Rejuvenation Instructions

#250 – Cable Constructions

This NRI covers the following:

- Standard medium-voltage cable construction
- EPR insulation medium-voltage cable construction
- Specifically manufactured medium-voltage cable constructions

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WARNING: It is dangerous working around energized high-voltage systems. Always work in accordance to the Novinium Field Operations Safety Handbook (FOSH) or other local governing safety standards.

engineering@novinium.com
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Novinium, Inc.
22820 Russell Rd Kent, WA 98032
(253) 395-0200

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Anatomy of an Underground Power Cable

Figure 1, below, shows the general construction of underground power cables. Typical distribution cables consist of several layers.

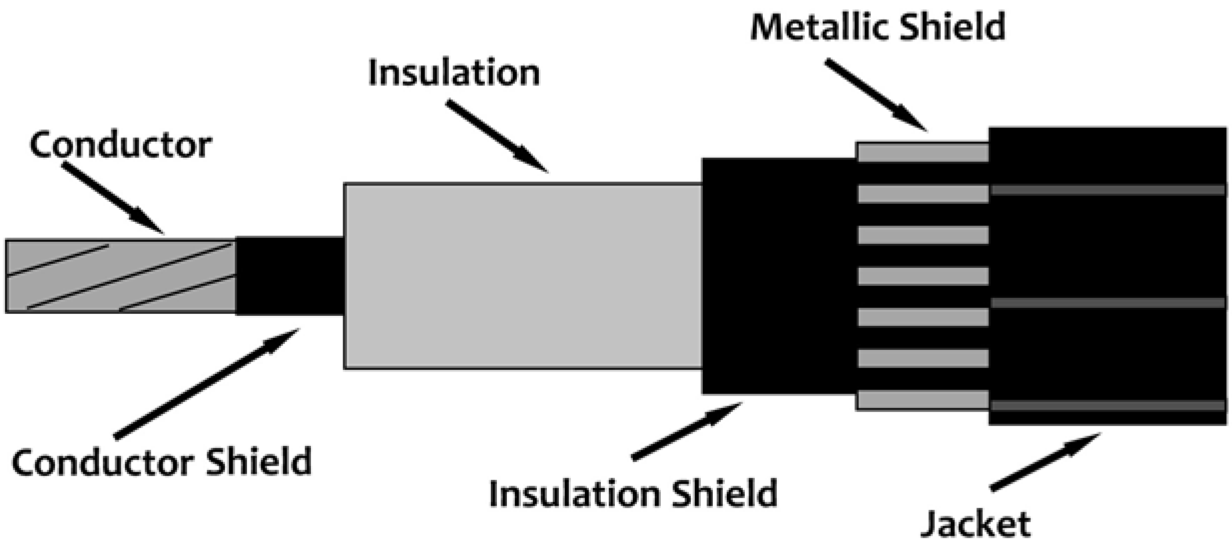

Figure 1: The typical construction of an underground power cable.

- The **conductor** is most often aluminum, but can be copper. Conductor can be a single solid piece, but is more often stranded. Cables with 19 or fewer strands are generally referred to as underground residential distribution (URD) or underground distribution (UD) cables and those with more than 19 strands are often called feeder cables.
- The **conductor shield** is a semi-conducting layer designed to smooth electrical stress evenly around the perimeter of the conductor. It is normally a semi-conductive carbon-black filled polymer.
- The **insulation** surrounds the conductor shield and is typically made of polyethylene (hard plastic) or rubber such as ethylene-propylene rubber (EPR). The insulation is also known as the dielectric.
- The **insulation shield** or screen is a semi-conducting material intended to evenly spread the electrical stress around the cable's circumference.
- The **metallic shield** or neutral makes direct contact with the insulation shield and is nominally at ground potential.
- The **jacket** protects the neutrals or metallic shield from mechanical damage and chemical damage, namely corrosion. The jacket is optional and generally not found on most pre-1990 vintage North American URD cables.

