CABLE LUBRICANT APPLICATION GUIDE FOR ELECTRICAL CABLE

This practice describes the procedure for effective and safe use of Polywater® cable lubricants for pulling cable, wire and innerduct into conduit or duct.

PLANNING AND LUBRICANT USE

1) Lubricant use is an important part of cable installation in conduit. Cable lubricants will reduce the coefficient of friction resulting in lower ending pull tensions and sidewall pressure. Installing cable with the least amount of tension will lengthen the life of your network and reduce wear and tear on your equipment.

   Cable lubrication is recommended for cables that are intended to be re-pulled, for pulls longer than 15 ft (4.5 m), or for pulls that have more than 90° of total bend.

2) Planning the pull is an important part of the installation process. Polywater's Pull-Planner™ software supports planning activities by estimating ending tension and sidewall pressure. It checks cable clearance and performs cable jamming probability calculations. It helps analyze the impact of pull direction and requirements for pull boxes. Consider the following before performing any work:

   - For long conduit or duct bank pulls, preplan the direction of cable pulls by performing cable pulling calculations in both directions. Check cable clearances by doing jamming, bend radius, and sidewall pressure calculations prior to pulling any cable.
   - Plan to have sufficient cable, pulling lubricants, and cable pulling accessories (shims, sheaves, rollers, ropes, etc.) available prior to performing any work.
   - Plan duct inspection and cleaning activities well in advance of cable pulling activities to determine the condition and suitability of the ducts for use.
   - Plan confined space inspection and test activities for combustible and toxic gases, water, and energized cables sufficiently in advance to make necessary preparations.
   - Plan the cable setup area to be sure that it is of adequate size to accommodate the equipment needed. This should also help ensure that pulling equipment is positioned to support the planned pull. Sometimes physical constraints will only allow pulling from one direction.
   - Avoid routing cables near oil reservoirs, hydraulic oil storage areas, etc., since potential leakage of petroleum products can negatively affect cable jacket, shield, and insulation materials. Avoid routing cables in areas that may be subject to damage caused by future maintenance activities. If it is required to run cables through these areas, proper physical protection should be provided.
   - Avoid routing cables near hot pipes (even insulated pipes) because the heat from pipes can cause accelerated aging to localized cable sections, which can lead to long-term failure points. As required under NEC, Article 300.8, "raceways or cable trays containing electric conductors shall ***not*** contain any pipe, tube, hose, or equal for steam, water, air, gas, drainage, or any service other than electrical."

LUBRICANT SAFETY

Polywater lubricants are slippery when spilled on non-absorbent surfaces. Such spills should be covered with an absorbent material as soon as they occur.

Polywater lubricants are water based. Precautions should be taken when working around energized cables because these lubricants are electrically conductive.

Polywater lubricants are non-irritating and non-sensitizing. Contact with human skin is not harmful.

LUBRICANT COMPATIBILITY

Lubricant compatibility with cable insulation and jacket materials should be checked before use. Lubricant compatibility testing is described in IEEE Std 1210 and UL Subject 267. Cable lubricants should not support combustion, emit toxic gases, or harden after the cable installation is complete.

Polywater lubricants have been tested for compatibility and are approved by cable manufacturers.

RECOMMENDED LUBRICANT QUANTITY

The recommended amount of lubricant is dependent on the size and length of the conduit system into which the cables, wires or innerduct are being pulled. The following equation predicts a satisfactory quantity of Polywater lubricant for an average cable pull.

Q = k x L x D

- Q = quantity needed in gallons (liters)
- L = length of the pull in feet (meters)
- D = I.D. of the conduit in inches (mm)
- k = 0.0015 (0.0008 if metric units)

Quantity appropriate for complex pulls should be increased from the above recommendation by up to 50%. Consider the following factors:

- Conduit type and conditions – increase quantity for old, dirty or rough conduits.
- Conduit fill – increase quantity for high percent conduit fill.
- Number of bends – increase quantity for pulls with several bends.
- Pulling environment – increase quantity for high temperatures.

**Do not add water to increase lubricant quantities. This can affect the lubricant's coefficient of friction, cable tension, and sidewall pressures during the cable installation.*

Table A provides quantities calculated from the equation based on pull length and conduit size.

