BURNS McDONNELL

CASE STUDY / **GAS-INSULATED SWITCHGEAR SUBSTATION**

RETROFITTING IMPROVES PERFORMANCE AND MONITORING CAPABILITIES

Replacing century-old substation equipment to meet growing network demand was necessary for an electric utility. Installation and implementation of sophisticated new equipment laid a compact foundation for a robust and enduring system.

SEQUENTIAL BUILD APPROACH PROVIDES OPERATIONAL CONTINUITY

When permitting and space restrictions posed a challenge, we responded with customized tactics.

PROJECT STATS

CLIENT
Confidential client

LOCATION
Northeastern U.S.

COMPLETION DATE
August 2017

$39.5M
TOTAL PROJECT COST

13K
SQUARE FEET OF OPEN SPACE FOR FUTURE EXPANSION

COMPLETED
3
MONTHS AHEAD OF SCHEDULE

CHALLENGE

An electric utility serving millions of customers in the Northeastern U.S. needed to expand and retrofit one of its century-old air-insulated switchgear (AIS) substations to accommodate ongoing regional growth, and the corresponding load increases, while maintaining system reliability.

This substation is one of the three load-serving substations in that region and a major junction for the underground and overhead network. It serves educational, medical, commercial, industrial, state and federal facilities in the area. Its original configuration was a six-breaker ring bus supporting nine lines (overhead, underground and a transformer that was being fed through one of the bay positions), which did not comply with modern reliability guidelines.

Due to various permitting and easement constraints, the construction space was extremely limited, allowing very few options to execute this project. Installing gas-insulated switchgear (GIS) was the most suitable option because it is compact and enclosed; GIS equipment requires less maintenance and is safer and more reliable than AIS equipment. The new GIS enclosure had to be located between the existing substation and the property line of the site, and it had to be built while the existing facility remained in service. To comply with city zoning requirements and the U.S. Army Corps of Engineers levee/dam setbacks for a utility site, the permit required a 25-foot setback of the GIS enclosure wall from the site boundary.

Keeping both the new and old substations operational during construction and cut-overs was vital to minimize impacts to the critical load. This was of great importance because an existing generation station was also feeding this substation, so timing of the outages and careful planning and coordination was critical.

Burns & McDonnell was selected to provide complete engineer-procure-construct (EPC) services to replace the century-old substation with a new, 115-kV, substation utilizing three-in-one GIS equipment. The site had a lot of underground network infrastructure in and around it, and multiple components of the AIS were to remain in place because of station configuration.

SOLUTION

The reconfigured substation is designed for 115-kV operation in a breaker-and-a-half configuration, ultimately consisting of six bay positions. The facility currently consists of four fully populated bays and one partially populated bay in a breaker-and-a-half configuration, creating nine terminal positions. Five of the terminal positions are dedicated to 115-kV transmission lines, with two of the lines connected to overhead and the other three lines connected to

the underground system. The other four terminal positions are dedicated to four transformers. The low side of each transformer remained as it was connected prior to the retrofit, serving the existing 13.8-kV yard. Relaying and control systems use IEC 61850 for most operations, including fully separated primary and backup systems located within a new control enclosure.

We started with developing safety and health plans by performing a systematic overview of the project's scope with the owners, focusing on identifying potentially hazardous tasks, conditions, toxic/hazardous materials and special training or procedures that would be required to perform this project safely.

As the EPC prime contractor, we developed construction plans addressing off-site storage, laydown areas, stockpile areas and other construction logistics. Construction sequencing was carefully planned to accommodate critical project milestones and to balance the resource and construction space requirements.

To optimize the substation design, we worked closely with the owner, construction partners and a preferred GIS vendor to design and install:

- A six-bay breaker-and-a-half indoor GIS switchgear lineup, including independent bay positions for each of the existing lines and transformers.
- A data server to collect disturbance records, enabling engineers to monitor the health of assets across the system.
- An enhanced site layout that cleared 13,000 square feet of space for future site expansion.
- A gas density monitoring system to provide advanced warning of SF6 leaks and historical performance data, and to automatically generate SF6 gas inventory reports.
- Monopoles to transition overhead lines to GIS bushings.
- Protection and control systems based on IEC 61850 design protocols to improve local data archiving and retrieval of substation events, as well as enable secure, remote access for maintenance and troubleshooting.
- One of the first circuit breaker monitoring system applications in the U.S. to allow the client to prioritize and maintain circuit breakers before a fault or disruptive operation occurs.

Additionally, to keep the old facilities operational during construction and cut-overs to the new substation, we:

- Developed detailed cut-over and commissioning plans, as well as construction sequence documents illustrating each iteration of the process.
- Established multiple temporary three-terminal sources to feed the existing AIS substation and the new GIS substation.
- Followed a pragmatic approach to commission the GIS substation on a circuit-by-circuit basis.
- Conducted collaborative workshops with all project stakeholders to sequence construction and commissioning tasks safely and efficiently.

RESULTS

We completed more than 125,000 total man-hours on the project with zero safety incidents.

As a result of closely coordinated efforts and our robust planning process, we maintained generation reliability and customer distribution load throughout the yearlong cut-over process. There were multiple outages planned during that period, and all were successfully completed within the stipulated time.

The entire project duration, from design through delivering the new GIS substation and performing the yearlong cut-overs, was 34 months. Despite encountering extreme winter weather conditions, the project was completed three months ahead of schedule and within budget. The project earned industry awards as a best project and for safety excellence.

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