INSTALLATION GUIDE FOR OPTICAL FIBRE CABLE

TABLE OF CONTENTS

Important Remark : ***Installation is to be performed by qualified service personnel***

1 - Safety Warnings

Risks of inhaling fumes or of allergic reactions to chemicals used to prepare and process optical fibres. The installer shall have documented procedures for the control of substances hazardous to health meeting the requirements of relevant national legislation.

Risks of optical fibre fragments piercing the skin (and the eyes), which can lead to infection and complications due to the difficulty in their removal.

Risks from exposure to the eyes from optical power either direct from sources (LED , VCSEL or LASER) or from free interfaces (connectors, fractured optical fibres, splices, etc.).

If fibre optic cable contains metal (for example: corrugated steel armour, metallic strength member, messenger) it is necessary to earth both metallic sides of the cable. (Relevant national legislation for safe working practices must be complied with).

2 - Working Practice

Certain chemicals used to prepare and clean optical fibres may be considered hazardous when inhaled or ingested by mouth. Other such as the epoxy resins used in the assembling of connectors may cause allergic reactions.
The following practices should be adopted, failure to do so may endanger the health of those involved.

The work should be carried out in well-ventilated areas or forced ventilation should be provided. Prolonged and repeated breathing of vapour fumes should be avoided.

Precautions should be taken to avoid contact with eyes or skin or clothing.

Eating and smoking should not be permitted in the vicinity of processing chemicals used since this may represent an enhanced hazard due to potential explosion.

In case of contamination a basic First Aid kit should be available together with a ready supply of water.

All chemicals should be stored in clearly and correctly marked containers and should be sealed when not in use.

Exposed optical fibre ends must be kept away from eyes.

Waste fragments should be treated with care and collected (not by hand) together with other waste materials and disposed of in suitable containers.

Under no circumstances should a connector end-face, prepared optical fibre or fractured optical fibre be viewed directly unless the power received from the optical fibre is known to be safe under local control. This allows inspection of components using locally injected visible light and prevents the inspection of components using light injection from a remote non-controlled location.
The provision of the correct safety labelling is a mandatory requirement on all products where transmission features an optical hazard. All potential hazard areas must be similarly marked.

Adaptors within Patch Panel closures and free connectors should be permanently capped to prevent accidental eye contact, which might result in injury.

The user should ensure that all authorized personnel are aware of the relevant safety issues and should obtain training where appropriate.

3 - Precautions

Never install a fibre optic cable if temperature is below –5°C (Be aware that in cold environment the cable jackets are stiffer and more sensitive to bending and pulling. The range of recommended installation temperatures of cables is much smaller than the operating temperature ranges).

For reasons of safety, always unroll cable by the bottom side of the reel.
(figure 1).
For same reasons, only LSZH-FR cables can be installed inside premises.

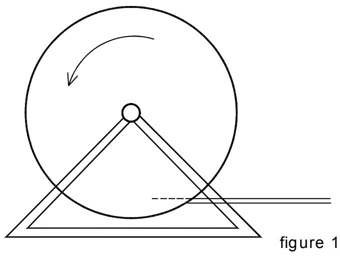

figure 1

During the delivery of the optical cable the off-loading of the reels should be monitored to ensure that no mechanical damage occurs (kinking, unravelling or twisting).

If fibre optic cable is installed in the same tray as copper ones, always place the copper cables below.

At both cable ends, it’s recommended to leave a few meters of cable for reserve.
It’s also recommended to leave some extra cable (+-5m) at different places on the cable link (This makes it easier to repair in case of a broken cable).

Always cut first meters of cable as this part can be damaged by pulling of the cable, bending, water…

4 - Storage

Fibre optic cable reels must always stand upright.

Never forget to place a wedge to avoid that the reel can roll.

On fibre optic cable stored outside, a cap must be placed at both ends to avoid water infiltration.

Storage temperature range is specified for each cable and must be respected.

Indoor cables must not be stored outside to prevent water infiltration and UV damages.

If several reels are stored at the same place, take care that flanges of a reel don't damage the cable of another reel.

5 - GENERALITY

5.1 Pre-installation procedure

Before laying the different cable sections, all reels should be visually inspected for possible transportation damage.

Before pulling the cable, to ensure of the stability of the pay-off.

To avoid possible damage from a sudden stop, the pay-off must be equipped with a progressive braking system. Under no circumstances should the reel be stopped by hand.

The route defined by the design should be accessible and available in accordance with the installation schedule. The users should be advised of all proposed deviations.

