



Guidelines for Installation of Fiber Optic Cables

Scope

The intent of the document is to provide installation guidelines for NextGen fiber optic cables to assure proper optical and mechanical performance and long cable life.

- ◆ Basic fiber and cable design
- ◆ Tight and loose buffered cables
- ◆ Intrabuilding and interbuilding installations
- ◆ Handling procedures and jacket removal

FIBER OPTIC CABLE CONSTRUCTION

Before any detailed discussion on how to handle optical fiber cable, some brief discussion of fiber and cable design is required. Eliminating confusion between the different terms, and providing an understanding of the cable construction will make handling the products less complicated.

Fiber

The cable cross-section in figure 1 demonstrates a two fiber cable for interconnect applications. The construction of the glass can be looked at separately from the design of the cable, as the fiber itself is constructed using distinct materials and is shipped by the fiber manufacturer as a finished product. NextGen takes the coated optical fiber and incorporates it into a multitude of finished cable products.

All of the glass fiber used by NextGen is manufactured using the same basic construction. Two layers of glass are covered by a protective coating. As demonstrated in figure 2, the fiber's core and cladding are both made of silica glass. It is these two layers that propagate the light signal and determine the performance of the fiber. A slight difference in optical characteristics between these layers keeps the signal within the core region. The glass is protected by a dual layer of ultra-violet-cured acrylate material. The coating protects the surface of the glass from abrasion during normal routine handling, thereby ensuring the glass maintains its high tensile strength. The acrylate coating, which also functions optically by stripping out any light which might enter the cladding region, is removed for termination and splicing.

Buffer Types

All of NextGen fiber optic cables fall into one of two categories: tight buffered or loose tube buffered. The two cable buffer styles exhibit different optical, mechanical, and cost characteristics. Originally, loose tube cable constructions were developed for long haul telephony applications which required a rugged, low cost, high fiber count outside plant cable solution. In a premises wiring plan this cable type is often used between buildings, although recent developments in cable design have produced loose tube cable for indoor/outdoor applications. The tight buffer cable construction was developed for both indoor and outdoor premises wiring applications. Most of NextGen's tight buffer cables are rugged enough for many interbuilding applications while offering the tight buffer design advantages of ease of terminations, meeting NEC flammability codes, and cable flexibility (figure 4).

Tight Buffered Fiber

A thermoplastic material is extruded directly over the acrylate coating, increasing the outside diameter of the fiber to 900 microns (0.9 mm), an industry standard. The tight buffer supplies the fiber with added mechanical and environmental protection, increased size for easy handling, and a simple means of adding color coding for fiber identification. During connectorization, the buffer is stripped back to an exact length as required by the connector manufacturer.

Loose Buffered Fiber

In loose tube cables, the coated fiber "floats" within a rugged, abrasion resistant, oversized tube which is filled with optical gel. Since the tube does not have direct contact with the fiber, any cable material expansion or contraction will not cause stress on the fiber. Much of the external stress placed on the tube also will not be transferred to the fiber. The non-hygroscopic gel prevents water from entering the tube. See figure 5 for a diagram of a multi-tube, gel-filled outside plant cable.

Strength Members

NextGen's optical fiber cable designs utilize aramid yarn as the primary strength member. Some designs also use a fiberglass central strength member. Both of these materials serve as the load bearing members of an optical fiber cable during installation. In many cables the aramid also acts as a strength member during termination. Figure 6 demonstrates a single fiber cable, where the tight buffered fiber is surrounded by aramid and coated with an overall jacket.

Core Wrap and Ripcords

Core wraps and ripcords are designed to make removal of the exterior cable sheath easier, preventing unnecessary stress to the core. The non-hygroscopic core wrap creates a barrier between the core and the jacket, preventing adhesion and facilitating jacket removal. Ripcords provide a means of stripping back the jacket without the use of invasive tools which could harm the cable core and damage fibers.

Outer Jacket

The true cable jacket is usually the outermost element in the cable design. It serves to protect the cable against environmental hazards and gives the installer a means of managing the cable. Without the outer jacket, in many designs the buffered fibers would have only the aramid wrap to cover them. Typical jacket materials include Polyvinylchloride (PVC), Polyethylene (PE) or Polyvinylidene Fluoride (PVDF). Also, without selectively choosing the appropriate jacket material most cables would be entirely incapable of passing a flame test. Outer jackets are always stripped back to expose the fibers at the point of termination or connectorization.

