

OVERVIEW

Proper care and handling of semiflexible trunk and feeder cable during installation is critical to the long term reliability of a CATV system. The following guidelines are intended to assist CATV operators and construction contractors to help make cable installation safe and trouble free, to avoid cable damage, and to build a cable plant that will provide long term system reliability.

CABLE HANDLING

A separate technical note (1034) is available which covers the proper handling of the cable from the time it is received to the time it is transported to the construction site. The key points are that the cable can be easily damaged and personal injury can result if the cable is not handled properly. Cable reels should not be unloaded by dropping them off the back of the truck. If an unloading dock is not available, a fork lift or ramp should be used. The cable should be visually inspected for damage when it is received and electrically tested before it is sent to the construction site if there is any question of damage during shipment from the manufacturer. The protecting outer wrapper should be left in place as long as possible to avoid cable damage. A visual inspection of the cable at the construction site should be conducted to assure that the cable was not damaged during transport from the warehouse. Cable ends of partial reels should be tightly secured with a staple, string, or nylon filament tape to keep the cable from loosening due to vibration and bouncing during transport to the next location. If the cable is loose, problems such as cross wraps and kinks can result as it is paid off of the reel. Reels with cross wraps should not be used.

CLEARANCE

Before cable installation can proceed, it is necessary to assure that there will be enough clearance between the CATV cable and the other utilities at the pole and between supports. It is also necessary to assure enough clearance between the CATV cable and the ground, roadway, rail, or water surfaces below. The 1997 National Electrical Safety Code (NESC) requires that these clearances be determined under a specific set of conditions. In general, the final sag of the CATV plant must be known to determine the minimum separation at the pole between CATV cable and the other utilities. Forty inches of separation between CATV and power at the support, may not be sufficient to meet clearance requirements (e.g., 30 inches) between supports. The final sag is also

needed to determine the minimum CATV cable attachment height on the pole to assure proper clearance above the ground, roadway, etc...

Although final sag can be calculated (See Technical Note 1006-A at www.timesfiber.com), the calculation is rather complex and a knowledge of the materials is required. For this reason, Times Fiber Communications, Inc. provides initial and final sag tables in a separate series of sag tables (Technical Note 1064 at www.timesfiber.com). The requirements of the NESC are invoked by the local authorities, but there may be other, more stringent, requirements that also apply and must be observed. Good communications with the other utilities involved should facilitate the resolution of clearance related problems. At the heart of the clearance requirements is a concern for safeguarding the people that work on the cable and the general public. It is this thought, for safety, that should be kept in mind not only for clearance but during all phases of cable installation.

STRAND TENSION

Before the strand can be installed, consideration must be given to tension that will be applied to the strand under various loading conditions and span lengths. Obviously, the size and number of cables are also important.

NESC Heavy Loading District Requirements

The NESC requires that 60 percent of the break strength of the steel support strand not be exceeded at 0° F with 1/2 inch radial ice, 4 pounds per square foot of wind loading and with an added weight constant of 0.3 pound per foot for a Heavy Loading District. In general, tension can be reduced by increasing sag. The sag tables mentioned above assure that the maximum strand tension is not exceeded. A separate set of corresponding tension tables (Technical Note 1065 at www.timesfiber.com) provides the initial and final tension for various span lengths and cable types.

STRAND INSTALLATION

The amount of sag is dictated by clearance and tension requirements. The strand is initially placed loosely in the clamps to allow for adjustment. The strand should be tightened to the proper stringing tension for the ruling span of the run and the suspension clamps tightened. Stringing tension is provided in Technical Note 1065 (See Technical Note 1065 at www.timesfiber.com) for various cable types and span lengths. An alternate technique is to adjust the sag to 1.5 percent of the ruling span after the cable is installed and then tighten the suspension clamps.

