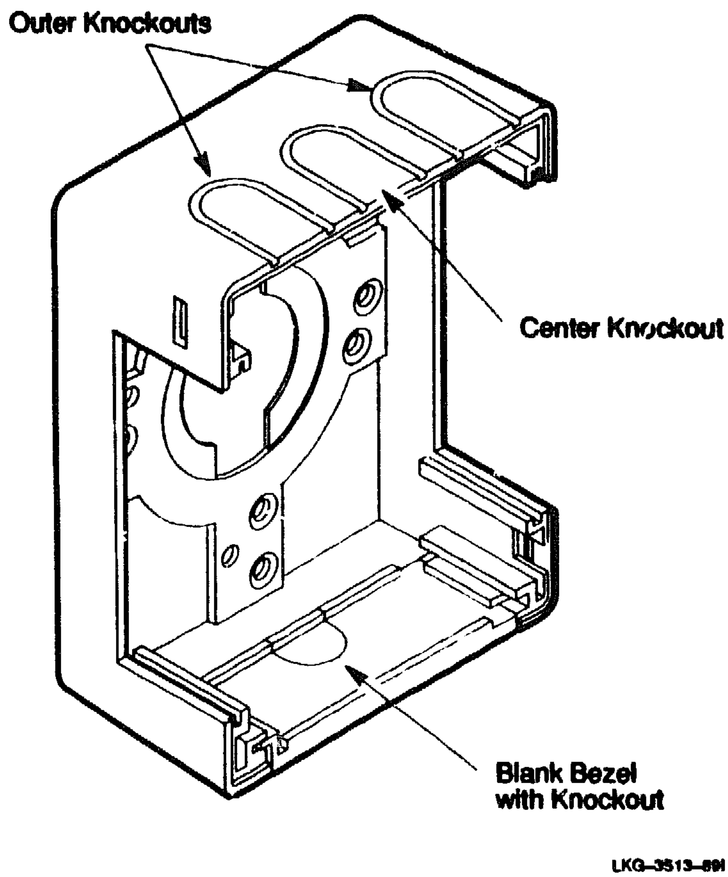
Figure 6–10: Hardwall Mounted Ganged Wallboxes



6.1.6 Modular Furniture Mounting and Cable Routing

There are three knockouts in the top of the wallbox that are used to allow cable entry when the wallbox is modular furniture mounted. The outer knockouts should be used for initial cable entry into a single wallbox and the first wallbox of a horizontal or vertical ganged configuration (see Figure 6–11).

Figure 6–11: Wallbox and Blank Bezel Knockouts



For modular furniture mounting, use the following procedure to mount the wallbox and route the cable:

1. Attach the wallbox to the wall or mounting surface with the screws, the wall mounting back, or the Velcro strips (see Figure 6–9).

2. Ensure that all copper and/or fiber cables are properly connectorized.

NOTE

The daisy-chain connector (H3114-AA) can only be installed after all wire routing has been completed.

3. Use a pair of diagonal cutters or needle-nose pliers to remove one of the outer knockouts in the top of the wallbox.

4. Route the copper and/or fiber cable into the wallbox through the removed knockout.

5. If fiber cable is being installed, insert the necessary fiber routing ring(s) in the fiber routing ring hole(s) (see Figure 6–8) and route the fiber cable through them (see Figure 6–4).

6. Go to Section 6.1.7 to install the correct bezels and the front cover on the modular wallbox.

If ganged wallboxes are being modular furniture mounted, refer to Figure 6–12 and perform the following steps:

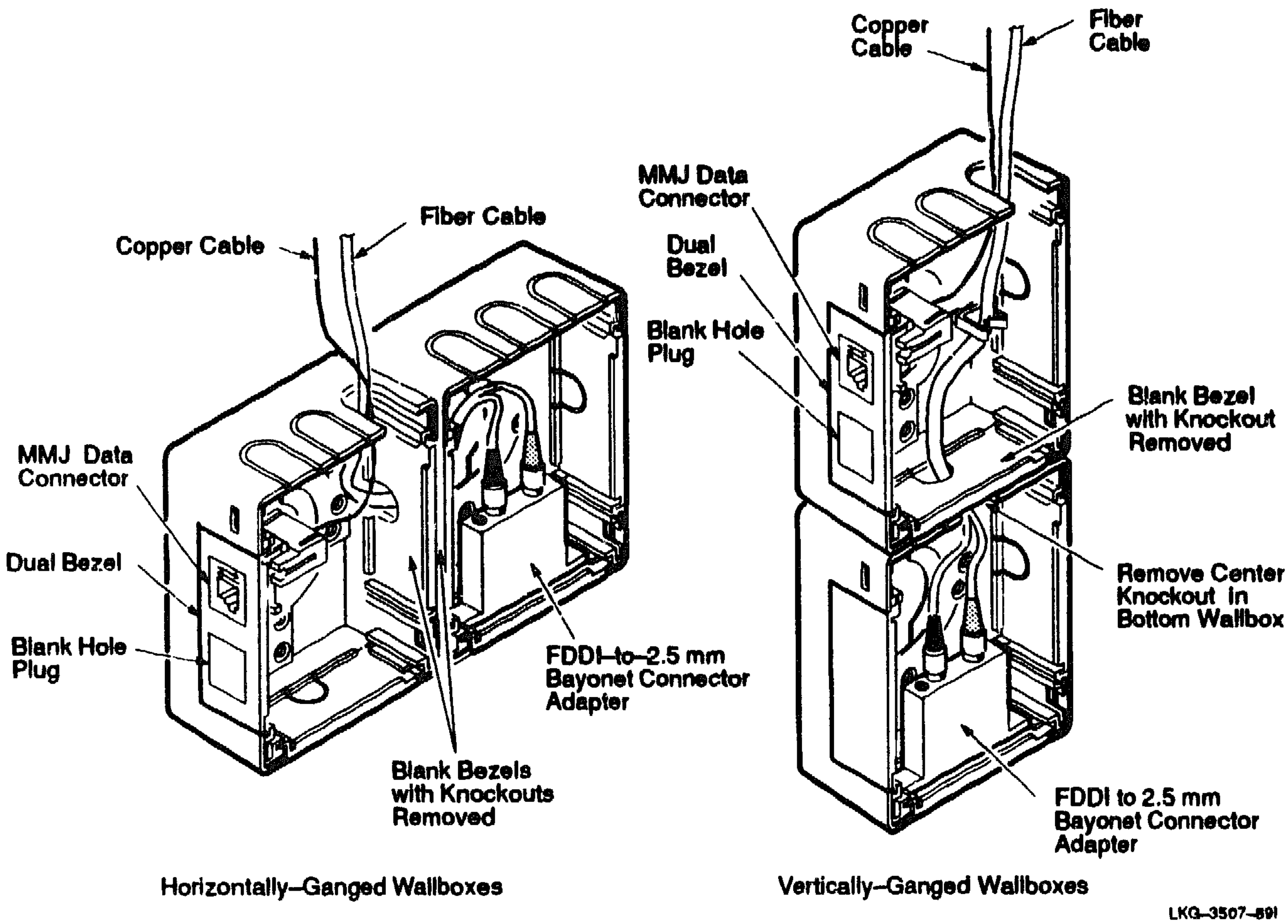
1. Attach the second wallbox to the wall or mounting surface, in either the horizontal or vertical configuration, using the screws, wall mounting back, or Velcro strips (see Figure 6–9).

2. Route the copper or fiber cable from the first wallbox to the second wallbox (see Figure 6–12 for the correct routing path for the horizontal and vertical ganged configurations).

3. If fiber cable is being routed to the second wallbox, insert the necessary fiber routing ring(s) in the fiber routing ring hole(s) in the second wallbox (see Figure 6–8) and route the fiber cable through them (see Figure 6–4).

4. Go to Section 6.1.7 to install the correct bezels and the front covers on the ganged modular wallbox.

Figure 6–12: Modular Furniture Mounted Ganged Wallboxes



6.1.7 Assembling the Wallbox

After mounting the wallbox(es) and routing the copper and/or fiber cables, the bezels that are required for the specific installation must be installed. The following bezels can be installed in the wallbox slots:

- Blank bezel
- Dual bezel
- Daisy-chain connector bezel (H3114-AA)
- Dual 2.5 mm bayonet ST-type connector adapter bezel (H3114-FF)
- FDDI to 2.5 mm bayonet ST-type connector adapter bezel (H3114-FE)

NOTE

In copper-fiber installations, the copper cable connectors and bezels should be installed first.

