Application for Approval of Capital Projects Necessary for the Continued Operation of the Holyrood Thermal Generation Station

April 7, 2019

newfoundland labrador hydro
a nalcor energy company

An Application to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Hydro Place. 500 Columbus Drive.
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 f. 709.737.1800
www.nlh.nl.ca

April 07, 2020

Board of Commissioners of Public Utilities
Prince Charles Building
120 Torbay Road, P.O. Box 21040
St. John's, NL A1A 5B2

Attention: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: Application for Approval of Capital Projects Necessary for the Continued Operation of the Holyrood Thermal Generation Station

Attached is Newfoundland and Labrador Hydro's ("Hydro") application for approval of capital projects necessary for the continued operation of the Holyrood Thermal Generation Station ("Holyrood TGS").

The attached application proposes four projects with a total estimated capital cost of approximately $7.6 million. The projects were not proposed in Hydro's 2020 Capital Budget Application as, at that time, the production forecast for the Holyrood TGS anticipated a lower level of production due to the in-service of the Labrador-Island Link ("LIL") and the planned retirement of Holyrood TGS Units 1 and 2. In light of the material increase of production levels over those anticipated, as well as Hydro's extension of Holyrood TGS's operations to March 31, 2022, these projects are necessary for the reliable operation of the Holyrood TGS. The projects, previously identified in the "Reliability and Resource Adequacy Study – 2019 Update" as required should the operation of the Holyrood TGS be extended, are as follows:

- Boiler Condition Assessment and Miscellaneous Upgrades;
- Overhaul Unit 2 Turbine Valves;
- Overhaul Unit 3 Boiler Feed Pump West; and
- Overhaul Unit 2 Generator.

Details of these projects are found in the individual project reports, included as Appendices A through D attached to Schedule 1 to this application. Hydro does not consider deferral of these projects to be a viable alternative and believes the projects are necessary to maintain the Holyrood TGS at full capacity until the LIL assets are proven reliable. Hydro submits the proposed capital expenditures are necessary to ensure the continued provision of service which is safe and adequate, and just and reasonable as required by section 37 of the *Public Utilities Act*.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Senior Legal Counsel, Regulatory
SAW/las

Encl.

cc: **Newfoundland Power**
Gerard M. Hayes

Consumer Advocate
Dennis M. Browne, Q.C, Browne Fitzgerald Morgan & Avis

Industrial Customer Group
Paul L. Coxworthy, Stewart McKelvey
Denis J. Fleming, Cox & Palmer
Dean A. Porter, Poole Althouse

ecc: **Board of Commissioners of Public Utilities**
Jacqui Glynn
PUB Official Email

Newfoundland Power
Kelly C. Hopkins
Regulatory Email

Consumer Advocate
Stephen F. Fitzgerald, Browne Fitzgerald Morgan & Avis
Sarah G. Fitzgerald, Browne Fitzgerald Morgan & Avis
Bernice Bailey, Browne Fitzgerald Morgan & Avis

Iron Ore Company of Canada
Gregory A.C. Moores, Stewart McKelvey

Labrador Interconnected Group
Senwung Luk, Olthuis Kleer Townshend LLP
Julia Brown, Olthuis Kleer Townshend LLP

Application

newfoundland labrador hydro
a nalcor energy company

IN THE MATTER OF the *Electrical Power Control Act,* RSNL 1994, Chapter E-5.1 (*"EPCA"*) and the *Public Utilities Act*, RSNL 1990, Chapter P-47 ("*Act"*), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro ("Hydro") for approval of certain capital projects necessary for the continued operation of the Holyrood Thermal Generation Station ("Holyrood TGS") pursuant to Subsection 41(3) of the *Act*.

TO: The Board of Commissioners of Public Utilities ("Board")

THE APPLICATION OF NEWFOUNDLAND AND LABRADOR HYDRO STATES THAT:

A. Background

1. Hydro, a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the *Act*, and is subject to the provisions of the *Electrical Power Control Act, 1994*.

2. Hydro is the primary generator of electricity in Newfoundland and Labrador. As part of its generating assets, Hydro owns and operates the Holyrood TGS. The Holyrood TGS has three oil-fired generating units providing an installed capacity of 490 MW, and represents approximately one third of Hydro's Island Interconnected System generating capacity and approximately one quarter of the total Island Interconnected System capacity, when included with all other customer-owned generation.

