Intrabuilding Installation of Corning Cable Systems Fiber Optic Cable

1. General

1.1 This procedure describes how to install Corning Cable Systems fiber optic cable for distribution within a building.

1.2 Corning Cable Systems fiber optic cable may be ordered with or without factory-installed connectors. This procedure describes the installation of both versions of cable.

1.3 The methods and instructions provided in this procedure are intended only as guidelines, as each installation will be influenced by local conditions and user preferences. The reader should be experienced in fiber optic cable placement. *When local building codes conflict with this procedure, the codes should be followed. Corning Cable Systems Engineering Services can advise on such matters if a copy of the local code is provided.*

1.4 This procedure contains references to specific tools and materials in order to illustrate a particular method. Such references are not intended as product endorsements.

1.5 Corning Cable Systems loose tube cables incorporate coated fibers encased in buffer tubes for separation and protection. By varying the number of buffer tubes and the number of fibers in each tube, Corning Cable Systems loose tube cables can be constructed with fiber counts ranging from 2 to 288. Loose tube cables are available for outside plant applications (ALTOS® cables) and indoor/outdoor applications (FREEDM™ cables).

1.6 Corning Cable Systems MIC® cable is a family of rugged, high performance cables designed for various indoor distribution applications. MIC cable has the bandwidth to transport all voice, data, and video signals required in an automated office environment.

1.7 Methods used for placing Corning Cable Systems fiber optic cables are essentially the same as those used for placing conventional copper cable. However, fiber optic cable is a high capacity transmission medium whose qualities and characteristics can be degraded when it is subjected to:

- Excessive pulling.
- Excessive tension.
- Crushing forces.

See Section 5, *Cable and Connector Handling Precautions*, for further information.

1.8 Pre-connectorized cables require special attention to prevent damage to the connectors. Be sure to read and understand Section 5, *Cable and Connector Handling Precautions and Specifications* before starting an installation.

1.9 This issue includes updated corporate information.

2. Safety Precautions

2.1 Observe the following safety precautions when placing cable inside a building and between buildings. These practices may change, or may not be suitable in a specific situation, and are, therefore, suggested guidelines. Your company's safety precautions and practices take precedence over any conflicting recommendations given in this document.

Caution: *Before starting any cable installation, all personnel must be thoroughly familiar with all applicable Occupational Safety and Health Act (OSHA) regulations, the National Electric Safety Code (NESC), state and local regulations, and company practices and policies. Failure to do so can result in life-threatening injury to employees or the gen-*

General Safety Precautions

Warning: *To minimize hazards to yourself and others in or near the work area, follow all company rules for setting up barricades, ladders, scaffolding, and warning signs. Any material used above the floor should be arranged so that it cannot fall and hit individuals underneath.*

Warning: *To reduce the chance of accidental injury:*

- *Equipment should not unnecessarily impede pedestrian traffic.*
- *Establish good communications between the pull, feed, and monitoring locations before starting any pull operation.*
- *Inspect all equipment (ladders, cable stands, etc.) for defects before using. Repair or replace equipment if it is found in a deteriorated or unsafe condition.*
- *Personnel normally should not remain in an area where a cable is being pulled under tension around a piece of hard ware. Personnel can remain in such an area (e.g., to observe the alignment of a cable around a corner block), if he or she stays clear of the hardware under tension and has a clear path to safety.*
- *If you use a cable lubricant during a pull operation, make provisions to clean up any spilled lubricant to prevent slip ping and possible injury.*
- *Always use a ladder or scaffolding when working above floor level. Keep hands free of tools or materials when descending or ascending a ladder. Do not step on cables, cable enclosures, or equipment when working above the floor.*
- *Ensure that the building structure (floor, walls, ceilings, and raceways) is in a good state of repair and does not present a hazard.*
- *Observe standard safety precautions. Wear safety headgear, eye protection, gloves, etc., as specified in your company's practices.*

2.2 Laser Precautions

Warning: *Laser light can damage your eyes. Laser light is invisible. Viewing it directly does not cause pain. The iris of the eye will not close involuntarily as when viewing a bright light. Consequently, serious damage to the retina of the eye is possible. Never look into the end of a fiber which may have a laser coupled to it. Should accidental eye exposure to laser light be suspected, arrange for an eye examination immediately.*

3. Building and Fire Codes

3.1 Construction in virtually all areas of the United States is regulated by building codes and standards which are normally enforced by a local agency. A thorough understanding of the regulations imposed by these codes and standards is an essential part of the planning stage of any new construction, expansion, or renovation. Such codes and standards cover virtually all elements of the construction process, including communications.

3.2 Each state or local jurisdiction has its own method for defining, implementing, and enforcing codes and standards. In addition, some types of operations, such as governmental, maritime, railroads, mining, and military installations have their own codes. Thoroughly investigate all codes and standards applicable to each installation before beginning work.

3.3 Building codes and standards govern the installation practices and materials used in the construction of communication systems. The purpose of codes and standards is to ensure the quality of the construction and to protect life, health, and property.

The National Electrical Code® (NEC®) and Fiber Optic Cable

3.4 The National Electrical Code (NEC) provides the guidelines for all electrical installations in industrial, commercial, and residential buildings.

3.5 NEC Article 770 states that fiber optic cables installed within a building be listed as resistant to the spread of fire in accordance to its specific building application: *plenum*, *riser*, or *general purpose*.

Plenum

A plenum is defined as a "...compartment or chamber to which one or more air ducts are connected and which forms part of the air distribution system." The NEC advises that fiber optic cable installed in

a plenum application comply with the Underwriters Laboratories UL-910 standard.

Fiber optic cables that are installed in plenum applications should be marked as Type OFNP or OFCP and listed to verify compliance to the UL-910 Standard. Type OFNP cables show resistance to flame spread and smoke generation.

Riser

A riser is defined as a vertical cable run that travels from one floor to another floor within a building.

The NEC advises that optical fiber optic cable installed in a riser application comply with the Underwriters Laboratories UL-1666 Standard.

Fiber optic cables that are installed in riser applications should be marked as Type OFNR or OFCR and listed to verify compliance to the UL-1666 Standard. The use of Type OFNR listed optical cable serves to deter the spread of fire from one building floor to another.

General Purpose

General purpose (horizontal) is defined as the wiring area that extends along only a building floor, or those areas not addressed in plenum or riser environments.