REEL PLACEMENT

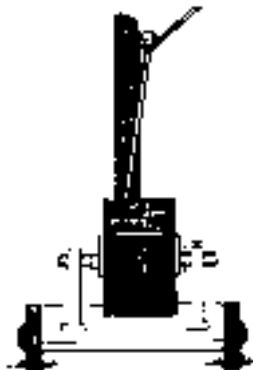
Obstructions

Take the proper safety precautions of checking the trailer and placing the required safety cones. Usually, the reel is unattended, therefore the location of the cable reel in relation to the first pole or roller is extremely important. The first pole location must be clear of obstructions that could interfere with a smooth payout. Potential obstructions include telephone drops, support guys, or tree limbs. If the payout reel cannot be located at the first pole, consideration should be given to moving forward to the next pole. The reel should be loaded on the reel trailer so that cable will feed from the top of the reel so that the cable will straighten properly as it pays out.

Reel Centering

When the payout trailer is set up, the center of the reel should be positioned so that the cable pulls from the center of the reel, directly into the first roller or chute, and along the line of sight of the strand. The flanges should be parallel with the strand - not at an angle. If the cable is pulled at an angle, the cable may catch the flange of the reel and be damaged, causing jacket abrasion or cable kinking. By having the flanges parallel to the strand and the reel centered on line of sight of the strand, the cable will always pull away from the reel flange and no damage will occur. If the payout reel or reel trailer cannot be leveled, a member of the crew should remain at the reel to insure that the cable unwinds without making contact with the flanges. If for some reason the reel can not be properly positioned at the first pole consideration should be given to moving forward to the next pole. Although it should be avoided as much as possible, a mid span take off, which is described below, may be necessary.

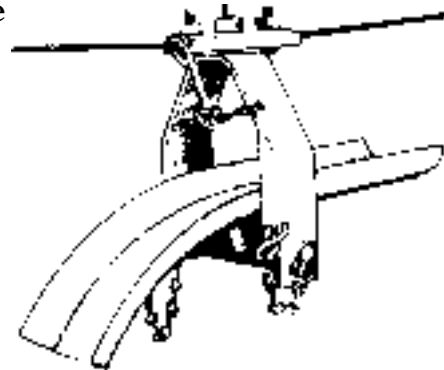
Figure 1.
Cable Reel Centered At Pole



Chute

The purpose of the chute is to guide the cable paying off of the reel onto the cable blocks or rollers. A 45° Corner Block can also be used as a cable chute. A single roller should not be used as a chute because of the small radius of the single roller. The chute bend radius is much larger than a single roller so the cable is not bent too tight. The chute has a surface that has a low coefficient of friction to reduce back tension as the cable is being pulled through the bend. A 45° Corner Block has very low friction. Ideally the chute is securely fastened to the first pole using a pole attachment and adapter.

Figure 2.
Chute



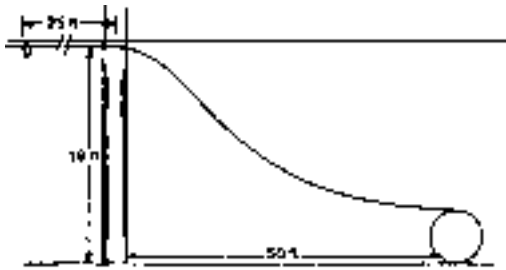
An alternate technique which should be avoided unless absolutely necessary, is the mid span take off which attaches the chute to the strand at some distance from the first pole. The problem with the mid span take off technique is that as the tension on the cable varies as it is being pulled, the first roller or chute tends to jump up and down. An experienced crew that carefully controls tension can successfully make mid span take off pulls. Multiple chutes may be used when multiple cables are pulled.

Distance of the Reel to the Chute

The distance from the payout reel to the chute should be approximately 50 feet (Figure 3). A minimum distance from payout reel to pole should be twice the height of the chute from the ground. The 50 foot distance prevents the cable from being pulled into the strand line at too sharp of an angle. If the cable is pulled over the chute at too great an angle, it is difficult to control pulling tension and the cable will bend and straighten in a non-uniform way. The chute usually can make a transition of 45°. This means that if everything was set up perfectly, the reel could be as close to the chute as the height of the chute or a 1:1 distance to height factor. Also, the greater the

angle the cable has to bend, the more force is needed to pull the cable through the bend. Using a minimum 2:1 distance to height factor, will reduce the pull force, will make the set up easier to maintain, will reduce the possibility of cable damage, and will help assure that the cable will straighten as it pays off the reel.

