Spacer Cable is a Compact Alternative for Tennessee Electric Coop's Substation Exits

Fort Loudoun Electric Cooperative (FLEC) faced serious challenges keeping up with the area’s growth. While the recent economic downturn has slowed development somewhat, the area grew at a record pace for the past 20 years, primarily due to the explosive expansion of residential, commercial, and educational facilities in Blount County, the second fastest growing in Tennessee.

According to Chad Kirkpatrick, P.E., FLEC’s Vice President of Operations and Engineering, the challenging mountainous geography and limited rights of way available made him look for alternatives to traditional open wire structures, especially at substation exits. He decided early on that one excellent solution was the use of a spacer cable system, which features a compact configuration and reduced clearance requirements.

FLEC was founded in 1940, and serves approximately 32,500 customers in portions of a three-county area that includes Blount, Loudon, and Monroe counties, near the Great Smoky Mountains National Park, south of Knoxville, Tennessee. With more than 3,200 miles of distribution lines, FLEC gets its power from a mix of nuclear, coal, hydro, solar, and wind power provided by the Tennessee Valley Authority (TVA). Seven 161 kV substations and 38 circuits service the 750 square mile area.

FLEC had used spacer cable in the 1970s to under-build a congested area of the small town of Friendsville, allowing engineers to add a new line by weaving through the area without having to reconstruct the existing open wire structure. The spacer cable system was supplied by Hendrix, a New Hampshire-based Marmon Berkshire Hathaway firm that provides underground cable, spacer cable, tree wire, insulators, and other overhead accessory products worldwide.

“When I came on board in the early 1990s, I saw how well the spacer cable system solved tight space constraints and began to envision all kinds of other uses for spacer cable that would allow us to add capacity,” says Kirkpatrick. “We are blessed with beautiful mountainous areas, but they keep us from cutting as much as we need for adequate right of way, and spacer cable solves that problem.”

According to Kirkpatrick, there are three main reasons that spacer cable is the best solution for FLEC. Limited right of way is the driving factor; there is simply no way to obtain the additional right of way needed for open wire circuits.

Second is that spacer cable gives FLEC the ability to be flexible with the number of circuits in the right of way corridor and the configuration and clearance requirements. Finally, the spacer cable solution allows the use of the existing pole line. “We do not want to have to change poles, and it is relatively easy to add an

additional circuit on an existing line using spacer cable. Under-building using the same poles results in significant savings," says Kirkpatrick.

FLEC offers its customers the option of spacer cable whenever feasible, in a rocky area, for a tap line, or when there is a lot of vegetation. Many customers have chosen single phase spacer cable when there is just enough right of way to get the line through. Also, since much of the service area is located in the foothills of the Smoky Mountains, FLEC tends to leave hardwood trees close to the circuit, so any softwood trees that fall tend to be caught by the hardwood instead of falling on the line. FLEC still maintains clearances, but not as much as are needed with open wire structures.

Spacer cable systems allow multiple circuits on a single pole
Spacer cable systems feature a compact configuration and reduced clearance requirements, which means that multiple circuits can be installed on a single pole. Over- or under-building spacer cable systems in substation exits can greatly reduce the cost of adding capacity.

A spacer cable system consists of a messenger cable that supports the structure, polyethylene spacers to hold the cable across spans, and covered conductor cable.

The messenger cable is the support member for the structure and serves as both system neutral and lightning shield.
Their mechanical strength makes them suitable for long spans.

Clipped to the top of the messenger wire is a series of spacers, molded using a proprietary, gray, track resistant, high density polyethylene. The spacers support, separate and clamp the phase conductors in a triangular, diamond-like configuration.

Spacers are placed between spans of about 30 to 40 feet. They feature quick, easy installation and removal. No ring ties are required; patented integral clamps are used for conductors and messenger. The clamp design accommodates a full range of conductor and messenger sizes. The wedge-shaped messenger hook provides maximum grip.

The spacers have excellent weather washing characteristics and their unique design provides high short circuit strength.
They are highly resistant to shock, impact, or rifle fire, and can be installed with hot line tools.

Covered conductors consist of stranded hard drawn aluminum conductors with three extruded layers, the thickness of which depends on the voltage rating. Hendrix's proprietary, high density outer layer resists abrasion, electrical tracking and UV degradation. Also, reduced NESC phase spacing is possible, due to high impulse strength covering. The 3-layer covering withstands temporary contact with tree branches and other vegetation, thus reducing outages and improving power quality. This, along with the compact configuration of the system, greatly reduces the need for vegetation removal during circuit installation, cutting tree trimming

costs significantly. The covering also protects wildlife from exposure to lethal currents.

FLEC system substations take advantage of spacer cable systems
As Vice President responsible for Operations, Engineering, Protection and Control (including substations and down line controls), as well as Fleet and Vegetation Management, Kirkpatrick is responsible for all electrical engineering related to SCADA (supervisory control and data acquisition), substation, line design, relay programming, relay testing, and integrated electronic device (IED) programming. In the mid-90's he developed FLEC specifications for use of Hendrix spacer cable systems and added them to FLEC's specification book.

In 2003, he designed FLEC's first substation exit using the spacer cable system, for the new Madisonville substation. The substation included 8-bays, in a split bus configuration

FLEC was faced with a tricky design problem, since underground exits were problematic and there were serious right of way issues associated with taking five circuits for eight spans away from the Madisonville substation to the north and three circuits to the south, before splitting up and going in separate directions.

Kirkpatrick began seriously looking at spacer cable circuits as an option, based on his previous positive experience with spacer cable lines in tight areas and along roads with limited right of way. After preparing profile drawings of spacer cable circuits, he found that the system could accommodate the required number of circuits exiting the station in both directions.

Each of the substation exits uses a "vertical fence" feeder exit strategy, with four conductors per circuit. With the vertical fence configuration, "E-type" brackets can be used to support each circuit and it is easy configure phase orientation. Three positions are available and phases are stacked vertically, which can be tapped off the bracket and dropped into the substation.

"We could not possibly do what we have done at this and other stations with open wire. It is much less complex and easier with spacer cable," said Kirkpatrick. "Other alternatives would have required at least three pole lines, crossing under a transmission line, and over a railroad track and a 4-lane highway, which would have been difficult with open wire. We would have had to use a more costly underground wire option if we didn't have Hendrix spacer cable."

After the success of the Madisonville substation exit project, Kirkpatrick has since used the same design at the Jena and Niles Ferry substations. Additionally, Kirkpatrick notes Hendrix is ready and willing to assist with any issues that might arise during an installation. "Hendrix continually has provided support far and away above other specialty product manufacturers," says Kirkpatrick. "They understand that the uniqueness of their product required a higher level of customer support and engineering, and has not wavered in its commitment to ensuring they provide the answers needed in a timely fashion."

While the use of spacer cable systems at substation exits was not standard practice in his area, Kirkpatrick found it relatively easy to get approval from the RUS (Rural Utilities Service). “My advice to other rural electric cooperatives is to work closely with your General Field Representative (GFR) and explain to him why the spacer cable solution is the best thing for your particular circumstance.”

Kirkpatrick, who sits on the Overhead Distribution Line Subcommittee of the National Rural Electric Cooperative Association’s (NRECA’s) Transmission and Distribution Engineering Committees, says “Our subcommittee oversees questions that come into the RUS and I am hopeful we can develop standards that would make it easier for Cooperatives to use spacer cable. The more Cooperatives that request its use, the more RUS will open up to it.”

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