CORNING

Indoor Installation of Corning Cable Systems Fiber Optic Cable

p/n 005-014, Issue 11

1. SAFETY PRECAUTIONS

CAUTION: 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 general public.

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.

Laser Precautions

WARNING: Never look directly into the end of a fiber that may be carrying laser light. Laser light can be invisible and can damage your eyes. 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. Should accidental eye exposure to laser light be suspected, arrange for an eye examination immediately.

2. 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.

2.1. 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.

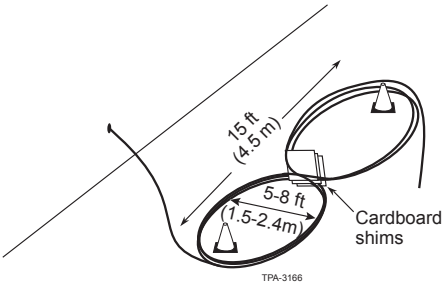
2.2. Determine if your company requires that the cable be tested for optical continuity prior to installation. This test can be done with an Optical Time Domain Reflectometer (OTDR).

2.3. 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.

2.4. 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.

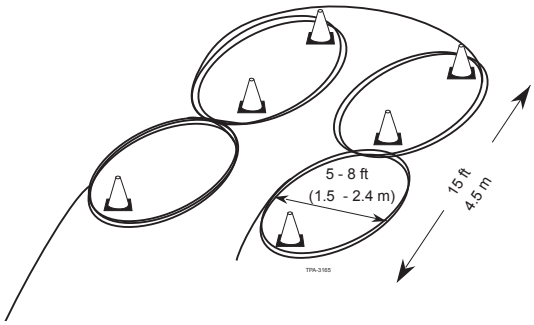
⚠	**WARNING:** Automated Figure-eight machines that coil fiber optic cable on a drum may exceed cable design limits by exceeding torsion, tension, and bend radii limitations. Do not use automated Figure-eight machines when installing fiber optic cables with a central tube design or any loose tube cable having one or more layers of corrugated steel armor. Use of these machines may result in the cable's jacket being breached and the armor being exposed.

2.5. 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 100 ft (30 m) or less.



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

2.7. When figure-eighting long lengths of cable, relieve pressure on the cable by placing cardboard shims at the crossover of the eight or by forming a second figure-eight. Potential problems should be identified and resolved if possible.

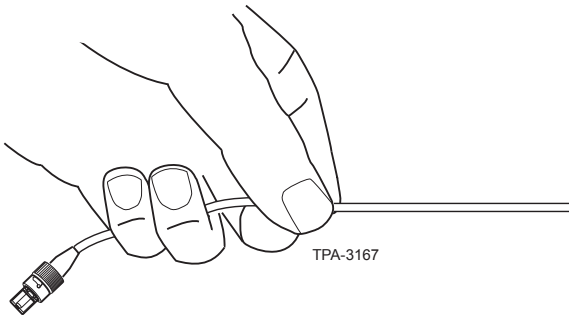


2.8. If a figure-eight must be flipped over to reach the cable pulling eye, do so with three installers, one at each end and one in the center. The cable can then be pulled off the figure-eight the remaining distance.

2.9. 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.

Installation of Preconnectorized Cable Assemblies

2.10. 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.



2.11. 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.

2.12. 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.

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

2.14. The installation of a cable which is preconnectorized on both ends requires special raceway considerations and pulling grips. A typical fiber optic connector is 0.5 in (1.25 cm) in diameter, has a pull-off rating of 15 lb (6.8 kg) or less, and must be protected during cable installation. 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.

2.15. 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.

3. PLANNING AND PREPARATION

3.1. Prior to installing 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.

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

3.3. 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 termination / splicing table, plus an additional 9.75 ft (3 meters).

3.4. Carefully choose rack 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 of equipment racks or hardware, and for future repair purposes.

3.5. 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.

3.6. 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.

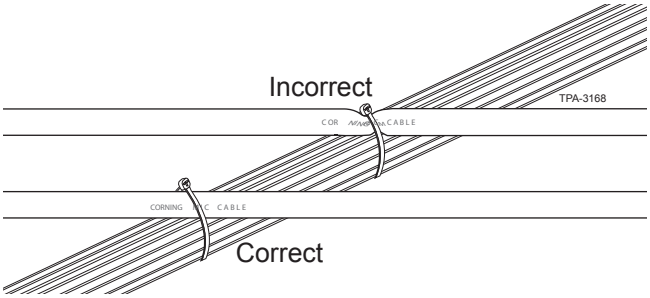
3.7. Develop a cable installation plan based upon the cable route survey and available equipment / manpower resources. Good plans:

- 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.