Use the following procedure to assemble the wallbox:

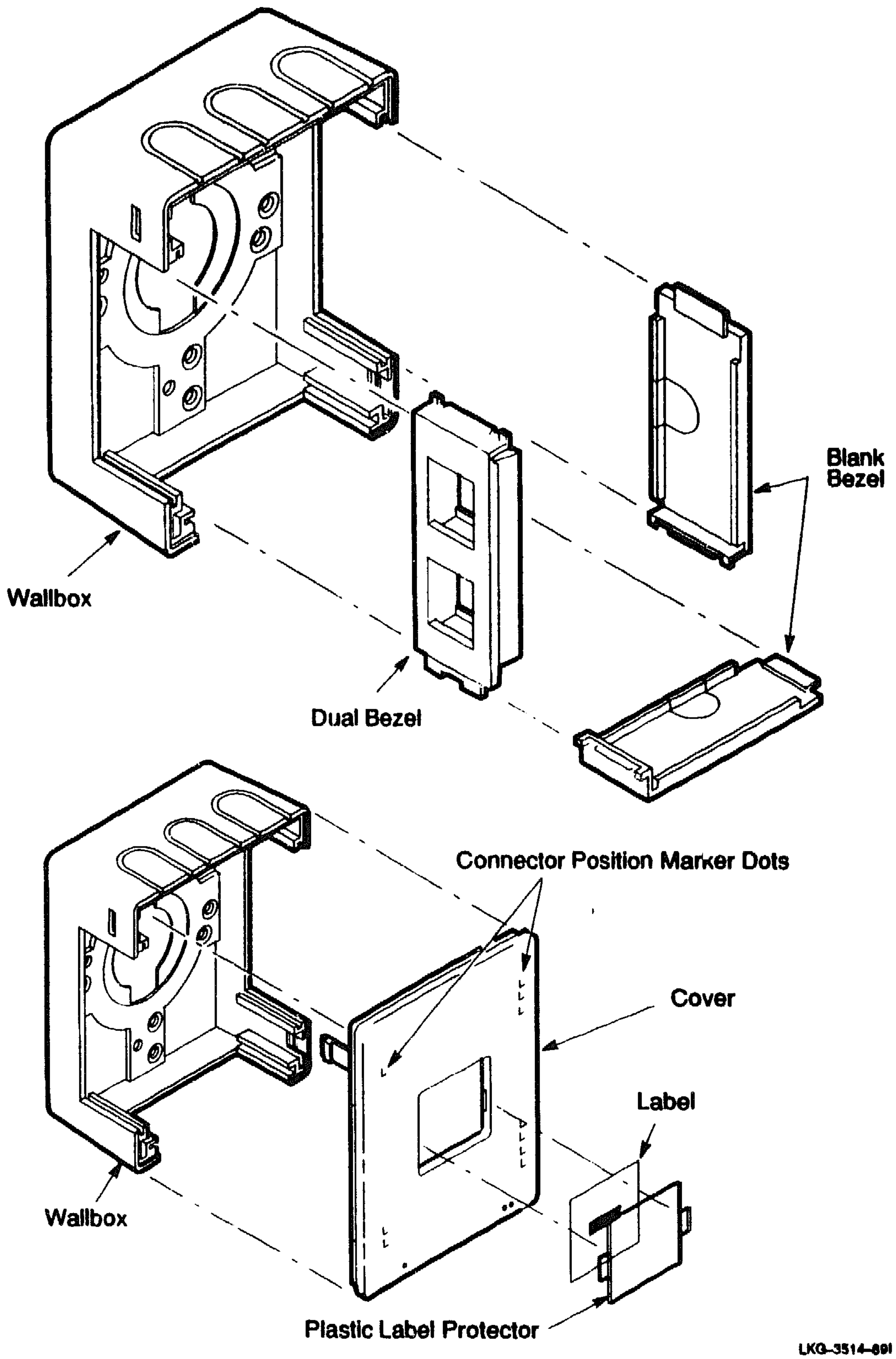
1. Identify the types of bezels needed for the specific installation. Figure 6–13 shows a dual bezel being installed for copper cable data and voice connectors along with two blank bezels.
2. For fiber cable, connect the 2.5 mm bayonet ST-type connectors to the fiber bezel.
3. Slide the bezel into the selected slot on the wallbox.
4. Dress the cables neatly within the wallbox, ensuring that there are no sharp bends in the cables or excessive stress on the cable connectors.
5. Install the cover on the front of the wallbox (see Figure 6–13).

   NOTE

   The cover should be installed with the position marker dots positioned as shown in Figure 6–13. The position marker dots correspond to the bezel slots on the wallbox.

6. Take one of the labels shipped with the wallbox kit and mark the wallbox identification on it.
7. Insert the label in the center of the cover and then insert the plastic label protector to hold it in place (see Figure 6–13).

Figure 6–13: Mounting the Wallbox



CHAPTER 7

7

Fiber Optic Cable Plant Acceptance Procedures

7.1 Introduction

This chapter contains the certification procedures for a fiber optic network that has been installed in accordance with the guidelines contained in this guide and in the *DECconnect System Fiber Optic Planning and Configuration* guide.

NOTE

These procedures are recommended by Digital and are required for the on-site maintenance service contract.

WARNING ⚠

Never look into a fiber optic cable or connector port because the light emitted by the source may cause eye damage. Always assume the cable is connected to a light source.

Fiber optic network cable plant acceptance is performed in three steps: workmanship quality verification, optical power loss measurement using a fiber optical loss test kit, and a hardcopy signature using an Optical Time Domain Reflectometer (OTDR).

Both the project manager and the network manager review all of the procedures described in this guide, with the aid of a checklist, and jointly verify the quality of the workmanship.

To certify a DECconnect System fiber optic cable plant at both windows, the certification procedures in Section 7.3.3.5 must be carried out at both wavelengths, and a hardcopy signature of the end-to-end link must be made from the OTDR at both wavelengths.

A power loss measurement made with an optical loss test set, using the procedure and equipment described in Section 7.3, is the only way accepted by Digital to certify the end-to-end loss of an installed fiber optic cable.

The OTDR determines the location and quality of splices and connectors along a fiber optic cable link. It can also measure the fiber's length and perform fault isolation. The OTDR is most useful for characterizing a fiber optic cable's connectors, splices and faults. It will print out a hardcopy of the fiber trace or "signature." The signature is a graphic display of the location of the splices and connectors and the amount of power loss they create, and can be used with future traces to determine changes to the link.

7.2 Workmanship Quality Verification

The installed cable plant workmanship verification uses a checklist that is reviewed jointly by the project manager and the network manager. It covers all procedures given in this guide. When the network manager accepts the network and the associated documents from the project manager, the workmanship quality verification is complete and the optical power loss measurement (Section 7.3) and OTDR hardcopy signature (Section 7.4) can begin.

- Verify that all wallboxes have been installed and labeled properly (Chapter 6).
- Verify that all cables are routed as specified in the planning document and if there are any variations from the planning document, ensure those variations are noted in the as-built documents.
- Verify that each cable meets the cable installation requirements (Section 3.12).
- Verify that all fiber terminating at distribution frame panels is terminated as specified by each panel's connection map (Secion 1.6).
- Verify that the upper and lower hierarchical labeling of all distribution frame panels has been done properly (Section 1.6).
- Ensure that all electrical and fire code requirements are being complied with by doing the following:
  - Verify that all areas have only properly labeled cable and hardware. For example, plenum areas have only properly labeled plenum cables.
  - Verify that all fire stops are resealed and intact. Ensure compliance with local fire codes.
  - Check if an approval by local authorities is required at this time. If so, verify that it is received.
- Ensure that the lag bolt anchors are installed in the equipment room racks (Section 5.5).

- Inspect the entire site for neatness of installation, good workmanship, and cleanliness. Specific points to check include:
  - Any visible cables are neatly routed.
  - Ceiling panels are in place.
  - All hardware is firmly mounted.
  - Installation debris has been removed.
- Ensure that the system installation log (described in Sections 3.4.1 and 3.5) includes updated versions of:
  - As-built documents showing actual cable routing, equipment room rack and cabinet locations, wallbox locations, grounding points, and labeling.
  - The network logical, schematic, and concept diagrams that were created during the design process.
- Verify that all grounding has been done in accordance with BICSI procedures (Section 4.8.3).

7.3 Relative Power Loss Test

The relative power loss test is a field measurement of the power loss of a cable link under test conditions. The test consists of launching a preset quantity of optical power into the cable being tested, and then measuring the received power at the opposite end using an optical power meter. The difference between the launched and received power represents the loss associated with the installed cable link.

7.3.1 Required Equipment

The following equipment is part of the **850 nm only** optical power loss test set:

- FOTEC optical power meter equipped with appropriate adapters (2.5 mm bayonet ST-type connector and SMA)
- FOTEC 850 nm optical LED source, equipped with appropriate adapters (2.5 mm bayonet ST-type connector and SMA)
- 200/240 micron launch cable, terminated with a 2.5 mm bayonet ST-type connector and an SMA connector
- Consumables kit containing cleaning equipment, 2.5 mm bayonet ST-type connector couplers, and SMA connector couplers

The following equipment is part of the 850 nm/1300 nm dual-window optical power loss test set:

- INTELCO optical power meter equipped with appropriate adapters (2.5 mm bayonet ST-type connector, FDDI, SMA optional)
- INTELCO optical LED source, 850 nm/1300 nm dual wavelength, equipped with fixed 2.5 mm bayonet ST-type connectors
- Two 200/240 micron launch cables, terminated on both ends with 2.5 mm bayonet ST-type connectors (used for 2.5 mm bayonet ST-type connector and FDDI connector cable plants)
- Consumables kit containing cleaning equipment, 2.5 mm bayonet ST-type connector connector couplers, and FDDI connector couplers
- Two 200/240 micron launch cables, terminated with a 2.5 mm bayonet ST-type connector and an SMA connector (optional, only used for SMA cable plants)
- SMA connector couplers (optional)

7.3.2 Preparation

Fiber optic cables and connectors should always be handled with care. Cables should not be bent or twisted tightly, especially near the connectors, as damage or breakage can occur. Care should be taken to ensure that connectors are not dropped or physically impacted in any way. The connector can become damaged if this happens, impairing optical transmission.

The measurement of loss in a fiber optic cable is affected by many variables. Two of the most critical variables are wavelength and launch conditions. The wavelength and launch characteristics of the test source must simulate that of the system source as closely as possible. For example, if the wavelength of the test source is 30 nm different than that of the system source, the measured loss can differ by as much as 0.5 dB per kilometer.

Launch characteristics are affected by connector accuracy and repeatability. If the test source does not launch light into the connectors on the cable under test with the same modal conditions and physical dimensions of the system source, the loss measured by the test equipment will differ from that of the active equipment.