FIBER OPTIC CABLE SPECIFICATIONS

Tensile Strength

One of the goals in any optical fiber cable installation is to complete the installation with as little stress as possible to the fibers themselves. For this reason, all cables are provided with a carefully calculated tensile loading value which should never be surpassed. For optical fiber cables, the tensile strength is the value that represents the highest load that can be placed upon a cable before any damage occurs to the fibers or their optical characteristics. It is not the cable breaking strength but a realistic allowable limit. Most manufacturers will specify two load values, installation and long term.

The installation maximum load will be a higher value than the long-term load. The installation or short term load is the load the cable can withstand during the actual installation process. It includes additional stresses caused by pulling cable through, over or around stationary objects such as ducts, corners and conduits. Many installers will carefully meter the force with which they are pulling the cable throughout the installation to avoid accidentally pulling on it too hard. After the cable has been installed it will be subject to lower loads. This value is referred to as the installed, long term, static or operating load.

The tensile strength of the cable will depend upon the cable construction, and the application for which it is designed. For example, NextGen's outside plant cables are designed to be plowed directly into the ground and have an installation load rating of 600 lbs. Our duplex Interconnect Series cables which are typically used inside wiring closets have an installation load rating of 211 lbs. if you are ever concerned that you may be exceeding listed cable values or are not certain what they are, contact NextGen

Bend Radius

The minimum bend radius is the value determined by the cable manufacturer to be the smallest bend a cable can withstand. Bending the fiber beyond recommended limits could cause an increase in the fiber attenuation at those points. Sometimes straightening the cable out will improve performance, but the best policy is to not over-bend the cable. Like tensile strength, there are two values associated with bend radius, installation and long term.

The installation bend radius, again the higher value, is the amount of bending the cable can withstand while under the load of installation. After the cable has been installed and the stress of being pulled is removed, the cable may actually be bent to a smaller radius. These values will again depend on the size of the cable, its' construction and intended application. The outside plant cable mentioned earlier may have a minimum installation bend radius of 6.3" and long term bend radius of 4.2". The zipcord minimum bend radii are 1.8" and 1.2", for installation and long term, respectively.

There are several common handling mistakes that lead to cable bend radii being surpassed. One of the most frequent errors is pulling cable through conduit with too small of a bend radius. Similarly, cable must never be

over-bent going through trays, between tray sections, or when making transitions between locations. Cables should be “swept” to prevent sharp bends or corners (figure 7). Optical fiber cables are designed for extra flexibility in closets or work areas. Unfortunately, it is often tempting to bend the cables tightly over corners, to keep the cables closer to equipment. Bending cable over corners, sharp or not, can cause serious damage to the performance of the cable. Care must also be taken to prevent wrapping the cable tightly around itself to be stuffed behind walls at the user end. Cables should never be kinked or knotted.

Crush and Impact

Cable crush and impact are often listed but rarely understood details of optical fiber cables. They do, however, provide some legitimate guidelines for cable installation. EIA RS-455-41 (the Electronic Industries Association, Recommended Standard 455, Fiber Optic Test Procedure [FOTP] 41) lists the crush resistance requirements of optical fiber cables. The intent of this document is to provide a standard means of testing cables to ascertain how well they either withstand or recover from a slow crushing or compressive action. FOTP-41 details the entire test procedure which crushes a cable between two plates while measuring any optical power loss. The amount of attenuation allowed under a given compression can be specified by customer requirements. Most cables should meet the guidelines put out under Bellcore GR-409-CORE, “Generic Requirements for Premises Fiber Optic Cable”.

Impact testing is documented in EIA RS-455-25 (FOTP 25) with the intention of determining the ability of optical fiber cable to withstand repeated impact loads, as they might be forced to encounter during installation in exposed or open access areas. Cables may be tested simply for fiber breakage, or changes in optical transmission characteristics. Values of attenuation change per impact per number of cycles may come from Bellcore 409 or customer specifications.