B. Application

3. Units 1 and 2 were commissioned in 1970 and 1971, respectively, and Unit 3 in 1979. Units 1 and 2 were originally designed to produce 150 MW each and were upgraded to 170 MW in 1988 and 1989, respectively. Unit 3 retains its original configuration and is rated at 150 MW. In 1986, Unit 3 was retrofitted with synchronous condensing capability to provide voltage support on the eastern area of the Island Interconnected System during periods when power generation from this unit is not required.

4. In its 2020 Capital Budget Application ("2020 CBA"), Hydro provided the Holyrood TGS Overview Future Operation and Capital Expenditure Requirements ("Holyrood Overview Report"). The Holyrood Overview Report provided information on the short- and medium-term operational outlook and schedule for the Holyrood TGS, the maintenance strategy through each of the operational phases, and a summary of planned capital expenditures for 2020–2024.

5. At the time the 2020 CBA was filed, Hydro anticipated that the Holyrood TGS would be transitioning from the normal production phase to the standby production phase in early 2020, remaining in that phase until March 31, 2021, after which it would transition fully into standby mode. This schedule was premised on Hydro having access to off-island supply via the Labrador-Island Link ("LIL") through the standby production phase and a resulting reduced operational requirement for the Holyrood TGS.

6. On February 14, 2020, Hydro advised the Board that as the schedule for construction and commissioning of the Muskrat Falls project has changed over time, Hydro did not expect the planned transition of the Holyrood TGS to post-steam operation on March 31, 2021 to be possible. Hydro advised that it was extending the readiness to operate the Holyrood TGS to March 31, 2022 to ensure reliable service for customers while the Muskrat Falls Generation Facility and the LIL are brought online and proven reliable.

7. As a result of the delays with the in-service of the Labrador Island Link, and the resultant reduction in available off-island purchases, Hydro was unable to transition the Holyrood TGS from the normal production phase to standby production phase. Hydro has run the Holyrood TGS at a higher level of production than anticipated; this higher level of production, along with the extension of the Holyrood TGS to March 31, 2022 noted above, has resulted in a material change in production requirements. Further detail on the developments regarding the Holyrood TGS transition as well as the increased production is contained in the Holyrood Supplemental Projects Overview Report, included with this application as Schedule 1.

8. Due to the material change in production requirements, additional capital work is necessary to extend the operational life of the Holyrood TGS. Specific projects were identified in the Reliability and Resource Adequacy Study – 2019 Update ("RRA 2019 Update") as being required in 2020 for the reliable operation of the Holyrood TGS, should the operation of the Holyrood TGS be extended to March 31, 2022. They are:

(i) Boiler Condition Assessment and Miscellaneous Upgrades;

(ii) Overhaul Unit 2 Turbine Valves;

(iii) Overhaul Unit 3 Boiler Feed Pump West; and

(iv) Overhaul Unit 2 Generator.

9. Hydro intends to fully execute the above projects during planned outages in 2020, prior to the 2020–2021 winter season. Hydro acknowledges some uncertainty in the time frames necessary for execution due to limitations related to the COVID-19 pandemic; should aspects of the proposed projects not be completed within the noted time frame, Hydro will advise the Board and provide plans for mitigation.

Boiler Condition Assessment and Miscellaneous Upgrades

10. The Holyrood TGS boilers require regular inspection and analysis to monitor wear rates and plan interventions; failure of any steam system in service could result in forced outages. Hydro commenced a three year Condition Assessment and Miscellaneous Upgrades program in 2017, with the last project carried out in 2019 based on the anticipated transition of the Holyrood TGS.

11. As the Holyrood TGS will now operate through March 2022, and due to the actual and anticipated increase in production requirements, Hydro believes it is prudent to extend this program into 2020.

12. The scope of this project includes Level 2 condition assessments on internal components of the main steam generators and associated external high energy piping to identify required refurbishments or replacements. Hydro will also complete necessary miscellaneous upgrades of condition based deficiencies identified in the 2019 Condition Assessment and Miscellaneous Upgrades Project.

13. The Boiler Condition Assessment and Miscellaneous Upgrades project is necessary to support appropriate levels of safety and reliability, and contribute to Hydro's ability to meet customer demand through peak periods. Additional information about this project, including discussion of the deferral alternative, is provided in Appendix A to Schedule 1, included with this application.

