Submission for the ACEC Canada
Canadian Consulting Engineering Awards 2016

Western Alberta Transmission Line (WATL) HVDC Project

Submitted by Teshmont Consultants LP
as a Consultant to AltaLink

Teshmont
Leaders in Power Delivery Engineering

50 YEARS
1966-2016

Attachment 1

Confirmation Receipt from the online

Official Entry Form & Project Outline

Phase 2 – Bid Evaluation and Contract Award

After a three month tendering period, Teshmont performed a comprehensive and detailed review of the bids submitted to evaluate conformance to the specifications and to assess the different offerings from a technical standpoint in order to provide AltaLink with a ranking of the bidders on a technical merit and value basis. The review also included a series of clarification questions and associated responses. Once a preferred bidder was identified, Teshmont supported AltaLink through the contract negotiations and prepared a conformed specification at the end of negotiations, which encapsulated all of the changes to the original specification that were agreed upon during the negotiations. The final contract for the converter stations was awarded to Siemens of Germany.

Phase 3 – Design, Manufacture, Installation, and Commissioning

The third phase of the project was broken down into four distinct stages as follows:

Stage 1: Design Review – During the design review stage, Siemens was required to submit study reports, drawings, equipment specifications, schedules, plans, and other documents. Teshmont's job was to not only review these documents, checking for conformance to specified requirements but also to manage the flow of these submittals within the AltaLink/Teshmont team to ensure timely responses, which were critical in maintaining the project schedule. Teshmont also reviewed the design of the transmission line, which was being built under separate contracts managed by SNC Lavalin. The line design review included conductor and insulator selection, tower design, as well as minimum electrical clearances.

Stage 2: Manufacturing – During the manufacturing phase, Teshmont monitored Siemens' progress and reviewed factory test plans and subsequent test results of major components. For the most critical components, Teshmont staff attended factory acceptance tests together with AltaLink staff to ensure the quality of the delivered equipment.

Stage 3: Installation – During site installation of the equipment, Teshmont supported AltaLink by providing feedback to any questions or concerns that arose. Teshmont staff, while not permanently on-site, did make site visit at key times to view progress.

Stage 5 Commissioning – During final energization and commissioning of the system, Teshmont reviewed the commissioning plan and was on-site for critical first energization and subsequent system testing up to achievement of full power transmission readiness on December 10, 2015.

In addition to the above, Teshmont provided project management support and coordination throughout the lifecycle of the project, overseeing the effective and time critical flow of information between the various stakeholders. This involved management of the massive amounts of data flowing through the project SharePoint portal between all of the project stakeholders in a timely manner so as not to delay the project schedule. Teshmont also had the responsibility of reviewing, vetting, and coordinating comments from various teams of subject matter experts involved in the project.

Teshmont worked together with key AltaLink personnel throughout the project for training and technology transfer purposes. This was seen from the outset as a key factor to having a successful project, as this would be the first HVDC project for AltaLink and they would be ultimately be responsible for ongoing operation and maintenance of the system after it was commissioned.

Project Complexities and Challenges

The WATL Project was a $1.65 billion dollar project with multiple parties involved over a span of five years. Teshmont had to ensure that the technical specifications were clear and concise and that the contractors adhered to the technical specifications while remaining on schedule and within budget. In order to accomplish this, information exchange between stakeholders in a well-organized and timely manner was essential. Teshmont was responsible for setting up and managing a process and system for document submittal and review utilizing Microsoft SharePoint that ultimately was used on over 32,000 documents shared amongst a number of stakeholders over the course of the five year project.

WATL also brought particular technical challenges as it was the first HVDC system to be energized in Alberta. Thorough study was essential to ensure that the initial 1000 MW line embedded in the heart of the existing Alberta electric system would not have any adverse effects. Some of the particular technical issues that had to be examined for WATL included:

- Effects of commutation failures
- Effects of transformer energization
- Effects of transient overvoltages
- Possible control interactions and power voltage instability
- Effects on the rating of existing harmonic filters in other substations

Another challenge was the potential impact of the transmission line on the countless pipelines found in the surrounding area. In many instances, HVDC systems are developed utilizing ground electrodes, which allow for the HVDC system to operate in ground current return mode for short periods of time during certain operating conditions. Utilization of a ground electrode allows for a much simpler, smaller, and less expensive design of the HVDC transmission line towers. However, operation utilizing a ground electrode may have undesirable impacts on nearby infrastructure, which would need to be examined and possibly mitigated. Due to the possible safety and operating concerns with the numerous oil and gas pipelines in the region, it was decided to develop the HVDC line with a metallic return conductor and avoid the use of ground electrodes.