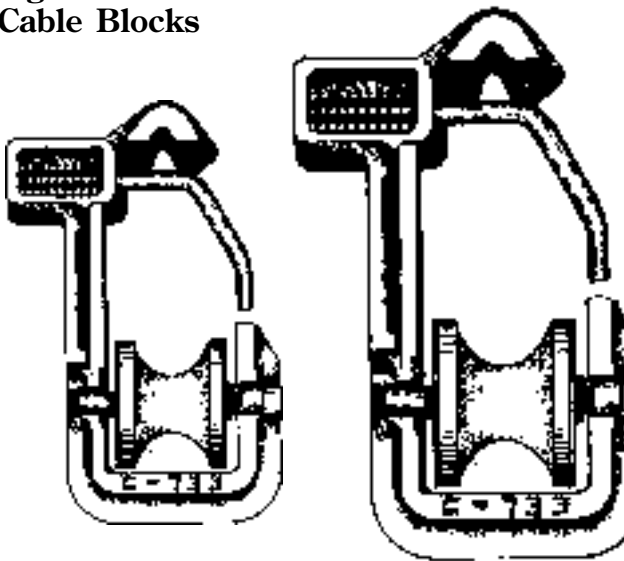
Figure 3.
Location Of Payout Reel In Relation To Pole



CABLE BLOCKS

Cable blocks or rollers should be placed every 25-30 feet to support the cable or cables between poles. Use of cable blocks or multiple cable blocks for multiple cables will reduce pulling tension, keep the cables straight, and reduce the safety hazards such as the cable drooping down when the pull is stopped or whipping up in the power lines if the pull is abruptly started.

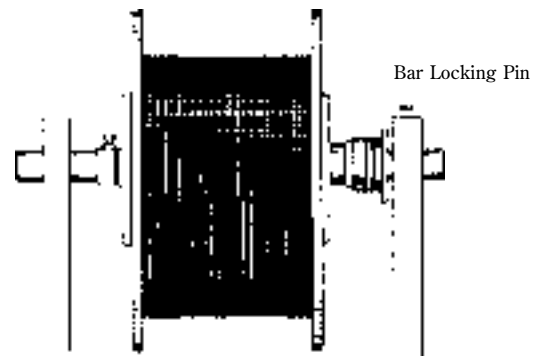
Figure 4.
Cable Blocks



REEL BRAKING

Before pulling the cable onto the strand, the reel should be braked so that as the cable pull is stopped, cable will not continue to pay off the reel and droop down between the reel and chute. The standard reel braking methods use an adjustable friction assembly to prevent over braking or under braking (Figure 5). The brake should be adjusted so that the reel can be turned using the strength of one hand. When the turning of the reel by hand is stopped, the reel should also stop. In some cases the reel weight is not uniformly balanced. Without braking, the reel will make another half turn if no brake is used.

Figure 5.
Adjustable Pressure Brake Assembly



PULLING THE CABLE

Cable Puller

The use of an anti-slack cable puller (Figure 6), which has a locking mechanism that grips the strand, is recommended to prevent slack from pulling back into the strand line when tension is removed from the pull line. As cable is pulled off of a reel it naturally untwists. Swivels are included on the cable puller to accommodate this untwisting so that when multiple cables are pulled, the cables will not cross over and tangle, which can result in flattening or kinking of the cable during lashing.

Pulling Tension

While pulling the cable to the strand, it is necessary that the pull begin slowly and smoothly and that a constant pulling force be applied during the pull. Even though the reel is braked, the tension should be slowly reduced as the run is being completed. Maintaining good clearance with overhead power lines is very important during the pull for obvious safety reasons. If the cable has slack between blocks and the cable is pulled too abruptly, the cable can whip up into the power lines.

Pulling Summary

The combination of steady pulling tension, reel braking, using a cable puller equipped with an anti-slack device and swivels, and properly spaced rollers will reduce the possibility of “wee-wahs” occurring, cable drooping down between rollers, and whipping up into power lines.

