Record Energized Reconductor Project Brings Reliable Power to South Texas

THE ENERGIZED RECONDUCTOR of the Lower Rio Grande Valley (LRGV) is a landmark project for Quanta Services, American Electric Power (AEP) and the utility industry. The 240 mile project capitalized on multiple innovative technologies from across the industry, allowing AEP to provide an immediate solution to the problem of reliable electricity while addressing future load growth. This challenge was met by Quanta Energized Services (QES), an entity of Quanta Services, who is the recognized industry leader for live line work. Their forward thinking allowed for the entire 240 miles to be completed while in an energized state.

The LRGV is served by two 345-kV transmission lines that originate in Corpus Christi, 120 miles to the north, and account for the bulk of the electricity carried into the LRGV. The lines are in a precarious position due to the LRGV's dependency on them to supply the majority of the power to South Texas, as well as their proximity to the Texas Gulf Coast exposing them to corrosive salt spray and making them susceptible to storm outages.

In February 2011 South Texas experienced record winter temperatures which dropped as low as 20 degrees Fahrenheit. For a region accustomed to average February temperatures in the mid 60's, these temperatures were crippling. Panicked residents

flooded the stores in search of portable heaters. This immediate demand for electricity in conjunction with downed generation due to prescheduled maintenance caused an overload of the electric transmission system resulting in rolling blackouts.

Steady Load and Population Growth

Summer highs in the LRGV routinely hit triple digits, this compiled with a 30% population growth from 2000-2010 resulted in AEP's peak electric demand increasing from 1000 MW in the summer of 2000 to a summer record peak demand of 2220 MW in 2010. While an increase in load over a decade is to be expected the 514 MW jump from the previous summer during the 2011 winter storm (2220 MW to 2734 MW) was outside all modeled projections. Furthermore, due to continued growth, the projected 2016 summer peak load was expected to reach 2800 MW with a forecasted summer 2020 peak load of over 3000 MW.

An immediate plan was needed to supply relief to the circuits most affected by the short term seasonal spikes. However, this plan also had to offer a long term solution to address the load increases for 2016, 2020 and beyond. AEP, as well as the Electric Reliability Council of Texas (ERCOT), needed a solution that could meet the pressing reliability demands while safely maintaining the aggressive schedule. ERCOT was presented with a number of traditional cold constructions options, running the gamut of temporary upgrades to complete overhauls. However as AEP looked into permitting, rights of way (ROW) acquisition and various customer disruptions it became apparent that these variables had a very real chance of interrupting or adding unforeseen costs to the project. However the biggest area of concern was that ERCOT could only grant outages in the spring and summer months, if at all, and the lines would be required to be back in service within hours whenever system anomalies warranted. Taking these limitations into account, it was apparent that a traditional construction solution would only add additional delays to an already time sensitive project and therefore could not be counted on as a reliable option to meet the 2016 completion schedule.

Partnering on a Progressive Option

AEP approached Quanta Energized Services (QES), to discuss their live-line planning capabilities and North Houston Pole Line, a Quanta Services entity, about their construction

expertise and cable manufacturer CTC Global for their ACCC Lightweight Core Conductor. A plan was conceived to reconductor the entire 240 miles while keeping it in an energized state. While smaller energized projects had been successfully completed in the past, an energized reconductor project of this size and length had never been attempted. In early spring 2011, AEP's plan to perform the energized reconductor of the existing 345-kV transmission lines was approved by the regional planning group at ERCOT.

A year before the first lineman hit the right-of-way Quanta Energized Services technical advisors went about developing detailed, project-specific work procedures with calculated man-hours, sequencing, schedules and anticipated resources. Among the unique aspects of these one-of-a-kind work proce-

dures was the ability to adapt to job irregularities. A necessary adaptation that occurred early in the project was related to the bundled conductor, which sat in a vertical configuration rather than the tradition horizontal configuration. To most efficiently tackle this issue the team needed to adapt both the equipment and the procedures. This first test proved to be a calling card for the entire project as procedures were continually updated to make the project safer and more efficient.

