FEASIBILITY STUDY AND CABLE SYSTEM OPTIMIZATION IN APPLICATION OF 500KV XLPE CABLE IN THE EDMONTON REGION OF ALBERTA

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ABSTRACT

This paper presents a summary of the feasibility study, design optimization, construction methodology and unique testing requirements (for cold temperature) for a 500kV underground cable system proposed for a portion of a double circuit transmission line near Edmonton, Alberta, Canada. The transmission system is an n-1 design that will include two parallel, 500 kV, 3000 MW circuits with a route length of approximately 65km. There were many options included within the Feasibility Study. The cable section considered here will be about 20km in length.

KEYWORDS

Feasibility study; optimization; cold temperature; cable critical length; ground temperature prediction; 500 KV

INTRODUCTION

Alberta's Industrial Heartland (the "Heartland") is a 317 square kilometer area located northeast of the City of Edmonton in Alberta, Canada. The Heartland is one of Canada's largest processing centers for petroleum, petrochemical and chemical industries.

The purpose of the Heartland bulk transmission link project is to provide 500 kV transmission facilities to meet the load growth in the Edmonton, Heartland and Northeast Alberta regions, and to provide interconnection to the East Alberta HVDC link.

The Heartland transmission link consists of two parallel 65 Km 500 kV overhead circuits, with each circuit rated for 3,000 MW.

A 20 km portion of the Heartland link may be constructed using 500kV underground cables.

If the underground transmission is approved for the Heartland project by the regulatory body, the AESO (Alberta Electric System Operator) decided that the underground transmission can be staged to accommodate the predicted load. It is anticipated that the average load would be 500 MVA per circuit up to 2027 and from 2027 and beyond the average load would be 1000 MVA per circuit. Therefore, two underground circuits, each rated at 1500 MVA, would be installed in series with the overhead transmission. In 2026 a third underground circuit would be installed. Both the overhead and underground circuits would be designed for n-1 with the staged approach.

Challenges of this design include the crossing of many route obstructions such as roads, railroads, wetlands existing transmission lines and oil and gas pipelines and the undulating lands where the 20 km of underground cable would be installed.

The winter air and ground temperatures that occur in the vicinity of Edmonton are lower than those previously reported for existing 400 kV and 500 kV applications of XLPE cable and joint systems. For the 500 kV cable system to be acceptable it is necessary to demonstrate the operational reliability of the cables and joints at low temperatures. The cable joints are likely the most vulnerable, because during cold periods, the elastomeric insulation would be operating closer to the 'glass transition' temperature at which the properties of high elasticity, believed to be essential for reliable electrical performance, are lost.

A requirement of the design of the 500 kV link is for n-1 redundancy such that either one of the two overhead circuits can carry the peak load of 3000 MW as a contingency operation in the event that the other circuit is unavailable.

The project started with the 500 kV Underground Feasibility Study and preliminary cable optimization engineering. This phase of the project started in Q2 2009 and was completed in Q1 2010.

In the next stage for the cable optimization process, the following stages would be considered and iterated as required in terms of performance requirement, reliability and availability and associated cost impact:

Stage 1 - Preliminary design of the cable system

Stage 2 - Preliminary cable route selection

Stage 3 - Checking of the cable design

Stage 4 - Choice of route and civil design

Stage 5 - Cable installation plan

FEASIBILITY STUDY

Underground transmission for medium and low voltage systems are frequently used in urban areas where space land costs and environmental impact are often the determining factors. For medium to long distance bulk power transmission where high voltage systems are more practical, application of underground cable systems is not a default choice due to installation techniques complexity, higher cost and longer construction time.

A feasibility study is the first step for determining whether an underground cable system is technically viable for the application. The system configuration for