The NEC advises that optical fiber cable installed in a general purpose application comply with the Under-writers Laboratories UL-1581 Standard.

Fiber optic cables that are installed in general purpose applications should be marked as Type OFN or OFC and listed to verify compliance to the UL-1581 Standard.

3.6 Corning Cable Systems recommends installing dielectric or non-conductive-listed optical cables rather than conductive optical cables within a building. Conductive listed cables are required to be grounded in accordance with NEC Article 250. Dielectric cables are not affected by this grounding requirement.

3.7 NEC Article 770-53 (d) permits optical cables which pass more stringent UL flame tests and are listed accordingly to be substituted for lower-rated designs i.e., a riser rated cable may be used in a general purpose application.

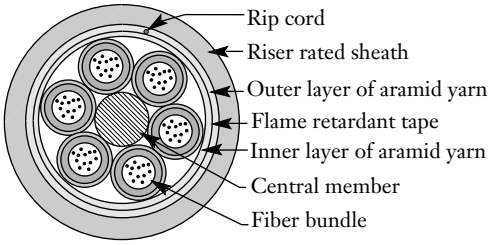
3.8 Cable installers should be familiar with the building codes used by local officials for inspection. In a few instances, cables which meet the NEC requirements may not meet all of the local building codes.

3.9 For more information on building and fire codes, see Corning Cable Systems procedure SRP005-032, *Building Codes and Fiber Optic Cable Installations.*

4. Cable Types

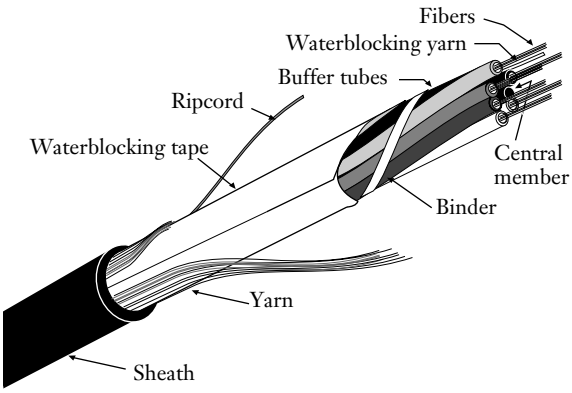
4.1 Corning Cable Systems' standard cable products fall into three categories in relationship to fire codes:

1) Corning Cable Systems' standard, loose-tube constructed cables are optimized for outdoor applications and are not listed. However, two of Corning Cable Systems' outside plant cables (ALTOS® Riser and FREEDM™cables), are listed OFNR for riser applications (Figures 1 and 2).



72-fiber ALTOS® Riser Cable

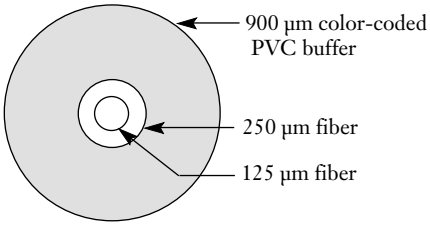
Figure 1



FREEDM™ Riser-rated Cable

Figure 2

2) Corning Cable Systems Tight Buffered and Enhanced OptiStrip™ cable constructions are listed to pass the UL 1666 Riser Shaft Test and can be used in riser environments without the use of non-combustible tubing (Figure 3).



Tight Buffered Fiber

Figure 3

3) Corning Cable Systems plenum-rated tight buffered cable constructions are listed to pass the UL-910 Steiner Tunnel Test for use in plenum environments without the use of non-combustible tubing.

4.2 Corning Cable Systems Zipcord (Figure 4) and Single Fiber Cables are designed for use as "jumpers," "patch cords," or "pigtails" in intrabuilding distribution. Both cables have the bandwidth to transport all voice, data, and video signals required in an automated office environment.

These cables are *not* intended for use in installations requiring long or difficult "pulls" or routing between buildings.

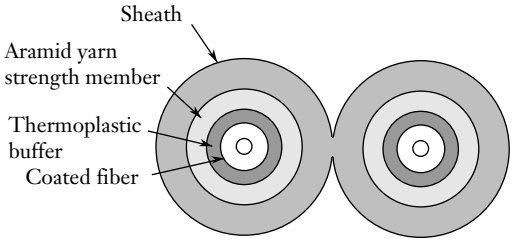


Figure 4 **Zipcord Cable**

NEC Exceptions

4.3 The NEC has defined exceptions that permit unlisted optical cable to be installed in specific building applications.

Building Entrance Exception

Article 770-50 of the NEC allows the use of Corning Cable Systems loose tube constructed cable 1) without the use of non-combustible tubing "...where the length of cable within the building does not exceed 50 feet (15.2m) and the cable enters the building from the outside and is terminated in an enclosure..." and 2) "...where the cable is run in rigid metal conduit or intermediate metal conduit."

For more information concerning cable ratings and building codes, refer to SRP-005-032, *Building Codes and Fiber Optic Cable Installations.*

4.4 These exceptions permit unlisted outside plant cable (loose tube cable) to enter a building cable vault room and be transition spliced to a listed optical cable that runs to the fiber distribution frame. Riser listed fiber optic cable is normally spliced to the outside plant cable at the cable vault. The use of the riser rated cable deters the spread of flame from the vault room to the fiber distribution frame.

4.4 If an unlisted outside plant cable is run inside a building more than 50 feet from the building entrance the cable must be enclosed in raceways as stated in 4.3 and transition spliced to properly listed cables.

5. Cable and Connector Handling Precautions and Specifications

Caution: *Exercise care to avoid cable and connector damage during handling and placing. Fiber optic cable and connectors are sensitive to excessive pulling, bending, and crushing forces. Any such damage may alter the cable's and /or connectors' transmission characteristics to the extent that the pre-connectorized cable may have to be replaced. To ensure all specifications are met, consult the specific cable specification sheet for the cable being installed.*

5.1 Use the following information as a general guideline for intrabuilding installation of Corning Cable Systems fiber optic cable. (This information is based upon standard Corning Cable Systems cable designs). Mechanical specifications, minimum bend radius, and cable temperature ranges can be obtained form the Corning Cable Systems Fiber Optic Products Catalog or by contacting Corning Cable Systems Engineering Services.