14. The estimated capital cost of the project is $3,056,700 and is intended to be complete by the 2020–2021 winter season.

Overhaul Unit 2 Turbine Valves

15. The Holyrood TGS Unit 2 turbine was manufactured by General Electric in 1969 and has a number of major turbine valves. This project consists of total disassembly, detailed internal inspection, refurbishment, and reassembly of all major steam valves. Valve refurbishment includes replacement of any identified damaged components.

16. The Unit 2 turbine valves are critical to the unit's operation. The Original Equipment Manufacturer ("OEM") recommends a three-year overhaul cycle, which is consistent with industry standard practice. The valves were last overhauled in 2017. As noted above, this project was not included in the 2020 CBA due to Hydro's expectations regarding the Holyrood TGS transition and production levels. However, in light of the increased production, the turbine valves have now operated at similar levels over the past three years as they did in previous overhaul cycles. That, along with the extension of the Holyrood TGS operations, supports Hydro's belief that the 2020 overhaul is necessary to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

17. Deferral of these overhauls will increase the chance of an over-speed event and increase the likelihood of a valve failure which could result in a loss of 170 MW of generation for several weeks, compromising Hydro's ability to maintain full capacity and meet customer demand. As set out in the project description and justification document attached to this application as Appendix B to Schedule 1, Hydro is recommending an overhaul of the Holyrood TGS Unit 2 Turbine Valves.

18. This project is scheduled to be completed prior to the 2020–2021 winter season and has an estimated capital cost of $2,919,500.

Overhaul Unit 3 Boiler Feed Pump

19. Unit 3 has both an east and west boiler feed pump. Each pump individually supports 80 MW of generation for Unit 3. Together, the pumps allow Unit 3 to operate at its rated capacity of 150 MW.

20. Unit 3 boiler feed pump west was placed in service in 1980. The Holyrood TGS Unit 3 has operated for approximately 3,100 hours since this boiler feed pump was last overhauled in 2013. Based on Hydro's six-year overhaul frequency standard, the next overhaul was due in 2019. Hydro did not complete an overhaul at that time as it was anticipated that production requirements from the Holyrood TGS would be materially reduced through 2020 and subsequent years.

21. Due to the higher than anticipated levels of production to date, higher production than anticipated forecast for 2020, and an extension of the Holyrood TGS operation to March 31, 2022, Hydro believes that a continued extension of this overhaul is an unacceptable risk. If an overhaul is not completed at this time, the pump could fail while in operation. Such failure would result in the reduction of 70–80 MW from Unit 3 generating capacity for several weeks. An overhaul is necessary at this time to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

22. Further detail with respect to this project is found in the project description and justification document attached to this application as Appendix C to Schedule 1.

23. The project is scheduled for completion prior to the 2020–2021 winter season and has an estimated capital cost of $367,900.

Overhaul Unit 2 Generator

24. The Holyrood TGS Unit 2 generator was last overhauled in 2014. Based on Hydro's experience with the Holyrood TGS generators, a six-year overhaul frequency is an appropriate timeframe based on the equipment condition noted during previous overhauls. It is also consistent with the OEM recommendations.

25. Hydro had not included the Unit 2 generator overhaul in its 2020 CBA due to anticipated material reductions in production requirements; however, the actual production requirements have been consistent with levels experienced in previous overhaul cycles. A failure of any generator could result in extensive damage to the generator and a loss of 175 MW of generation capacity for a period of time. As a result, Hydro recommends the overhaul of the Unit 2 generator to support the safe and reliable operation of the Holyrood TGS Unit 2 and its rated output.

26. Detail with respect to this project and its justification is contained in Appendix D of Schedule 1 to this application.

27. The project is scheduled for completion prior to the 2020–2021 winter season and has an estimated capital cost of $1,294,100.

C. Newfoundland and Labrador Hydro's Request

28. Hydro submits that the proposed capital expenditures detailed above and further described in Appendices A through D of Schedule 1 to this application are necessary to ensure that Hydro can continue to provide service which is safe and adequate and just and reasonable as required by Section 37 of the *Act.*

29. Therefore, Hydro makes application that the Board make an Order pursuant to section 41(3) of the *Act* approving the total capital expenditure of approximately $7,638,200 for the Boiler Condition Assessment and Miscellaneous Upgrades, Overhaul Unit 2 Turbine Valves, Overhaul Unit 3 Boiler Feed Pump West, and Overhaul Unit 2 Generator projects as more particularly described in this application and in the project description and justification documents attached as Appendices to Schedule 1.