All connector faces should be cleaned before testing or inserting into any optical port. This is done using cleaning pads dipped in alcohol (methanol) to remove dust, debris, or fingerprints from the connector/fiber end. When removing and reinserting connectors, cleanliness should be checked, and if there is dirt or debris on the connector endface, it should be re-cleaned.

Before any testing is performed, the equipment must be removed from the carrying case and brought to room temperature. If the temperature in the testing environment is approximately 20 degrees Farenheit (or more) above or below the previous environment the test equipment came from, allow up to 30 minutes for this stabilization to occur. (This step only applies to the **850 nm only** test set.)

7.3.3 First Window (850 nm) and Second Window (1300 nm) Test Procedures

The relative power loss test consists of the following procedures:

- Set-up procedure
- Reference level adjustment procedure
- Measurement and correction calculation procedure
- System certification procedure

7.3.3.1 Set-Up Procedure

Perform the following set-up procedure:

1. When measuring cable terminated with 2.5 mm bayonet ST-type connectors or FDDI connectors, select the launch cables terminated on both ends with 2.5 mm bayonet ST-type connectors (this applies in dual-window kit only). When measuring cable terminated with SMA connectors, select the launch cable(s) terminated with a 2.5 mm bayonet ST-type connector and an SMA connector. Clean and connect the launch cable(s) to the optical source(s).

   NOTE

   If the 850 nm/1300 nm dual-window test kit is used, it is recommended that measurements be performed at both windows

2. The optical source will contain a sticker that indicates the exact wavelength of the emitters. Record the value of the exact wavelengths for both windows on photocopies of Figure 7–1. The first window wavelength value will be used during the **850 nm Measurement Procedure**.

3. To ensure that the launch cable-to-optical source connections are not disturbed, immobilize both the launch cable(s) and optical source as follows:

   CAUTION ⚠

   Take care not to bend the launch cable beyond its minimum bend radius of 12.7 centimeters (5 inches).

   – Tape the optical source down to a stable surface using masking tape.

- Tape the launch cable(s) to the same surface as the optical source about 7.5 to 12.7 centimeters (3 to 5 inches) away from the optical port of the source.

4. Attach the appropriate adapter (2.5 mm bayonet ST-type connector or SMA) to the meter.

7.3.3.2 Reference Level Adjustment Procedure (for FOTEC)

Perform the FOTEC reference level adjustment procedure as follows:

1. Clean and connect the launch cable to the power meter.

2. Refer to Table 7–1 and obtain the reading on the optical power meter for the correction setting that corresponds to the fiber size of the cable being tested. Set the reading by adjusting the trim pot located on the source with a small flat-blade screwdriver.

NOTE

It is important that the trim pot not be readjusted or disturbed for the duration of the measurement.

Table 7–1: FOTEC Power Meter Coupling Loss Correction

Fiber Core Diameter	First Window (850 nm) Coupling Loss Correction
50 µm	15.5 dBµ
62.5 µm	11.0 dBµ
85 µm	9.3 dBµ
100 µm	7.0 dBµ

7.3.3.3 Reference Level Adjustment Procedure (for INTELCO)

Perform the INTELCO Reference Level adjustment procedure as follows:

1. Clean and connect the 850 nm launch cable to the power meter.

2. Set the meter to 850 nm.

3. Store the 850 nm reference value in the meter by pressing the **STO REF** button twice.

4 Clean and connect the 1300 nm launch cable to the power meter.

5. Set the meter to 1300 nm.

6. Store the 1300 nm reference value in the meter by pressing the **STO REF** button twice.

7.3.3.4 Measurement Procedures

This section consists of the 850 nm and 1300 nm test procedures. When performing these procedures, complete an End-to-End Cable Loss Calculation Worksheet. This worksheet is used to calculate the cable loss by recording the measured end-to-end cable loss and adding in correction values.

Figure 7–1 is a blank End-to-End Cable Loss Worksheet. Before proceeding with the measurement procedure, make one photocopy of this worksheet for each optical fiber to be certified.

Figure 7–2 is a blank Field Derating Worksheet. Before proceeding with the system certification procedure, make one photocopy of this worksheet for each *pair* of optical fibers.

850 nm Measurement Procedure

1. Disconnect the 850 nm launch cable from the power meter and connect it to the cable being tested using the corresponding connector coupler (for example, if 2.5 mm bayonet ST-type connectors are being used, the 2.5 mm bayonet ST-type connector coupler must be used). The connector coupler must be free of dirt and debris to ensure optimum coupling of power.

   When using SMA connectors, attach the plastic full sleeve that goes inside the connector coupler. The plastic sleeve must be free of dirt and debris. Place the sleeve on the end of the first connector that is to be inserted into the coupler, before inserting the connector.

2. If measuring FDDI-terminated cables, attach the FDDI adapter to the meter, and use the 2.5 mm bayonet ST-type connector-FDDI coupler to attach the launch cable to the drop cable.

3. Take the power meter to the opposite (receive end) of the cable being tested.

4. At the receive end of the cable, clean the connector on the cable being tested and attach it to the power meter.

   NOTE

   If a measurement is being made from one patch panel to another patch panel without the drop cables to the installed equipment, it will be necessary to use a jumper from the patch panel to the power meter. In this case, use a jumper with a fiber core that is equal to or larger than the fiber in the cable under test.

5. Enter the **Test Date** and the **Cable Identification Number** on the worksheet.

6. Enter the **First Window Test Source Wavelength** (i.e., the value marked on the source enclosure, not 850 nm).

7. Turn the meter on and set it to the dB scale by pressing the **dB** button.

8. Select the 850 nm range on the meter with the wavelength (λ) button.

9. On the **Measured Relative Loss** line of the worksheet (line 1), write the value (including the minus sign) that is displayed on the power meter.

10. On the **Length of Tested Cable** line of the worksheet (line 2), write the rounded-off length of the cable under test by taking the cable length and rounding it upwards to the next tenth of a kilometer (for example, if the cable length is 1.375 km, round it off to 1.4 km). If the cable length is unknown, use the OTDR to measure it.

11. Refer to Table 7–2 and choose the wavelength correction value that applies to the optical source wavelength (noted during Step 6 above). Write the value from Table 7–2 on the **Wavelength Correction Value** line of the worksheet (line 3).

12. Multiply the **Wavelength Correction Value** (line 3) by the **Length of Tested Cable** (line 2) and write the result on the **Total Wavelength Correction** line of the worksheet (line 4).

13. Calculate the wavelength corrected output power by subtracting* the **Total Wavelength Correction** (line 4) value from the **Measured Relative Loss** line value (line 1) and write the result in the **Wavelength Corrected Cable Loss** line (line 5) of the worksheet.

NOTE

> This step corrects for a worst-case loss at 800 nm, which certifies that all first window products can work on this cable plane.

14. If using the FOTEC test kit, enter zero (0) on the **Coupling Loss Correction** line (line 6).

    If using the INTELCO test kit refer to the first column of Table 7–3 (First Window [850 nm] Coupling Loss Correction). Enter the value that corresponds to the fiber size being tested onto the **Coupling Loss Correction** line (line 6).

15. Add lines 5 and line 6 and enter the value into the **Total Corrected Cable Loss** line (line 7).

---

*To subtract two negative values, drop the minus sign (–) on both numbers, subtract the smaller number from the larger value, and add a minus sign (–) to the result. For example, –0.5 subtracted from –7.4 becomes 7.4 minus 0.5, which results in –6.9 with the minus sign added. To subtract a positive number from a negative number, drop the minus sign (–) from the negative number, add the two numbers together, and add a minus sign (–) to the result. For example, 0.5 subtracted from –7.4 becomes 7.4 plus 0.5, which results in –7.9 with the minus sign added.

Figure 7–1: End-to-End Cable Loss Worksheet

Date: ____________

Cable I.D.: __ __________

First Window Test Source Wavelength: ____________

Second Window Test Source Wavelength: ____________

Test Kit: ☐ FOTEC ☐ INTELCO ☐ ____________

850 nm		1300 nm
(1) ____________	Measured Relative Loss	(1) ____________
(2) ____________	Length of Tested Cable	(2) ____________
(3) ____________ (From Table 7–2)	Wavelength Correction Value	
(4) ____________ (Multiply 2 by 3)	Total Wavelength Correction	
(5) ____________ (Subtract 4 from 1)	Wavelength Corrected Cable Loss	
(6) ____________ (FOTEC = 0, get INTELCO from Table 7–3)	Coupling Loss Correction	(3) ____________ (From Table 7–3)
(7) ____________ (Add 5 and 6)	Total Corrected Cable Loss	(4) ____________ (Add 1 and 3)

LKG–3515–89I

Table 7–2: Wavelength Correction Values for First Window

Wavelength	dB/Km
790	-0.2
795	-0.1
800	0
805	0.1
810	0.2
815	0.3
820	0.4
825	0.5
830	0.6
835	0.65
840	0.7
845	0.8
850	0.9

1300 nm Measurement Procedure

When performing the 1300 nm test procedure, do the following:

1. Connect the 1300 nm launch cable to the cable being tested.
2. Enter the Second Window Test Source Wavelength (i.e., the value marked on the source enclosure, not 1300 nm).
3. Select the 1300 nm range on the meter with the wavelength (λ) button.
4. On the Measured Relative Loss line of the worksheet (line 1), write the value that is displayed on the power meter (including the minus sign.) Make sure that the meter is set to the dB scale.
5. On the Coupling Loss Correction line (line 3), enter the value from the second column of Table 7-3 (Second Window [1300 nm] Coupling Loss Correction) that corresponds to the fiber size of the cable being tested.
6. Add the Measured Relative Loss line (line 1) to the Coupling Loss Correction line (line 3) and write the result on the Total Corrected Cable Loss line (line 4) of the worksheet.
7. If the 850 nm measurement was not performed, then on the Length of Tested Cable line (line 2) of the worksheet, write the rounded-off length of the cable under test by taking the cable length and rounding it upwards to the next tenth of a kilometer (for example, if the cable length is 1.375 km, round it off to 1.4 km). If the cable length is unknown, use the OTDR to measure it.