5.2 Leave the protective covering on the reel intact until it arrives at the installation site. If the covering has been previously removed, secure the cable end(s) during transit to prevent damage. Cable reels should be stored vertically on their flanges,end-to-end in rows,and chocked to prevent rolling. Make sure that reels rest edge-to-edge with reels in adjacent rows to prevent damage to cables.

5.3 Determine if your company requires that the cable be tested for optical continuity prior to installation. This test can be done with an Optical Time Domain Reflectometer (OTDR).

5.4 Before the installation begins, carefully inspect the cable reel for protrusions such as nails and broken flanges which might cause damage to the cable as it is unreeled.

5.5 Take precautions to protect reeled cable from mishaps or other sources of possible damage whenever it is unattended. Pre-connectorized sections of cable are produced to meet specific length requirements. Any damage to the cable sections may require replacement of the entire section.

5.6 Whenever unreeled cable is placed on the floor in high traffic areas, provide barricades or other means of preventing vehicular or pedestrian passage through the area.

5.7 If the cable must be unreeled during installation, use the "figure-eight" configuration to prevent kinking or twisting. Do not coil fiber optic cable in a continuous direction except for lengths of 30 m (100 ft.) or less.

5.8 For loose tube cables, the preferred size of the "figure-eight" is about 4.5 m (15 ft.) in length, with each loop about 1.5 -2.4m (5 - 8 ft.) in diameter. Traffic cone spaced 2.1 -2.4 m (7 - 8 ft.) apart are useful as guides during "figure-eighting". Smaller "figure-eights" may be used for low-fiber count MIC cables.

5.9 When "figure-eighting" long lengths of cable, relieve pressure on the cable at the crossover of the eight by placing cardboard shims at the crossover (Figure 5) or by forming a second "figure-eight." (Figure 6).

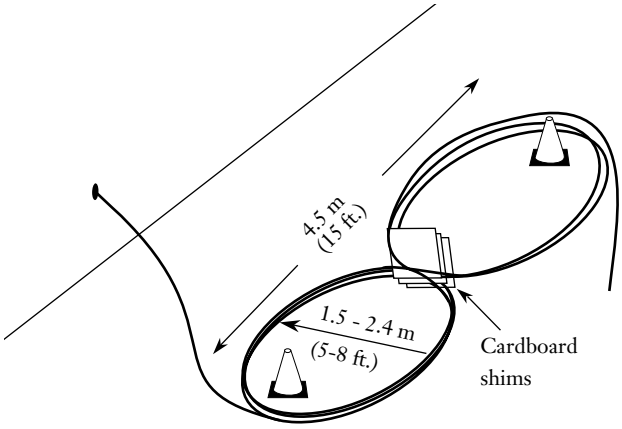


Figure 5

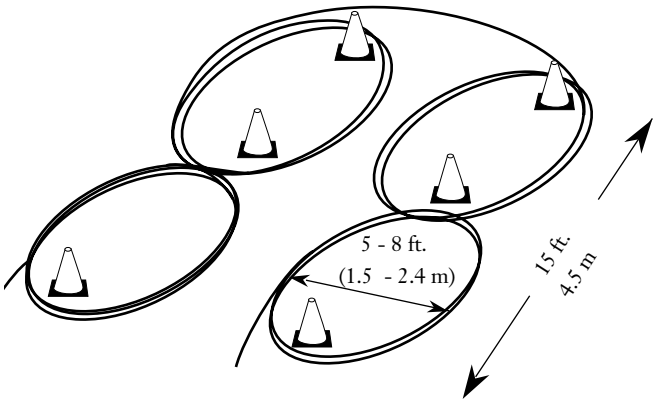


Figure 6

5.10 If a "figure-eight" must be flipped over to reach the cable pulling eye, do so with three installers, one at each end and one in the center .The cable can then be pulled off the "figure-eight" the remaining distance.

Installation of Preconnectorized Cable Assemblies

5.11 Corning Cable Systems can preconnectorize cables with connectors (e.g.,ST-compatible, FC, SC, etc.) at the factory prior to shipment. Connectors can be installed at one or both ends.

For instructions for pulling Corning Cable Systems 6-72 fiber preconnectorized cables supplied with factory-installed Plug and Play pulling grips, see SRP-004-059, *Installation Instructions for Corning Cable Systems Pre-Connectorized (6-72 Fiber) Fiber Optic Cables Equipped with Plug and Play™ Pulling Grips.*

5.12 When placing a connectorized Zipcord or single fiber cable, take care to protect the fiber optic connectors. *Never use a connector to pull a cable into place – any tensile load on the jumper or pigtail must be isolated to the cable (Figure 7).*

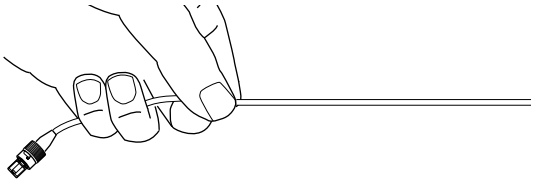


Figure 7

5.13 The installation of a preconnectorized cable can be easily accomplished by setting up at one of the termination points and by placing or pulling the unterminated end through the conduit or raceway. Care must be taken not to damage the connectors.

5.14 Normally, it is most economical to set up near the pre-mounted electronic equipment racks or fiber optic termination hardware and pull the unterminated end back to the vault where transition splicing will occur. This method will reduce the set up time required to terminate the cables.

5.15 Leave the connectorized end of the cable under its protective wrap on the reel until after the cable has been pulled into place.

5.16 The installation of a cable which is preconnectorized on both end requires special raceway considerations and pulling grips. A typical fiber optic connector is 1.25 cm (0.5 in.) in diameter, has a pull-off rating of 13.6 kg (30 lb.) or less, and must be protected during cable placement. A pulling grip for a preconnectorized cable must successfully isolate the connectors from any tensile load by placing the load on the cable itself. The pulling grip must also protect the connectors from abrasion and damage.

5.17 In medium fiber counts (6 to 24 fibers) the connectors must be staggered when installed to reduce the diameter of the pulling grip. In high-fiber counts (greater than 24 fibers), installation of a connectorized cable may not be possible due to the conduit size that would be required.

Contact Corning Cable Systems prior to planning a pre-terminated installation for additional guidance, recommendations, and pulling grip developments.