The project schedule was another challenge. Despite the five year duration, a number of key activities throughout the project had very short timelines in order to meet key milestone dates. The initial front-end engineering study, design, specification, bid, review, negotiate, and award process for the converter stations was completed within six months compared with a more typical duration of eight to twelve months. Construction of the transmission line was also a challenge due to the relatively tight construction schedule. In order to expedite construction of the line, helicopters were used to assist with not only tower erection as shown in Figure 4, but also stringing of the line as shown in Figure 5.

Figure 4: Tower Assembly Using a Helicopter Air Crane

Figure 5: Conductor Stringing using a Helicopter

Innovation and Application of Technology

The selection of HVDC transmission technology for interconnecting the major Alberta load centres of Calgary and Edmonton was made based on studies results that showed the technical advantages of HVDC over a similarly rated AC option were of higher benefit.

Any HVDC project is technically complex and involves careful study and planning to ensure that the HVDC technology is properly applied and the WATL project was no exception. Power system analysis performed by Teshmont indicated that there were potential issues with interactions between the planned converter station and the Alberta interconnected electric system at the Crossings Converter Station near Langdon. In order to mitigate the identified issues, the project implementation required a STATCOM, which is a fast power electronic based regulating device used to provide precise voltage regulation. The STATCOM at Crossings Converter Station minimizes the impact on the AC system when the HVDC system's filter banks required to absorb the harmonics generated by the converters are switched in and out.

The converters are controlled by state of the art high speed advanced control and protection systems, which are able to precisely regulate the amount and direction of power flow through the HVDC system. The control and protection systems are also able to quickly respond to disturbances in the adjoining AC network to help operators maintain system control and stability during outages. Another major application of advanced technology on the project was in the method of testing these control and protection systems in the factory. These tests took over two months and were performed in Siemens' factory in Germany utilizing a power system real time digital simulator (RTDS). The RTDS is an advanced parallel processing super computer that, when loaded with a model of the power system, is able to simulate the response of a power grid to HVDC controls in real time. When connected to the simulator, the HVDC controls behave and respond as if they were in operation in the real power grid. This method allows for very accurate testing to be performed and modifications to be carried out on the HVDC controls without the risk of causing problems, including blackouts, in the real power system.

While initially installed and commissioned for two terminal operation at 1000 MegaWatts (MW) maximum power transfer capability, the HVDC line has been designed to be upgraded to 3000 MW with no additional structures or conductors required. As well, the system has also been developed to support the potential future addition of more converter stations to form a multi-terminal scheme. Multi-terminal HVDC transmission is highly complicated from a HVDC control and protection perspective and currently there are only two such systems in operation in the world.

Social/Economic/Environmental Impact

As noted previously, HVDC technology was selected for a number of reasons, including the reduction of electrical power loses. As a result of these lower losses, the project is estimated to reduce carbon emissions by approximately 350,000 tonnes, which is the equivalent of removing 65,000 vehicles from Alberta's roads.

By selecting HVDC to interconnect the two largest load centres in the province, WATL will help to improve the overall reliability of electricity supply to consumers in these centres and in the province. Secure and dependable supply of electricity helps maintain a high quality of life, security, and productivity for the people of Alberta.

The project also relieves transmission system congestion that existed in the existing AC network and that limited consumers' access to the generator facility owners. As Alberta is the only truly deregulated energy market in North America, with consumers having choice in their electricity provider, unrestricted access to electricity generators results in increased competition and ultimately lower energy costs to consumers.

The selection of HVDC also resulted in a transmission line whose towers are smaller in size and therefore take up less space than a similarly rated AC transmission line. This reduction in tower size results in less land being required for the line right-of-way and is less visually obstructive than a comparable AC transmission line.

Finally, the application of HVDC has no observed negative effects on potential health impacts resulting from electric or magnetic fields.

Conclusions

The WATL project was significant and historic for both AltaLink, as well as the electric power system in Alberta. Teshmont was instrumental in helping AltaLink throughout the five years of development and implementation of the project by working closely to provide technical leadership, guidance, advice, and training for the successful operation of the WATL HVDC Project. Thanks in large part to Teshmont's extensive involvement in the project, the WATL HVDC Project will provide environmental, economic, and societal benefits for all Albertans throughout its life.

Attachment 4

Photographs