Table 7–3: INTELCO Power Meter Coupling Loss Correction

Fiber Core Diameter	First Window (850 nm) Coupling Loss Correction	Second Window (1300 nm) Coupling Loss Correction
50 μm	15.0 dB	15.1 dB
62.5 μm	11.5 dB	11.8 dB
85 μm	9.5 dB	9.7 dB
100 μm	7.4 dB	7.7 dB

7.3.3.5 System Certification Procedures

For certifying a cable plant link that is using known active equipment, use the procedures outlined in Active Link Certification. For certifying a cable plant link when the active equipment is not known, use the procedures outlined in Passive Link Certification, below.

Active Link Certification

Active link certification procedures are used when the active equipment to be used in the link is known.

Table 7–4 and Table 7–5 define the minimum attenuation and system loss budgets for fiber optic cable by fiber size, window, and network products used on the link.

1. Enter the **Network Product(s)** and the **Fiber Core Diameter** on the worksheet.
2. Enter the **System Loss Budget(s)** from Table 7–4 and Table 7–5 for the network product(s) planned for this link on line (1).
3. Allocate 0.8 dB *per cable segment* for future maintenance splices. For example, if the end-to-end link consists of two cable segments concatenated by a patch panel, write 1.6 dB on line (2).
4. If the INTELCO optical test set is used, enter 0.5 dB for **Measurement Margin** at both windows. Note: If the second window network product is DEC FDDI, a **Measurement Margin** of 0 may be used.

   If the FOTEC optical test set is used, enter 1.0 dB for **Measurement Margin** at the first window.
5. Add lines (2) and (3).
6. Subtract line (4) from line (1).

7. Compare the values on the **Total Corrected Cable Loss** lines of Figure 7–1 to the values on the **Cable Loss Budget** line of Figure 7–2 (ignoring minus signs). If the value from the cable loss worksheet is less than the value from the Field Derating Worksheet, the cable is accepted. The derated budget allows for measurement uncertainty and for future cable repairs.

If the planning and design of the cable plant was executed correctly, allowances should have been made for splice loss, connector coupling, and future maintenance of the installation. The calculated **Cable Loss Budget** represents the loss that allows for future maintenance of the cable plant. The future maintenance can include splices or replacement of transmitters/receivers.

Passive Link Certification

Passive link certification is used when the active equipment for a link is not known. The passive certification procedure requires the following worksheets:

- Link Certification Loss Value Summary Worksheets — these worksheets were filled in by the network designer during the design process, and included as part of the documentation set that the designer handed over to the installation contractor.
- End-to-End Cable Loss Worksheet — this worksheet is filled in using procedures outlined in Section 7.3.3.4.

To perform the passive certification procedures for a link, do the following:

1. Find the **Total Corrected Cable Loss** values (both 850 nm and 1300 nm) given on the link's End-to-End Cable Loss Worksheet.
2. Record those loss values (without minus signs, both 850 nm and 1300 nm) in the **Total Corrected Cable Loss** section of the Link Certification Loss Value Summary Worksheet.
3. Subtract the **Total Corrected Cable Loss** for each wavelength (both 850 nm and 1300 nm) from the **Total Calculated Certification Loss** values (both 850 nm and 1300 nm) and record the differences in the **Difference Value** section of the Link Certification Loss Value Summary Worksheet (for both 850 nm and 1300 nm).

   If the difference value is greater than or equal to 0 dB the cable is accepted.

Table 7–4: System Loss Budgets for 850 nm

Fiber Core Diameter	Minimum Attenuation[1]	System Loss Budgets
DEREP/DEBET-RC/RD		
50 µm	None	3.1 dB
62.5 µm	None	8.3 dB
85 µm	None	10.1 dB
100 µm	None	12.5 dB
DEREP/DEBET-RH/RJ		
50 µm	None	8.0 dB
62.5 µm	None	12.0 dB
85 µm	None	13.5 dB
100 µm	3 dB	14.0 dB
DEBAM/DEBAM-RC/RD, DEBAM-RC/RD to DEREN-RC/RD, and DEREN-RC/RD to DEREN-RC/RD		
50 µm	None	9.0 dB
62.5 µm	None	14.0 dB
85 µm	None	15.0 dB
100 µm	4 dB	16.0 dB
Chipcom/ORnet		
50 µm	None	5.55 dB
62.5 µm	None	10.75 dB
85 µm	None	12.84 dB
100 µm	None	14.35 dB

[1]If relative loss is less than this value, an optical attenuator must be installed on the transmit end of the system cable. See the *Attenuator Installation and Configuration Reference Card* (EK-DEFOE-RC).

Table 7–5: System Loss Budgets for 1300 nm

Fiber Core Diameter	Minimum Attenuation	System Loss Budgets
DEBAM/DEBAM-RF/RG		
50 μm	3 dB[1]	12 dB
62.5 μm	7 dB[1]	17 dB
85 μm	9 dB[1]	17 dB
100 μm	9 dB[1]	17 dB
Digital FDDI		
50 μm	none	6 dB
62.5 μm	none	11 dB
85 μm	none	11 dB
100 μm	3 dB[2]	11 dB

[1]If attenuation is less than this value, an optical attenuator must be installed on both the transmit and receive ends of the system cable. See the *Attenuator Installation and Configuration Reference Card* (EK-DEFOE-RC).

[2]If attenuation is less than this value, use 62.5/125 patch cables (such as BN24B-*xx*) to induce the required loss.

Figure 7–2: Field Derating Worksheet

First Window Network Product: ____________________ (I.e. DEBAM–RC, Chipcom)

Second Window Network Product: ____________________ (I.e. DEBAM–RF, FDDI)

Fiber Core Diameter: ____________________ (50, 62.5, 85, 100)

850 nm		1300 nm
(1) ____________ (From Table 7–4)	System Loss Budget	(1) ____________ (From Table 7–5)
(2) ____________ (Minimum of 0.8)	Maintenance Splices	(2) ____________ (Minimum of 0.8)
(3) ____________ (FOTEC=1.0) (INTELCO=0.5)	Measurement Margin	(3) ____________ (INTELCO=0.5 except for FDDI=0)
(4) ____________ (Add 2 and 3)	Field Derating	(4) ____________ (Add 2 and 3)
(5) ____________ (Subtract 4 from 1)	Cable Loss Budget	(5) ____________ (Subtract 4 from 1)

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7.4 Optical Time Domain Reflectometry

This section provides an overview of Optical Time Domain Reflectometry. It does not provide a step-by-step procedure for any particular Optical Time Domain Reflectometer (OTDR) model. Each manufacturer provides the necessary operational detail in the product's user manual.

NOTE

Optical time domain reflectometry is used as one part of the certification process to evaluate the relative optical parameters of each element of the fiber link, and should not be used as a substitute for the relative power loss measurement described in Section 7.3. Refer to the OTDR manufacturer's users' guide to obtain information on interpretation of the OTDR trace.

An OTDR performs the following functions:

- Uses a laser source to launch a pulse of light of very short duration into a cable under test.
- Measures the amplitude and timing of the reflected or back-scattered light.
- Graphically displays the result.

WARNING ⚠

Do not look into a fiber optic connector or cable end while the cable is connected to an OTDR. Follow safety procedures recommended by the OTDR manufacturer.

Digital certification process requires the use of an OTDR equipped with a printer because a permanent record of the fiber optic link measurement is required. Such records should be obtained whenever possible and stored for future reference. The display (or printout copy) is used to determine the length of the cable, the location of splices, and the locations of faults, breaks, and other anomalies that might be present.

The OTDR accesses only one end of the cable during a measurement, in contrast to the relative power loss measurement, which accesses both cable ends simultaneously. However, it is recommended to perform OTDR measurements from both cable ends to ensure that near-end blind spots are not masked.

An OTDR displays the power (in decibel [dB] units) in the vertical axis and the length (in meters) in the horizontal axis. The most obvious characteristics of the graphic trace on the display are the "spikes" that occur on the otherwise smooth and gradual slope. These are caused by connectors, poor mechanical splices, or breaks in the fiber. A fusion splice, or an anomaly, which can be a kink or stress on the cable, would appear as a less dramatic step in the trace slope. The large spikes at the beginning and end of the fiber are the reflections of the laser light off of the cleaved ends of the fiber

A typical OTDR test configuration is shown in Figure 7–3 and an OTDR display is shown in Figure 7–4. The display represents the reflection of laser light, splice location and loss, and the distance to the end of the fiber.