5.18 Always follow the instructions provided with the connector assemblies or connectors you are installing. Keep all connectors clean, and carefully mate them according to their manufacturer's instructions. For a summary of connector care, see SRP-006-056, *Corning Cable Systems Fiber Optic Connectors – Use, Care, and Maintenance.*

6. Planning and Preparation

6.1 Prior to placing fiber optic cable inside a building:

- Conduct a survey of the cable route.
- Inspect pull boxes
- Verify conduit assignments.
- Identify potential problems with conduit, pull boxes and cable placement.

6.2 Rodding or slugging may be required to verify conduit suitability and accurate length. *Cable cut length is especially critical when installing factory-connectorized cables.*

6.3 Inspect locations in which cables will be spliced or terminated and make plans for hardware and cable slack storage (if required). Plan to leave enough cable slack at the termination points to allow the cable to be routed through the termination hardware to a polishing / splicing table, plus an additional 3 meters (9.75 ft).

6.4 Carefully choose racking space for storing cable slack so that it will provide maximum protection for the cable and maintain the cable's minimum bend radius. Slack must also be considered for any additional moves or equipment racks or hardware, and for future repair purposes.

6.5 Make plans on how to protect the cable in areas of high potential damage such as:

- Within raceway transitions.
- Along walls or baseboards.
- Around sharp bends or angles.
- Congested false ceilings and floors.

6.6 Cable should be protected from any future cables being pulled in over them. Many of these precautions can be accomplished by using innerduct for added protection.

6.7 Develop a cable placement plan based upon the cable route survey and available equipment / manpower resources. Good plans:

- Allow for minimum unreeling and "figure-eighting" of the cable
- Use the advantage of gravity (work from the top-down).
- Minimize interference with the customer's activities through installer / customer coordination.

6.8 Most intrabuilding cable placement can be done by hand. If you do use a cable puller, make sure that recommended pulling tension of the cable is not exceeded. Do not pull pre-connectorized cable through junction boxes, especially elbow's (90° conduit fittings), unless precautions are taken to maintain the long term minimum bend radius.

6.9 Corning Cable Systems does not recommend the use of tight-buffered cables outdoors. Tight-buffered cables do not provide adequate protection against water penetration and ultraviolet (UV) light Corning Cable Systems recommends FREEDM cable for indoor/outdoor applications

7. Installation Considerations

7.1 Fiber optic cable can be installed inside buildings using the same methods as coax or twisted pair; how-ever, the following guidelines should be observed:

- *Do not deform the cable sheath*, specifically when using cable fasteners or ties to secure the cable to a support or hardware (Figure 8).

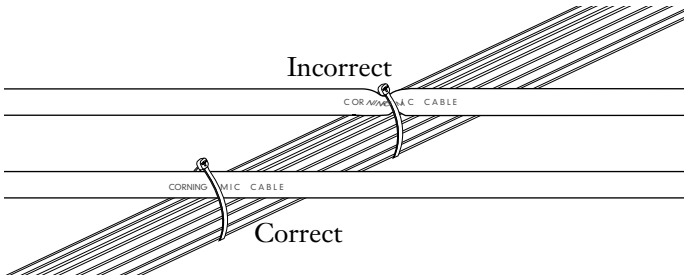


Figure 8

- Do not exceed the cable's maximum pulling tension.
- Do not pull fiber optic cables with copper cables.
- In multiple cable pulls, pull cables of the same weight and design.

  Do not exceed the maximum pulling tension of the lowest-rated cable in a multiple cable pull.
- Do not pull fiber optic cables over existing cables. The friction could be excessive and cause cable damage. The cables may also become entangled, resulting in damage to the fiber optic cable.
- Do not exceed minimum (installed and long-term) bend radius.
- The minimum bend radius varies with the cable diameter. Consult the appropriate Corning Cable Systems cable specification sheet for the minimum bend radius "loaded" (during installation) and "installed" (after installation) of the cable you are installing.
- Do not pull the cable around sharp corners, such as support brackets.

- Provide additional crush / mechanical protection in high risk environments.
- Observe all governing building and fire codes (either by using a properly listed cable or suitable raceway).
- Secure the cable to larger permanent cables or available supports when possible. Do not attach the cable to cables that may be removed later or to steam or water lines.
- Protect connectors when installing preconnectorized cable.

Caution: *Installation tension exerted on some low-fiber count (six fibers or less) tight-buffered cables may cause the buffered fibers to assume a sinusoidal "wave" appearance. This effect is caused by installing the cable incorrectly. Corning Cable Systems recommends that all tight-buffered cable pulls employ a grip on the pull end of the cable coupled to the aramid strength member, not the cable jacket.*

Pulling grips and lubricants should be used regardless of the length or duration of the pull. If the pulling end of the cable has not been preconnectorized, then a knot can be tied in the pull-end of the cable before attempting the pull. The knot will help couple the cable components together. If cables are pulled without coupling to the strength member, the cable jacket will stretch. When the jacket relaxes, it may bunch up the fibers underneath the jacket, which may result in degraded fiber performance.

Pulling the cable in unlubricated conduit may also cause additional damage to the cable..

Pulling Grips and Swivels

7.2 A factory- or field-installed pulling grip is necessary to secure the pull line to the strength members of the cable. Pulling grips for preconnectorized cables are typically factory installed.

7.3 Corning Cable Systems recommends the use of a woven-wire type of grip for field installation (Figure 9). Refer to the appropriate SRP for specific field-installation procedures, e.g.:

- SRP-005-003, *Installing a Wire Mesh Pulling Grip on Corning Cable Systems Mini Bundle® Loose Tube Fiber Optic Cable*
- SRP-005-024, *Installing Pulling Grips on Corning Cable Systems Multifiber Tight Buffered Cables*
- SRP-005-031, *Installing a Wire Mesh Pulling Grip on Corning Cable Systems Mini Bundle® Riser Fiber Optic Cable*

Figure 9

7.4 Use a ball bearing swivel to prevent the pull line from imparting a twist to the cable as it is pulled through the conduit (see Figure 10).

Lubricants

7.5 The use of lubricants is recommended for all cable pulls, regardless of length or duration of pull, as a means of reducing friction.

7.6 Considerations in choosing a lubricant are drying time, temperature performance, and handling characteristics.

7.7 Due to compatibility issues between the outer sheath material of the cable and the pulling lubricant, Corning Cable Systems recommends the use of pulling lubricants manufactured with water-based polymer materials.

