by Joel Scruggs

BPA innovation increases line capacity and saves millions

There are many paths to innovation. For civil engineer Len Custer, it was discovering a new use for a simple device.

Connectors join sections of conductor together and play an essential role in the efficient transfer of electricity. But they are commonly viewed as a weak link in the power delivery chain because they can fail, particularly if they get too hot. For decades, the Bonneville Power Administration (BPA) and others in the industry installed compression shunts on inadequate or failing connectors as a means of extending their operational life and potentially avoiding an outage.

While the Electric Power Research Institute, vendors, and others researched new materials that could minimize high-temperature effects on connectors, Custer theorized that compression shunts could split the amount of current traveling through the connector and allow a line to be continuously operated at much higher temperatures, therefore increasing the amount of electricity it could carry.

"At that time they were nothing more than a maintenance tool," recalled Tyler Ashburn, a civil engineer. "Installing them on existing connectors in good condition was unheard of."

The key to Custer's ingenious idea lay in the shunt's design. Shunting involves providing an additional electrical path around the connector by either wrapping preformed aluminum wires or clamping a jumper over sections of a power line adjacent to compression connectors. By providing a parallel path, it conducts most of the current and only a fraction of it flows through the connector.

Since it was a new application for certified off-the-shelf components, his concept was quickly embraced and tested. "There was tremendous support," Custer said. "As it evolved, more and more people got involved."

Getting more amperage out of a line typically meant completely rebuilding and replacing the existing conductor. But early testing at BPA's labs in Vancouver, Wash., confirmed Custer's hunch: the addition of aluminum shunts lowered the operating temperature of the connector and protected it under additional amperage and higher temperatures, allowing the transmission line to operate well above the previous summer normal rating of 1,070 amps and 212 degrees Fahrenheit (100 degrees Celsius), increasing its capacity by 40 percent.

"Using shunts to get more performance out of existing transmission lines was a ground-breaking concept," said Terry Oliver, BPA's chief technology innovation officer.

In 2007, BPA became the first in the industry to use a wrapped or helical connector shunt for high-temperature application. BPA installed shunts on its 68-year-old,

BPA Linemen Cole Bradbury and Patrick Gibbs install a helical connector shunt on BPA's 230-kilovolt Midway-Vantage line in central Washington, north of Hanford. Photo by Barry Peckham.

230-kilovolt Ross-Lexington line in order to accommodate the output from a natural gas-fired power plant in Longview, Wash. In addition to increasing the line's peak capacity from 1,070 amps to 1,500 amps, the upgrade cost $4 million less than rebuilding and reconductoring 20 miles of transmission line and it cut the outage time by more than half. They're also easy to install because they don't require equipment to handle full-line tension and most are installed in about a half-hour using bucket trucks.

In addition to the use of wrapped shunts, which are designed to be used on a single conductor size, BPA has developed an alternate shunt, commonly referred to as the "Custer" or "BPA" shunt, with two line tap clamps that can be applied when conductor changes are made within a line. It can also be used in substations when a shunt connection is needed from a conductor to a riser.

Custer dedicated more than 30 years of his professional career to increasing the capacity of BPA's transmission system. And before his retirement in December, EPRI released a report that endorsed the use of the Custer shunt for thermal upgrades of existing lines with conventional conductors and recommended it for protecting connectors on lines operating at high temperatures.

To date, BPA has installed shunts on several lines and realized cost savings of more than $32 million, most recently on its Walla Walla-Pendleton line to relieve overloading when both Combine Hills II and Vancycle wind sites are at full output. And the assessment for potential shunt application has been built into the agency's standards for planning transmission upgrades.

In the near term, BPA has three projects currently in design for shunts — one high-temperature application and two for compression fitting. "And we could easily see a couple of retrofits every year for the next 15 to 20 years," Ashburn added.

Whether increasing a line's capacity without replacement or protecting connectors from premature aging and failure, the helical shunt allows BPA to make the most of its existing transmission resources, which saves the agency, its electric utility customers, and their ratepayers millions in avoided costs.

"The connector shunt is a tremendous example of how we're finding creative, cost-effective solutions that help us continue to deliver reliable power to the people of the Northwest," said Larry Bekkedahl, senior vice president for Transmission and a member of EPRI's Power Delivery and Utilization Executive Committee. NWPPA

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