The installer should establish that the environmental conditions within the routes and the installation methods to be used are suitable for the optical fibre cable to be installed (Check the datasheet of the cable used). If the route contains sections where the optical cable is subject to high temperatures the necessary protection should be provided. Look out for heating tubes, which are not heated all the time.

Any measure necessary should be taken to prevent the optical cable experiencing direct stress following installation.

The installer should determine the locations at which reels are to be positioned during the installation program.

Where necessary, the minimum quantity of ceiling tiles, floor covers should be removed.

The installer should ensure that all necessary guards, protective structures and warning signs are used to protect both the optical cable and third parties. **Relevant national legislation for safe working practices must be complied with.**

6 - Fibre optic cable construction

Before more detailed discussion on how to handle optical fibre cable, some brief discussion of fibre 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.

6.1 Fibre

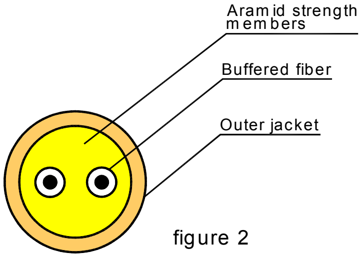

figure 2

The cable cross-section in figure 2 demonstrates a two fibre cable for interconnect applications. The construction of the glass fibre can be looked at separately from the design of the cable, as the fibre itself is constructed using distinct materials and is shipped by the fibre manufacturer as a finished product. Nexans takes the coated optical fibre and incorporates it into a multitude of finished cable products.

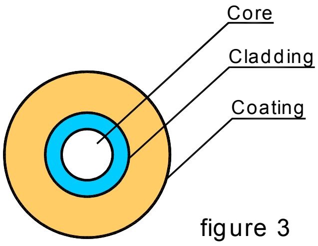

figure 3

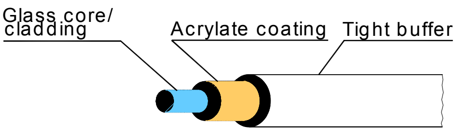

figure 4

All of the glass fibre used by Nexans is manufactured using the same basic construction. Two layers of glass are covered by a protective coating. As demonstrated in figure 3, the fibre'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 fibre. A slight difference in optical characteristics between these two 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 it's 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 (figure 4).

6.2 Buffer types

All of Nexans fibre optic cables fall into one of 3 categories: tight buffered or micro tube or loose tube buffered. The 3 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 fibre 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 Nexans tight buffer cables are rugged enough for many interbuilding applications while offering the tight buffer design advantages of ease of terminations, meeting IEC flammability codes, and cable flexibility.
Notice: These tight buffer cables cannot be directly buried (excepted the TBC cable).

6.2.1 Tight Buffered Fibre

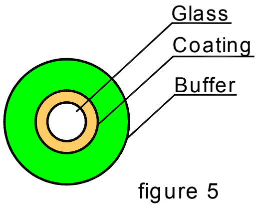

figure 5

A thermoplastic material is extruded directly over the acrylate coating, increasing the outside diameter of the fibre to 900 micron (0.9 mm), an industry standard. (figure 5)
The tight buffer supplies the fibre with added mechanical and environmental protection, increased size for easy handling, and a simple means of adding colour coding for fibre identification. During connectorization, the buffer is stripped back to an exact length as required by the connector manufacturer.

6.2.2 Micro tube Buffered Fibre

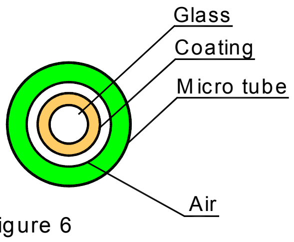

figure 6

The fibre at 250 micron is loose inside a micro tube. Outside diameter of this micro tube is 900 micron (0.9 mm), an industry standard (figure 6). The micro tube supplies the fibre with added mechanical and environmental protection, increased size for easy handling, and a simple means of adding colour coding for fibre identification. During connectorization, the micro tube is easily stripped back to an exact length as required by the connector manufacturer. The big advantage of this product (In comparison with tight buffer) is that you can easily strip up to 1 m in one go.

6.2.3 Loose Buffered Fibre

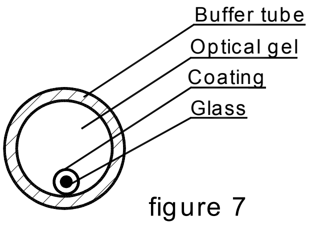

figure 7

In loose tube cables, the coated fibre « floats » within a rugged, abrasion resistant, oversized tube, which is filled with optical gel. Since the tube does not have direct contact with the fibre, any cable material expansion or construction will not cause stress on the fibre. Much of the external stress placed on the tube also will not be transferred to the fibre. The non-hygroscopic gel prevents water from entering the tube. See figure 7 for a diagram of a multi-tube, gel-filled outside plant cable.