Caution: *Never use detergent-based lubricants when installing loose tube fiber optic cable. Most detergents will promote stress cracks when used on polyethylene. Check the lubricant manufacturer's specification sheet to verify that the lubricant you intend to use is approved for use with PE or PVC sheathes.*

7.8 Apply lubricants according to the manufacturer's recommendations. Distribute lubricant throughout the innerduct by pulling a swab in front of the cable (Figure 10), or use a pump or gravity feed device to inject lubricant into the conduit (Figure 11).

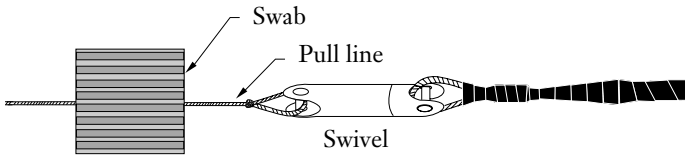


Figure 10

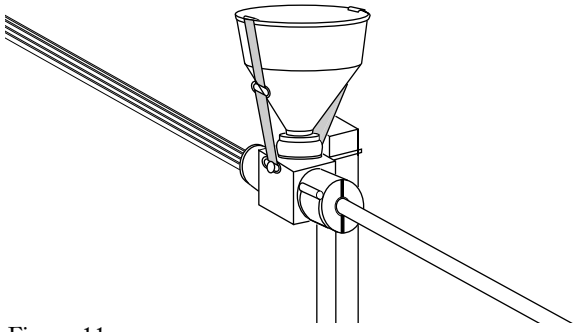


Figure 11

7.9 Inject or apply additional lubricant before bends and known severe offsets and sections with “uphill” elevation changes.

Conduit / Innerduct

7.10 Use the following guidelines when installing cable in a rigid conduit raceway system :

- Ensure the conduit system does not exceed minimum bend radius.
- Do not pull the cable through pull boxes or junction boxes unless the cable's bend radius can be maintained through the use of conduit or innerduct (Figure 12).

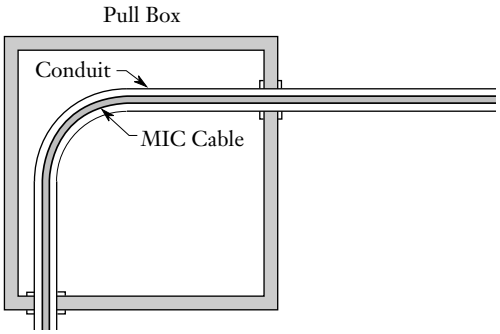


Figure 12

- Avoid the use of elbows, if possible, and use an elbow only if the cable's long-term bend radius can be maintained. Never pull cable "through" an elbow (Figure 13 a). Pull the cable out of the elbow, and “back-feed” it into the conduit exiting the elbow for a second pull (Figure 13 b).

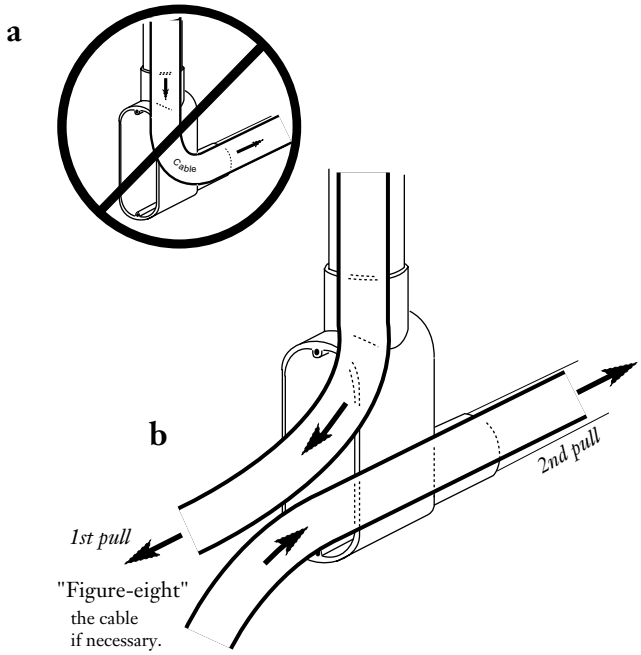


Figure 13

7.11 Innerduct is semi-rigid plastic tubing commonly used in fiber optic installations to subdivide the duct and to provide for future cable pulls. Three 1.25 inch I.D. innerducts can usually be pulled into a 4 inch duct. Proper size and installation of the innerduct is critical for ease of cable installation.

7.12 Innerduct is available in ribbed, corrugated, and smooth-walled constructions of polyethylene or PVC material (Figure 14). Corning Cable Systems fiber optic cable is compatible with all major brands of innerduct. Consult your company’s practices for innerduct specifications.

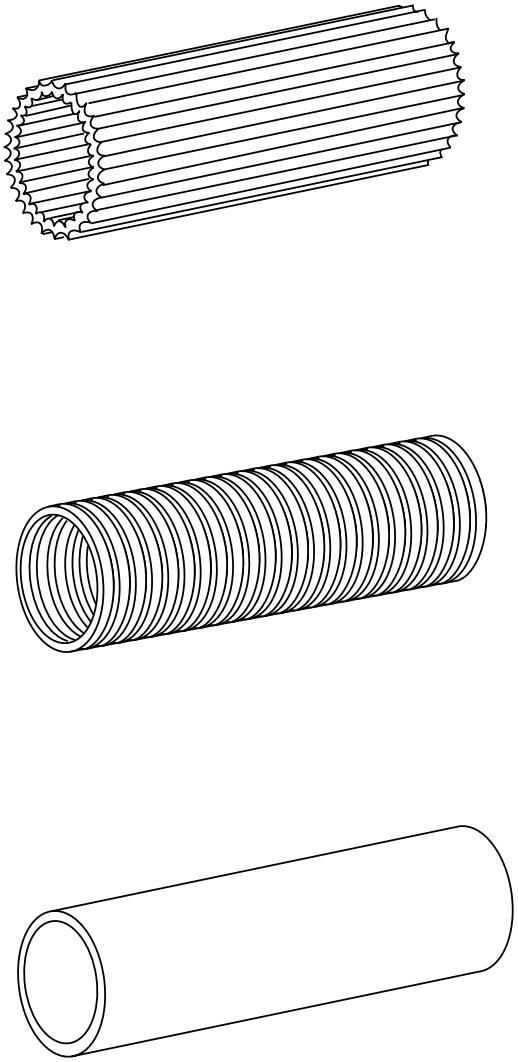


Figure 14

7.13 When placing fiber optic cable in an innerduct or conduit, do not exceed the “fill ratio.” Fill ratios are calculated by comparing the area of the inner diameter cross section of the conduit/inner duct to the outer diameter cross-section area of the fiber optic cable.

