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Xcel Energy Recycles Towers and Right-of-Way

ACCR enables line-capacity increase by conductor replacement, eliminating the need for new structures and new permits.

By **Kathy Beaman**, *Xcel Energy*

DURING 2004 AND 2005, XCEL ENERGY ADDED TWO NATURAL GAS TURBINES at the Blue Lake peaking plant. The 350 MW of additional generation exceeded the existing transmission line capacity. The US$100 million project required replacing the existing 795-kcmil 26/7 aluminum conductor steel reinforced (ACSR) rated at 975 A at 230 kV with a higher ampacity conductor to deliver 1640 A at 115 kV. However, the line crossed an environmentally sensitive area along the protected Minnesota River Valley, complicating permitting and jeopardizing the deadline for upgrading the line.

DESIGN ALTERNATIVES

The line runs between two Xcel Energy Minnesota power plants: the Blue Lake plant in Shakopee and the Black Dog plant in Burnsville. To begin with, Xcel Energy considered two options for upgrading the line. However, both choices posed significant problems. The first option, replacing the existing ACSR with a twin-bundled 795-kcmil ACSR, would have required replacing all of the structures to accommodate the heavier weight of the additional conductor as well as the increased metrological loadings. All other options using conventional conductor solutions would have required replacing at least some structures or increasing some structure heights, as that conductor sags would meet National Electric Safety Code clearances.

Setup with 3M-recommended 3-to-1 breakover wire slope from the first dolly to the tugger and tensioner.

The cost of new construction was a factor, of course, but an even bigger hurdle was the need to obtain new permits from the Minnesota Environmental Quality Board, a process that could take anywhere from six months to several years. Adding further

uncertainty to the permitting process was that the Blue Lake to Black Dog line's right-of-way crossed the Minnesota River Valley and several of the river-associated wetlands, including a protected, rare type of wetland called a fen.

To address these issues and upgrade the line within the needed time frame, Xcel Energy evaluated and adopted a third alternative: a lighter-weight aluminum-based high-capacity conductor developed by 3M called aluminum conductor composite reinforced (ACCR).

Using a single 795-kcmil 26/19 ACCR conductor would meet Xcel Energy's capacity needs without requiring new structures or additional permits. The 795-kcmil ACCR is rated at 1553 A for continuous operation at 210°C (410°F) and 1778 A for emergency operation at 240°C (464°F). Sag calculations show that the 795-kcmil ACCR provides less sag than the other choices.

Choosing the single ACCR to avoid both replacing existing towers and the need to apply for a new permit also met another requirement. Xcel Energy needed to complete the additional electrical supply line into the Blue Lake Substation and have the line energized within four to six months. The ACCR could be installed within a few weeks, unlike new or replacement towers.

INSTALLATION DETAILS

3M provided 174,240 ft (53,108 m) of conductor on 5000-ft (1524-m) reels for the 3-phase, 10-mile (16-km) line. The installation, which followed IEEE 524 guidelines for both conductor and accessory installation, took eight weeks, starting on March 4 and ending by May 13, 2005. The line was immediately energized and has been in operation ever since.

The installation had to go through nonconventional areas, such as at a back-water lake of the Minnesota River, with limited access to towers and a freeway crossing. Normally, in Minnesota, a transmission upgrade such as this could have been done in the winter when the ground and wetlands were frozen, to avoid environmental damage. However, due to timing constraints, construction was in the spring when permitting constraints prohibited bucket trucks and other heavy equipment in the fens and wetlands of the Minnesota River Valley. In addition, where equipment was allowed, the ground had to be protected with heavy matting.

The second conductor pull was through the Black Dog Preserve. Because no heavy equipment could be used, the conductor had to be installed with a single pull. To accommodate one splice in each phase of the conductor, the splices had to be installed on the ground, and then the conductor with the splice had to be pulled through a sheave. The need for pulling splices over sheaves required the larger 46-inch (117-cm) sheaves, instead of the normal 15-inch to 36-inch (38-cm to 91-cm) ones. A setup tensioner and tugger were applied on each side of the lake to keep spans even while stringing. A 50-inch (127-cm) diameter bull wheel was used.

