RECOMMENDED Procedure

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SP-F01-001 Cable Placing, Issue 4

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1.0 General

This procedure describes the standard technique for placing optical fiber cables in duct, direct buried and aerial installations. Although actual on-site placing techniques may vary depending on installation site conditions, the descriptions given in this procedure are typical techniques that are applicable to conventional communications cables as well as optical fiber cables.

Generally, optical cables are installed in longer lengths than conventional cables. Aside from special consideration for bend diameter, pulling tensions, handling and cable slack, fiber optic cable installation require no specialized training or equipment.

Optical fiber cable is lighter, and has a smaller diameter and higher flexibility, than conventional cables. Optical fiber cable must not exceed the minimum bending radius during handling and installation.

10 X Cable OD - No Tension
20 X Cable OD – Tension

The cable's maximum allowable pulling tension must not be exceeded during installation. The maximum tension is typically <600 lbs.

At the splicing location a sufficient amount of excess cable length should be stored to allow for easy access.

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2.0 General Precautions

2.1 Pre-Installation

Prior to any cable operation, the specifications for the cable and installation must be checked to confirm the following:

1. Maximum allowable pulling tension
2. Minimum allowable bending radius during installation
3. Minimum allowable bending radius after installation
4. Construction and dimensions of the pulling ends
5. Cable weight and diameter
6. Supply length of cable
7. Excess cable length required at the splicing location

2.2 Cable Reel Handling

Always handle the cable reels with the greatest amount of care to safeguard against possible damages to the optical fibers. Special handling precautions are as follows.

2.2.1 Never lay the cable reels flat.

2.2.2 Do not drop reels.

2.2.3 Do not roll the cable reels for long distances. Reel movement is permitted for short distances as long as the reel is rolled in the direction indicated by the arrow on the outer surface or flange of the reel.

2.2.4 Keep the cable reel lagged until placing begins. If it becomes necessary to leave the cable on the reel for an extended period of time, securely fasten the cable end and relax the cable.

2.3 Maximum Allowable Pulling Tension

Unlike the metallic conductors of conventional cables, optical fibers do not contribute to the tensile strength of the cable. The fibers rest freely in cables utilizing the loose buffer tube design while the kelvar and center strength member bear the pulling force during installation. As a result of this design, optical fiber cables have maximum allowable tension much lower than that of conventional cables. The maximum allowable pulling tension varies for optical cables, depending on the particular cable designs, but as a general rule, 600 lbs. is used as the maximum limit.

NOTE: Always consult your cable manufacture before installation begins so that the proper value of maximum allowable pulling tension is known. Never exceed the specified maximum allowable pulling tension since a higher pulling force can affect the optical performance and characteristics of the fibers.

2.4 Minimum Allowable Bending Radius

Since optical fiber cables require very careful handling during all stages of installation, one important parameter to consider is the minimum bending radius of the cable. A good rule of thumb is that during installation the minimum-bending diameter should be at least 20 times the cable's outer diameter and at least 10 times the cable's diameter during storage.

NOTE: For exact specifications, check with the cable manufacturer. It is important to recognize that the rule of thumb given in terms of radii. To establish the diameter of necessary bullwheel installation, the minimum bend must be multiplied by two.

2.5 Storage of Excess Cable Length at the Splicing Location

A sufficient amount of excess cable length should be stored at each splicing location. The specific amount of excess cable needed is determined by site location, conditions (i.e. underground, direct buried, aerial), and splicing method

2.5.1 In general, 60' of slack is required at splice vaults and manholes

2.5.2 For aerial applications 25' from the base of the pole or structure is sufficient slack cable.

2.6 Pre-Installation Testing

Fiber optic cables are manufactured in long lengths requiring considerable installation costs. Pre installation tests are generally conducted to guard against cable damage during shipping and unwarranted construction expense.

3.0 Reference Documents

Sumitomo Recommended Procedure:
SP-F01-002 *Installing Cable Pulling Grip*
SP-F01-007 *OTDR Measurements*

4.0 Duct Inspection

4.1 Initial investigations prior to installation.

The following areas of concern should be examined before starting any cable installation in an underground duct system.

4.1.1 Compare and confirm the position, type, and span of the manholes with the related drawing designs.

4.1.2 Compare and confirm the type and position of the designated duct with the related design drawings.

4.1.3 Inspect all manholes for water and harmful gases. Drain and ventilate manholes wherever needed.

NOTE: Poisonous gases should be completely exhausted before workers enter the manhole.