Use the following table for fill ratio guidelines:

# of cables	Fill Ratio
1	50%
2	33%
> 2	40%

7.14 Using the 50% fill ration, fiber optic cables with an outside diameter of 0.71 inch or less can be pulled into a 1 inch l.D. innerduct; cables with an outer diameter of 1.4 inches or less can be pulled into a 2 inch I.D.innerduct.

7.15 Multiple cables may be pulled simultaneously into one innerduct. For non-armored cable, pulling a new cable over an existing one is not recommended due to the possibility of entanglement.

7.16 If additional cables, specifically larger, bulkier cables, are to be installed in the same conduit, install the fiber optic cable inside an innerduct for mechanical protection (Figure 15).

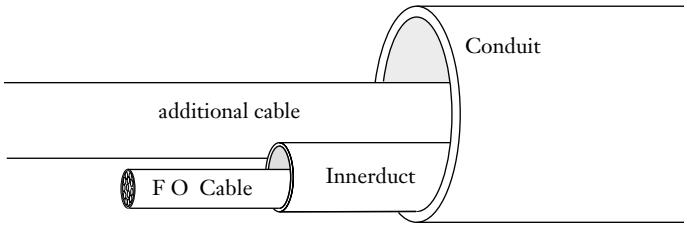


Figure 15

7.17 Eliminate sharp edges, such as entrance points into the conduit or pull boxes, through the use of bushings, box end connectors, or flexduct (Figure 16).

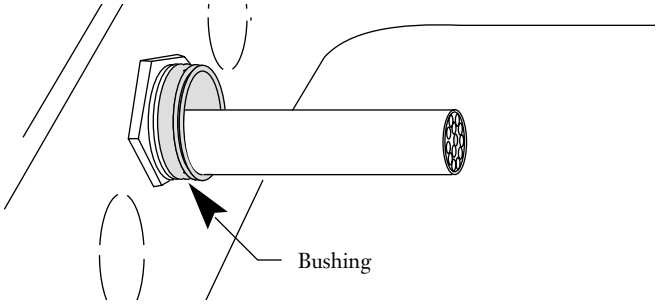


Figure 16

Pull-line

7.18 Various types of pull-line have been used successfully with fiber optic cable. Pull-lines can be of either a round or flat cross section. Selection of a pull-line will depend upon the length and conditions of the pull. Small diameter pull-line may have tendency to cut innerduct when under tension.

7.19 Available pull-line materials include wire rope, polypropylene, and aramid yarn. For pulls using winches, materials with low elasticity such as wire rope and aramid yarn can minimize surge-induced fluctuation in pull-line tension. Consult your company's standard practices with regards to pull-line materials.

7.20 Some inner duct is available with pre-installed pull tape or line. Otherwise, pull-line can be installed by rodding or blowing. Lubrication of the pull-line may be necessary for ease of installation or to prevent the line from cutting the innerduct.

Tension Monitoring Equipment

7.21 Fiber optic cable is subject to damage if the cable's specified maximum tensile force is exceeded. Except for short runs or hand pulls, tension must be monitored. Maximum pulling tension varies with the cable fiber count. Refer to cable specification sheets for maximum tension.

7.22 The use of a winch with a calibrated maximum tension is an acceptable procedure. The control device on such winches can be hydraulic or in the form of a slip clutch. Such winches should be calibrated frequently.

7.23 The use of a breakaway link (swivel) can be used to ensure that the maximum tension of the cable is not exceeded. Breakaway links react to tension at the pulling eye and should be used as a fail-safe rather than a primary means of monitoring tension.

Pulling Equipment

7.24 A dynamometer or in-line tensiometer may also be used to monitor tension in the pull-line near the winch. This device must be visible to the winch operator or used to control the winch. Special winches are available that monitor the tension remotely at the pulling eye via a wire in the pull-line. Such winches may also provide a record of the tension during pulls.

7.25 All pulling equipment and hardware which will contact the cable during installation must maintain the cable's minimum bend radius. Such equipment includes sheaves, capstans, bending shoes, and quadrant blocks designed for use with fiber optic cable.

Vertical Runs

7.26 Use the following guidelines when installing cable in vertical runs (Figure 17):

- Work from the top down, when possible.
- Install a split wire mesh support grip at the top of each run prior to entering termination hardware or horizontal distribution.
- Each fiber optic cable in the vertical run needs to be supported by its own support grip at the top of the run.
- Never use fiber optic cables as support for other cables.
- Cable that are individually supported may be taped or cable-tied together every 3 meters (10 ft.) for cable management – not support.
- Install additional support grips wherever additional security is desired
- Securing the cable to the riser shaft with a split-grip every 6 meters (20 ft.) is recommended in order to keep the cable in its desired location.
- Secure the cable in riser wiring closets with cable ties or straps as needed to prevent accidental damage to cable.
- Ensure that the governing fire codes are maintained through the use of non-combustible tubing or fire stops at each floor.