Crush and impact are important not as laboratory guidelines but as they apply to real life installation situations. For example, according to Bellcore 409, an interconnect riser rated cable must withstand a compressive load of 200 N/cm with an average increase of attenuation of not more than 0.4 dB. This means that every centimeter (.3937”) of cable length can tolerate 200 newtons (44.9 lbs.) of pressure. That translates to 114 lbs. per inch tolerable pressure.

Optical fiber cables can be run in the same duct or tray as much heavier power cable. It is desirable to avoid placing excessive crushing forces on the fiber cables, however, by limiting the amount of “crossovers” (figure 8) or placing the heavier cables to the side or beneath the fiber cables. Consider the fact that a cable may be supported by ½” rungs in a runway or tray. If numerous heavy cables are placed on top of a fiber cable a force or pressure is exerted on the fiber cable, pressing it into the rung, causing potential damage at that point (figure 9). Moving or shifting already installed cables that have large weights on top of them greatly increases the chance of damaging the cables.

FIBER OPTIC CABLE INSTALLATIONS

Interbuilding/Outside Plant

Much of the truly long-haul optical fiber pulled is for trunk or telephony applications, and is installed by trained professionals using special and not inexpensive equipment. However, routine cable installations in many realms will see some amount of cable run outside. This can vary from the campus application with many long outdoors runs to a simple 50’ network segment connecting two buildings.

Direct Burial

Optical fiber cables can be manufactured in such a way as to be ideal for long haul buried applications. Loose tube designs make the cables particularly able to withstand certain stresses, while the gel filling prevents water migration. Specially selected jacket materials are abrasion and UV resistant. Outside plant cables have high tensile strengths to withstand environmental abuse and the pressures of direct burial installations. There are two basic methods of direct burial installation: trenching and plowing.

Trenching simply involves digging a hole, placing the cable in it, and refilling the hole. Trenches are often dug with backhoes and visually inspected for rocks or debris that could potentially damage the cable. This is not a quick process and is most effective for shorter distance applications. On most premises network installations if a trench is dug a conduit will be laid in the trench and the fiber optic cable will be pulled into the conduit. This tactic enables the end user the ability to pull additional cables between locations without trenching. Plowing involves the use of a cable-laying plow, designed to dig a ditch, place the cable in it and cover it. Capstan-assisted plow systems are available which feed the cable off the reel, reducing tensions. Plowing can be done quickly, as much as five miles of continuous cable can be installed a day. Plowing is less destructive to the soil than trenching and more useful for long-distance operations.

Cables directly buried in the ground should be placed deeply enough to provide adequate protection for the cable. This does seem obvious, but the depth for different cables may vary with their application, intended user and construction. It is usually beneficial to attempt to bury cable below the frost line for any given area.

Cables should be placed at a depth calculated to prevent damage from occurring, depending on the expense of the installation vs. the importance of the service provided. One of the major hazards a buried cable faces is the possibility of being dug up. A long haul trunk cable serving thousands of users should be placed as low as 42" under soil to prevent damage along its entire length. A small cable serving one residence may be placed as shallow as 12". It is usually desirable to place a marker tape over the cable but below the soil to warn future workers in the area that an optical fiber cable lies below (figure 10). Armored cables (cables with a thick metallic wrap) are available for areas where the cable will be directly buried and rodents are a problem.

Underground Conduit

The conduit used in outside plant applications is designed to provide extra protection for the cables, but can also offer certain installation advantages. Duct or conduit for underground burial is manufactured using rigid, very rugged, abrasion resistant material. In many cities the "underground plant" is a series of ducts placed under the streets, accessible by utility vaults (manholes, to be politically incorrect) or handholes. Installed conduit is advantageous because it offers a route for new cable installation or old cable removal without damage to streets, pavements, edifices, etc. Conduit should be placed (by the quality installer) with some sort of pull rope or tape already installed to ease future runs. Conduits are sometimes placed with direct burial cable in trenching operations, again for future use.

Innerduct or duct liner is slightly less sturdy plastic tubing designed to fit within larger conduits. Without providing the primary protection for the cable, innerduct serves several functions. Many manufacturers offer innerduct in diverse colors to assist in cable identification and maintenance. Innerduct affords a clean path for new cable installations: where cables are already placed in duct it is difficult and often impossible to pull new cable in the same duct. Cables can become snagged, rub together, and sometimes block the conduit when new cable is installed along with the old. Innerducts keep cables separate to prevent future installation cable damage (figure 11).