Figure 7–3: OTDR Test Configuration

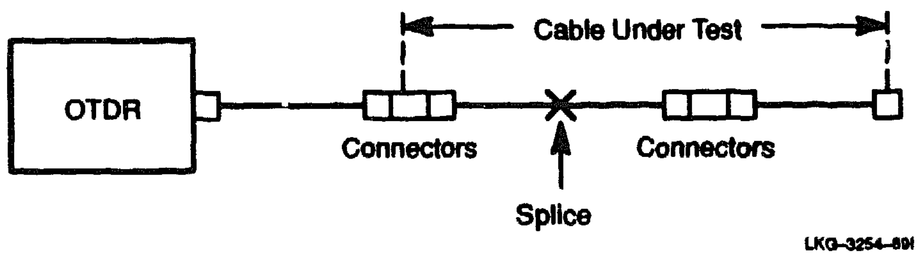
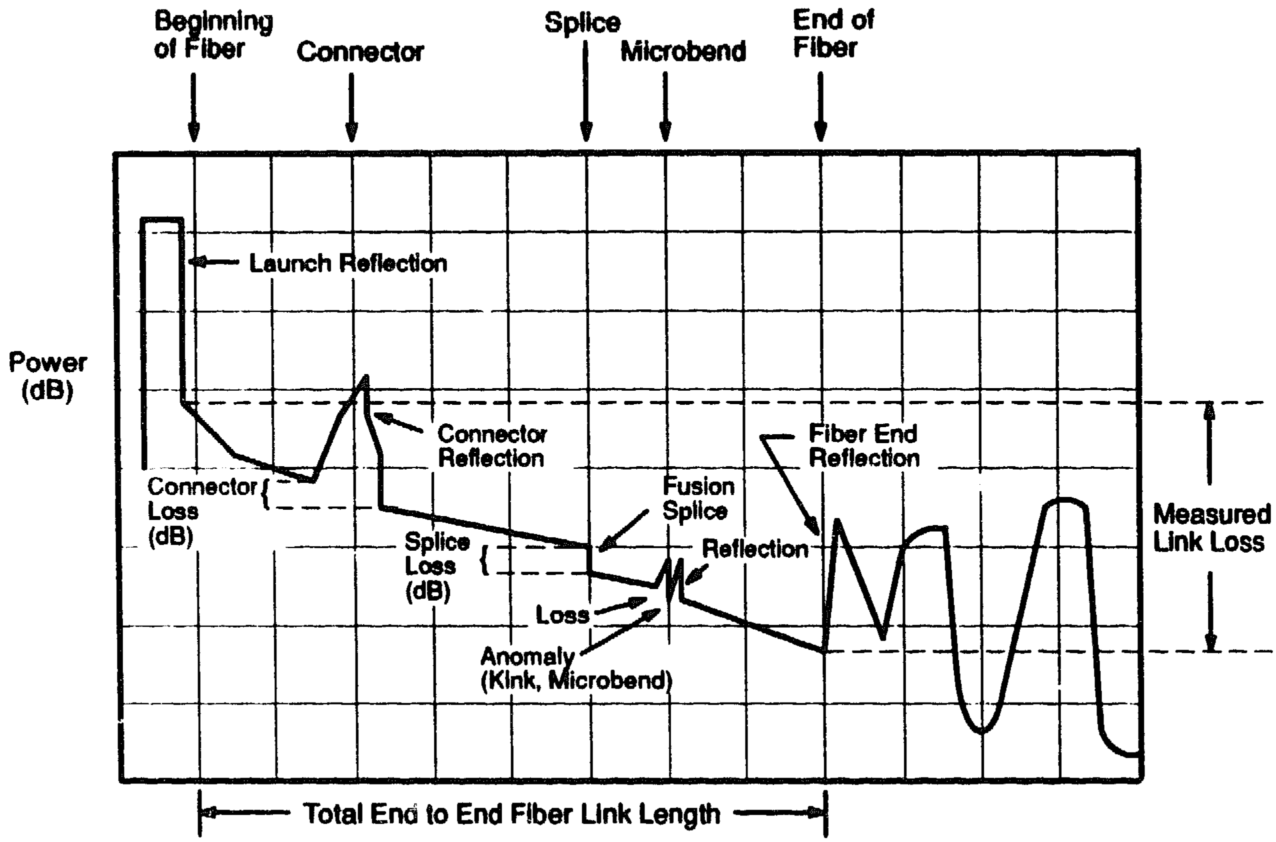


Figure 7–4: OTDR Trace



7.5 Single-Mode Fiber Acceptance

Digital recommends pulling single-mode cable, but currently has no applications that require single-mode fibers. Single-mode testing is part of the fiber optic cable-plant certification and consists of an OTDR test to insure that the fiber was correctly installed and not damaged during the installation. Once the single-mode fiber has passed OTDR testing, the fiber is left unterminated until an application is specified.

Passing the OTDR test establishes a fiber baseline that can be consulted should subsequent problems be suspected.

This type of unterminated fiber OTDR testing is similar to the testing done when a coil of fiber cable is received from a shipping agent. This test ensures that the fiber was not damaged in transit and provides a baseline for future reference.

APPENDIX A

A

References

This appendix provides ordering information for reference documents. Additional sources of standards and codes are listed at the end of this appendix.

ANSI Documentation

- *Communications Wire and Cable for Wiring of Premises ANSI/ICEA 5–80–576–1988, Second Edition, September 1988*
- *ANSI/IPC–FC–213, Undercarpet Cable Specification*
- *Fiber Distributed Data Interface (FDDI) Physical Media Dependent (PMD)*
- *ANSI/EIA/TIA–492AAAA, Detail Specification for 62.5 µm Core Diameter/125 µm Cladding Diameter Class Ia Multimode, Graded–Index Optical Waveguide Fibers*

Order from:

American National Standards Institute (ANSI)
430 Broadway
New York, NY 10018
(212) 642–4900

ASTM Documentation

- *ASTM D 4566–86, Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable*

Order from:

American Society for Testing and Materials (ASTM)
1916 Race Street
Philadelphia, PA 19103
(215) 299–5400

AT&T Documentation

- *AT&T Premises Distribution System Fiber Installation Manual* (Document No. 555–401–102)
- *LST1U–072/7 Lightguide Termination Shelf Installation AT&T 636–299–103–5*
- *LSC1U–024/5 Lightguide Combination Shelf Installation AT&T 636–299–103–6*
- *LSS1U–072/5 Lightguide Splice Shelf Installation AT&T 636–299–103–11*
- *LSJ1U–072/5 Lightguide Storage Shelf Installation AT&T 636–299–103–14*
- *LT1A Splice Organizer Installation AT&T 636–299–103–15*

Order from:

AT&T Customer Information Center
Commercial Sales Representative
P.O. Box 19901
Indianapolis, IN 46219
1–800–432–6600

BICSI Documentation

- *BICSI Telecommunications Distribution Methods Manual*
  The Building Industry Consulting Service, International (BICSI)
  1989–1990 price: $72.00/members $179/non–members

  Order from:

  TESTMARK Laboratories
  Publications Department
  3050 Harrodsburg Road
  Lexington, KY 40503
  (606) 223–3061

  Make Checks Payable to:

  GTE Supply Inc.

EIA/TIA Documentation

- *EIA/TIA–568 Draft Standard, Commercial Building Wiring Standard*
- *EIA/TIA–570 Draft Standard, Residential and Light Commercial Building Wiring Standard*
- *EIA/TIA–569 Draft Standard, Building Standard for Telecommunications Media and System*
- *EIA–440A Fiber Optic Terminology*
- *EIA Interim Standard Omnibus Specification, Local Area Network Twisted Pair Data Communications Cable, NQ–EIA/IS–43, September 1987*
- *EIA–455 Fiber Optic Test Procedures*
- *EIA–472, Generic Specification for Fiber Optic Cables*
- *EIA–49a Specification Series for Optical Fibers*
- *EIA–472A, Sectional Specification for Fiber Optic Communication Cables for Outside Aerial Use*
- *EIA–472B, Sectional Specification for Fiber Optic Communication Cables for Underground and Buried Use*
- *EIA–479C, Sectional Specification for Fiber Optic Communication Cables for Indoor Use*
- *EIA–479D, Sectional Specification for Fiber Optic Communication Cables for Outdoor Telephone Plant Use*
- *Commercial Building Wiring Standard (EIA Part No. 1907)*

Order from:

The Electronic Industries Association (EIA)
1722 Eye Street, N.W., Suite 300
Washington, DC 20006
(202) 457–4900

or from:

Telecommunications Industries Association (TIA)
1722 Eye Street, N.W., Suite 4040
Washington, DC 20006
(202) 457–4934

GTE Documentation

- *Line and Cable Placing* (CH No. 140)
  Approximate price: $32.00

- *Cable Splicing* (CH No. 150)
  Approximate price: $28.00

- *Cable Maintenance and Testing* (CH No. 170)
  Approximate price: $26.00

Order from:

GTE Communication Systems Corporation
Publications Manager
Department 431.1 – Tube Station C1
400 North Wolf Road
Northlake, IL 60164
(312) 681–7483 or
(312) 681–7479

IEEE Documentation

- *IEEE 802.3–1988 (also known as ANSI/IEEE Std 802.3–1988 or ISO 8802–3: 1989 (E)), Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

- *IEEE 802.3 Supplements*

- *IEEE 802.5–1985 (also known as ANSI/IEEE Std 802.5–1985 or ISO Draft Proposal 8802/5), Token Ring Access Method and Physical Layer Specification*

Order from:

The Institute of Electrical and Electronic Engineers, Inc. (IEEE)
IEEE Service Center
445 Hoes Lane P.O. Box 1331
Piscataway, NJ 08855–1331
(201) 981–0060

ISDN Documentation

- *ISDN BRI(ISO 8877)*

Order from:

International Standard Organization (ISO)
1, Tue de Varembe
Case Postale 56
CH–1211 Geneva 20
Switzerland
+41 22 34 12 40

NEC Documentation

- *National Electrical Code (NEC)*

Order from:

The National Fire Protection Association (NFPA)
1 Batterymarch Park
Quincy, MA 02269
1–800–344–3555

NEMA Documentation

- *NEMA–250–1985, Enclosures for Electrical Equipment (1000 Volts Maximum)*

Order from:

National Electrical Manufacturers Association (NEMA)
2101 L Street
Washington, D.C. 20037
(202) 457–8400

UL Documentation

- UL 1863

Order from:

Underwriters Laboratories, Inc. (UL)
333 Pfingsten Road
Northbrook, IL 60062
(312) 272–8800

Additional Sources

CSA:

Canadian Standards Association (CSA)
178 Rexdale Boulevard
Rexdale (Toronto), Ontario
Canada M9W 1R3
(416) 747–4363

FCC:

Federal Communications Commission (FCC)
Washington, DC 20554
(301) 725–1585

Federal and Military Specifications:

Naval Publications and Forms Center
Commanding Officer
NPFC 43, 5801 Tabor Ave
Philadelphia, PA 19120–5099
(215) 697–3321

ICEA:

Insulated Cable Engineers Association (ICEA)
P.O. Box 440
South Yarmouth, MA 02664
(508) 394–4424

IEC:

International Electrotechnical Commission (IEC)
Sales Department
P.O. Box 131
3 rue de Varembe
1211 Geneva 20
Switzerland
+41 22 34 01 50

APPENDIX B

B

Core Blocking, Unit Splitter and Buffer Installation

The guidelines listed below are for core blocking, installing the unit splitter and adding buffers for loose tube outdoor fiber optic cables.