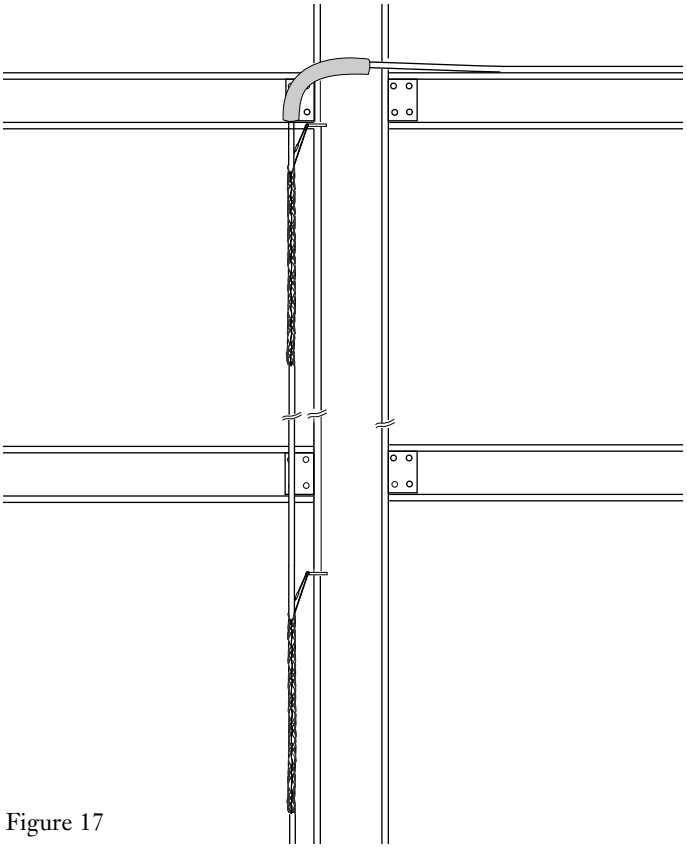


Figure 17

Cable Trays and Ladder Racks

7.27 Use the following guidelines when installing cable in cable trays or ladder racks (Figure 18):

- Install the cable so as to minimize potential damage when additional cables are installed or retrieved.
- Route fiber optic cable on the outside of the ladder rack if possible. Use flexible conduit throughout the installation if there is concern about crushing from later cable installations
- Use cable ties (Figure 18, **a**) to secure the cable to the cable tray or rack (or to larger, stationary cables when present), every 60 -90 cm (24 - 36 in.).

> ⚠ **Caution:** *Do NOT tighten the cable ties to the point they deform the shape of the cable (Figure 18, inset).*

- Maintain the fiber optic cable's minimum bend radius around corners through the use of flexible conduit or other supports (**b**).
- At raceway transitions, maintain the minimum bend radius and provide support and protection for the cable through the use of flexible conduit (**c**).
- When routing cable into equipment from the ceiling or a ladder rack, use flexible conduit to maintain the cable's minimum bend radius (**d**).

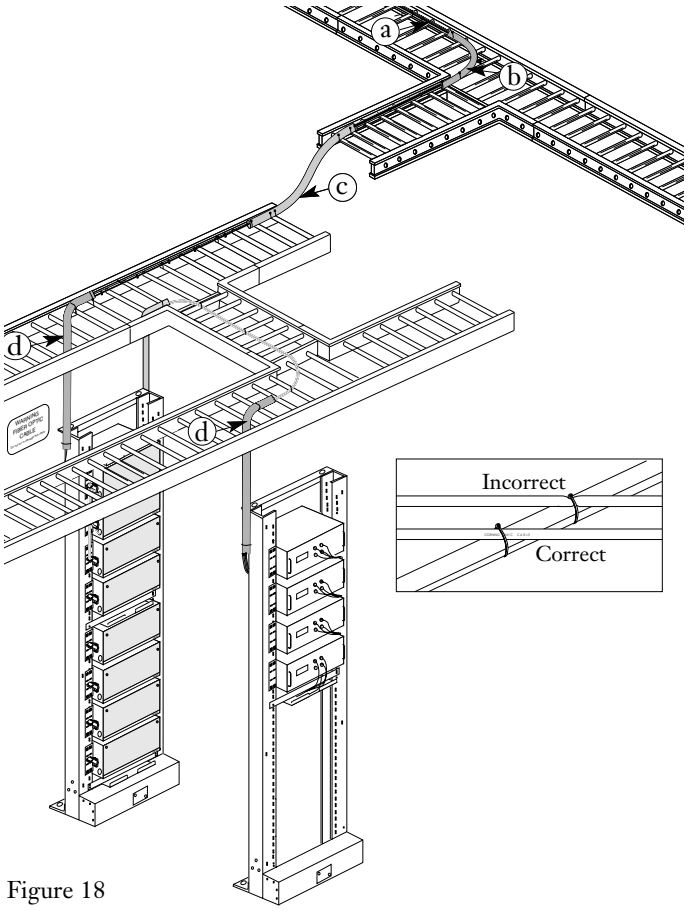


Figure 18

Raised Floors and Suspended Ceilings

7.28 When installing fiber optic cables under raised floors floors or above suspended (false) ceilings), observe the following guidelines:

- Use flexible conduit for additional crush/mechanical protection in areas of high potential damage, such as congested, highly used computer room false floors (Figure 19).

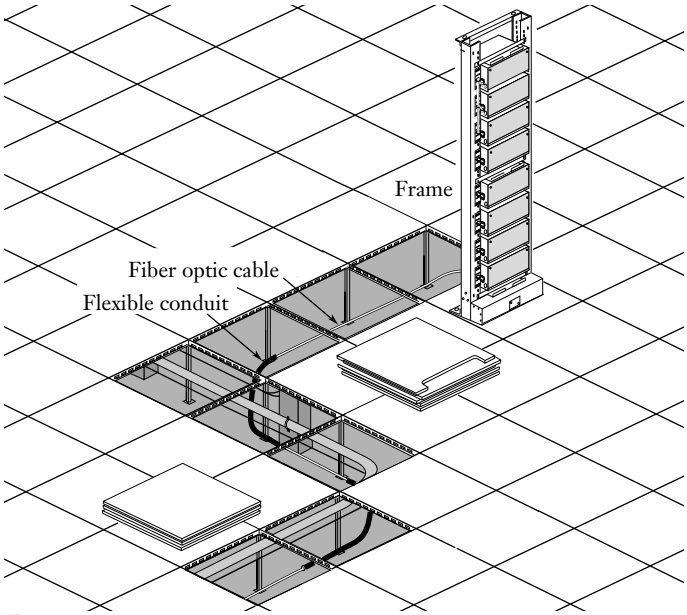


Figure 19

- Secure the cable to available supports or larger cables when possible.
- When entering or exiting a raised floor or suspended ceiling, ensure that the fiber optic cable's minimum bend radius is maintained. Use of flexible conduit is recommended (Figure 20).

