

# Bipole III Project

## Capital Expenditure Review Converter Stations

# Introduction

- The Bipole III HVDC project is currently being built by Manitoba Hydro.
- The overall Bipole III project includes:
  - Two HVDC converter stations, comprising two “poles” of 1,000MW each (the Keewatinohk Converter Station and the Riel Converter Station).
  - Bipolar HVDC transmission line connecting the two HVDC converter stations.
- Amplitude’s scope of work was to:
  - Assist MGF with the assessment for reasonableness of the current forecast at completion capital costs; and
  - Provide an opinion on whether appropriate contingencies and reserves have been provisioned;
  - In relation to the Keewatinohk Converter Station and Riel Converter Station only.

# Forecast Completion Costs for the Converter Stations

- Most recent revision to cost estimate completed in 2016.
- Manitoba Hydro applied a Work Breakdown Structure (WBS) to the cost estimates for the converter stations.
- The same WBS structure was used for the 2014 estimate.

WBS No.	Description
14363	Property – Riel Converter Station
14364	Riel Converter Station & 230kV AC Switchyard Site Development
15533	Property – Keewatinohk Converter Station
15540	Keewatinohk Converter Station
15541	Riel Converter Station
15544	Keewatinohk 230kV AC Switchyard
21082	Keewatinohk Converter Station Distribution
23788	Riel 230kV Expansion for Bipole III
23837	Converter Stations Contingency

- Overall estimate for both converter stations:
  - 2014 Estimate - \$2,675,082,692.80
  - 2016 Estimate - \$2,779,633,110.33
- Increase from 2014 to 2016 - \$104,550,417.53.

# Forecast Completion Costs for the Converter Stations

- Increases from 2014 to 2016 estimate noted to comprise:
  - Some material changes to WBS 15540 (Keewatinohk Converter Station) and 15541 (Riel Converter Station).
  - Most notable increase was to contingency (23837).
  - Identified by MH as being due to increase in confidence from P50 to P75 as recommended by the Boston Consulting Group.
- The only significant scope change noted between 2014 and 2016 was additional funding for the access road for Conawapa, which was originally to be shared with the Conawapa project which has since been shelved.
- WBS 15540 (Keewatinohk Converter Station) and 15541 (Riel Converter Station) make up close to 78% of the total budget for the converter stations. The major elements of these WBS include:
  - The EPC contract for the HVDC converter stations; and
  - The EPC contract for the synchronous condensers.

# Converter Station Costs

- EPC Contract for engineering , procurement, construction and commissioning of both converter stations.
- Competitive tender process – three bidders:
  - Siemens / Mortenson Construction
  - ABB / Kiewit
  - Alstom / PCL Constructors Canada Inc.
- The technology partners of all 3 bidders (Siemens, ABB and Alstom) are well known in the HVDC industry and have a long history of providing this technology globally.
- The techno-economic evaluation of the bidders appears to have been thorough with consideration given to technical capability, compliance, performance, technology, schedule and overall value.
- The contract was awarded to Siemens / Mortenson.

# Converter Station Costs

- The pricing of HVDC converter dependent on many factors, many of which are known only to the vendors at the time of pricing.
- Some factors that influence pricing when comparing converter station EPC costs between projects include:
  - Cost of raw materials and metals.
  - Global demand for HVDC and vendor manufacturing capacity.
  - Project location.
- There is also the issue of confidentiality – While the final EPC price (or ballpark price) of HVDC projects is often published, the detailed breakdown of these prices are most often not available, making it almost impossible to obtain accurate unit prices for key HVDC items.
- The comparison of the overall cost of others projects requires an understanding of the scope of each project and any key differences between them and the project under review.