4.1.4 Insure that all-necessary tools and materials are at the proper locations throughout the route.

4.1.5 Compare and confirm the cable reel number, cable reel rotation (clock-wise or counter clockwise)

4.2 Utilization of Safety Devices

Safety devices such as fences, safety cones, sign posts, and warning lights, flashing lights, red flags, etc. are to be provided at each installation site as a means of safeguarding against moving vehicles and pedestrians. During night work or when an escavated trench is left open overnight, lighting should be available.

4.3 Protection of Existing Cables

Adequate precautionary measures should be taken to protect cables previously installed in manholes.

4.4 Rodding

A technique called rodding is used to clear the duct passage and install the pulling rope. Rodding can be performed using a steel rod, plastic rod, or air-blowing device.

4.4.1 Push the steel or plastic rod into the duct until the front end of the rod reaches the adjacent manhole.

4.4.2 Attach the pulling tape to the front end of the rod at the adjacent manhole.

4.4.3 Pull the rod and pulling tape all the way back through and out of the duct entrance. (Figure 1B)

4.4.4 If the air pressure method is preferred, the pulling tape should be blown through the duct until the front end of the tape reaches the adjacent manhole. (Figure 1A)

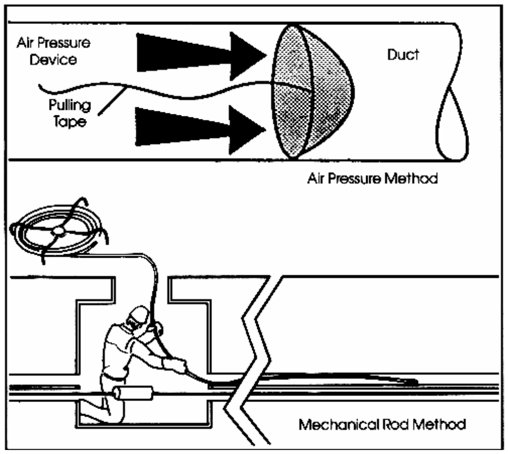

Figure 1

4.5 Duct Cleaning

Attach a wire brush, rags and a second rope to one end of the pulling rope as shown. The wire brush, rags, and second rope combination should be securely attached to the pulling rope to prevent them from coming off or unfastened in the duct during the duct cleaning process. (Figure 2)

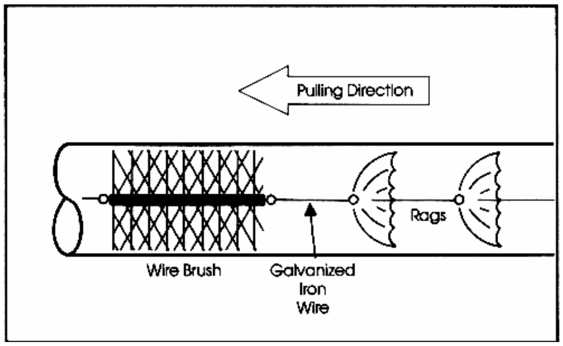

Figure 2

4.6 Mandrel Passing Test

This test is performed on ducts (excluding concrete pipes an asbestos cement pipes) whenever the possibility of cable damage exists as a result of the duct condition. The test may be performed simultaneously with the duct cleaning process by attaching a suitable-sized wooden mandrel (10% smaller than the duct's inner diameter) to the second pulling rope.

4.7 Cable Sample Scratch Test

Since the wooden mandrel's diameter is only slightly less than that of the duct's diameter, the mandrel may not be able to pass through the duct easily. If such difficulty arises, a two-meter sample of the cable is substituted for the mandrel and is passed through the duct. This test provides a method of determining the duct condition and its effect on the cable. The cable sample is coated with black enamel to aid in the visual inspection of the outer sheath for scratches after being passed through the duct. The scratch inspection results provide a basis for determining the duct condition and probability of a smooth cable installation. If the cable sample cannot pass through the duct, use of an alternative duct or repair of the designated duct should be performed after consulting the proper authority.

4.7.1 Swivels should be attached to both ends of the cable to prevent it from twisting during the pull test.

4.7.2 Attach the swivel ends to the rope and pull through the duct system.

NOTE: In the case of a newly installed duct or when the duct inner diameter is comparatively larger than the cable outer diameter, some of the processes mentioned above may be eliminated unless otherwise specified in the Cable Placement Contract.