Table A Recommended Quantity in Gallons/Liters

LENGTH	CONDUIT ID inches/mm			
ft/m	2/50	3/75	4/100	5/125
100/30	0.3/1.2	0.45/1.8	0.6/2.4	08/3.0
500/150	1.5/6.0	2.25/9.0	3.0/12.0	3.8/15.0
1000/300	3.0/12.0	4.5/18.0	6.0/24.0	7.5/30
1500/460	4.5/18.4	6.8/27.6	9.0/36.8	11.3/46.0
2000/610	6.0/24.4	9.0/36.6	12.0/48.8	15.0/61.0
2500/760	7.5/30.4	11.3/45.6	15.0/60.8	18.8/76.0

***General guidance is to use 1 gallon lubricant per 100 feet (3.7 liters per 30 m) cable installed.*

LUBRICATION METHODS

There are several methods to lubricate cable and conduit systems:

- Lubricant can be pumped or packed into the conduit *before* the pull. It is most effective if lubricant is spread with a mandrel in front of the cable grip.
- Lubricant can be pumped onto the cable using a special spray collar or feeder tube at the mouth of the conduit, duct, or feeder tube. Polywater's LP-D5 Pump works well with Polywater lubricants.
- Front End Packs™ can be attached to the pulling line to deposit lubricant ahead of the cable. For maximum friction reduction, Front End Packs can be used to prelubricate the conduit by attaching to the back end of the pulling line as it is installed into the conduit.
- High-viscosity gel lubricant can be placed into a feeder tube to coat the cable when it passes through it. Alternatively, pour lower viscosity lubricants into the conduit, duct, or feeder tube.
- Lubricant can be placed directly on the cable jacket by hand. This is the most widespread practice. Use caution during hand application. Apply lubricant to the entire circumference of the cable as it enters the conduit or duct opening.

GENERAL CABLE INSTALLATION GUIDANCE

- Keep conduits clean and clear for successful cable and innerduct installation. Conduits blocked with ice, debris, or by collapsed or displaced sections, are often impossible through which to pull with or without cable pulling lubricant. Conduits should be thoroughly cleaned with stiff bristled brushes and proven with a mandrel to test clearance prior to installing the cable.
- Make sure there is enough lubricant to complete the installation. Once the pull has started, it should not stop. It is hard to get the cable moving once it stops. Continue to apply lubricant throughout the pull.
- Position cable reels directly over the conduit or vault opening. Assist the cable from the reel to the conduit to eliminate back tension.
- Cable should be protected and guided from the cable reel into the raceway by a suitable means. Do not exceed the minimum bend radius of the cable. Attach a swivel between the pulling eye and pulling line to prevent the cable from twisting.
- All sharp edges between conduit joints should be removed. Any sharp points from the attachment hardware should be taped or properly secured. Insert cable guides or a feeding sheave into the conduit opening to help guide the cable.
- At the end of the pull, use a rag to remove the excess lubricant from the cable. Hold the rag tightly around the cable to remove (squeegee) the lubricant from the cable jacket. Continue and repeat the process as needed with a fresh rag until cable is clean and dry.

LUBRICATION PROCEDURE

1) Conduits should be thoroughly cleaned prior to installing the cable. Any abrasive or sharp edges, which might damage the cable, should be removed.
2) Place approximately two-thirds of the recommended quantity of lubricant into the conduit. Use the Polywater Front End Pack lubricating system or load the lubricant directly into the conduit by hand application, pouring, or pumping.

3) Use a lubricant spreader, flexible steel mandrel, disc mandrel, swab, or attach a sponge/rag to the pulling eye to push and spread the lubricant throughout the conduit system during the pull. The spreader should fit snugly inside the conduit to distribute the lubricant evenly throughout the conduit.

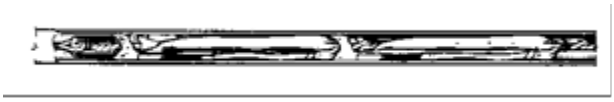
4) Directly lubricate the cable or wire during the entire portion of the pull. It is best to try to coat the entire top and bottom of the cables or wires as they enter the conduit. It is especially critical to lubricate the head end of the cable. To keep the pulling hardware clean, tape heavy plastic around the mesh cable grip or the pulling eye. Once the installation is completed, remove the wrap for immediate removal of the pulling hardware.

5) The conduit can also be prelubricated from the back end of the cable pull to the front end by reversing the above procedures. Attach the Front End Packs to the pulling tape or winch line and pull the tape or winch line towards the cable reels. Then remove the Front End Packs and attach the cables to the winch line. Add lubricant onto the cables as they are pulled back through the conduit. Alternatively, pour the lubricant into the conduit at the back end of the pull and use the lubricant spreader to distribute the lubricant towards the front end of the cable pull where the cable reels are located.

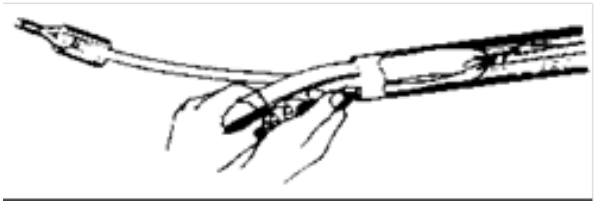
LUBRICATION PROCEDURE -- FRONT END PACK SYSTEM

1) Attach Front End Pack(s) to the winch line in front of the cable. Fasten with tape or cable tie inserted around the pulling line and tighten behind the metal clip.