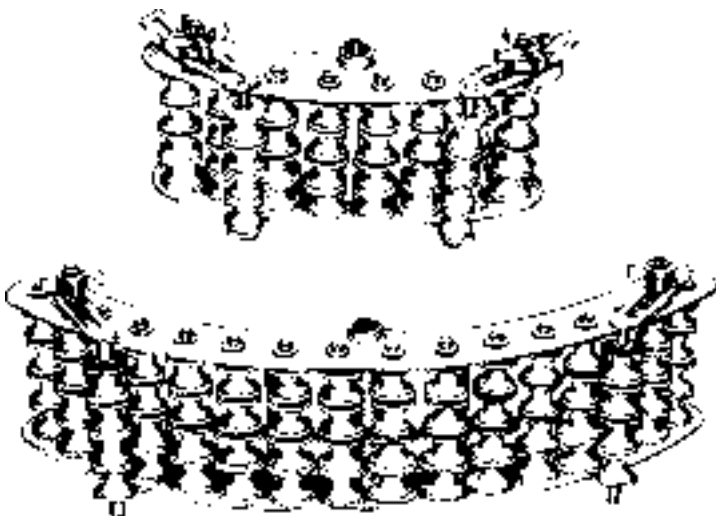
Figure 6.
Cable Puller With Anti-Slack Device



45° AND 90° TURNS

As the cable is pulled along the strand, 45° and 90° turns may be required. In general, such bends require an experienced crew who will pull the cable carefully, and the proper 45° and 90° corner blocks (Figure 7) for the cable to be pulled without being damaged. The corner blocks must be positioned so that the cable is tangent to the bend. If it is not tangent, the cable can be bent to the very small radius of first or last roller in the corner block. Tight bends can cause the cable to wrinkle or flatten as it exits the corner block.

Figure 7.
Typical Corner Blocks



Multiple 45° and 90° bends can be pulled but the true test is to not exceed the maximum recommended pulling force nor should the cable show any signs of flattening or wrinkling as it exits the corner block. If either of these conditions occur, the pull should be stopped and the next run pulled separately. If a 90° bend is anticipated in a run, it is better to have the bend near the start of the run rather than at the end. The reason is that the bend tends to multiply whatever the back tension is rather than simply add to the back tension.

CABLE PROTECTION

When an installation run is completed, any damage at the end of the cable should be removed and 30 inches of undamaged cable left for future use (Figure 8). A plastic cap should be used to protect the cable from moisture exposure both on the line and on the reel so any remaining length can be preserved for future use (Figure 9).

Figure 8.
30 Inches Of Cable Overlap For Future Equipment Installation

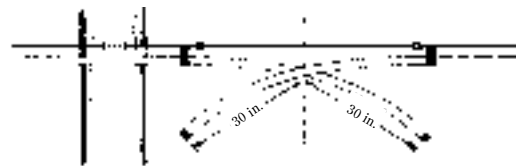
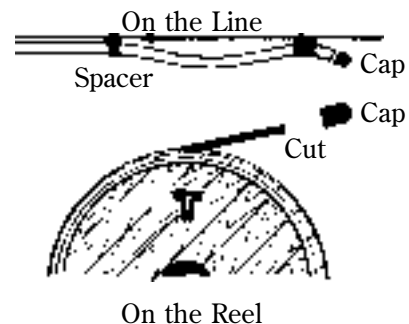


Figure 9.
Sealing Cable Against Moisture



LASHING

Lashing Wire Tension

The lashing machine is put in place and lashing of the individual spans begins. Internal tension of the lashing machine is controlled by routing the lashing wire around one or two wheels inside the lashing machine. The

tension should not be adjusted to maximum tension since cable damage has occurred when lashing tension has been too tight. The lashing wire itself is prone to fracture if installed too tight. In addition, the cable expands and contracts more than the steel strand so if the lashing wire is too tight, the cable will undergo cyclic stress that can cause the cable to become brittle and fatigue. Thus, the lashing wire should support the cable but not restrict the cable's movement. Routing the lashing wire around only one wheel in the lasher usually provides sufficient but not excessive tension.