Conductor Compaction Types

1. Concentric Round Strand

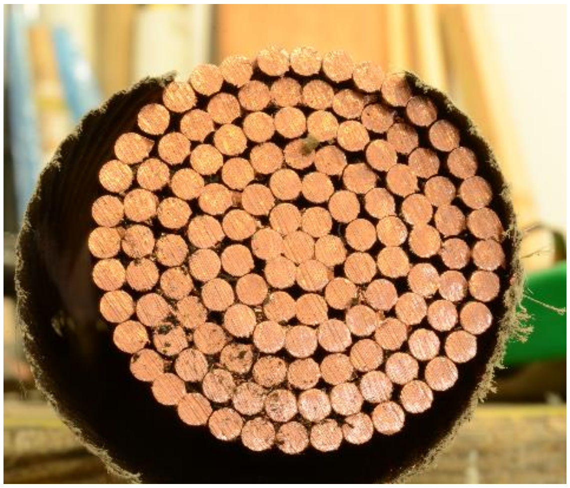

Figure 2: Example of concentric round strands.

Concentric round strands appear as round, uncompressed strands with plenty of space between each strand. This type of conductor typically holds the most fluid and is the least restricted for actual flow.

2. Compressed Strand

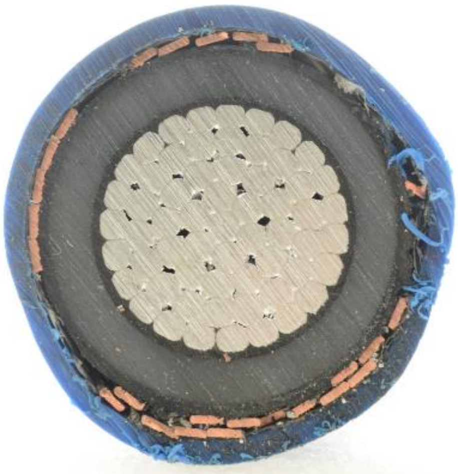

Figure 3: Example of compressed strands.

Compressed strands are mostly round with flattened conductor bundle edges. During manufacturing, the conductor bundle's diameter is reduced approximately 3% from the original concentric round diameter.

This compression causes the individual strands to deform slightly, and reduces the interstitial strand area through the conductor. Flow is restricted through the cable.

3. Compact Strand

Figure 4: Example of compact strands.

Compact strands are wedge-like in appearance as the conductor bundle is compressed into a round shape. During manufacturing, the strand bundle's diameter is reduced approximately 8-10% from the original concentric round diameter.

Flow through compact stranding is difficult and slow with a greatly reduced interstitial strand area.

This construction is more typical in the northeastern part of the United States and bordering Canada. Secondary construction is often compact stranding.

Conductor Shield Types

1. Extruded Conductor Shields

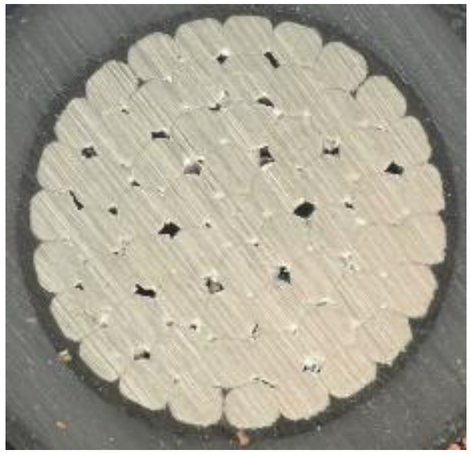

Figure 5: Example of an extruded conductor shield.

The extruded conductor shield is formed around the conductor bundle during manufacturing. Typically material similar to the insulation, it is a semi-conductive layer.

Fluid passes through this semi-con layer and continues into the insulation. Normal fluid calculations are performed with this type of conductor shield in mind.

Removal

Extruded shields are bonded to the insulation. Normal use of the insulation stripper will remove this layer.

2. Conductor Tape Shields

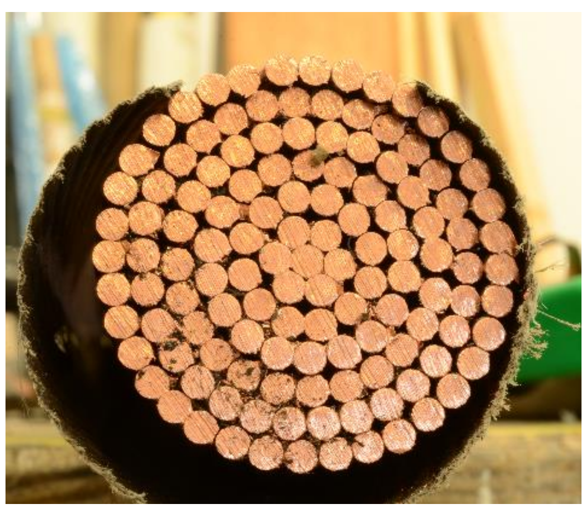

Figure 6: Example of a conductor cloth tape shield.