# Converter Station Costs

- There are some specific characteristics of the Bipole III project that may influence the cost of this project compared to others.
  - Each pole of the Bipole III project comprises two series valve groups. The majority of HVDC projects built up to now have only one valve group per pole.
  - Extreme temperature and environmental conditions to be experienced both during construction (at both sites) and during operations.
  - The remoteness of the Keewatinohk Converter Station site, and the additional costs associated with performing work in these locations (personnel, travel, transportation etc.).
  - Unique controls, which may not apply to other projects, including those in warmer climates or outside of North America, including:
    - De-icing controls.
    - SPS interface, frequency controls, damping controls and reduction (“run-back”) capability.
    - NERC cyber security requirements.
- While the project is rated at 2,000MW, the converter stations are designed for a “continuous overload” of 2,300MW.
- From a cost perspective, all equipment within the converter stations would need to be rated at 2,300MW continuously and therefore we have used a unit rate (\$/kW) based on 2,300MW.

# Converter Station Costs

- Amplitude performed a comparison of the overall cost per MW for the EPC Contract price (including variations to date) against published costs of similar projects (where available). These were scaled based on time and forex assumptions.
- Of the similar projects applied in the comparison, all but one was based on one valve group per pole.
- We concluded that:
  1. Analysis of published contract costs for similar converter stations installed worldwide, showed a vendor (EPC contract) price for two 2,300MW bipole converter stations of the order of \$667M, with an error of at least  $\pm 30\%$ .
  2. The values drawn from Cigre technical brochures will result in a vendor (EPC contract) price for two 2,300MW bipole converter stations of the order of \$685.8M. The values are stated as having an accuracy no better than  $\pm 20\%$ , widening the range to between \$548.6M and \$822.9M.
  3. The values drawn from information from recently completed HVDC LCC projects in Canada, the WATL and EATL projects in Alberta, will result in a vendor (EPC contract) price for two 2,300MW bipole converter stations of the order of \$865.7M.
- All values determined above, except for one comparative project used in item 1, are based on one valve group per pole.
- We are of the view that the EPC costs for the Bipole III converter stations (including variations to date) are reasonable after taking into consideration the use of two valve groups per pole, the remoteness of the Keewatinohk Converter Station and the extreme temperature and environmental conditions to be experienced both during construction and during operations.



# Synchronous Condenser Costs

- EPC Contract for engineering , procurement, construction and commissioning of four 250MVAR synchronous condensers at the Riel Converter Station.
- Competitive tender process – three bidders – Siemens, Alstom and Voith.
- The contract was awarded to Voith.
- An analysis of published costs of similar synchronous condenser projects, worldwide, was performed.
- The contract value (excluding tax and escalation) was compared against an estimated range (based on 8 sources, and scaling and forex assumptions) of between \$120.66/kVAr to \$240.60/kVAr.
- The Voith contract is within the range of other projects, although it is on the high side of this range.
- We are of the view that the EPC costs for the synchronous condensers are reasonable, after comparison to publicly available cost references and consideration of the extreme temperature and environmental conditions to be experienced both during construction and during operations.

# Reasonableness of Contingencies and Reserves

- Amplitude compared the reported actual costs (up to September 2017) to the 2016 Budget for each WBS number, and for each network number (within the WBS).
- The comparison showed (for the converter station WBSs):
  - 2016 Budget for converter stations - \$2.78Bn
  - Actual costs incurred to September 2017 - \$2.14Bn
  - Remaining Budget (as at Sept 17) - \$0.64Bn

# Reasonableness of Contingencies and Reserves

- Amplitude considered the completion status of the converter station components of project and the reported remaining amounts on the major contracts.
  - No information was provided on outstanding contracts associated with P14354 and P23788, covering the Riel 230kV AC switchyard site development and the Riel 230kV expansion.
- We are of the view that:
  - The remaining budget for the Keewatinohk 230kV AC Switchyard (P15544) will not be enough to cover the outstanding contract amounts payable to SNC Lavalin and will require a draw from contingency.
  - For the remaining WBS numbers associated with the HVDC converter stations (i.e. P14363, P14364, P15533, P15540, P15541, P21082, and P23788), the information made available indicates that there should be satisfactory amounts remaining in the budgets for each WBS to complete the project without having to draw from contingency.
  - After taking out the expected draw from contingency for P15544, the remaining contingency should be considered reasonable to cover the impact of any unexpected events or activities which cannot be ascertained from the information made available for this review.

Thank You