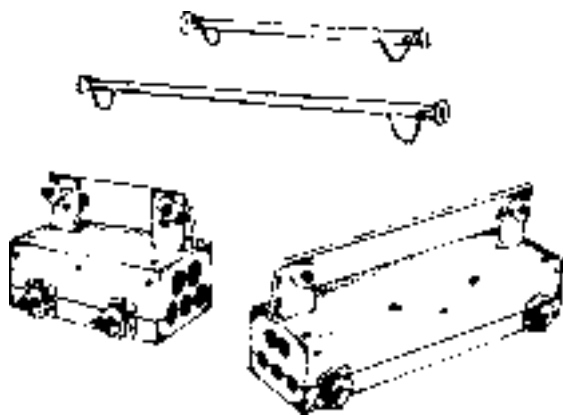
Lasher Pull Angle

The lasher should be pulled in a straight line without changing the angle the lasher is pulled. If the pull angle is changed abruptly, the cable will be pulled off to the same side as the lasher and the cable will appear to have a bend or wee-wah. In many cases obstructions prevent the lasher from being pulled at a constant pull angle over the entire span but smooth transitions in lasher pulling angle can minimize cable bending appearance problems.

Cable Straighteners

Some construction companies use a cable block pusher combined with a straightening box. These devices, which attach to or are pushed ahead of the lashing machine, push the cable blocks and help straighten the individual cables in front of the lashing machine and achieve a clean looking cable span. The lasher should not be allowed to slip backward, nor should the pulling tension be released until the man positioned at the pole has control of the lasher.

Figure 10.
Cable Block Pusher ("Shotgun"),
Cable Positioner, Cable Straightener



Double lashing should be used when two or more trunk cables are lashed together. Also, it is a wise precaution to double lash in locations where it would be particularly inconvenient to relash, such as over railroad crossings and highways.

The lashing wire should be wrapped two or three turns around the strand, starting 8 to 10 inches from the clamp, before feeding it through the clamp washers for attachment. To avoid snapping the lashing wire, do not allow it to overlap itself. The tail should be cut off and tucked back into the clamp for future ease of removal.

BANDS AND SPACERS

Spacers are intended to separate the cable from the strand and hardware attached to the strand such as lashing wire clamps and 3 bolt strand clamps. Separation is needed because as the cable expands and contracts it would otherwise abrade against the strand hardware and damage the cable. The band is used to hold the cable and spacers next to the strand. It should not be drawn down tightly on the cable. It should only cradle the cable.

TEMPERATURE EXPANSION AND CONTRACTION

The aluminum sheath of trunk and feeder cables has a linear coefficient of thermal expansion about twice that of a steel so the cable expands and contracts twice as much as the strand with temperature. The strand is allowed to expand and contract with temperature as evident by increases and decreases in sag. That is unless the sag is so tight to begin with that the sag can only change a small amount. The expansion and contraction of the strand accommodates some of the change in length of the aluminum cable but the remainder, however, must be taken care of by expansion loops.

The life and reliability of the cable plant are a function of the temperature changes, length of the spans, the amount of sag, and the depth of the expansion loops. Although we have no control over the temperature changes, and only some control over the span lengths, we do have control over the how much sag is installed and the depth of expansion loops. A separate Technical Note (1049) "Performance of Expansion Loops" goes into the details of the importance of expansion loop depth and proper sag. These two factors, more than any others, control the life of the cable.

Cable Movement

The following table illustrates the net cable movement which must be accommodated for a single 0.750 inch trunk cable lashed to a 0.25 inch steel strand with the pole spacing of 150 feet.

Table 1.

Cable Movement

Initial Sag @ 60°F	@ -40°F	@ +130°F
0.5 percent	- 2.68 inch	+ 1.75 inch
1.0 percent	- 2.40 inch	+ 1.36 inch
1.5 percent	- 2.00 inch	+ 1.19 inch
2.0 percent	- 1.71 inch	+ 1.13 inch

Note that there is substantial cable movement due to temperature. Note also that there is substantially more movement if the sag is tight. If expansion loops are used at every pole location, the cable has a better chance of providing reliable operation.

Cable And Center Conductor Tension

If expansion loops are omitted, or cable movement is restrained, the length changes are translated into relatively severe tension forces at low temperatures. Using the previous table of a single 0.750 inch trunk cable installed at 60°F with zero initial cable tension, the following forces result at -40°F.

Table 2.