Cloth conductor tape shields take the place of the extruded semi-con shield. Tape shields readily absorb more fluid than the extruded kind, which makes noting this construction in Knomentous important.

Tape shields aren't formed around the conductor, creating open volume around the conductor for fluid flow.

Normal fluid calculations don't account for the fluid a tape shield will hold. The amount of extra fluid depends on the conductor size and compaction, potentially up to 50% more.

Removal

Cut and remove tape shields with scissors or a blade. Avoid damaging the conductor strands.

Insulation Types

1. –Polyethylene Insulated Cable (PE, HDPE, XLPE, TR-XLPE, etc.)

Figure 7: Example of polyethylene insulation.

Due to technological advances, there are many varieties of PE insulation all with similar properties. PE insulation is plastic and is more resistant to the fluid pressure inside the cable from injection.

Removal

Use the stock insulation stripping blade to remove PE insulation. As the blade cuts, the vertical edge of the blade pushes the insulation upward, clearing a path for the blade.

Figure 8: One type of XLPE stripper blade.

Injection pressures used for the SPR process are calculated normally following the steps in **NRI 352**. The low injection pressures for UPR and iUPR are also determined normally as in **NRI 351 and 352**.

2. Ethylene Propylene Rubber (EPR) Insulated Cable

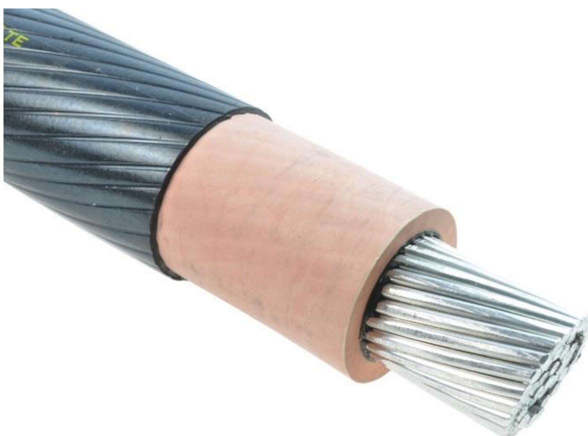

Figure 9: Example of EPR insulation.

There are many varieties of EPR insulation each a different color. EPR is similar to a pencil eraser.

Removal

Before working on the cable, change the insulation stripping blade to the EPR blade. The shape of the blade allows it to glide smoothly through the insulation during cutting.

Figure 10: EPR stripper blade.

Injection

EPR insulation is unable to maintain the same internal pressures as PE due to its material properties.

a. Use **NRI 352** to calculate the SPR injection pressures as normal.

b. Further reduce the pressures by dividing by 4 to find the final injection pressures.

    - This will typically reduce pressures to 60 psi and below.

- Cablecure 733 mixtures are prohibited from being used with EPR insulations.
- Cablecure iXL has restricted use depending on the cable size and interstitial strand volume. Contact Engineering for details.
- The low injection pressures for UPR and iUPR normally pose no danger to EPR insulation, and can be determined normally as in **NRI 351 and 352**.

Common Specific Cable Constructions

1. EPR Insulated, Non-Conductive Insulation Shielded Cable

Figure 11: A sample of the non-conductive shield.

Locations Encountered

- Colorado area

Construction

- Commonly, 5kV #4 AWG copper conductor and an insulation/insulation shield OD around 0.660”.
- This type of cable has a removable non-conductive insulation shield.
- Markings dictating not to remove are scribed on the insulation shield.
- Unlike most cables, the insulation shield is a non-conductive high-insulating layer.

Cable Preparation and Component Installation

a. Check the condition of the non-conductive shield by gripping and gently trying to slide down.

- If the non-conductive shield is loose, remove the shield to the normal semi-con cutback dimension as stated by the template used.
- If the non-conductive shield is tight against the insulation, removal is not required, and the semi-con cutback is skipped during preparation.
- If the component is too tight, it is possible the non-conductive shield will be bunch up causing a failure, which is typically instantaneous.
- Removing the shield during cable preparation typically won’t cause a failure.

Special Considerations

- iUPR applications may be impossible if the insulation shield is removed and a 167/168AELR repair length elbow is required. The 167/168AELR-6689 elbow can be used on cables as small as 0.665”.
- SPR is recommended for this smaller cable. The IA will typically hold the non-conductive shield tight and standard elbows with capacitive test points are available in the correct diameter range.