3.8. Most indoor cable installation 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-degrees conduit fittings), unless precautions are taken to maintain the long term minimum bend radius.

4. INSTALLATION CONSIDERATIONS

4.1. Fiber optic cable can be installed inside buildings using the same methods as coax or twisted pair cable; however, the following guidelines should be observed:



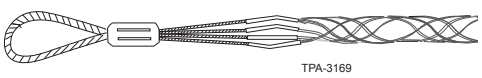
- Do not deform the cable sheath, specifically when using cable fasteners or ties to secure the cable to a support or hardware.
- Do not exceed the cable's maximum pulling tension.
- Do not pull fiber optic cables with copper cables.
- In multiple cable pulls, pull cables of the same weight and design. 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 ("loaded", during installation and "installed", after installation) bend radius.
- 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 "wave" appearance. This effect is caused by installing the cable incorrectly. Corning Cable Systems recommends following the procedure in SRP 004-137 to install pulling grips correctly. 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..

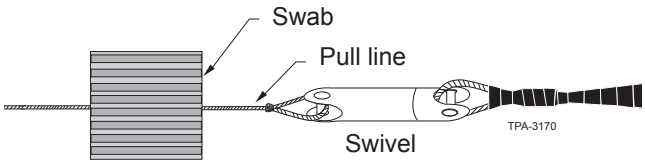
Pulling Grips and Swivels

4.2. 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.

4.3. Corning Cable Systems recommends following the procedure in SRP 004-137 to install pulling grips correctly.



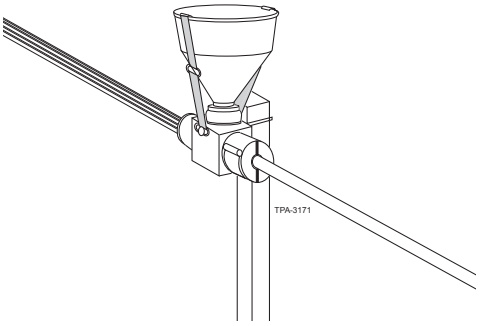
4.4. Use a ball bearing swivel to prevent the pull-line from imparting a twist to the cable as it is pulled through the conduit.



Lubricants

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

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



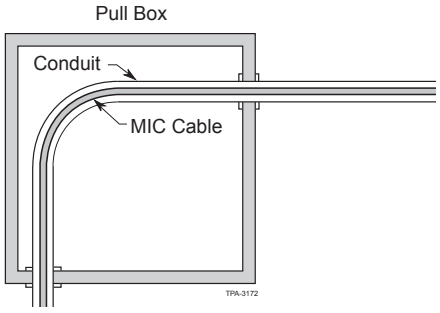
4.7. Due to compatibility issues between the outer sheath material of the cable and the pulling lubricant, Corning Cable Systems recommends the use of pulling lubricants manufactured with water-based polymer materials.

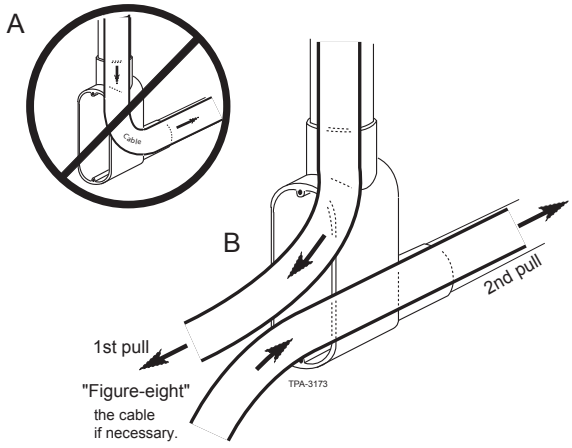
4.8. Inject or apply additional lubricant before bends and known severe offsets and sections with “uphill” elevation changes.

