# Installation Guideline
# Medium Voltage Cables

## Overview

This Installation Guideline contains recommendations for handling and installing LS Cable & System U.S.A., Inc. Medium Voltage cable products in commercial, industrial, and utility environments. These guidelines are designed to help ensure a successful installation. Failure to adhere to any of the applicable guidelines may void the product warranty.

## Confidential and Proprietary Statement

The information included in the Installation Guideline is intended to be used for LS Cable & System U.S.A., Inc. cables only.

## Pre-Installation Checklist

**Code Review**

- Review all applicable local, state, provincial, and national codes relating to cable installation.
- Consult local inspection authority Cable Inspection.
- Check for shipping damage before accepting shipment. Record any damage on the way bill.
- Confirm that the cable specified was received.
- Verify that the cable end seals are intact.

**Cable Handling**

- Remove nails and staples from reel flanges.
- Calculate and comply with recommended bending radii.
- Use swivels, and avoid overruns when unreeling by utilizing a reel brake or back tension Cable.
- Storage
- Provide firm support for reels.
- Protect cable from mechanical damage and from liquid spills.
- Check cable end seals periodically.
- Advise all splicers, installers and handlers of all special instructions.

## Installation Assessment Checklist

The following is a recommended checklist for selecting the appropriate conductor and conduit based on the application and environment.

This checklist also provides steps to evaluate your selection.

- Conductor Type: Select a conductor type based on your application and the conductor ratings and listings.
- Conduit Size: Determine the conductor size required based on your application and conductor ampacity.
- Reel Size: Determine the maximum reasonable cable length that permits proper on site handling, accounting for weight and dimensions.
- Conduit Size: Select conduit size based on required fill, clearance, jamming, and applicable codes and standards.

- Conduit Layout: Determine an initial conduit layout based on NEC® compliance and reasonable expectations of pull length.
- Maximum Tension: Calculate maximum allowable tension based on either cable stress or pulling device limitations.
- Jamming Probability: Calculate weight correction factor (ω) and jamming ratio.
  - Does the jamming ratio indicate a likelihood of conductor jamming? If so, increase the conduit size to alleviate this issue.
- Pulling Tension and Sidewall Pressure: Calculate pulling tension (T) and sidewall pressure (SP) for each segment.
- Verify: Compare calculated results to established limits.
- Redesign Pull: If limits are exceeded, consider one or more of the following:
  - Increase bend radii
  - Decrease fill
  - Reduce number of bends
  - Reverse pull
  - Pull in stages
  - Decrease length of pull

## Installation Checklist

1) Installing in cold weather: As a general guideline, prepare cable beginning with a minimum of 24 hours at or above 18°C (65°F) and increase the duration and/or temperature as needed to obtain the desired handling characteristics.
2) Conduit Free of Debris: Was the conduit proofed using a mandrel to remove any debris and ensure the conduit is free from obstructions?
3) Rollers and Sheaves Properly Installed: Are the rollers and sheaves the appropriate size to meet the minimum bending radius of the conductor and limit excessive sidewall pressures?
4) Tugger Properly Setup: Must the conductor be pulled across a roller on the tugger? If so, is the roller on the tugger of sufficient size for the conductor's minimum bend radius and sidewall pressure?
5) Reels Damage Free: Have the conductor reels been inspected for damage during shipping?
6) Conductors Freely Payoff Reel: Are the conductor reels setup in an area that permits the conductor to payoff freely?
7) P**ull Rope Properly Attached**: Is the appropriate pulling device, based on the expected pulling tensions, installed properly on the conductor ends?
8) Conductor Lubrication: Has the conductor been sufficiently lubricated?
9) Proper Terminations: Are the equipment terminations properly sized and rated for the Conductor?

## Temperature Rating

Due to dynamic forces at play during installation, Energy cables often have stricter temperature ratings for installation than allowed for storage/shipping and/or operation. To ensure that all the cable materials are safely within the installation temperature ratings, cables may need to be temperature conditioned immediately prior to installation. The conditioning time required will vary with the temperature differential (greater differential means more conditioning time) and package size (longer lengths require more time). If in doubt, allow a minimum of 48 hours in the allowed temperature range. The allowed installation temperature ranges is printed on most packaging, available in our product catalog, or by contacting our LS Cable & System U.S.A., Inc. Tech Support at 1.800.249.0014 or Energy.TechSupport@spsx.com.

## Storage procedures

Where possible, reels should be stored indoors on a hard, dry surface. If reels must be stored outside they should be supported off the ground and covered with a suitable weatherproof material.

--- Reels should be aligned flange to flange.

--- Each reel should be chocked for safety.

--- Reels should be stored in a position to permit easy access for lifting and moving.