A double 28-inch sheave was used at the tensioning structure.

CONDUCTOR ACCESSORIES

Despite the unusual installation, all the accessories installed with ACCR on this line are exactly the same type of accessories installed on other ACCR lines since 2002. Some of those lines are subjected to extreme cold weather and ice loading, such as an installation in Fargo, North Dakota, U.S., as well as hot desert conditions, such as one in Phoenix, Arizona, U.S. In all installations, the accessories are performing according to expectations and have proven to be reliable, as extensive laboratory testing was conducted on the accessories and conductors before their commercialization.

Overall, the installation included preformed wire helical rod from Preformed Line Products (PLP; Cleveland, Ohio, U.S.), compression deadends and splices from ACA Conductor Accessories (Duncan, South Carolina, U.S.), PLP THERMOLINE high-temperature suspensions, ACA dampers and ACA HiTemp high-temperature and filler compound. Old and damaged insulators were replaced during the process.

ACCR is rated to 210°C (410°F) continuous operation. Using The Valley Group Inc.'s (Ridgefield, Connecticut, U.S.) rate kit thermal model to estimate conductor surface temperature at conservative emissivity values of 0.5 and 0.8 and zero wind velocity, a conductor surface temperature of about 170°C (338°F) was predicted at 1240 A.

Generally, however, the current transmitted through the line has been below 80% of the rated ampacity for continuous operation, leaving margin for additional demand growth. In addition, because the ACCR looks like the ACSR that was on the line before, the appearance of the line has not changed.

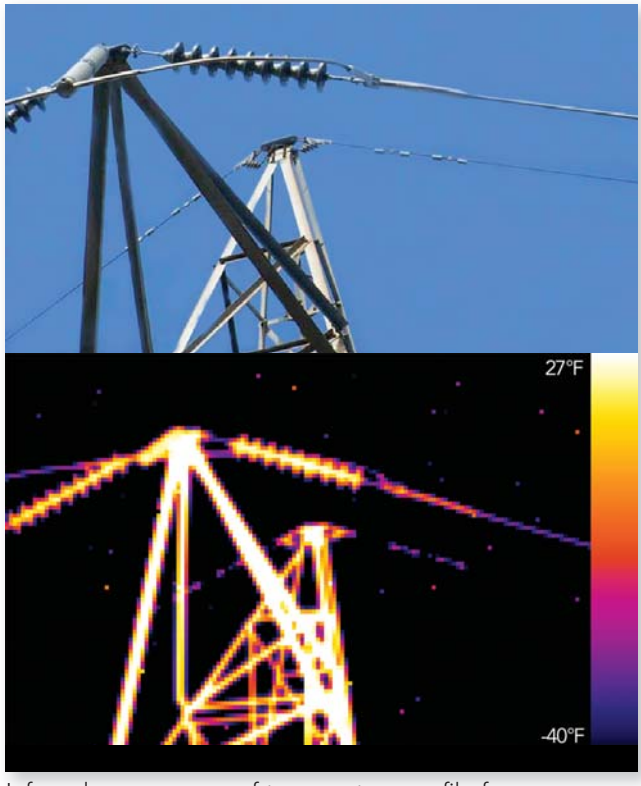
A high-resolution FLIR (Portland, Oregon, U.S.) in-

ACA compression deadend pull over Black Dog Lake.

frared camera was used to scan the temperature profile of all accessories (deadends, splices, and terminal and jumper connectors) to identify any hot spots or problems with installation. This was done in the mornings in late September 2006 while the line was energized. All measurements showed that the accessories ran cool with no localized overheating. A few degrees rise with current energized was observed, with the highest measurement recorded for a jumper connector. Measurements are taken during the summer months when current loading is high.