Conduit / Innerduct

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

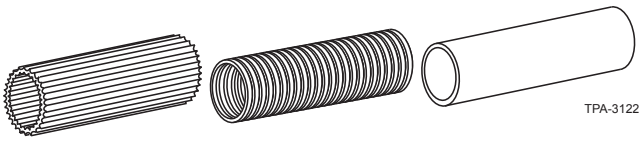
- Ensure the conduit system does not exceed the minimum bend radius.
- Do not pull the cable through pull boxes or junction boxes unless the cable’s bend radius can be maintained through the use of conduit or innerduct.
- Avoid the use of elbows, if possible, and use an elbow only if the cable’s long-term bend radius can be maintained. Never pull cable “through” an elbow (A). Pull the cable out of the elbow, and “back-feed” it into the conduit exiting the elbow for a second pull (B).





4.10. 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 inside diameter (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.

4.11. Innerduct is available in ribbed, corrugated, and smooth-walled constructions of polyethylene or PVC material as well as fabric. Corning Cable Systems fiber optic cable is compatible with all major brands of innerduct. Consult your company's practices for innerduct specifications.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4.12. Fill ratios are calculated by comparing the area of an inner diameter cross-section of the innerduct to the outer diameter cross-section area of the fiber optic cable. Larger diameter innerducts (which result in smaller fill ratios) will normally reduce pulling tension.

To calculate a fill ratio, use the following formulas from the chart. For a quick calculator, see www.corning.com/cablesystems/fillratio

Formulas Used to Calculate Fill Ratio

First Cable	Second Cable	Third Cable
$\frac{d^2}{D^2} < 65\%$	$\frac{d_1^2 + d_2^2}{D^2} \leq 31\%$	$\frac{d_1^2 + d_2^2 + d_3^2}{D^2} \leq 40\%$

Legend

d = Cable Diameter
d_1 = First Cable Diameter
d_2 = Second Cable Diameter
d_3 = Third Cable Diameter
D = Innerduct Diameter

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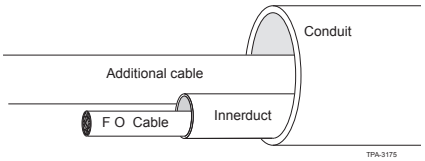
4.13. Multiple cables may be pulled simultaneously into one innerduct. Pulling a new cable over an existing one is not recommended due to the possibility of entanglement.



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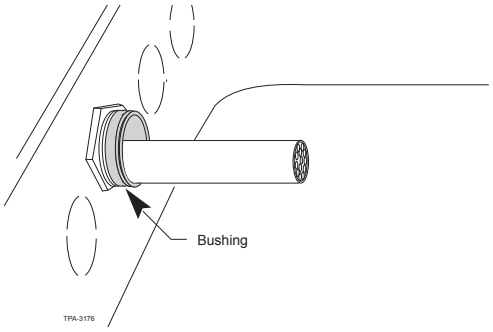
4.14. If additional cables, specifically larger, bulkier cables, are to be installed in the same conduit, install the fiber optic cable inside an innerduct for mechanical protection.

4.15. Eliminate sharp edges, such as entrance points into the conduit or pull boxes, through the use of bushings, box end connectors, or flexduct.



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Pull-line

4.16. 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.

4.17. 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

4.18. 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.

4.19. 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.

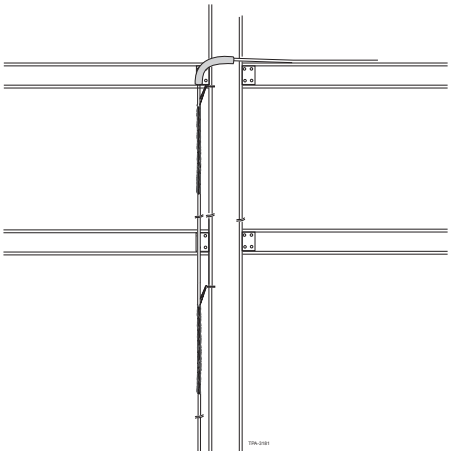
4.20. A dynamometer or in-line tensiometer may also be used to monitor tension in the pull-line near the winch. This device must be visible to the winch operator or used to control the winch. Special winches are available that monitor the tension remotely at the pulling eye via a wire in the pull-line.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