Duct and conduit are excellent for installing tight buffered cables such as NextGen's Heavy Duty or Premises Distribution Series cables between buildings. The benefit of these cables versus standard loose tube Outside Plant cables is their flexibility, riser and plenum flame ratings, and the ease of splicing or termination (figure 12). Conduit can also serve as rodent protection in these short interbuilding installations where splicing to armored cable is not a reasonable alternative. Conduits can economically be installed for applications where a second trenching or plowing operation would be impossible. Conduit may be placed under concrete banks, landscaping, farmland or private premises where it would be extremely undesirable to disturb the soil after some time has elapsed. Cables may be chosen, added and installed at a later time without disrupting the environment. When duct or conduit capacity may be perceived to be constricted, it may be advisable to run extra fibers in the cable to be installed to be prepared for prospective uses.

Aerial

The full details of aerial cable installations are too complicated for this discussion. But a few key points should provide some critical guidelines. Like direct burial installations, aerial installations will often be executed by utility companies with specialized equipment for long haul runs. However, many campus or industrial environments do see shorter links between buildings that may most efficiently be run aurally.

Although most optical fiber cables are intrinsically lightweight, they are subject to stresses caused by the environment they are installed in. Cables located in aerial runs can be affected by wind and ice, creating a situation that can cause the cable to stretch or sag, pulling on the fiber. Under most conditions aerial optical fiber cables should be supported by an external support member, suspension strand, or “messenger”. Strong “wires” made of steel are positioned and secured to utility poles along the desired route. The cable is then placed along the route under the messenger, lifted into place and lashed or tied to the messenger with a steel or dielectric thread. Lashing can be accomplished using standard lashers designed for this purpose. Lashing strands should be chosen in accordance with guides associated with the lashing tool. As a general rule, there should be at least one wrap of the lashing wire per foot.

Messenger wires are chosen by their tensile strength and size and the span distance per the requirements of each application. Charts for recommended messenger strands are readily available. Under certain conditions fiber cables can be “overlashed”, or tied onto existing lashed cable. Many variables have to be taken into account, and the inability to place a dedicated messenger must outweigh the benefits of a known system.

Intrabuilding

There are many variations in intrabuilding installations. Areas include risers, plenums, conduits, and an assortment of ducts, modular furniture pathways and wireways. One of the critical factors an installer or planner must be aware of when selecting cable is the rating of the cable that is required. The National Electric Code (NEC) states that cables entering a building for a distance of more than 50' must either be placed in flame resistant conduit, or meet an appropriate rating for the installation.

Plenum

A plenum is a space within a building designed for the movement of air associated with the environmental system, often used for air return. The plenum can be the space above a suspended ceiling (figure 13) or below an access floor. Since it is part of the air handling system, the NEC requires that cables installed in plenums meet strict guidelines defining smoke output and density as well as fire resistance. The plenum rating (Type OFNP for optical fiber cable) requires cables to pass the UL 910 or modified Steiner Tunnel flame test. Cables meeting lesser tests must never be placed in true plenum spaces.

Riser

A riser is a vertical pathway or space between floors. Cables within risers must be rated in order to prevent the spread of fire between floors. NEC Type OFNR cables pass the UL 1666 flame test. This test is not as stringent as the UL 910 test. Plenum cables can be placed in risers; riser rated cables must never be placed in plenums. Riser rated cables can be used in general purpose applications in place of cables with lower ratings.

INTRABUILDING: HORIZONTAL

Conduit Applications

Intrabuilding conduit runs can be in ceilings, walls or under floors, with certain limits, as conduit systems are very inflexible. Conduit systems should be used only when workstation outlet locations are absolutely permanent, no flexibility is required, and densities are low. In-floor conduits are often embedded in concrete making it particularly difficult to make adds, changes and moves. Conduit can be made of metallic tubing or rigid PVC according to the NEC.