5.0 Cable Installation in Ducts

5.1 Cable Reel Set-Up

5.1.1 Position the cable reel so that it is on the same side of the manhole as the direction of pull (see figure 3).

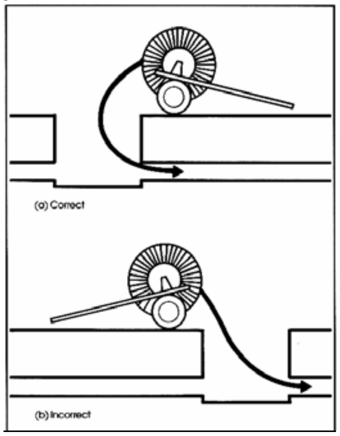

Figure 3

5.1.2 Stabilize the cable reel shaft to a horizontal level by using a cable reel trailer or cable jacks.

5.1.3 Carefully remove the lagging from the cable reel.

5.2 Attachment of the Pulling Rope to the Cable

Generally, the pulling end of the cable is prepared to endure the pulling tension encountered during installation. The methods for attaching the pulling rope to the pulling end of the cable are classified into two categories according to the type of gripping hardware selected (a pulling eye or cable grip).

5.2.1 When a pulling eye has been selected as the preferred gripping hardware, a swivel, shackles, and a pulling rope are also required as shown in Figure 4 below.

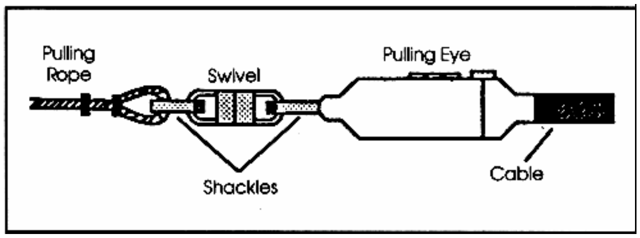

Figure 4

NOTE: Attachment of a pulling eye can be preformed either at the cable factory or at the installation site. For a detailed explanation on attaching a pulling eye, please refer to manufacturers' instruction for particular model selected.

NOTE: To prevent the cable from twisting during installation, a swivel should always be used between the cable grip (or pulling eye) and the pulling rope. Also, the swivel selected should be one of quality workmanship that can withstand the maximum pulling tension and still allow pivoting about its axis.

5.2.2 For a detailed explanation on attaching pulling grips, refer to Sumitomo Recommended Procedure Installing Cable Pulling Grip, SP-F01-002.

5.3 Cable Pulling

While there are several different mechanisms to pull the cable through a duct, manual pulls and slip winches generally are the two methods considered as the industry standard. Although both the manual pull and slip winches are effective methods, it is difficult to install a whole reel of optical fiber cable in one operation without exceeding the maximum allowable tension, due to the length of cable on each reel. Lubrication helps but in many cases it does not completely resolve the problem. To eliminate this difficulty, specialized techniques, such as bi-directional pulling and section pulling, can be combined together and applied with either the manual pull or slip winch methods.

5.3.1 Slip Winches

5.3.1.1 The slip winch should be set up at the manhole to which the cable is being pulled (Figure 5).

5.3.1.2 The slip winch arrangement can be set up with a driving wheel located down in the manhole (Figure 6).

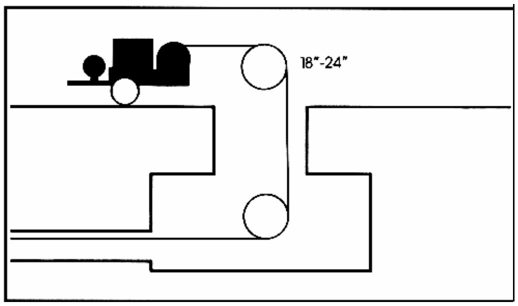

Figure 5

NOTE: Typically, the cable-pulling device should be designed with an 18” cable sheave minimum diameter. Two to three wraps about the sheave should provide a sufficient pulling grip. Multiple pulling devices can increase pulling distances.