6.3 Strength Members

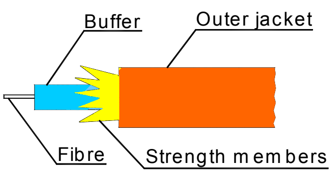

figure 8

Nexans 's optical fibre cable designs utilise glass yarn as the primary strength member (Aramid yarns are also used in some cable designs like patch cables and TB cables). Some designs also use a fibreglass central strength member. These materials serve as the load bearing members of an optical fibre cable during installation. In patch cables the aramid also acts as a strength member during connectorization. Figure 8 demonstrates a single fibre cable, where the tight-buffered fibre is surrounded by aramid and coated with an overall jacket.

6.4 Ripcords

Ripcords are designed to make removal of the exterior cable sheath easier, preventing unnecessary stress to the core. Ripcords provide a means of stripping back the jacket without the use of invasive tools, which could harm the cable core and damage fibres.

6.5 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. Typical jacket materials include Polyethylene (PE) or LSZH-FR material.
Also without selectivity choosing the appropriate jacket determines the level of fire performance. Outer jackets are always stripped back to expose the fibres at the point of termination or connectorization.

7 - FIBRE OPTIC CABLE SPECIFICATIONS

7.1 Tensile Strength

One of the goals in any optical fibre cable installation is to complete the installation with as little stress as possible to the fibres themselves.
For this reason, all cables are provided with a carefully calculated tensile loading value, which should never be surpassed. For optical fibre 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 fibres or their optical characteristics. It is not the cable breaking strength but a realistic allowable limit. Nexans specifies 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, corner 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. You will find both values in the cable data sheet.

7.2 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 fibre beyond recommended limits could cause an increase in the fibre 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.
These 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 9). Optical fibre cables are designed for extra flexibility in closets or work area.
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.

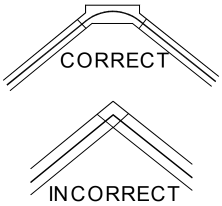

figure 9

7.3 Crush and Impact

Cable crush and impact are often listed but rarely understood details of optical fibre cables. They do, however, provide some legitimate guidelines for cable installation. IEC794-1-E3 (International Electro technical Commission) details the crush test method of a fibre optic cable. The intend 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. It 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.

Impact testing is documented in IEC794-1-E4 with the intention of determination the ability of optical fibre 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 fibre breakage, or changes in optical transmission characteristics. Crush and impact are important not as laboratory guidelines but as they apply to real-life installation situations. Optical fibre 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 fibre cables, however, by limiting the amount of « crossovers » (figure 10) or placing the heavier cables to the side or beneath the fibre cables. If numerous heavy cables are placed on top of a fibre cable a force or pressure is exerted on the fibre cable, pressing it into the rung, causing potential damage at that point (figure ???). Moving or shifting already installed cables that have

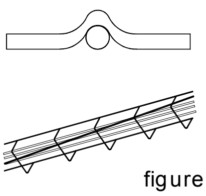
figure 10

large weights on top of them greatly increases the chance of damaging the cables.

8 - FIBRE OPTIC CABLE INSTALLATIONS

8.1 Interbuilding / Outside Plant

Much of the truly long-haul optical fibre pulled is for trunk or telephony applications, and is installed by trained professionals using special and expensive equipment.
However, routine cable installations in many cases will see some amount of cable run outside. This can vary from campus application with many long outdoor runs to a simple 20 m segment connecting two buildings.

8.2 Direct Burial

Optical fibre 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 pressures of direct burial installations.
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. (It is strongly recommended to fill the hole with 20 cm of sand under and over the cable).
This is not a quick process and is most effective for shorter distance applications. 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. One of the major hazards a buried cable faces is the possibility of being dug up. 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 fibre cable lies below (figure 11). Armoured cables (cables with corrugated steel or FRP (Fibre Reinforced Plastic)) are rodents resistant.

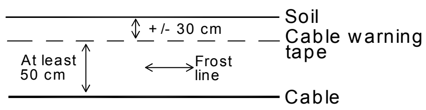

figure 11

8.3 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 or manholes. Installed conduit is advantageous because it offers a route for new cable installation or old removal without damage to streets, pavements, edifices, etc.