Conduit runs should be limited to 100' with no more than two 90° bends between pull points or boxes. EIA/TIA-569, “Commercial Building Standard for Telecommunications Pathways and Spaces”, details many of the requirements for conduit installations and sizing, and the NEC lists appropriate conduit types. Pull boxes must be installed for several reasons: for fishing the run and looping the cable for the next length of conduit. Pull boxes are not used for splicing the cable. Fish tapes or pullcords should always be placed in the conduit to ease installation. Innerduct is an excellent tool for protecting cables and making future installations easier.

Dropped Ceiling and Raised Floor

Plenum or dropped ceiling/raised floor runs can sometimes be the easiest to install. Many dropped ceilings or raised floors have panels that are easily removed or opened to provide fast access to the area. Most new buildings have dropped ceilings, making this an extremely popular method of installing cables. Raised floors are usually found in computer rooms, although they can be used in many different conditions. When the area is used for environmental air handling, the cable must be plenum rated.

Suspended ceilings consist of low-weight panels supported by a system of metal frames or grids which are attached to the ceiling using struts or wires. Typically the panels are easily moved: when they are pushed up they are dislodged from the grid and may be pushed to the side. If there is not a great deal of equipment in the air space, there can be ample room to work. Although it is not particularly recommended, smaller cables can rest directly on the ceiling support grid. This is done at the discretion of the installer. Cables should be supported in some manner, ideally in organized, easy-maintenance trays, wireways or racks. At the very least cables can be supported by "J hooks" or bridle rings (picture 1).

Cable in Trays

Cable trays or "ladder racks" can often provide a convenient, safe, efficient method of optical fiber cable installation. Trays can be installed in ceilings, below floors and even in riser shafts. Some trays are designed to be aesthetically pleasing, to be placed BELOW the ceiling, in the line of vision, while still supporting a multitude of cables. Frequently the tray installation precedes the fiber cable installation, as trays can be used for many other cable types. This means that in many buildings a tray distribution system exists and if the plan can be followed the routes may be clear for the new cable installation.

Although the tray provides a sturdy support and basic protection for the cable, there are still stresses the cable will be subjected to. Optical fiber cable must always be run in trays in a way to avoid as much tension, crush, and over-bending as possible. Routes should be inspected for possible sharp turns, snags (sometimes from other cables), or rough surfaces. Effort should be made to run the fiber cable without pulling it under or between heavier cable or multiple cables that will create added forces on the fiber. The same holds true for moves and adds. It is desirable to secure the cable to the tray to avoid damage during future changes, at least every 3'.

All Pathways and Spaces

If the optical fiber cable is being installed in wireways, racks, ducts, or plenums, some basic guidelines hold true. Support the cable and avoid crushing, stressing and over-bending it. Every cable will have values attached for minimum bend radius and maximum tensile loading. In addition to metering cable pulling tension, added but simple installation efforts to support the cable and protect will greatly lengthen its working life.

Cables should never be allowed to hang freely for long distances or be allowed to press against edges in any installation. When pulling cable in conduit all transition points, such as going from conduit to a pull box or exiting the conduit, should be kept smooth. Sometimes adding a piece of conduit beyond the transition will keep the cable from resting on a sharp edge (picture 2). Bushings designed to fit the ends of conduit are also available. Flexible conduit can also be placed within boxes or at interfaces to prevent pressure against the cable or scraping on rough edges. Flexible conduit can also be added in areas open to frequent access, such as raised computer room floors, when there is a higher potential risk to the cable.

Complying with the cable's minimum bend radius cannot be overstressed. Many applications will automatically present conditions wherein the bend radius of the equipment or its configuration will damage the cable if precautions are not taken. Conduit bends, pull boxes and joints must be checked to verify that the radius is not too small. Innerduct or flexible conduit can be used to ease or sweep the cable around tight corners. The inside radius of conduit bends for fiber optic cable should be at least 10 times the inner diameter of the conduit. Pulls through tightly bent elbow fixtures should be back-fed: the cable is not pulled from end to end, but out of the opened junction, coiled loosely on the ground, and fed through the rest of the run (figure 14).

In tray and rack installations the minimum cable bend radius must also be monitored as the cable will be routed around corners or through transitions. Where raceway or rack transitions expose the cable flexible conduit should be used for protection.