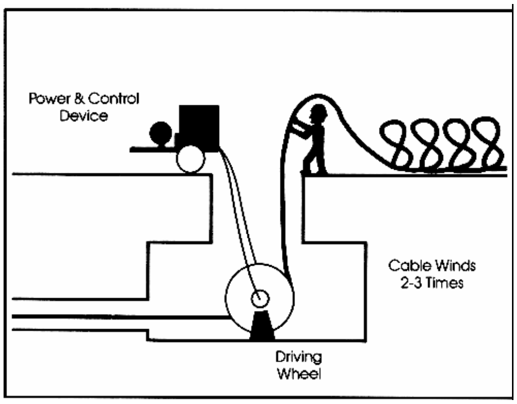

Figure 6

5.3.1.3 The pulling tension at the slip winch should be at an amount under the maximum allowable pulling tension. As a general rule, the pulling tension is set at 500 lbs. for cable specified at a 600 lb. limit; however the actual specification should be obtained from the cable manufacturer before pulling begins.

5.3.1.4 The sheave or wheel should be aligned with the duct at the take-out manhole.

5.3.1.5 Communication between the lead-in and pulling manhole locations is essential and must be maintained at all times.

5.3.2 Manual Pulling Method

5.3.2.1 At least one worker must be in each manhole to pull the cable through the duct while curved manholes require at least two people. Refer to Figure 7 below.

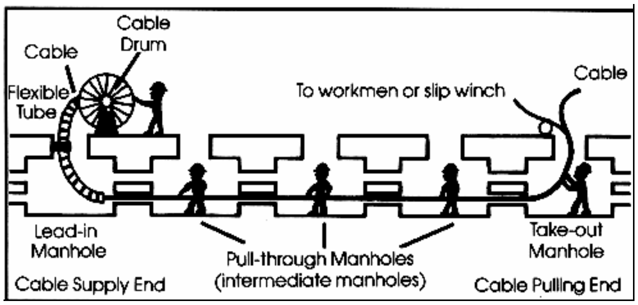

Figure 7

5.3.2.2 Communication between each work site is essential so that the pulling action can be achieved in a synchronized movement as directed by the leader. Communication by use of a walkie-talkie, two-way radio, or some other means is recommended.

5.3.2.3 The cable should always be pulled in a straight direction without bending as illustrated in Figure 9 below. Special gripping gloves are available to facilitate pulling lubricated cables.

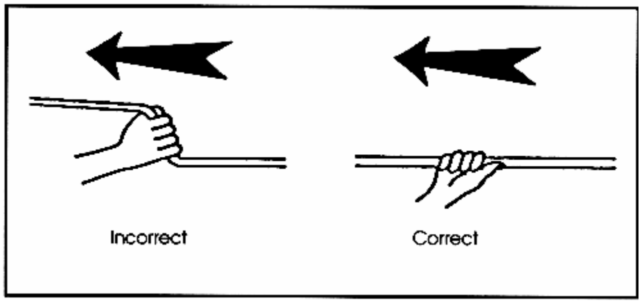

Figure 8

5.3.3 Bi-Directional Pulling Technique

This specialized technique is recommended for difficult or longer cable pulls.

5.3.3.1 The lead-in manhole should be located at turns, bends or misalignments in the route. If a large amount of cable is to be pulled from the reel (3-5 km), then the lead-in manhole should be located at the midpoint of the span.

5.3.3.2 The pulling action should be performed in the following order: Refer to Figure 9).

1. Set up the cable at manhole A
2. Pull the cable towards manhole B
3. Reel off the remaining cable onto the ground in a figure eight pattern
4. Pull the cable towards manhole C

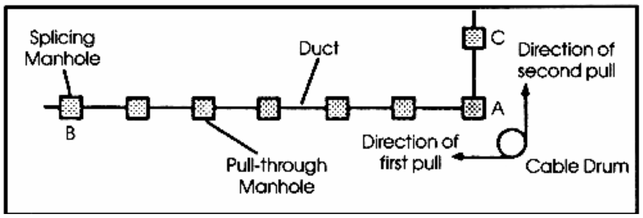

Figure 9

5.3.4 Section Pulling Method

This technique is recommended when the average cable length per reel is 3-5 km.

5.3.4.1 Determine the maximum possible distance to which the cable can be pulled through the duct without exceeding the limit of the maximum allowable tension

5.3.4.2 Pull the cable through the duct until the pre-determined distance is reached and then figure eight the cable at that location.

5.3.4.3 After the cable has been figured-eighted, begin pulling the cable to the next manhole take-out. See Figure 10.

5.3.4.4 Repeat this process until all of the cable has been pulled off the cable reel and all of the figure-eight sections have been pulled through the duct.

