TRANSMISSION & DISTRIBUTION WORLD

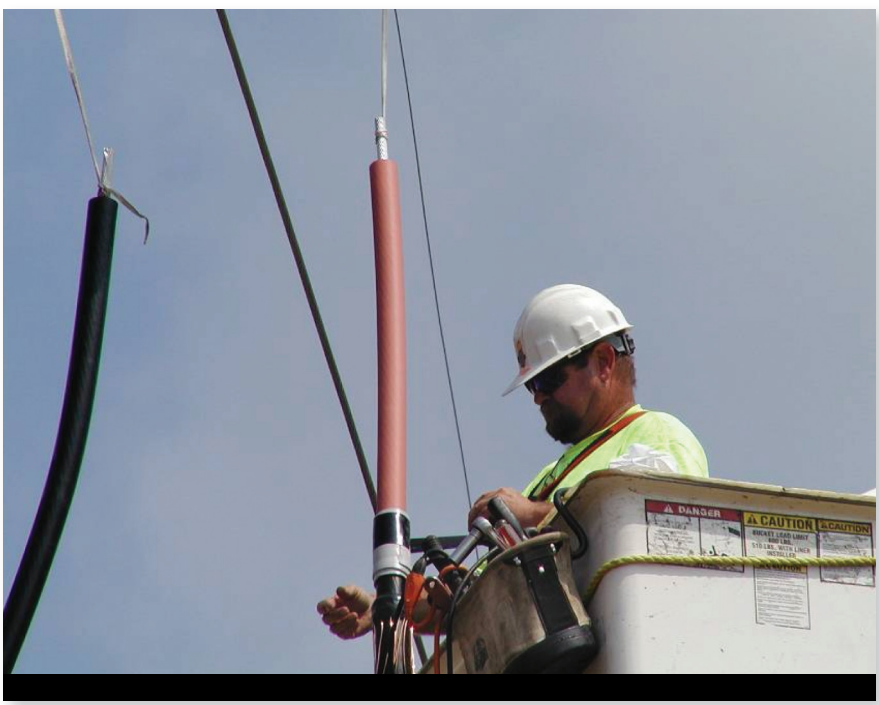
Ameren Warms Up to Cold-Shrink Terminations

Utility reduces steps required to terminate 69-kV ethylene-propylene-rubber cable.

By **Harry Hayes**, *Ameren Services*

TRANSITIONS FROM OVERHEAD TO UNDERGROUND CONSTRUCTION require a considerable amount of time for cable terminations. Ameren Corp. (St. Louis, Missouri, U.S) has adopted a new silicone-rubber cold-shrink termination system for locations where 69-kV facilities transition between buried and aerial distribution. This approach is proving to reduce installation time by half compared with the previous termination method.

Ameren serves 2.4 million electrical customers across a 64,000-sq-mile (166,000-sq-km) area in Illinois and Missouri, with 9069 employees and a net generating capacity in excess of 16,400 MW. The company's underground 69-kV facilities consist of specialized applications, such as where it is necessary to bypass obstacles in new power plant installations or when crossing beneath elevated roadways. The cables in these underground lines range from 500 kcmil to 750 kcmil.



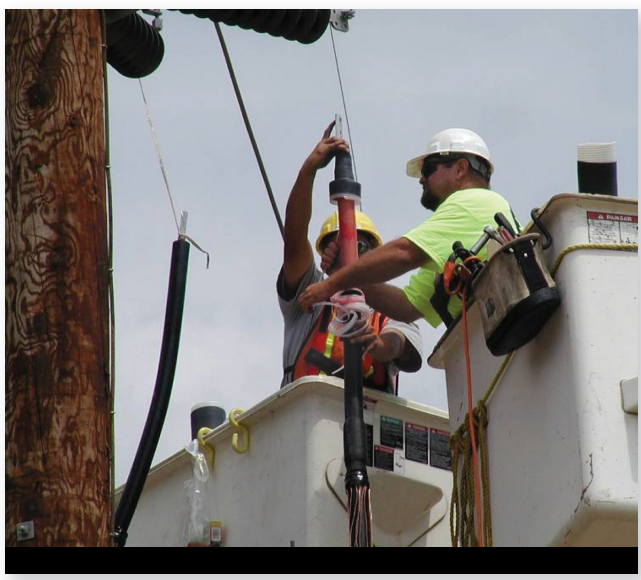
Bob Bradley of Sachs Electric Co. applies black vinyl tape over the sealing mastic wrap to seal the outer sheath.