To block the cable core tube, prepare the fibers, then follow Steps 1 through 3.

1. Inject sealant into the cable core tube, around the fibers.

CAUTION ⚠

When performing any steps requiring uncured sealant, do not allow the sealant to touch your skin or eyes.

2. Coat the end of the core tube with sealant.
3. Slide the clear split tube over the fibers and the core tube.

To install the unit splitter, follow Steps 4 through 8.

4. Remove the cover of the unit splitter. See Figure B–1.
5. Put the fiber bundles in the stepped end of the unit splitter.
6. Carefully slide the stepped end of the splitter into the clear plastic tube and the cable core tube.
7. Turn the clear split tube so that the split is opposite the open side of the splitter.
8. Fill the slot in the stepped end of the splitter with sealant. See Figure B–2. Do not fill the slot past the end of the clear tube.

When adding the buffer tubes, follow Steps 9 through 11.

9. Feed the separated fibers into the protective tubes. See Figure B–3.

10. With fibers in the finger slots, slide the tubes over the fibers and fingers until they touch the unit splitter.

11. Replace the plastic cover on the splitter by inserting the two pegs on the cover into the holes in the splitter.

12. Complete the assembly. See Figure B–4.

Figure B–1: Removing the Blocking Splitter Cover

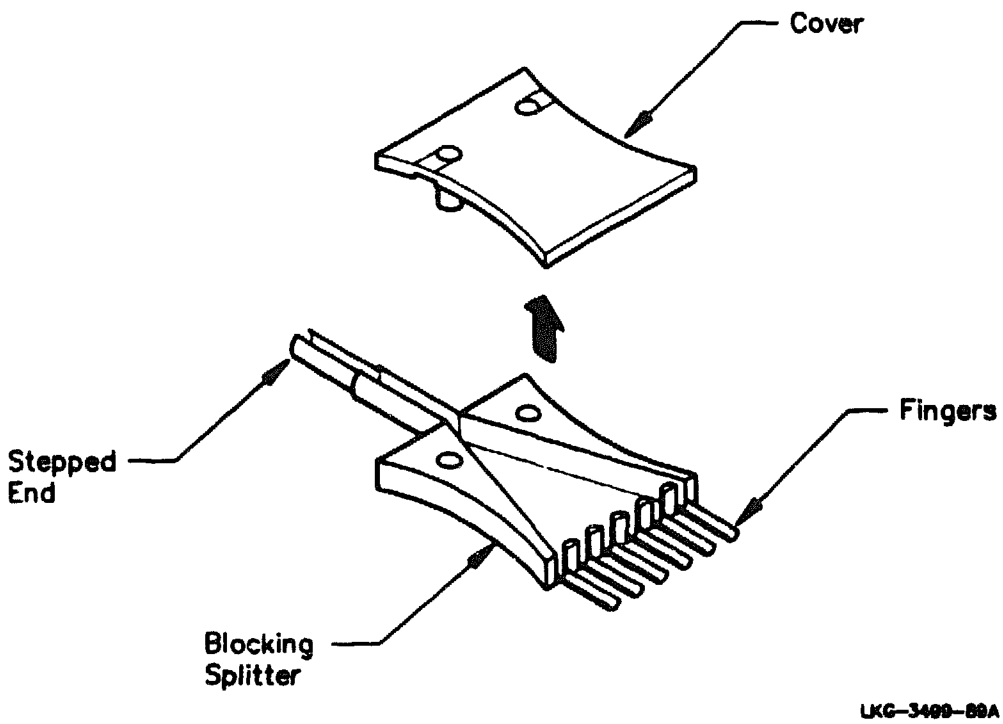


Figure B–2: Placing Fibers and Filling the Slot

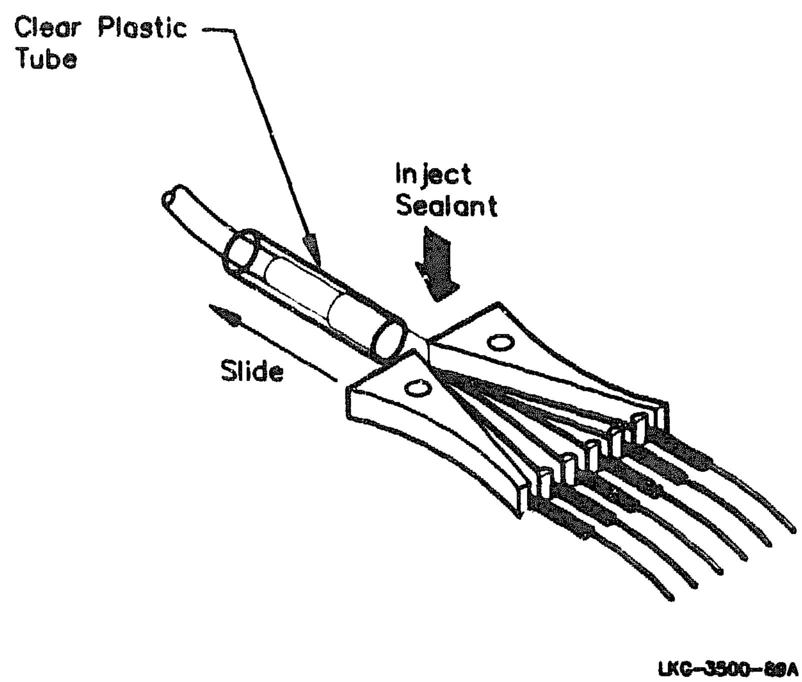


Figure B–3: Feeding Fibers into Blocking Splitter

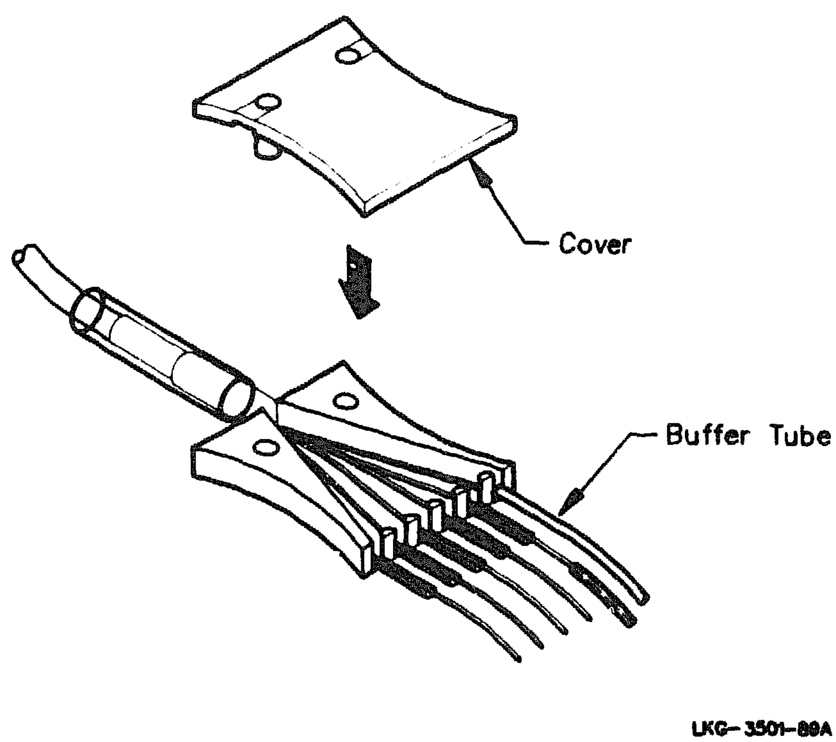
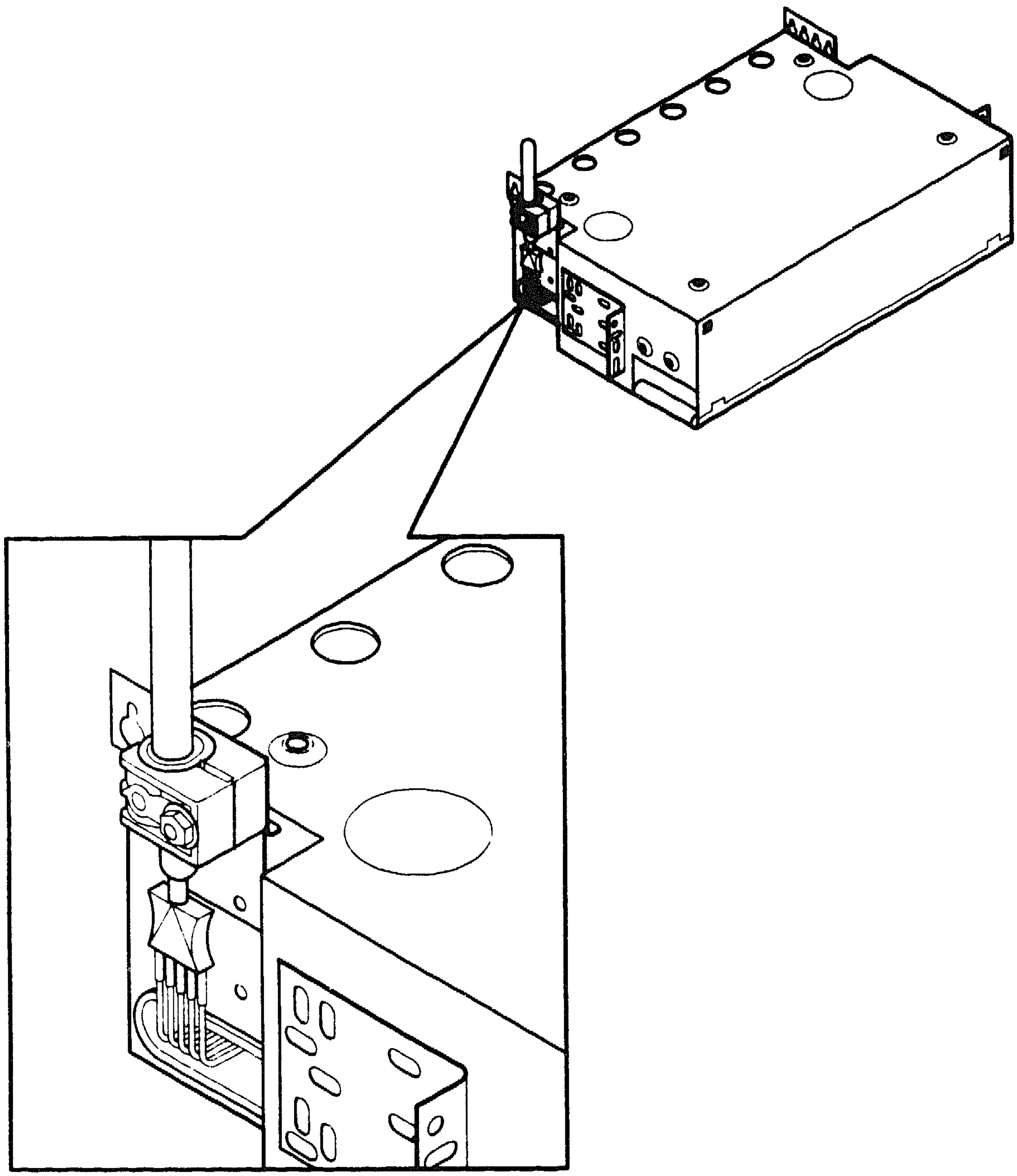