State-of-the-Art Technologies

Through these collaborative partnerships, a number of innovative technologies were applied that allowed for an accelerated work schedule to ensure that the required in service date for the upgraded line was achieved. The technological advances that made this project possible were:

- Quanta Services Energized Barehand work methods and proprietary LineMaster Robotic Arm made it possible for all 240 miles of 345kV conductor to be removed and replaced without interrupting the flow of electricity. Attached to a boom on a ground-based vehicle, the LineMaster Robotic Arm safely moves and securely holds energized power lines while the conductors, insulators and structures are maintained, replaced or rebuilt. In addition to the practical importance of the robotic arm, the barehand work methods were developed by a team which collectively has more than 400 years of energized work experience, starting with the first-ever energized reconductor project in 1990.

- The use of Aluminum Conductor Composite Core (ACCC) to replace the existing conductor. While the same diameter as the original conductor, the ACCC is comprised of 28% more aluminum making it lighter. The extra aluminum doubles the conductivity capacity of the lines, while reducing sag overtime due to less weight and heat. This meant that AEP could replace the old conductor without widening clearances or causing tower modifications and rebuilds. Also of great importance due to the location of the job, the ACCC is more resistant to corrosion and has the ability to handle future increases in load.

Project Execution

The project called for an aggressive schedule to ensure that the line would be upgraded by the required date. The project was divided into five segments between the substations. Doing so resulted in several strategic as well as financial benefits:

- It reduced the risk on the entire system serving the LRGV;

- It prioritized the line sections between the substations, so that the completed areas could immediately reap the benefits of the system upgrade;

- It created five smaller projects, which increased the efficiency of scheduling materials, equipment and crews, as well as minimizing the project costs.

An energized reconductor of this size required careful planning. Processes and work procedures for each task had to be developed. A group of Quanta technical advisors collaborated together to produce these procedures. As the project progressed, lessons were learned and these procedures were further refined and revised.

The barehand work method was instrumental to the work that was performed on the energized conductors. When working barehand the lineman wear conductive suits and are

bonded to the conductor, putting them at the same potential as the energized conductor allowing them to physically touch the energized conductor and equipment. To support conductors while unclipping or clipping, the LineMaster Single Point Lifter robotic arm was used. This tool provided safe, secure and controlled support of the energized conductors.

In order to replace conductors in an energized state, a temporary support for a phase conductor needed to be established. This was done by installing temporary structures at the edge of the right of way next to the existing line. Since the temporary structures were installed in the ROW, no additional land or the timely permits associated with land acquisition were required.

The new conductor was then installed in its permanent position, clipped in and sagged. Load from another phase transferred to this new conductor and the old conductor was de-energized. The old conductor was then reconductored. This was repeated, until all three phase conductors were replaced, without any interruption to the electrical service. This was performed section by section, on average 20 to 30 miles. This plan allowed for the reuse of existing structures, therefore minimizing the impact on landowners and negating any of the timely permits associated with land acquisition and construction.

Other realized cost savings during construction were the energized crews' ability to perform out of the scope upgrades, such as replacing damaged V-string insulators and the upgrade of existing shield wire with OPGW fiber. This type of work often requires months of planning to get the necessary outages, which can be cancelled at any time, resulting in wasted revenue and man-hours. This is one of the factors that led ERCOT to be able to take back every scheduled outage because construction and repairs were made while the line was energized. The state-of-the-art and proprietary technology used on the energized reconductoring, led to ahead of schedule completion of the project, despite adapting to inconsistent outage schedules and record-setting inclement weather.

While numerous factors played an important part in the success of this project, from state-of-the-art equipment, to extensive training, none were as important as the detailed work procedures. The work procedures, developed by the technical advisors, were developed specifically for each part of this project. Making the scope even more unique, was the fact that it was under continuous evolution. Methods of success and failure from the field, were used to further refine these procedures. As work procedures were refined and the crews became experienced in these procedures and work methods the result was a gradual to substantial improvement in productivity, allowing the project to finished eight months ahead of schedule and millions of dollars under budget.

The Future of Transmission Construction

In South Texas with the completion of the Energized Reconductor Project, Quanta Services and AEP have ensured numerous communities in the LRGV that their need for reliable power today, tomorrow and well into the future will be met. Lights will stay on, homes will be cooled and heated, schools will stay in session and hospitals will continue to save people. Quanta Services has shown that with the use of innovative technology and the lessons learned from the project they are more than ready to tackle all future challenges. By creating a partnership between Quanta Services and AEP a solution was created that ensured the foundation built from the world's longest energized project will continue to benefit future utility customers around the globe.