When cable lengths are cut from a master cable reel, all exposed cable ends should be resealed with plastic weatherproof caps or tape to prevent the access of moisture into the cable assembly.

## Lubricants

We do not have a list of approved lubricants. Any commercially available pulling lubricant that is UL and/or CSA Listed and has been verified compatible with PVC jackets per IEEE Std 1210, Standard Tests for Determining Compatibility of Cable-Pulling Lubricants with Wire and Cable is acceptable. A few products that meet this requirements are Polywater J, Dura-Line Hydralube F-300i, and Ideal Industries Yellow 77.

## Coefficient of friction

0.50 = Dry cable in ducts
0.35 = well lubricated cable in ducts

## Conduit cleaning

Obstructions in the conduit will increase installation tensions and may result in damage to the conductors. Contractors should never assume that conduits are free of any type of dirt, concrete or obstructions. A correct size cleaning mandrel should be pulled through the conduits prior to starting the installation to ensure they are free of any obstructions.

## Moisture seals

Moisture seals are applied on all medium voltage cables shipped from LS Cable & System U.S.A., Inc. We recommend that contractors & distributors reinstall a moisture cap, preferably a heat shrink type cap to any cables remaining on the reel or cables that have been pulled by not terminated in a timely manner.

## Maximum allowable pulling tension

Following IEEE 1185 (2010) section 4.5, the formulas to calculate the maximum allowable pulling tension by conductor are:

- For configurations with up to 3 conductors: Tm = K x n x CMA
- For configurations with more than 3 conductors: Tm = K x n x CMA x 0.8

Tm is the max pulling tension in lbf[1]

K is a constant

- 0.008 for copper
- 0.006 for aluminum

n is the number of conductors (1 for single conductor)

CMA is the circular mil area of one conductor)

[1]this is the value of the maximum tension that can be placed on the cable or a group of individual cables at one time.

| Maximum Allowable Pulling Tensions (lbs) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Area | Copper Conductors | | | | Aluminum Conductors | | | |
| AWG/ kcmil | 1 cdr | 2 cdr | 3 cdr | 4 cdr | 1 cdr | 2 cdr | 3 cdr | 4 cdr |
| 2 | 531 | 1062 | 1593 | 1699 | 398 | 796 | 1194 | 1274 |
| 1 | 670 | 1339 | 2009 | 2142 | 50 | 1004 | 1506 | 1607 |
| 1/0 | 845 | 1690 | 2534 | 2703 | 634 | 1267 | 1901 | 2028 |
| 2/0 | 1065 | 2130 | 3194 | 407 | 799 | 1597 | 2396 | 2556 |
| 3/0 | 1342 | 2685 | 4027 | 4296 | 1007 | 2014 | 3020 | 3222 |
| 4/0 | 1693 | 3386 | 5078 | 5417 | 1270 | 2539 | 3809 | 4063 |
| 250 | 2000 | 4000 | 6000 | 6400 | 1500 | 3000 | 4500 | 4800 |
| 300 | 2400 | 4800 | 7200 | 7680 | 1800 | 3600 | 5400 | 5760 |
| 350 | 2800 | 5600 | 8400 | 8960 | 2100 | 4200 | 6300 | 6720 |
| 400 | 3200 | 6400 | 9600 | 10240 | 2400 | 4800 | 7200 | 7680 |
| 500 | 4000 | 8000 | 12000 | 12800 | 3000 | 6000 | 9000 | 9600 |
| 600 | 4800 | 9600 | 14400 | 15360 | 3600 | 7200 | 10800 | 11520 |
| 750 | 6000 | 1200 | 1800 | 19200 | 4500 | 9000 | 13500 | 14400 |
| 1000 | 8000 | 16000 | 24000 | 25600 | 6000 | 12000 | 18000 | 19200 |
| 1500 | 12000 | 24000 | 36000 | 48000 | 9000 | 18000 | 27000 | 36000 |

Data for multi-conductor configurations are based on same conductor size, and parallel or multiplex.

Because pulling tensions are subject to the configuration of the pull (straight, 90° or 45° angles) please have them refer to the IEEE 1185, or use a pulling tensions calculation software like the one Polywater J has (http://www.polywater.com/pullplan.html).

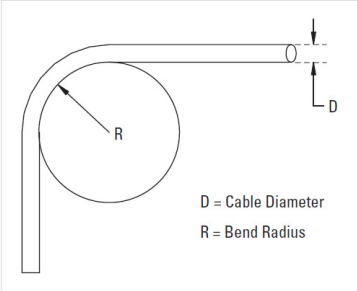
## Bend Radius

Cable is rarely installed perfectly straight from point to point. Accordingly, energy cables are designed to bend, but as with pulling tension, there are limitations to bend radius that must be observed.