4.21. 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

4.22. 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



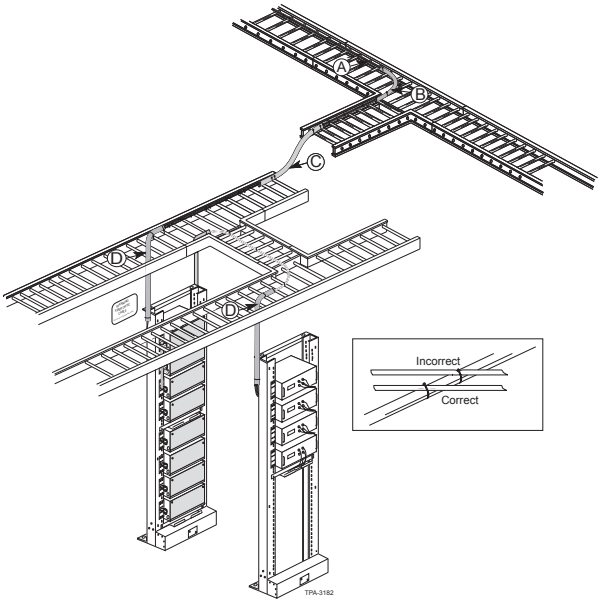
4.23. Use the following guidelines when installing cable in vertical runs:

- 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.
- Cables that are individually supported may be taped or loosely cable tied together every 20 ft (6 m) for cable management – not support.
- Install additional support grips wherever additional security is desired.
- Securing the cable to the riser shaft with a cable tie every 20 ft (6 m) 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.

Cable Trays and Ladder Racks

4.24. Use the following guidelines when installing cable in cable trays or ladder racks:

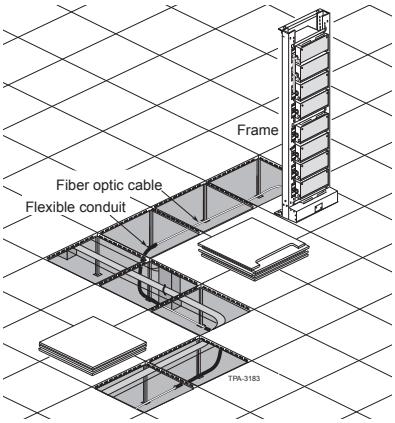
- Install the cable so as to minimize potential damage when additional cables are installed or retrieved.
- Route fiber optic cable on the outside of the ladder rack if possible. Use flexible conduit throughout the installation if there is concern about crushing from later cable installations
- Use cable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



⚠	**CAUTION:** Do NOT tighten the cable ties to the point they deform the shape of the cable.

- 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).



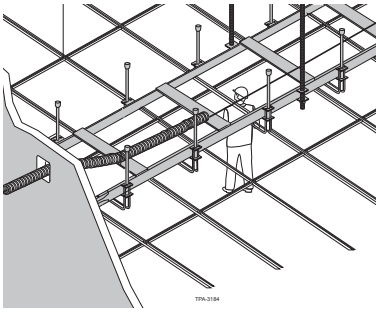
Raised Floors and Suspended Ceilings

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

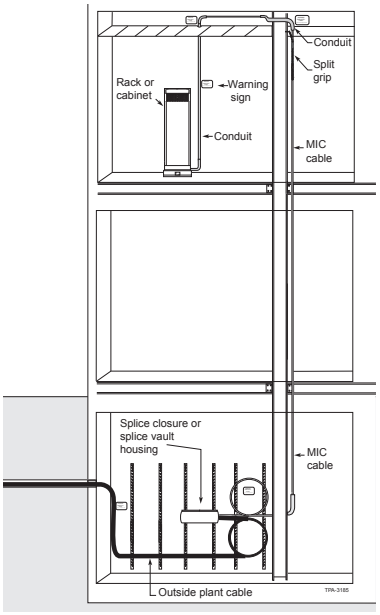
- Use flexible conduit for additional crush/mechanical protection in areas of high potential damage, such as congested, highly used computer room raised floors.
- Secure the cable to available supports or larger cables when possible.
- When entering or exiting a raised floor or suspended ceiling, ensure that the fiber optic cable's minimum bend radius is maintained. Use of flexible conduit is recommended.

Connector Termination / Splice Points

4.26. Use the following guidelines when installing cable at connector termination and splice points:



- 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.
- Ensure that there is enough cable slack to be able to move the 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 9.8 ft (3 m).



- 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.

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