Tension at -40°

Initial Sag @ 60°F	Strand (pounds)	Sheath (pounds)	Conductor (pounds)
0.5 percent	1658	1123	387
1.0 percent	954	967	345
1.5 percent	474	712	277
2.0 percent	48	413	202

Table 2 illustrates the problems of installing a cable plant with tight sag and with insufficient or ineffective expansion loops. The tension on the aluminum sheath and center conductor is very high. Predictable consequences of high tension include severe stress on both fittings and electronic devices, center conductors and/or radiation

sleeve pullout, broken conductors and housings, intermittent or degraded signal quality, ghosting, and other interference, including complete power failure. It should be noted that thermal expansion as the temperature increases can also cause unsightly cable waves (wee-wahs) and buckling if the sag is too tight, or if the loops are inadequate, or if cable movement is restrained.

Problems with thermal contraction become progressively worse when the initial plant is installed at temperatures higher than 60°F, when pole spacing is increased beyond 150 feet, or the sag is decreased below 1.5 percent.

Figure 11.

1.5 Percent Finished Sag at 60° F

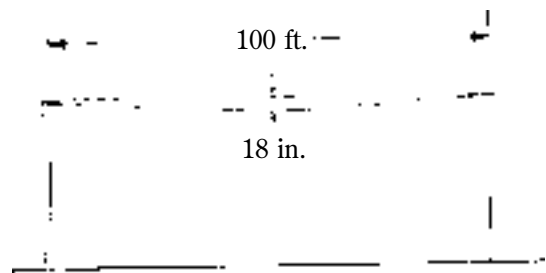


Table 3 illustrates some typical 1/4 inch steel strand tension forces resulting in a 1.5 percent sag at 60°F at various pole spacings with typical cable configurations.

Table 3.

Strand Tension (pounds)

Cable Configuration	100 feet Pole Spacing	150 feet Pole Spacing	200 feet Pole Spacing
Single T10500J Feeder	188	282	377
Single T10750J Trunk	284	426	568
T10750J Plus T10500J	366	549	732
Single T10625J Feeder	228	343	457
Single T10875J Trunk	342	514	685
T10875J Plus T10625J	464	696	928

It is TFC's recommendation, based on field experience, laboratory testing and engineering analysis, that the minimum finished sag in a CATV plant should be 1.5 percent at 60°F. As mentioned above, sag and tension tables are available to help properly install the cable.

EXPANSION LOOP CONSIDERATIONS AND LOCATION

Expansion Loop At Every Pole

TFC recommends the use of properly designed and correctly formed expansion loops at every pole. When multiple trunk and feeder cables are included in the same run, all the cables should have an expansion loop at every pole.

Expansion loops may be located either directly at the pole, or to either side. Advantages of direct pole location include convenient cable spacing away from the strand clamp without requiring spacers, physical protection from severe wind and weather conditions, and handling ease if using a tool for loop formation. Disadvantages are that loops at the pole may be accidentally grabbed by hand which could result in cable damage.

Using a loop forming tool can be convenient if located immediately to one side of the pole or the other. Either location can work reliably, provided an expansion loop is located at or adjacent to each pole.

Expansion Loop On Each Side Of Stationary Equipment

If the cable is connected to equipment that is clamped to the strand, expansion loops should be installed on both sides of the equipment. When a device is located at a pole, the loops at the device are the only ones necessary (Figures 12, 13, 15, 16 & 17). In the case of multiple cables and where equipment is installed, only the cables connected to the equipment require an expansion loop on both sides of the equipment.

Multiple Expansion Loops

In order to handle the increased expansion of long spans over 200 feet or where extreme temperature swings are anticipated, the installation of an additional loop is recommended (Figure 14).

EXPANSION LOOP FORMING TOOLS

There are many expansion loop forming tools available to form flat bottom expansion loops that provide long life service in the field. TFC has evaluated the tools to confirm the quality of the expansion loops. Two manufacturers that provide tools that have been proven effective for use with T10 and TX10 trunk and feeder cable are listed as follows:

LEMCO Tool Corporation

RR 2 Box 330A
Cogan Station, PA 17728

Jackson Tool Systems

7555 Jack Lane
Clayton, OH 45315

Other loop forming tools may also be used as long as they:

1. do not cause the outer conductor of the cable to be wrinkled,
2. provide at least 6 inch depth, and
3. are at least 42 inches long.