## Minimum Cable Bend Radius = Multiplier x O.D. of Cable.

| MINIMUM BEND RADIUS FOR NON-SHIELDED, NON-ARMORED CABLES | | | |
|---|---|---|---|
| Thickness of Insulation (mils) | Multiplier for cable O.D. < 1 in. | Multiplier for cable O. d. 1-2 in. | Multiplier for cable O.D. > 2 in. |
| < 69 | 4 | 5 | 6 |
| 169 - 310 | 5 | 6 | 7 |
| > 310 | - | 7 | 8 |

| MINIMUM BEND RADIUS FOR SHIELDED CABLES | |
|---|---|
| Type of Shield | Multiplier |
| Tape | 12 |
| Wire | 8 |
| Interlock Armor | 7 |




## Allowable Sidewall Pressure

Sidewall Pressure is the force that is exerted on the cable as it is pulled around an elbow or sheave wheel. The sidewall pressure that is exerted on the conductors insulation as it works its way around elbows will be the main limiting factor in most installations. Please reference the following chart with the published maximum (foot/lbs) of force that each cable type can handle

| SIDEWALL BEARING PRESSURE (SWBP) | |
|---|---|
| Cable Type | SWBP in (lbs/ft) |
| 300 Volt--Non Shielded; 300V & 600V Shield Control & Instrumentation | 500 |
| 600 Volt--Non Shielded Control & Instrumentation | 500 |
| 600 Volt & 2400 Volt--Non Shielded Power | 500 |
| 5 kV through 35 kV (Medium Voltage)--Shielded Power | 500 |
| Interlocked Armor Type Cables--(Any voltage) | 300 |
| Continuously Welded Armor Type Cables | 500 |

## Crush Resistance

Crush resistance is a very important attribute that is easily quantifiable in a test laboratory but difficult to predict in an installation environment. Energy cables are designed to withstand crush, but there are limitations that must be observed (although difficult to quantify). Crushing a cable can cause many issues from temporary, intermittent anomalies to permanent failure. Below are several caveats regarding the crushing of cables:

- Beware of other locations that may constrict cables or conductors and put them at risk for damage.

## Testing for and purging moisture

### Purging Cable Strands with a Dry Nitrogen Gas

From your local welding supply store acquire a tank of dry nitrogen. You will also need a regulator to reduce gas pressure from between 15-25 psi; adequate length ¼" gas hose; nipple to connect hose to regulator & clamps; cable cap that will fit snuggly over the "cable core" and large enough clamp to attach this cap; several plastic bags (1-gallon size recommended) to enclose gas exit end of cable.

Also, a standard tire valve (no valve core installed) to connect hose to cable cap.

The last item required will be a color indicating desiccant (Silica Gel or anhydrous cupric sulfate). You should be able to obtain the desiccants from a laboratory supply house or possibly from your local distributor. When exposed to moisture these desiccants will change color from usually blue to pink or off-white.

If only one end of the cable contains water –apply purging gas to the dry end. If both ends are wet—apply purging gas to the higher end. All terminations and splices should be removed before starting purging process. If cable is on the reel, untie the ends and drain any excessive water from the cable. Then position the inside end of the cable assembly to its lowest position. Always purge the cable strands separately from the shield. The nitrogen gas will always take the path of least resistance.

Cut a hole in the cable cap and install the valve stem. Install cap to high end of the cable and apply two layers of half-lapped electrical tape to attach cap to the cable. Install hoses to the tire valve and then connect to the regulator. Apply a pressure of 15-25 psi to the other end of cable. If water is not dripping out of the other end of the cable, sprinkle a tablespoon of desiccant and attach the 1-gallon bag to the exhaust end of the cable. Tape or clamp the bag securely to the cable. Check to see that the bag is filling with nitrogen. If so, cut a small whole in the corner of the bag. After a few hours check the color of the desiccant. If it has changed from blue to pink or off-white then moisture is present inside the cable. Replace with new desiccant and continue the purging process. Check the desiccant every few hours until the color remains blue. At this point—you can assume the cable is dry.

Depending on the amount of moisture in the cable purging can take up to eight hours or longer. One cylinder of nitrogen should be sufficient for at least one complete cable run.

Moisture can also be driven from the cables by applying a light electrical load using low voltage & low current. However, this process will not dry out the shield assembly. The terminations must be removed from the cable ends and the cable must have an open strand design to permit the evaporation of the water vapors.

As stated earlier, purge the insulated strands separately from the tape shield. If not, the gas will take the path of least resistance

## Purging Cable Shield

Follow the above process with the following changes:

- Block the conductor strands so that no gas can pass through them.
- Acquire a cable cap that will fit snuggly over the “cable jacket” rather than the “cable core”.
- Apply a maximum gas pressure of 15 psi and check for moisture using the above procedure.

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