Advanced Transmission Conductor Gains International Acceptance As a Problem-Solver for Line Upgrades

During the past three years, 3M’s aluminum conductor composite reinforced (ACCR) overhead conductor has gained popularity in international markets. Used primarily but not exclusively for transmission upgrades in places where environmental sensitivity or densely populated urban centers pose severe impediments to tower construction, the ACCR is a high-temperature, low-sag conductor that uses wires composed of alumina oxide fibers embedded in an aluminum matrix to replace traditional steel wires in the conductor’s core, reducing weight and sag. As a result, capacity can be substantially upgraded without bigger towers or expanded rights of way.

Utilities in China, India and Brazil, in particular—where demand for electricity power is growing in tandem with burgeoning economies—are adopting this new technology to complete urgently needed upgrades while avoiding regulatory, social and logistical problems that can lead to costly delays. 3M ACCR was first introduced in the United States in 2003 and is in use by more than two dozen U.S. utilities and in six other nations.

China
In 2007, Shanghai Electric Power Co. became the first utility outside the U.S. to adopt the 3M ACCR for a key upgrade in China’s largest metropolitan area. Anticipating a sharp increase in power demand that would accompany Shanghai’s hosting the 2010 World Expo (which opened in May), the utility decided that doubling transmission capacity would be necessary on its Yangxing line, which serves the 5.28-square-kilometer expo site—the largest area ever developed to contain a world’s fair.

The area, however, is in the heart of greater Shanghai along the Huangpu River, and the neighborhoods surrounding it are densely populated. Expanding the right of way to enable new tower construction would be costly and time-consuming and pose logistical challenges and much dislocation within affected communities.
The senior engineer also said that the aluminum-zirconium composition of the conductor's current-carrying outer wires has superior resistance to annealing. He said that its "special microstructure processes ensure that its mechanical strength will not (decline) after it is (operated) at the rated continuous high temperature."

Installation of the ACCR on the Yangxing line was completed over 10 days in October 2007, in time for the Shanghai Expo opening. Pan said the 3M ACCR conductor and its accessories cost more than conventional technology and hardware but enabled the utility to avoid much larger expenses.

"If a normal conductor is adopted to carry out capacity-enhancement transformation on an old power grid, it is necessary to remove the old line corridors and rebuild … towers, which means greater tower and foundation investment and huge land compensation cost in Shanghai," he said.

Taking note of Shanghai Electric's experience, in 2008 Chongqing Electric Power Corp. deployed the ACCR for a 5.47-kilometer (3.3-mile) upgrade on its Shuinian-Shuangshan line just before the start of Beijing's Summer Olympics.

INDIA

Near the same time Pan's paper was published, TATA Power Co., India's oldest and largest private-sector electric utility, was installing 3M ACCR to solve capacity problems in the crowded suburbs north of Mumbai. TATA faced a challenge similar to Shanghai Electric's. The population density of greater Mumbai averages 27,000 residents per square kilometer; Shanghai's is about 26,650. By comparison, New York City's is 10,500. But TATA faced another difficulty: Right-of-way expansion was out of the question, and the utility also had to be concerned about excessive line sag because so many residential rooftops lay directly under the lines.

By installing two double-circuit 110kV ACCR lines, the utility was able to upgrade without requiring right-of-way expansion or tower construction, and the conductor's low-sag characteristic eliminated the second problem. The result was minimal disruptive community impact.

BRAZIL

In addition to its application in dense urban areas, the 3M ACCR frequently is used to avoid environmental problems, especially with respect to river crossings and environmentally protected areas. Two major Brazilian utilities, ISA CTEEP Companhia de Transmissão de Energia Elétrica Paulista (ISA CTEEP) and CPFL Energia, recently installed the conductor to upgrade crossings over the Paraná and Tietê Rivers, respectively, without installing towers in the middle of the rivers; while a third utility, Bandeirante Energia, S.A., applied it on a nearly 5-kilometer line segment that crosses one of Brazil's Permanent Protected Environmental Areas. All three installations, together with a second by CPFL in a dense urban area,
community, took place in rapidly growing São Paulo state, which can fully benefit from its abundant hydro power only if it invests in significant additional transmission capacity.

CPFL Paulista, a unit of CPFL Energia, faced an unusual challenge when building its new Ramal Iacanga line, which crosses the Rio Tietê, a waterway that flows from eastern Brazil through São Paulo city and then northwest to join the Rio Paraná, with numerous hydroelectric stations along the way. As a result of a long period of above-normal rainfall, a mid-river island that was to bear a transmission tower became thoroughly submerged under the swollen river, further complicating the already troublesome prospect of constructing a tower there.

The solution was to bypass the island completely using the ACCR to eliminate needing a third tower. A 1-kilometer stretch of low-sag 88kV ACCR was able to link the new line’s towers on both shores, leaving sufficient clearance for river traffic while providing the needed boost in capacity.

ISA CTEEP encountered a variation on this scenario while implementing an upgrade on its Jupiá-Três Irmãos line in southwestern São Paulo state. The line crosses the Rio Parana on two towers with foundations in the riverbed. Replacing the existing ACSR with a higher-capacity version of the same conductor would have required the foundations to be dismantled and rebuilt to accommodate larger towers, raising environmental issues and possibly a lengthy permitting delay. Instead, the utility strung a double-circuit 138kV ACCR on the mile-long crossing and was able to leave the towers and their foundations unaltered. The installation took six days.

A river crossing is not the only circumstance posing environmental issues for transmission improvements. Bandeirante Energia’s Ramal Cesar de Sousa line, which supplies power to about 1.4 million customers in the growing eastern city of Mogi das Cruzes and major industrial sites, intersects the Rio Tietê close to the river’s fountainhead, where it is little more than a 30-meter-wide stream. But the line also crosses an Área de Preservação Permanente (Permanent Environmental Protected Area), in which developmental restrictions are severe.

With the existing ACSR already at capacity and demand increasing, speed in completing the upgrade was essential. But the right-of-way is narrow, which meant that moving needed equipment in and out of the construction area would have

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posed a logistical nightmare and significantly slowed the project. In addition, the downtime for the line would have required a temporary parallel line to prevent an unacceptable period of interrupted power. To mitigate these concerns, Bandeirante engineers opted to use an 88kV two-circuit line that required no additional tower support.

CPFL Piratininga, another subsidiary of CPFL Energia (which used ACCR to upgrade its Ramal Duratex line on a densely populated area of the city Varzea Paulista), also is planning to begin three additional ACCR installations this fall in projects that involve environmental sensitivities. One will traverse an 11-kilometer (6.8-mile) stretch of wetlands near the eastern coast city of Cubatão.

The latest scheduled South American installation, on a river crossing in Argentina, however, has little to do with environmental concerns or population density. Edesur, S.A. will deploy a 220kV ACCR conductor on a line across the Matanza-Riachuelo River to raise clearance for shipping in and out of the increasingly busy Buenos Aires port.

The growing roster of 3M ACCR applications indicates that this new, high-tech, metal-matrix conductor is a reliable, versatile and cost-efficient tool that helps get electric power where it’s needed with a minimum of environmental or urban disturbance.

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