INTRABUILDING

Vertical or Riser

The same critical observations must be made when installing cable in vertical shafts or risers. If the installation requires that the cable be rated for use in risers, use a cable rated Type OFNR, at a minimum. Cable bend radii and tensile loading can never be exceeded. Cables in vertical runs should be supported as well as possible, in a reasonable number of locations. Optical fiber cables intended for vertical applications have a calculated maximum vertical rise value assigned to them. The vertical rise is the distance the cable may be pulled (vertically) before being supported. It is determined by the weight of the cable and its ability to resist buckling or kinking. Split wire mesh grips (figure 15) work like basket or finger grips, supporting the cable without crushing the core. Cables should be supported by cable ties, straps or clamps in wiring closets to avoid damage. Whenever possible begin the installation from the top, allowing the weight of the cable to help the pull rather than adding more load.

FIBER OPTIC CABLE – HANDLING PROCEDURES

Pulling Cable

In many premises network cable installations the fiber optic cable is going a short enough distance, in a straight enough path, that it can be pulled in by hand without the use of special equipment. In any fiber optic cable it is imperative that the load be applied to the strength bearing members of the cable. Accomplishing this can be as simple as tying the cable in a knot at the pulling end for small Premises Distribution and Interconnect series cables. Failure to lock the cable components together can lead to elongation of the jacket material which when released will cause the optical fibers to pull back with the jacket and bunch up in the cable.

When additional mechanical force is required to pull a cable there are several relatively standard tools available to aid in the installation of fiber optic cable. External pulling grips (figure 16) are designed to lock into and tighten around a cable as a tensile load is applied to the grip. The mesh or basket grips operate on the same principle as the “Chinese Finger Trap”. The pulling end of the grip is a loop or eye for attachment of the pulling tape or rope.

When pulling NextGen Outside Plant cable with a pulling grip it is important to remove the outer jacket of the cable and attach the grip over the top of the aramid strength members surrounding the cable core in addition to the outer jacket. This can be accomplished by sliding the grip over the top of the cable jacket past the end of the cable. The cable jacket is then removed (the length of jacket removed depends on the length of the pulling grip), and a friction tape is applied over approximately three inches of the cable jacket and cable core. The grip is then positioned over the cable core and taped in place. This procedure ensures that the cable strength members are utilized during installation.

A swivel should be used when pulling to make sure a twist in the pulling tape or rope is not translated to the fiber optic cable. It is also important to monitor the tension being applied to the cable to be certain not to exceed the maximum specified cable installation load. Cutting a cable back 10 feet from the pulling end should eliminate any portion of the cable which might be damaged during installation.

Assuming the cable has been pulled and all of the restraints have been properly adhered to, the cable should not be ready for connectorization or termination. A reasonable amount of spare cable should be left at either end, and enough to reach the work area where the termination will take place. In some outside plant or factory-type environments the cable end may have to reach a special clean room or tent: this length must be considered when planning the cable link length. Before termination approximately ten feet of cable should be cut off, to remove any piece that may have suffered stress from the pulling tape or grip.

Jacket Removal

For any fiber count or cable type, some amount of the cable outer jacket will have to be removed to expose the fibers. For simplex or duplex cables whose jackets are designed to fit within the connector the length of jacket removed will be specified by the connector manufacturer. Typical values for outer jacket removal for these cables

is 1½ to 2". Multifiber cables will have longer lengths of the jacket removed. Outside plant cables that will be terminated in trays may have over two meters of jacket removed. Mark the cable with a piece of tape to show how far the jacket should be stripped (see photos).

- **Interconnect cables:** Simplex and duplex cable jackets are usually removed no more than a few inches from the point of termination and are easily taken off using standard buffer or jacket strippers. Round interconnect cable jackets can be removed using round cable slitters or other tools that will not damage the interior of the core.
- **Distribution cables:** Distribution cables are provided with ripcords to ease jacket removal. High fiber count, unitized cables have dual ripcords. For cables with ripcords only the first few inches of jacket need to be taken off with the assistance of tooling. Cable slitters or a "hook knife" can remove the first four inches to expose the ripcords. Grasp the cable end with one hand and pull both ripcords one at a time with the other hand (picture 3).
- **Heavy Duty break-out style cables:** All Heavy Duty cables contain dual ripcords for jacket stripping and clear polyester tape wraps to maintain core symmetry and fiber protection. Once several inches of jacket have been taken off, the ripcords can be used.
- **Outside Plant cables:** Outside Plant cables have ripcords and core wraps to aid in the removal of the rugged outer jacket. Care should be taken to avoid getting the aramid strength members tangled with the ripcords.