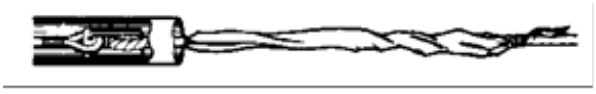
2) For pulls requiring multiple Front End Packs, the packs should be attached to the winch line in tandem.



3) Start the pull and **slit open the entire length of the pack(s)** with a sharp knife just as each pack enters the conduit. The opened Front End Packs will deposit lubricant in front of the cable as it is pulled through the conduit.



4) Empty Front End Packs can be removed and disposed as they exit the conduit at the end of the pull.



COLD WEATHER CONSIDERATIONS

Temperatures below freezing challenge all aspects of installing cable in conduits. Labor, equipment, conduit, cable, and cable lubricants are all affected by temperatures below freezing. Cable stiffness increases in cold temperatures, and this may increase pulling tension. A high-quality winter grade lubricant is a critical component for cold weather cable installation.

Polywater winter grade lubricants contain an anti-freeze solution to lower the freeze point. As the lubricant temperature drops below freezing, the lubricant will become thicker as slush begins to form. Polywater winter grade lubricants continue to perform at low temperatures, lubricating cable and lowering coefficient of friction. It is important to keep the lubricant as warm as possible before use. Larger packages take longer to thicken and freeze. Polywater's winter grade lubricants can be used down to -20° F (-30° C). Polywater lubricants do not phase out or separate after freeze/thaw cycling.

LUBRICATION PROCEDURE – ADDITIONAL GUIDANCE

Polywater uses multiple methods to test cable lubricant coefficient of friction. These include both research to maximize lubrication efficiency and collaboration with end users to help develop and understand best practices. Below is additional guidance for special installation situations.

HORIZONTAL PULLS WITH HIGH CONDUIT FILL

1) Place all the recommended quantity of lubricant in the conduit by using the Front End Pack lubricating system or by pouring, hand applying or pumping.
2) To help reduce the friction, make sure to pour or hand apply the lubricant directly onto the cable(s) or wire throughout the entire length of the pull.

WATER FILLED CONDUIT

1) Polywater® Plus Silicone™ Type NN is recommended for **water filled conduits** and **difficult** pulls. Type NN will cling to the cable or wire through water better than any other lubricant because of its silicone properties.
2) Use the same method and quantities discussed in the long pulling procedures. Polywater Plus Silicone Type NN is best applied by pouring it on cables as they enter the conduit. You can also pour it into the conduit and use a lubricant spreader to coat the duct prior to the cable installation

PULLS THROUGH INTERMEDIATE MANHOLES WITH OPEN CONDUIT

Use the access points to apply/reapply lubricant as necessary for maximum friction reduction. Proportion lubricant among the segments of the run. Use procedures described above, except treat each manhole as the beginning/end of a run. Hand application of the lubricant in long horizontal pulls with intermediate manholes is the preferred method of application.

CABLE PULLING LUBRICANTS

Polywater has a broad selection of lubricants for use in a wide range of applications. Some high-performance lubricant options are described below.

Polywater J

Polywater J lubricant is high-performing and slow drying. It provides maximum tension reduction in all types of cable pulling, especially in hot environments and multiple-bend cable installations. It is a semi-thick gel that can be pumped, poured, or hand applied. It is available in the Front End Pack package. It is also available in a pourable version, **Polywater PJ** and in a winter grade formula, **Polywater WJ**. For more information and installation videos, please see the product webpage: https://www.polywater.com/en/product/polywater-j-lubricant/

Polywater NN Plus Silicone

Polywater Plus Silicone Type NN provides superior friction reduction for difficult and long pulls. It is an excellent choice for underground transmission cable pulls. It is effective in continuous polyethylene conduit and for pulls in wet environments or through water filled duct. Polywater NN is a thin gel that can be poured or pumped into the conduit. It is available in a winter grade formula (**Polywater WNN**). For more information and an installation video, please see the product webpage: https://www.polywater.com/en/product/polywater-nn-lubricant/

Polywater LZ

Polywater LZ is designed to meet the requirements of critical power infrastructure and public transportation such as mass transit systems and airports. It is compatible with a wide variety of specialty cable jackets such as fire rated LSZH/LSHF, CPE, and CSPE. It is a semi-thick gel that can be pumped, poured, or hand applied. It is available in the Front End Pack package. It is also available in a pourable version (**Polywater PLZ**) and in a winter grade formula (**Polywater WLZ**). For more information and installation videos, please see the product webpage: https://www.polywater.com/en/product/polywater-lz-lubricant/

NOTES

Pull-Planner Software is a specialty calculator that sequentially calculates using the “pulling tension” equations to estimate cable tension. It is available for download; visit: https://www.polywater.com/en/pull-planner-2/

BIBLIOGRAPHY

IEEE 1185. 2019. Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities.

Cigre 194. 2001. Construction, Laying and Installation Techniques for Extruded and Self-Contained Fluid Filled Cable Systems.

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