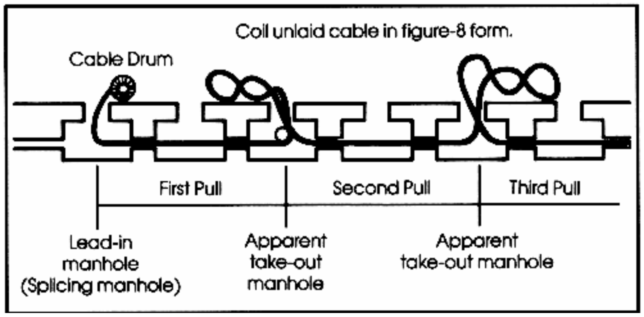

Figure 10

6.0 Racking the Cable in the Manhole

The Cables should be racked in the manhole in accordance with the following fundamental principles.

6.1 In order to position the cables properly, the cable can be bent whenever required but use precaution to stay within the allowable cable bending radius

6.2 Sharp bends are never recommended within 3 feet of intake or exit ducts. When bending the cable, do not allow a bend to occur 5 cm (2 inches) or more from the duct inlet/exit and 10-cm (4 inches) or more from the splice closure butt.

6.3 Protection of exposed cable in the manhole is recommended. This can be accomplished by racking the cable in the manhole or by strapping to existing cables. Preferably, the cable should be protected using preinstalled flexible conduit in the manhole. The conduit should extend approximately one meter into the duct entrance approximately one meter into the duct entrance and exit. The cable is then pulled through the flexible conduit at the time of installation.

6.4 Whenever a cable span is constructed under a bridge, road, or any other transportation crossing of more than 100 meters, always allow for slack during 100 meters, always allow for slack during cable placing in order to compensate for cable creep and vibration effects.

7.0 Direct Buried Cable Installation

Many fiber optic installations require direct buried applications. For any direct burial, the use of an armor tape cable design or a plowed conduit system is recommended. This will preclude cable damage during installation and provide additional support and rodent protection.

7.1 Fiber optic cables are typically buried at depths from 36 to 54 inches.

7.2 Pre-ripping the route or trenching using a backhoe may be required

7.3 The use of figure eight's allows installations or more than 6 km continuous reel lengths.

7.4 Figure 8's will be required at all obstacles including bores, road crossings, culverts, etc.

7.5 Cable should be fed smoothly into the plow shaft with no back tension.

7.6 Marker tape should be placed 1 to 2 feet above the installed cable. This tape can be purchased with metallic conductor for easier location or nonmetallic cable products.

7.7 The plow shaft should always ride squarely (perpendicular to the ground). In the event the shaft begins to rise, trenching may be required to properly place the cable.

7.8 Insure that all precautions are heeded which relate to bending radius and handling during installation.

7.9 Shading can be utilized during installation to prevent macrobending loses when cables are placed over rocks or other obstructions

7.10 In the event of rock cutting, cables are typically placed 18”- 24” with concrete caps.

8.0 Aerial Cable Installation

Aerial or overhead optical cables are placed utilizing methods similar to other telecommunications cables. Aerial optical cable systems are constructed both using self supporting design and standard optical fiber cables. Standard design cables should be lashed to a preinstalled strand or overlashed onto an existing cable.

8.1 The optical cable can be pulled in from a reel onto rollers hung from the strand or driven off and lashed. As fiber optic aerial cables are typically manufactured and installed in long lengths, special consideration should be placed on reel placement to eliminate the need to figure eight and mid-assist a series of pulls.

NOTE: During drive-off installations the cable is fed from a spool on a moving truck and lashed as it is installed. However, in order to perform this application the pole must be free from lower obstructions.

8.2 Pulling machines designed to pull fiber optical cables are recommended to enhance installation productivity.

8.3 When pulling the cable onto the rollers, pulling tension and bend radius should be closely monitored to insure that the installation does not exceed manufacturer’s recommended limits.

8.4 Roller Assemblies should be placed at all strategic locations including bends in excess of 45 degrees normal.

8.5 Rollers or similar type of pole guard should be placed on any poles that contact the cable to prevent damage. Attention to hanging straps or hardware should be used to prevent cuts and sheath damage.

8.6 Slack loops at poles are not required but are recommended. Check specific designs are aerial practices for the proper procedure. If applicable, a 4” slack loop and pole guard placement is recommended. Otherwise straps and spacers should be used to retain the cable securely to the strand above any equipment or obstacle.