Core Components

After the jacket has been removed to the required location, the clear tape, and ripcords can be cut back to the jacket. In cables that have layers of aramid in the core (Interconnect, low fiber count Premises Distribution style), trim the aramid to the necessary length as specified by the equipment or connector manufacturer. Aramid is most easily cut by utensils sold specifically for this purpose, although razor blades and scissors do work.

Central strength members will also be trimmed. Some are cut back to the jacket so they will not interfere with termination, other applications will call for the central strength member to be cut to a specific length and incorporated in termination (i.e. some break-out kits). Central strength members made with fiberglass rod can be cut using almost any cutting tool. Those made with aramid inners will be easier cut with aramid cutters. Unitized distribution cables have aramid yarn within and jackets over each subunit, which will also be cut back. It may be beneficial to complete installation on one six or twelve fiber subunit at a time to avoid connecting the wrong fiber to the wrong termination point. Buffer tubes on Outside Plant cables are easily removed. Buffer tube cutters are designed specifically for this purpose, but it can also be done with a razor blade. Score one side of the tube with the razor (not too deeply) and bend the tube away from the score. The separated piece of tube can be pulled off the end of the fiber (figure 17).

Fiber Stripping

There are a variety of commercially available tools that will strip the buffer and coating off of 90 µm tight buffered fibers or the coating off of loose buffered fibers. Tight buffered fibers can be stripped either in a one-step or two-step process. Tools sold for one-step removal will take off the buffer and coating with one action. The two-step procedure requires one tool to remove the buffer, one for the coating. Taking the coating off of loose tube fibers can be done with the same tool used for the coating of tight buffered fibers, or with some tools the blades can be exchanged for the two functions. The amount of buffer and/or coating removed will depend on the application and termination procedure. Many connectors will come with exact templates for this purpose. See the hardware or connector manufacturer's specific instructions. For the removal of cable filling gel, NextGen recommends the use of Hydrasol solvent. Any gel remover used excessively can mar the tube printing, but Hydrasol used in moderation will not effect the identification markings.

Break-out Kits

Break-out kits are designed to shield optical fibers from damage when the protective parts of the cable have been removed. They provide a layer of support and strain relief for 900 µm tight buffered fibers or bare 250 µm unbuffered fibers when the cable outer jackets, core wraps, aramid strength members and loose tubes have been removed for termination or connectorization. The standard break-out kit contains stress and abrasion resistant tubes which contain aramid strands for tensile strength. Some kits contain a sort of "boot" to separate and guide the fibers.

Not all installations will require break-out kits; even outside plant cables can be well enough protected to be terminated without them. Many outside plant cables will be terminated in entrance facilities or equipment rooms. The cable outer protection is stripped back to expose the fibers, which are wrapped in fiber trays for distribution and spliced into the next link. The tray protects the fiber from environmental and mechanical stress.

Many high fiber count Premises Distribution style cables are terminated in telecommunications closets, computer rooms, in boxes or other limited access areas. Standard connectors are available to affix to the 900 μm directly. When the connection will not require multitudinous changes (pulling the connectors in and out) and there is little hazard to the fibers, there is no real need for break-out kits.

When fibers may be exposed, or there is concern about having to change the connections often, break-out kits may be very useful. For information on specific installation recommendations, contact NextGen.

FIBER NOTES

Fiber optic cable installations, with some foresight and care, can be done in such a way as to secure cable performance for future applications.

- Never kink the cable
- Never exceed recommended bend radii, during or after installation
- Do not exceed recommended tensile loads
- Do not crush the cable; avoid impacts to the cable
- Optical fiber cable should not rest against sharp edges, and must be “swept” around corners
- Monitor tensile during pulls, avoid pulling long lengths in one direction
- Plan on installing extra cable protection in high risk areas
- Do not exceed maximum vertical rise
- Secure cables in all installations
- Plan all cable routes before beginning, making sure the cable will not be exposed to hazard
- Comply with all regulatory requirements and fire codes