Conduit should be placed 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.
Inner duct or duct liner is slightly less sturdy plastic tubing designed to fit within larger conduits. Without providing the primary protection for the cable, inner duct serves several functions. Many manufacturers offer inner duct in diverse colours to assist in cable identification and maintenance. Inner duct 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, rub together, and sometimes block the conduit when new cable is installed along with the old. Inner ducts keep cables separate to prevent future installation cable damage (figure 12).

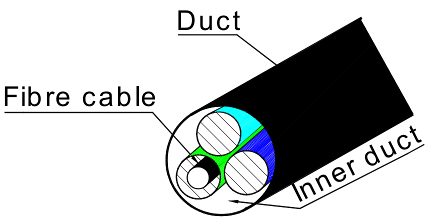

figure 12

Duct and conduit are excellent for installing tight-buffered cables such as Nexans 's TBW or TB cables between buildings. The benefit of these cables versus standard loose tube Outside Plant cables is their ease of termination (possibility to directly assemble connectors on fibres without use of pigtails). Conduit can also serve, as rodent protection in these short-interbuilding installations where splicing to armoured cable is not a reasonable alternative. Conduits can economically be installed for applications where a second trenching 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 fibres in the cable to be installed to be prepared for prospective uses.
Notice: Conduit diameter must be at least 2 times the fibre optic cable diameter.

Two ways to install fibre optic cable into conduit:
Cable pulling is the most used method to install a cable into conduit. First of all, a pulling tape is pulled in the conduit. The cable is attached to the pulling tape and then the cable is pulled through the conduit.
Cautions: Always respect the minimum bending radius and never exceed the maximum pulling force value specify in the cable data sheet.
Fore more information concerning the cable pulling, please have a look on the chapter "**Fibre Optic Cable handling procedures – Pulling Cable**".
Cable blowing is another way to install cable in conduit. It consists of blowing compressed air in conduit and the air pressure carries the cable through the conduit. This is a specific installation method, which needs very specific and expensive material.

8.4 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 aerially.
Although most optical fibre 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 fibre. Under most conditions aerial optical fibre 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 30 cm.
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 fibre cables can be “over lashed”, 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.

8.5 Intrabuilding:

Inside a building, it’s strongly recommended to select a cable with a LSZH-FR jacket (A major part of our Nexans Indoor and Indoor/outdoor cables are made using a LSZH-FR jacket material). In case of vertical installation of Loose Tube cables, it’s necessary to loop cable at the bottom end.

8.5.1 Horizontal

8.5.1.1 Conduit applications

Intrabuilding conduit runs can be in ceilings, walls or under floors, with certain limits, as conduit systems are very flexible. Conduit systems should be used only when workstation outlet locations are permanent, no flexibility is required, and densities are low. Under-floor conduits are often embedded in concrete making it particularly difficult to do additions, changes or moves. Pull cords should always be placed in the conduit to ease installation. Inner duct is an excellent tool for protecting cables and making future installations easier.

8.5.1.2 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.

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. 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, wire ways or racks.

At the very least cables can be supported by bridle rings.

8.5.1.3 Cable in Trays

Cable trays or “ladder racks” can often provide a convenient, safe, efficient method of optical fibre 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 fibre 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 fibre 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 fibre cable without pulling it under or between heavier cables or multiple cables that will create added forces on the fibre. The same holds true for moves and adds. It is desirable to secure the cable to the tray to avoid damage during future changes.

8.5.1.4 All Pathways and Spaces

If the optical fibre is being installed in wire ways, 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 monitoring the cable pulling tension, additional efforts to support and protect the cable 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 should be kept smooth. Sometimes adding a piece of conduit beyond the transition will keep the cable from resting on a sharp edge.

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. Inner duct or flexible conduit can be used to ease or sweep the cable around tight corners. The inside radius of conduit bends for fibre 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 13). 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.

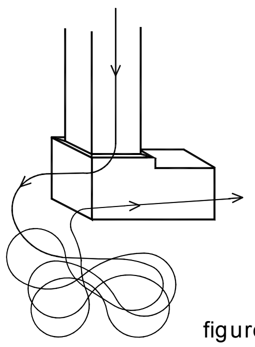

figure 13

8.5.1.5 Vertical or Riser

The same critical observations must be made when installing cable in vertical shafts or risers. 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 fibre 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 determinated by the weight of the cable and its ability to resist buckling or kinking.

Split wire mesh grips (figure 14) 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 rather than adding more load.