Figure B–4: Installing the Cornpleted Unit Splitter



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GLOSSARY

Glossary

19-inch RETMA racks

19-inch distribution frame racks, either 72 or 84 inches high, for mounting active and passive components. *See* RETMA.

23-inch rack

23-inch wide telecommunications rack for mounting passive fiber optic components only.

2.5 mm bayonet ST-type connector

A 2.5 mm ferrule straight tip connector. Connector is spring-loaded and keyed, enabling quick and repeatable mating and remating of cable.

2.5 mm bayonet ST-type connector kit

Kit containing six 2.5 mm ST-type bayonet connectors.

2.5 mm bayonet ST-type connector termination tool kit

Kit containing tools for field-connectorizing cable with 2.5 mm bayonet ST-type connectors.

above ceiling cable routing

In this method, cable is routed horizontally using either J-hooks, conduit, ducts or cable trays.

active device

See active equipment.

active equipment

A device that provides for communications services and requires primary power; for example, repeaters, bridges, terminal servers, concentrators, and computers.

administration zone

A section of a building's wiring that has its management and administrative functions controlled by a single horizontal wiring subsystem.

aerial cable routing

In this method, used for interbuilding cabling, cable is supported on poles that suspend it in the air between buildings.

aramid yarn

Strength element used in cable to provide support and additional protection of fiber bundles. Kevlar is DuPont's registered name for aramid yarn.

attenuation

Level of optical power loss expressed in units of dB.

backbone subsystem

Fiber optic communications system connecting the horizontal wiring subsystems into a structured wiring cable plant. *See* building backbone *and* campus backbone.

barrel connector

See coupler *and* connector.

baseboard raceway cable routing

In this method, cable is routed through channels running along the baseboards.

bend radius

The minimum radius to which a cable can be bent without damaging the cable.

Biconic connector

Tapered-sleeve connector.

BICSI

Building Industry Consulting Service International

BOM

Bill of materials, a listing of required equipment for a subsystem, a distribution frame, or for the site as a whole.

buffering

A protective material extruded on the fiber to strengthen it and to protect it from the environment. Also, the process of extruding a buffer tube around the coated fiber to isolate the fiber from stresses on the cable.

buffer tubes

A tube of protective material slipped over a fiber. Also used to increase fiber diameter to aid in fitting. *See* buffering.

building

A structure containing a floor(s) and an entrance area where communications cables enter and leave the structure.

building backbone distribution

Cabling connecting the building horizontal subsystem to the campus backbone. Consists of Intermediate Distribution Frame (IDF) and backbone wiring.

bundle

A group of up to 12 buffered fibers distinct from another group of fibers in the same cable core.

cable (fiber)

An assembly of optical fibers and other material providing mechanical and environmental protection. Materials may include a cable jacket and strength members.

cable assembly

Fiber optic cable that has connectors installed on one or both ends.

cable bend radius

See bend radius.

cable entrance point

Area where interbuilding cable enters a building.

cable jacket

A protective coating around a clad fiber or fibers.

cable manager bracket

Bracket that mounts into standard 19-inch rack and guides cable to rear of cabinet for cable management.

cable plant

The campus and building infrastructure that supports voice, video, and data applications.

campus

The buildings and grounds of a complex, such as a university, college, industrial park, or military establishment.

campus backbone distribution

Cabling connecting buildings in a multiple-building campus installation.

CC

See crossconnect.

cellular floor cable routing

In this method, cable is routed through a series of channels made of materials like corrugated cardboard, steel, or concrete.

cladding

Low refractive index material surrounding the core. Cladding provides optical insulation and protection to the total reflection interface.

combination shelf

Shelf used to splice indoor or outdoor cable for administration of crossconnect and interconnect administration points. Contains compartments for splicing, storing, and terminating up to 24 fibers.

conduit

Pipe or tubing through which cables can be pulled or housed. Conduit provides continuous support and protection for cables. Conduit may be vertical (riser) or horizontal.

conduit cable routing

In this method, used in both indoor and outdoor cabling, cable is routed through conduit. *See* conduit.

connector

Mechanical device used for terminating fiber. The 2.5 mm bayonet ST-type connector and FDDI connector are examples.

core

Central light transmission area of a fiber. The core always has a higher refractive index than the sheath or cladding.

core blocking

Insertion of sealant into the core tube of a cable to prevent leakage of water blocking material.

coupler

Mechanical device that mates two cables terminated with connectors. Housed in a termination shelf, combination shelf, remote wall unit, or wallbox. *See* 2.5 mm bayonet ST-type connector *and* coupler.

coupler panel

Panel with up to six 2.5 mm bayonet ST-type connector couplers used in termination and combination shelf and remote wall unit for fiber.

crossconnect

A patch cable and passive hardware that is used to administer the connection of cables at a distribution frame.

crossconnect point (CC)

An administration point where two fibers are connected at a patch panel, using panel-mounted couplers and patch cable.

crossover

Patch cable(s) within a link that connect in such a way as to route the transmit port of one piece of active equipment to the receive port of another piece of active equipment.

direct-buried cable routing

In this method, used for interbuilding routing, cable is buried in a trench.

distribution frame

See Horizontal Distribution Frame (HDF), Main Distribution Frame (MDF), Intermediate Distribution Frame (IDF), Satellite Distribution Frame (SDF), Office Distribution Frame (ODF), *and* Remote Wall Distribution Frame (RWDF).

EIA

Electronic Industries Association.

Electronic Industries Association (EIA)

A standards organization that includes standards for the electrical and functional characteristics of interface equipment. These EIA standards are used to ensure that there is compatibility between data communications equipment and data terminal equipment.

electromagnetic interference (EMI)

Electromagnetic interference, caused by radiation of electrical or magnetic fields.

EMI

See electromagnetic interference.

environmental airspace

Airspace below a floor or above a hung ceiling used as a return duct for heating, air conditioning, or both.

equipment rack

Rack used to house active and/or passive devices. *See* 19-inch RETMA racks.

equipment room

A room in which active equipment, telecommunications equipment, MDF, IDF, HDF, and SDF is housed.

faceplate

See wallbox.

ferrule size

Inside diameter of connector ferrule, determined by the fiber size.

fiber

Thin filament of glass used as an optical waveguide, consisting of a core and a cladding, which is capable of carrying information in the form of light.

fiber color codes

Use of colors to identify individual fibers and bundles of fibers.

fiber optic cable

A cable construction consisting of one or more fibers.

FOTEC

Optical power meter equipped with appropriate adapters; part of the **850 nm only** optical power loss test set.

fusion splice

Splice made by aligning two fibers and fusing them together with an electrical arc or flame.

graded-index fiber

A fiber in which the refractive index changes gradually with the distance from the fiber axis rather than abruptly at the core-cladding interface. *See* step-index fiber.

grommet

Plastic edging used on the cable and pigtail entrance holes of termination centers such as the storage shelf and combination shelf. Also used in fiber transition enclosure to seal against environmental intrusion.