PRIOR TERMINATIONS

Ameren originally used cross-linked polyethylene (XLPE)-insulated cable and porcelain terminations for 69-kV applications. Handling and safety issues led the company to move to ethylene-propylene-rubber (EPR)-insulated cable and heat-shrink terminations. While the heat-shrink termination method eliminated concerns encountered with porcelain terminations and was generally effective, it posed several challenges, as well.

Proper cutback and preparation are crucial in heat-shrink termination work, as is complete and consistent shrinkage. Good heat-shrink terminations require long field experience and careful attention to detail. Even the most experienced crews may find their work compromised by incomplete shrinkage and voids, particularly

Steve Norvell holds the semiconductive cold-shrink tube as the core is removed.



A cold-shrink lug insulator at the top completes the cable end's seal.

in unfavorable working conditions. High-voltage termination with this method has been particularly difficult under windy and cold conditions.

AN ALTERNATIVE APPROACH

Ameren recently decided to try an alternative termination approach for 69 kV in the form of a new cold-shrink solution from 3M (St. Paul, Minnesota, U.S.). Cold-shrink insulation technology has been in use for more than 30 years and is well-established in low- and medium-voltage applications. A 69-kV version was introduced recently.

Cold-shrink silicone-rubber insulation segments are prestretched on a plastic core that can be removed once the components have been properly positioned. This creates a living seal around the cable with the rubber continuously attempting to return to its original size.

Initial use of the new 69-kV cold-shrink termination was in June 2007, in conjunction with plant expansion work at Ameren Energy Generating Co.'s power station in Coffeen, Illinois. During plant construction, it was necessary to reroute an aerial segment of 69-kV line through an underground duct. EPR-insulated cable with a strippable shield manufactured by The Okonite Co. (Ramsey, New Jersey, U.S.) was selected for the project. This cable is more flexible and easier to strip than conventional XLPE cable with a bonded shield.

Outside contractor Sachs Electric Co. (St. Louis) handled the first 69-kV cold-shrink termination job because of a particularly heavy workload for Ameren crews at the time. Two installation teams of two men each were given brief hands-on training on the new products the day the work was done. This session included an explanation of the system and a review of the cable, required tools and termination-installation steps.

The contractor teams grasped the cold-shrink concept quickly and were able to complete the very first cold-shrink termination installation in 75 minutes, including cable preparation. In contrast, terminating with the heat-shrink process typically takes experienced crews more than three hours, plus an hour for cable preparation with bonded-insulation shield cable.

COLD-SHRINK INSTALLATION

Cold-shrink termination installation involves fewer steps than the traditional heat-shrink method. Ameren is adopting a companywide construction standard for 69-kV cold-shrink terminations that includes "checkoffs" to help ensure each installation step is performed as intended. This first use of checkoffs is being provided because measurements and the step sequence are important, since it is difficult to reposition heat-shrink or cold-shrink components once the process has begun.

The first step is to prepare the cable by removing the outer jacket and folding back neutral wires, which will be tied off and grounded. A wrap of black sealing mastic under the neutral wires and over the neutral wires seals the bottom of the outer sheath.

The next step is to wrap the high-K mastic pad over the semiconductive shield and insulation to fill in the step where the semicon has been ring cut

COLD-SHRINK HISTORY

3M (St. Paul, Minnesota, U.S.) developed and patented cold-shrink insulation technology in 1968. The first cold-shrink insulators were known as prestretched tubes (PSTs) or PST Zip-Core tubes, an insulation alternative for low-voltage underground electrical cable splices.

Consisting of an expanded rubber tube with a removable plastic core, cold-shrink insulators satisfied a demand for a faster and simpler splice-protection method. This insulation can be applied with minimal physical effort, requiring no sealants, heat source or other tools.

The earliest cold-shrink insulation was made of ethylene-propylene-diene-monomer (EPDM) rubber because of its favorable mechanical properties and elastic memory. The formulation has been modified and improved over the years to meet the requirements of specific applications. Cold-shrink tubing forms a permanent grip or living seal that can be flexed without cracking or breaking.

A few years later, a medium-voltage cold-shrink termination was developed that had an EPDM slide-on stress cone and a silicone-rubber insulator. This product was used for terminating shielded medium-voltage power cables either on poles or in switchgear. In 1996, a termination was developed that eliminated the need for silicone grease, reduced the length of the termination, improved arc and track resistance, and eliminated the need for tape sealing.