No matter which forming tool is used, proper installation techniques must be employed. If either the expansion loop is not formed properly or a portion of the cable is pulled out after the tool has been removed, the expansion loop may not have adequate depth, and sheath cracking may occur prematurely.

For proper forming, mechanical bending tools should be used instead of loops formed by hand. Flat bottom bending boards are not recommended because the cable must be bent by hand into the bends.

Figure 12.
Typical Expansion Loop Offset From Pole

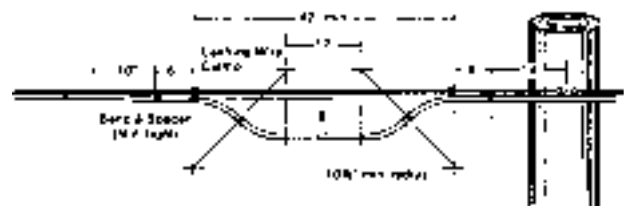
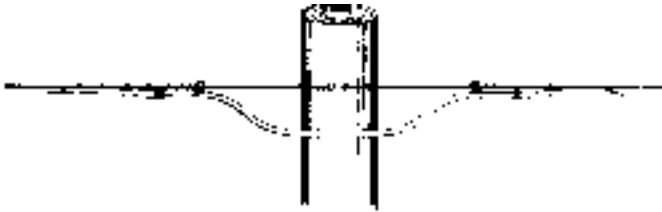


Figure 13.
Typical Expansion Loop
Directly On Pole



After the loop is formed, the spacer and band is installed as described above. (See Band and Spacer Section.) The cable is then lashed to the spacer and the lashing wire is secured on one side. The lashing wire should be wrapped around the strand three times and then tied off at the lashing wire clamp. This allows movement during expansion and contraction.

Following completion of one side of the expansion loop, the lasher is moved over to the other side and set up for the next run. The expansion loop forming tool should not be removed until the lasher is about 50 feet from the loop or it may pull some of the cable out of the loop. If cable is removed from the loop, the loop will be shallow and ineffective.

Figure 14.
Double Loop Over 200 Foot Spans

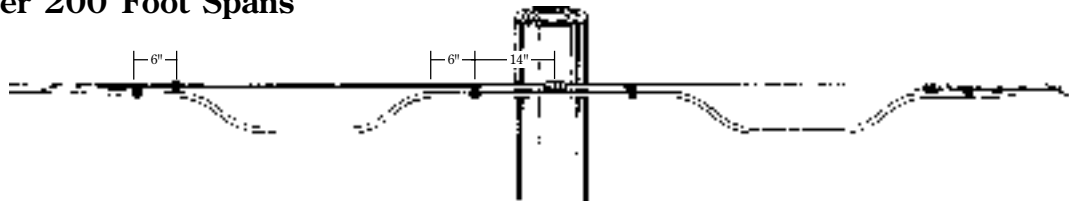


Figure 15.
Double Loop At Tap

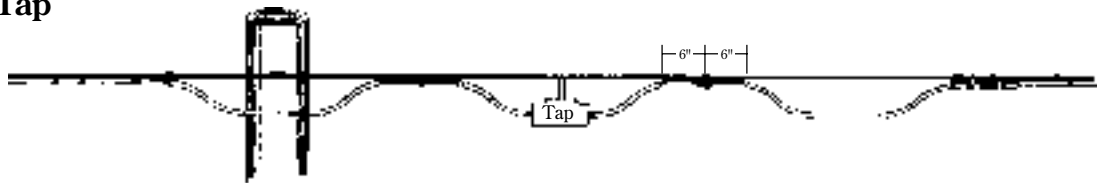


Figure 16.
Double Loop At Amplifier Location

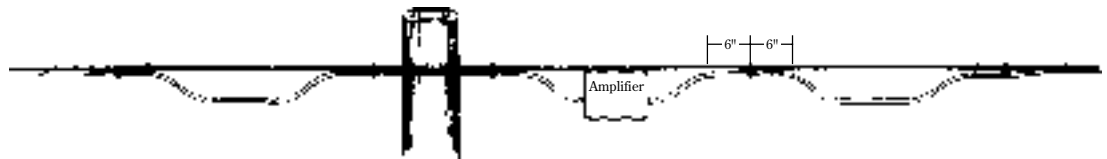


Figure 17.
Dual Cable