HC

See horizontal crossconnect

HDF

See Horizontal Distribution Frame.

heavy duty cable

Cable containing 2 mm subunit cables of buffered fibers and strength members, and a central strength member.

home-run cable routing

In this method, cable runs directly from the serving closet to each information outlet.

horizontal crossconnect (HC)

A crossconnect that is located within the horizontal wiring subsystem. Can occur at an horizontal, satellite, or office distribution frame.

Horizontal Distribution Frame (HDF)

Located in an equipment room on the floor of a building and consists of the active, passive, and support components that provide the connection between the building backbone cabling and the horizontal wiring.

horizontal wiring subsystem

Cabling connecting building backbone to the work area, computer labs, or system common equipment.

IC

See interconnect point.

IDF

See Intermediate Distribution Frame.

Intelco

Optical power meter equipped with appropriate adapters, part of the 850 nm/1300 nm dual-window optical power loss test set.

interbuilding cable

The communications cable that is installed between buildings.

interconnect cable

Jumper cable used for interconnection of active equipment to a panel. *See* jumper.

interconnect point (IC)

An administration point connecting two fibers using panel-mounted or wallbox-mounted fiber optic coupler.

intermediate crossconnect (IC)

A crossconenct that is located at the intermediate distribution frame (IDF).

Intermediate Distribution Frame (IDF)

Located in an equipment room and consists of the active, passive, and support components that provide the connection between interbuilding cabling and the intrabuilding cabling for a campus and for a building.

intrabuilding cable

The communications cable that is installed inside a building.

jumper

Two-fiber cable with connectors on both ends. Jumper cables can be patch cables (for crossconnects), interconnect cables (for active equipment interconnects), or work area wiring.

Kevlar

See aramid yarn.

light duty cable

Cable containing buffered fibers and aramid yarn strength members.

link

A segment or a number of segments connected together through crossconnects that provide the communication path between active equipment at both ends.

loose-tube cables

Cable containing optical fibers inside buffer tubes, with anti-buckling member at center of cable. Used primarily for outdoor cabling.

main crossconnect

A crossconnect that is located at the main distribution frame (MDF).

Main Distribution Frame (MDF)

Located in an equipment room and consists of the active, passive, and support components that provide the connection of the interbuilding backbone cables between IDFs.

MC

See main crossconnect

MDF

See Main Distribution Frame.

mechanical splicing

Joining device that aligns and clamps fibers end-to-end along a precision vee groove. Examples are single-fiber capillary splices and multiple-fiber array splices. *See also* fusion splice.

micron

Micrometer (μm). Millionth of a meter (10^{-6} meter), used in fiber dimensions.

minimum bend radius

See bend radius.

mm

Millimeter (mm). Thousandth of a meter (10^{-3} meter), used in connector dimensions.

modified modular jack (MMJ)

Jack used to connect unshielded twisted-pair data cables to a wallbox (faceplate).

modular office furniture cable routing

In this method, cable routing is done using the cable paths integral to the modular furniture used in an office area.

modular office wallbox

Wall mounted receptacle providing a network connection point for office communications equipment. *See* wallbox.

molding raceway cable routing

In this method, cable is routed through raceways that form moldings along the walls or hallways and rooms near the area where the wall joins the ceiling.

multimode fiber

An optical waveguide that allows more than one mode to propagate.

nanometer

One billionth of a meter (10^{-9} meter), used to identify light wavelengths.

National Electrical Code (NEC)

Nationally recognized safety standard for design, construction, and maintenance of electrical circuits.

NEC

See National Electrical Code.

NEMA

National Electrical Manufacturers Association.

NFPA

National Fire Protection Association.

nm

See nanometer.

ODF

See Office Distribution Frame.

Office Distribution Frame (ODF)

An enclosed rack usually located in an office area. It consists of the active, passive, and support components that provide the physical connection between the horizontal wiring and the wallbox.

optical fiber

See fiber.

OTDR Test

Use of Optical Time Domain Reflectometer to characterize a fiber run and determine slice and connector loss.

passive equipment

Cable plant hardware requiring no power.

patch cable

Cable with connectors on each end, connecting two separate fibers at crossconnect (CC) administration points. *See also* jumper.

patch panel

A termination shelf or combination shelf used in crossconnect administration points. *See* crossconnect point.

pigtail

Short fiber optic cable with factory installed connector attached to a cable with a splice.

plenum

An air handling space inside a building. Refer to the NEC documentation for additional information.

plenum cable

Cable with an outer jacket that meets NEC requirements (UL-certified) for installation without conduits in environmental airspaces. Plenum grade cable is marked OFCP or OFNP.

PVC

Polyvinyl chloride. A standard flame-retardant thermoplastic insulating material used for cable jackets.

raceway cable routing

In this method, cable runs through open or closed metal trays suspended from the ceiling.

rack cable routing

In this method, used for vertical and horizontal routing, cable is routed through aluminum or steel trays or assemblies that resemble ladders. The racks are attached to the building or hung from ceiling beams.

raised or access floor cable routing

In this method, cable is routed under a raised floor of square plates that rest on steel or aluminum locking pedestals attached to the building floor.

relative power loss

Field measurement of power loss on a cable link under test conditions; equal to the difference between the launched power and the received power.

Remote Wall Distribution Frame (RWDF)

A small wall mounted cabinet that consists of the passive and support components that provide the physical connection between the horizontal wiring and the wallbox.

RETMA

(Radio-Electronics-Television Manufacturers Association; later becoming EIA — Electronic Industries Association) RETMA racks are standard-sized cabinets that are used by Digital Equipment Corporation and other major manufacturers of electronic equipment. The cabinet rails, mounting hole patterns, and spacing conform to international standards that allow compatibility with products manufactured by Digital and others in the industry.

riser

A vertical shaft or conduit through which cables are run between floors.

RWDF

See Remote Wall Distribution Frame.

Satellite Distribution Frame

Located in an equipment room on the floor of a building and conists of the active, passive, and support components that provide the connections between the horizontal wiring and the wallbox.

Satellite Equipment Room (SER)

A DECconnect System dedicated area (room or wiring closet) for rack mounted active and passive horizontal wiring components.

SDF

See Satellite Distribution Frame.

segment

The fiber optic cable that is behind the wall or in ground with fiber connectors on each end.

sheave

Grooved wheel or pulley used to pull cable around a bend.

shoe

Plastic device used like a shoehorn to guide cable through narrow openings while it is pulled.

single-mode fiber

A fiber waveguide in which only one mode will propagate due to the fiber's small core diameter (10 µm or less). Single-mode fiber must be used with a laser light source. *See* multi-mode fiber.

site

The campus and building wiring coverage with a geographical extent up to 3000 meters (9840 feet), up to 1,000,000 square meters (approximately 10,000,000 square feet) of office space, and a population of up to 50,000 individual users. A site must have one MDF.

site plan

A set of drawings that show the buildings on a campus, geological features of the campus, streets, parking lots, waterways, interbuilding tunnels, conduits, and manholes.

sleeve cable routing

In this method, used in riser shafts, cable is routed through short lengths of conduit, usually metal.

slot cable routing

In this method, used in riser shafts, cable is routed through rectangular openings in each floor, allowing cable to pass from floor to floor.

slotted-core cable

Cable containing a core of optical fibers inside water-blocked slots. The slots and a central tension member are enclosed in wrapping tape and an outer sheath, and may contain strength members. Used primarily for outside cabling.

SMA connector

Straight-sleeved connector similar to SMA coaxial connector.

splice closure

Sealable unit used to protect splices in a harsh environment.

splice shelf

Shelf used to store mechanical or fusion splices. Contains up to 3 splice organizers, each tray storing up to 24 splices.

splice tray

Fits inside a splice organizer that fits inside a splice shelf. Container used to organize and protect up to 24 spliced fibers.

splicing

Joining ends of identical or similar fibers without using a connector. *See* fusion splicing *and* mechanical splicing.

split mesh grip

Device used to grip cable when running it through conduit.

ST connector

Straight-tip connector. *See* 2.5 mm bayonet ST-type connector.

step-index

A fiber in which the core is of a uniform refractive index. There is an abrupt change at the core-cladding interface. *See also* graded-index fiber.

storage shelf

Shelf used to store connectorized jumpers or buffered cable.

subsystem

A part of the structured wiring distribution system that is dedicated to a specific purpose; for example, the horizontal wiring subsystem.

system common equipment

The equipment on a campus that provides functions common to terminal devices such as telephones, data terminals, integrated workstations, and personal computers. Typically, the system common equipment is the PBX switch, data packet switch, or a central host computer.

telecommunications outlet

See wallbox.

tensiometer

Device used to measure the tension on cable during pulling operation. Used during installation to prevent excessive strain and damage.

termination shelf

Shelf used to terminate indoor or outdoor cable. Contains up to 12 connector panels, each panel connecting up to 6 fibers.

tight-buffered cable

Cable construction with each fiber tightly buffered by a protective thermoplastic coating to a diameter of 900 microns.

tunnel cable routing

In this method, used for interbuilding cabling, cable is routed through tunnels between buildings.

underfloor conduit cable routing

In this method, cable is routed through radiating from the riser closet, satellite closet, or satellite location to the terminal locations in the floor, walls, or columns of an office space.

underfloor duct cable routing

In this method, cable is routed through a series of metal distribution channels, often embedded in concrete, and through open or closed metallic feeder channels or troughs. A complex system may have more than one level.

unit splitter

Device used for managing optical fibers in outdoor cable assemblies.

wallbox (WB)

Also called faceplate, information outlet, or telecommunications outlet. Connects work area wiring to the horizontal wiring.

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