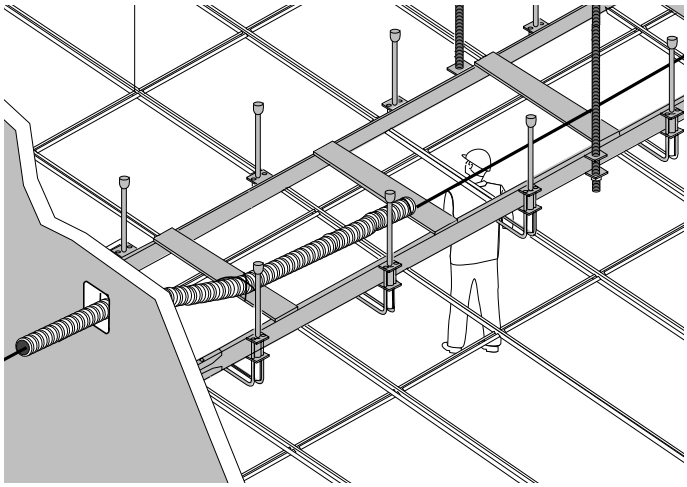


Figure 20

Connector Termination / Splice Points

7.29 Use the following guidelines when installing cable at connector termination and splice points (Figure 21):

- Position the termination hardware to allow its convenient use, convenient installation of the cable and its connectors, and routing to future hardware.
- When routing cable to the termination hardware, splicing hardware, or end equipment, maintain the minimum bend radius in the transition from the floor or ceiling to the unit with flexible conduit and a box end connector.
- When routing the cable along walls to the termination hardware or end equipment, protect the exposed cable with flexible conduit, rigid conduit, or wire duct to the entrance point of the termination hardware.
- Place fiber optic warning signs on all innerduct and conduits containing fiber optic cable. Warning signs can help prevent damage resulting from the cable being mistaken for something else.

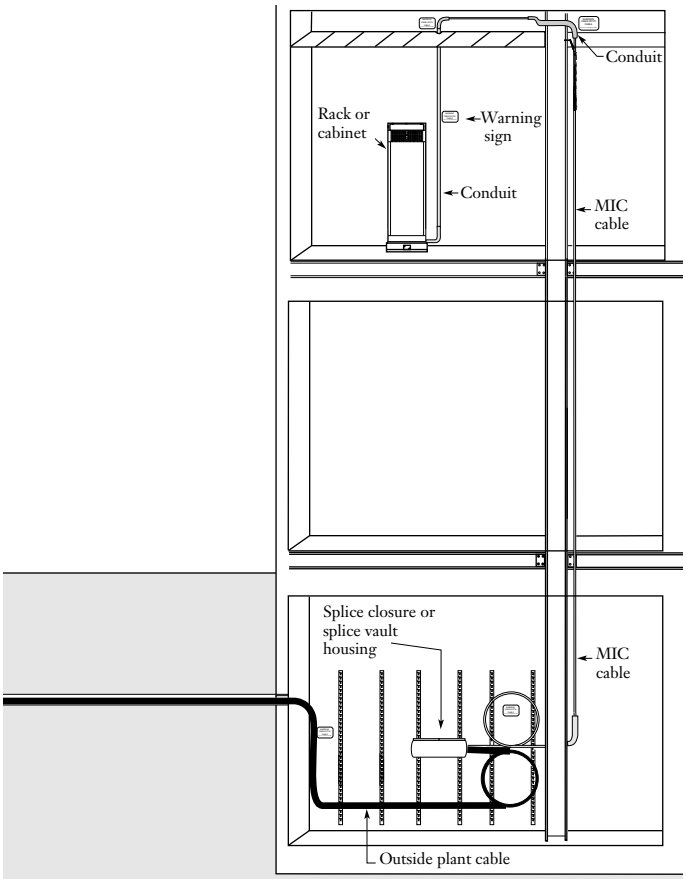


Figure 21

- Ensure that there is enough cable slack to be able to move the fiber fiber optic termination hardware to any potential place in the room.

- The amount of cable slack at the splice point or termination point should allow the cable to be routed to the splicing location with enough additional cable to reach a convenient location for the splicing work surface, plus an additional 3 meters (9.8 ft).
- Identify each jumper or pigtail with a number marker per your company's standard practice.
- Always follow the routing instructions provided with the termination hardware.
- Make sure that any protective grommets and/or edging provided with the termination hardware is properly installed before routing the cable (Figure 22).

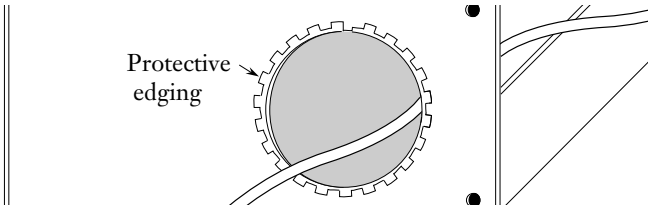


Figure 22

- If the hardware has split guides, use the rear set of guides to hold vertical jumper runs and the front set to hold horizontal jumper runs (Figure 23).

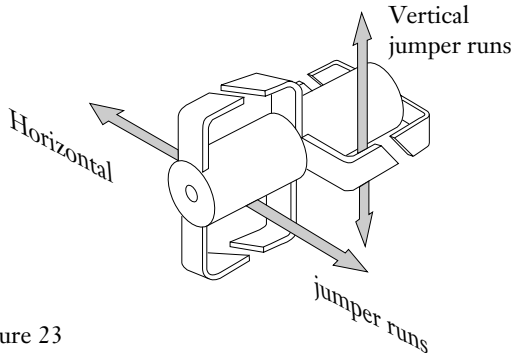


Figure 23

Caution: *Do not wrap a jumper completely around a split jumper guide. Doing so may violate the fiber's minimum bend radius, degrading its transmission characteristics. Always leave slack around routing guides.*

- Organize jumpers together with twist ties. If a group of jumpers are routed to the same location, secure them together about every 30 cm (12 in.) with electrical tape.
- In equipment racks, secure the cable to the frame with cable ties to prevent accidental snagging of the cable. Use of flexible conduit may be advisable in high activity areas.
- Secure the cable to the termination hardware according to the instructions provided with the hardware. Make sure that the loose tube cable's sheath, aramid yarn, and central member are all properly anchored to the hardware (Figure 24).

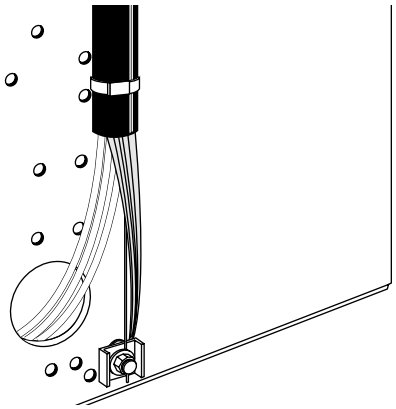


Figure 24

Special Note: Fiber Optic Training Program

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