ENERGIZED LINE

Despite unusual restrictions due to environmental issues, Xcel Energy and 3M successfully installed 795-kc-



Infrared camera scan of temperature profile for a compression deadend.

A line crews clips the conductor after stringing.

mil ACCR conductor between the Blue Lake and Black Dog substations. Portions of the line had to be installed over sensitive environmental areas, making permitting and tower installation challenging. However, the use of ACCR simplified permitting and eliminated the need to replace towers, saving money and time, allowing Xcel Energy to meet its deadline. This was true despite the need to install the line without the use of heavy equipment in the environmentally protected areas.

As electricity demand increases, more current will be transmitted through the line. ACCR should be able to provide around 1700 A for continuous operation and slightly more than 1800 A under emergency conditions, allowing for at least a 20% increase in the load now carried by the line without another upgrade.

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TDW

Kathy Beaman served as transmission engineer for Xcel Energy's Blue Lake project as part of her seven-year tenure as a civil engineer with Xcel Energy. She began her career working in construction management following graduation from Purdue University with a degree in civil engineering. Beaman currently is a transmission line design engineer with Great River Energy. She is a registered professional engineer.
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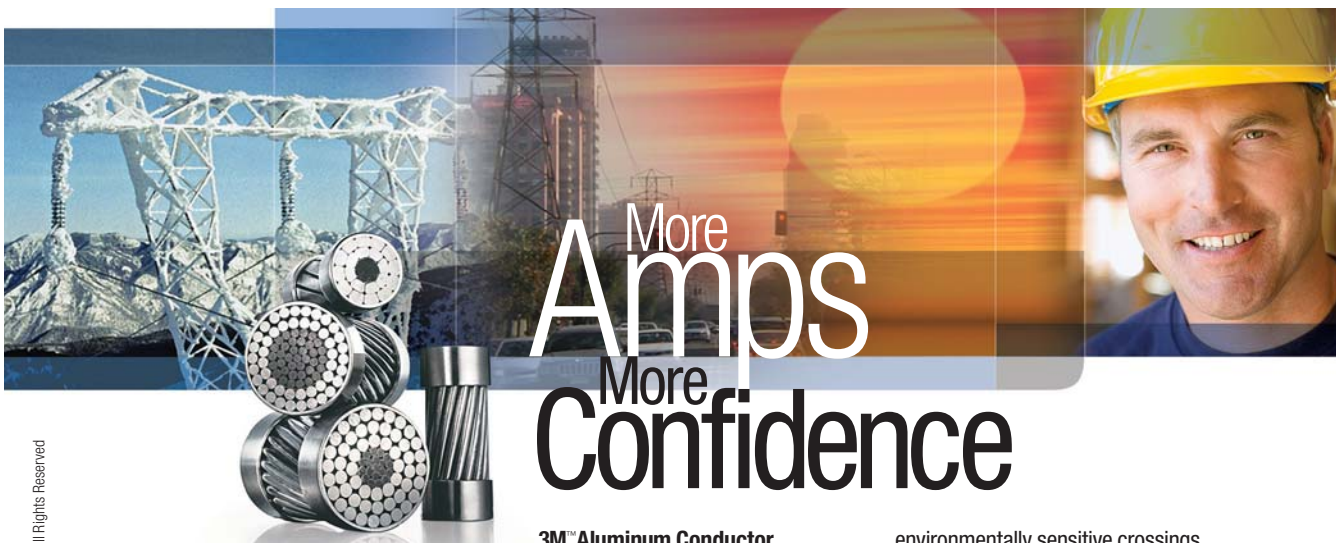
Note: For further information about Xcel Energy's ongoing experience with the 3M ACCR conductor, please contact Xcel Energy's Ben Gallay at benjamin.j.gallay@xcelenergy.com.



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