8.7 Splicing loops or cable slack loops which are designed into the system should be left well out of climbing space and clearly marked with fiber optic warning tags.

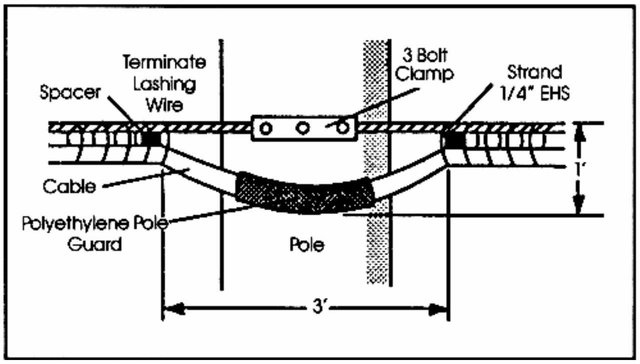

Figure 11

8.8 Fiber optic cables can be lashed to new strand using a standard lashing machine.

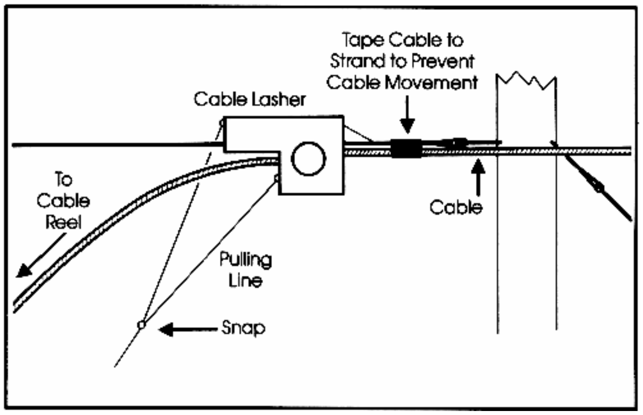

Figure 12

8.9 Fiber optic cable can be over lashed to existing cables using a F/D sized or modified lashing machine to accommodate the larger cable.

8.10 When over lashing large cable bundles the guide may have to be modified so that the cable rides on the rollers.

8.11 A 1 inch to 1 1/2 inch PVC or PE flexible pipe can be installed at road crossings and under bridges to provide additional cable protection.

8.12 Telecommunications installations use a standard 430 grade lashing wire.

8.13 Fiber cables typically weigh less than 100lbs/1000'. As such, double lashing is not required, but can be used to provide additional protection over road crossings and through trouble areas.

8.14 The preferred method for storing aerial cable slack splicing loops is to fold the closure and excess cable up to the strand. Additional cable designs are available, that are self-supporting. Two of these designs are Figure 8 Optical Fiber Cable and Optical Power Ground Wire (OPGW). When installing these products, refer to the manufacturer's specifications.

9.0 Cable Blowing

The most efficient and safe means of installing fiber optic cable utilizing a pressurized blowing system using two forces. A pulling force combines with a pushing force causing the cable to travel through the duct like air. This installation method provides increase installation speed with less stress than traditional pulling methods.

Note: Cable blowing distance is dependent on cable route and cable length.

9.1 Pre Installation testing

Pressurizing to check for leaks checks duct integrity. In order to insure a successful installation, the duct must be airtight and free of obstructions. As described in section 4.05 - Duct Cleaning must be performed by pouring a small amount of lubricant in the duct and blowing a foam carrier through confirming its integrity.

9.2 Cable Preparation

Install the recommended cable carrier to the end of the fiber optic cable. Cable carriers are available to match the specific duct ID. Once installed the cable is fed through the cable blower and into the duct.

9.3 Duct and Cable Lubrication

Once cable is prepared for blowing, lubrication is added in front of the cable carrier and behind the carrier.

9.4 Blowing Process

Compressed air is applied to the duct behind the cable carrier. As the pressure from the blower tries to equalize, it seeks out the path of least resistance and creates a pushing force on the cable carrier, causing a forward motion. At this point the cable carrier exerts a pulling force on the cable and begins to move through the duct. Additional pushing force is applied to the cable by a hydraulic powered tractor drive system on the cable blower. This reduces air consumption requirements from the air compressor.

Note: The tractor drive provides cable slack and reduces back tension and keeps the cable loose and flexible, reducing friction and resistance allowing cable to travel freely.