Most recently, cold-shrink technology was advanced to include high-voltage capabilities, including the 69-kV terminations used by Ameren Corp. 3M reports that today's cold-shrink products are made from a proprietary formulation, which varies to meet application requirements, including a range of cable types, voltages and environmental conditions.

and wrap that with vinyl tape. Next, silicone grease is applied over the exposed EPR insulation to fill small voids, and then a high-K cold-shrink sleeve is positioned over the cable and the plastic core is unwound from the top end to collapse it snugly against the insulation. The installer holds the bottom end of the sleeve as the core is removed from the top. This shrinks the semiconductive sleeve tightly against the cable insulation to provide high-voltage stress dissipation.

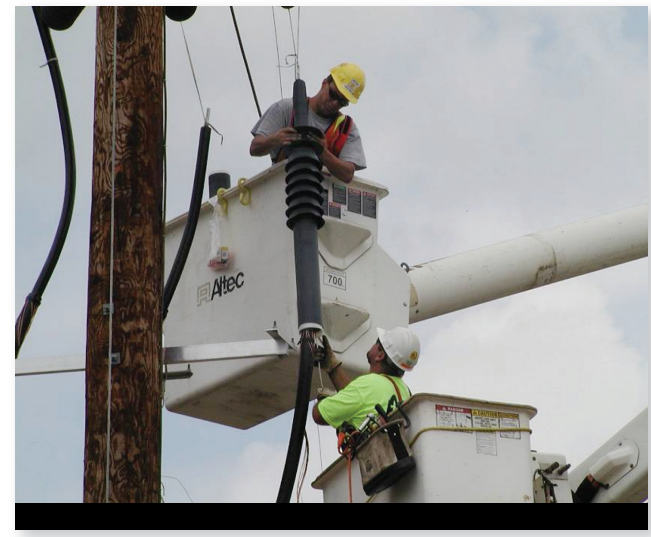
A connecting lug is crimped on the exposed conductor at the end of the cable, and the connector/insulation gap is wrapped with high-K mastic and overlying silicone tape to create a moisture seal. Then silicone grease is applied over the silicone tape and a cold-shrink lug-insulator segment is installed over the cable end. This lug insulator tightly grips the underlying mastic and silicone tape assembly to complete the cable end's seal. A cold-shrink non-skirted insulator tube is then installed over the lug seal and cable insulation.

Finally, the cold-shrink skirted insulator tube is lowered over the cable end, precisely positioned against the top of the nonskirted insulator, and its plastic core is removed. The rain-shed skirts extend as the core is removed from this sleeve, and the lug is ready to be bolted to the pad above, completing the termination.

SIMPLE LEADS TO EFFICIENT

The efficiency of cold-shrink termination benefits from a reduced part count compared to the earlier process. The heating step is eliminated, along with its associated tools and equipment, safety issues and potential for error. While this system costs more than the traditional heat-shrink product, the expense is more than offset by reduced labor. Ameren has found that the simpler nature of cold-shrink terminations considerably reduces the chance of mistakes, and crews are able to do the job quickly the first time they use it.

The UV-resistant cold-shrink materials used in this new high-voltage termination have been proven in other power applications, and 3M reports that



As the plastic core of the skirted insulator tube is removed, the rain-shed skirts extend.

similar parts continue in active use after 25 years of exposure. Cold-shrink rubber parts maintain a dynamic, compressive seal around the full circumference of the cable and have an estimated performance life of 30 to 50 years based on aging tests — or the life of the cable.

AmerenCIPS, one of the company's operations in Illinois, subsequently used the 69-kV cold-shrink termination method at a highway construction site. In this case, it was necessary to place an underground 69-kV segment beneath a newly constructed elevated roadway. Several AmerenCIPS crews were on-site to take part in preliminary training, and two of the crews went on to complete terminations at this location. Performance results and construction times were similar to what has been experienced with the Coffeen project.

NOW THE STANDARD

Terminating 69-kV lines is not a high-volume activity for Ameren, but it is high-profile work because of the critical importance of immediate and long-term termination performance. On the basis of the results the utility has achieved, and the positive response of its crews to this termination method, it is now phasing out the heat-shrink process and standardizing on the 3M cold-shrink terminations and The Okonite Co. strippable EPR-insulated 69-kV cable. TDW

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