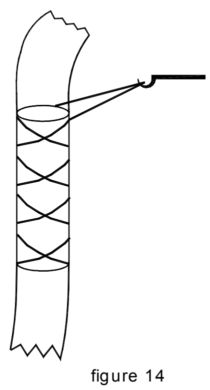

figure 14

Notice: If the cable installed is a Loose Tube one, don't forget to loop it at the low end to avoid the jelly drainage.
Generally, it's recommended to loop at 10 metre intervals so the fibre doesn't fall out or get stressed.

9 - Fibre Optic Cable handling procedures

9.1 Pulling Cable

In many premises network cable installations the fibre 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 fibre optic cable it is imperative that the load be applied to the strength bearing members of the cable.
Failure to lock the cable components together can lead to elongation of the jacket material which when released will cause the optical fibres 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 standards tools available to aid in the installation of fibre optic cable. External pulling grips (figure 15) are designed to lock into and tighten around a cable as a tensile load is applied to the grip. The pulling end of the grip is a loop or eye for attachment of the pulling tape or rope.

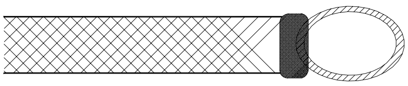

figure 15

When pulling Nexans Outside Plant cable with a pulling grip it is important to remove jacket of the cable and attach the grip over the top of the glass (or aramid) yarns strength members surrounding the cable core in addition to the outer jacket.
NB: If a multitube cable has no glass (or aramid) yarns around tubes, it will be necessary to use the central strength member as pulling element.
This can be accomplished by sliding the grip on 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 10 cm 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 fibre 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 3 m 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 now 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 3 m of cable should be cut off to remove any piece that may have suffered stress from the pulling tape or grip.

After cable pulling, if the cable is not directly terminated, it's absolutely necessary to replace a cap at both ends of the cable in order to avoid water penetration.

In case of partial use of a cable, both ends of the remaining cable must be fastened to a flange of the reel by means of a **"bridge nail".**
Under no circumstances should **"bridge nail"** will be higher than the thickness of the flange in order to ensure that the **"nail nibs"** do not cause injury to people or damage the remaining cable on the spool.

9.2 Jacket Removal:

For any fibre count or cable type, some amount of the cable outer jacket will have to be removed to expose the fibres. 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 4 to 5 cm. Multifibre cables will have longer lengths of the jacket removed. Outside plant cables that will be terminated in trays may have over 2 meters of jacket removed.
Mark the cable with a piece of tape or with an indelible ink marker to show how far the jacket should be stripped.

9.2.1 Patch cables:

Simplex and duplex cable jackets are usually removed no more than a few cm from the point of termination and are easily taken off using standard buffer or jacket strippers.

9.2.2 Distribution cables:

Distribution cable jackets can be removed using round cable slitters or other tools that will not damage the interior of the core.

9.2.3 Breakout cables:

All Heavy Duty breakout cables contain a ripcord for jacket stripping. Once several cm of jacket have been taken off, the ripcord can be used.

9.2.4 Outside Plant cables:

Outside Plant cables have ripcords to aid in the removal of the rugged outer jacket. Care should be taken to avoid getting the glass (or aramid) yarns strength members tangled with the ripcords.

9.3 Core Components

After the jacket has been removed to the required location, ripcord can be cut back to the jacket. In cables that have layers of aramid in the core (Patch or Distribution style), trim the aramid (or glass) to the necessary length as specified by the equipment or connector manufacturer. Aramid is more easily cut by scissors sold specifically for this purpose. 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 fibreglass rod can be cut using almost any cutting tool. 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 knife. Score one side of the tube with the knife (not too deeply) and bend the tube away from score. The separated piece of tube can be pulled off the end of the fibre (figure 16).

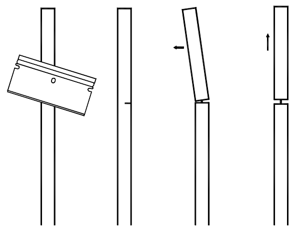

figure 16

9.3.1 Fibre Stripping

There are a variety of commercially available tools that will strip the buffer and coating off 900 µm tight-buffered fibres or the coating off loose-buffered fibres. Tight buffered fibres 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 (To strip from 900 to 125 µm in one go). The two-step procedure requires one tool to remove the buffer (To strip from 900 to 250 µm), and one for the coating (To strip from 250 to 125 µm). Taking the coating off loose tube fibres can be done with the same tool used for tight-buffered fibres, 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.