D. **Communications**

30. Communications with respect to this application should be forwarded to Shirley A. Walsh, Senior Legal Counsel, Regulatory for Hydro.

DATED at St. John's in the Province of Newfoundland and Labrador this 7th day of April, 2020.

NEWFOUNDLAND AND LABRADOR HYDRO

Shirley A. Walsh
Counsel for the Applicant
Newfoundland and Labrador Hydro
500 Columbus Drive P.O. Box
12400 St. John's, NL A1B 4K7
Telephone: 709.685.4973

Schedule 1
Holyrood Supplemental Projects Overview Report

April 7, 2020

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Executive Summary

The supplemental capital projects proposed through this application support the short-term operation of the Holyrood Thermal Generating Station ("Holyrood TGS"). These capital projects were not included as part of the original 2020 Capital Budget Application ("2020 CBA") as, at that time, the production forecast for the Holyrood TGS anticipated a lower level of production due to the in-service of the Labrador-Island Link ("LIL") and the planned retirement of Holyrood TGS units 1 and 2. Delays in the in-service of the LIL to date have resulted in (i) greater thermal production at the Holyrood TGS than was originally contemplated, thus placing further demand on plant equipment, and (ii) a decision by Newfoundland and Labrador Hydro ("Hydro") to extend the short-term operation of the Holyrood TGS from March 31, 2021 to March 31, 2022.[1] As a result, Hydro is submitting four supplemental projects critical to the continued operation of the Holyrood TGS in the short-term. Hydro has carefully considered the need for capital investment in advance of the 2021 Capital Budget Application.

Four projects are being proposed, as follows:

1) Boiler Condition Assessment and Miscellaneous Upgrades;
2) Overhaul Unit 2 Turbine Valves;
3) Overhaul Unit 3 Boiler Feed Pump West; and
4) Overhaul Unit 2 Generator.

It is Hydro's intent to execute these projects in 2020 during planned outages. There is some uncertainty surrounding the ability to fully execute these projects in the time frame noted due to limitations related to the COVID-19 pandemic (e.g., external consultants' interprovincial travel, procurement and supply chain challenges, etc.). Hydro will seek to manage the required work and planned outage schedules to achieve completion prior to the 2020–2021 winter season. Should aspects of the supplemental projects not be completed within this time frame, Hydro will inform the Board of Commissioners of Public Utilities ("Board") and provide mitigation plans.

[1] "Extension of Holyrood Thermal Generating Station as a Generating Facility," Newfoundland and Labrador Hydro, correspondence filed with the Board on February 14, 2020.

Hydro does not consider the deferral of these projects a viable alternative, as outlined within each project report included in Appendices A through D. These projects are necessary to maintain Holyrood TGS at full capacity until the LIL assets are proven reliable.

The four projects have a total cost estimate of approximately $7.6 million.

Contents

List of Appendices

List of Attachments

1.0 Background

In its 2020 CBA, Hydro provided the Holyrood TGS Overview Future Operation and Capital Expenditure Requirements ("Holyrood Overview Report"). The Holyrood Overview Report provided information on the short- and medium-term operational outlook and schedule for the Holyrood TGS, the maintenance strategy through each of the operational phases, and a summary of planned capital expenditures for 2020–2024.

When the Holyrood Overview Report was filed, it was anticipated that Holyrood TGS would be transitioning from the normal production phase to the standby production phase beginning in early 2020 and remaining as such until March 31, 2021 (two operating seasons), after which it would transition fully into standby mode (post interconnection phase). However, this schedule was built on the basis of Hydro having access to off-island supply via the LIL through the standby production phase and a reduced operational requirement for Holyrood TGS. Due to delays with the in-service of the LIL, off-island purchases are not available to the extent required to transition the Holyrood TGS from the normal production phase to the standby production phase in the timeframe provided in the Holyrood Overview Report. As a result, Holyrood TGS has been run at a higher level of production than anticipated and is required to be fully operational for the short-term as indicated in the announcement to extend the operation of the Holyrood TGS to March 31, 2022.[2]

The maintenance strategy and capital expenditures presented in the 2020 CBA Holyrood Overview Report were based on the production forecast anticipated at that time. In light of the material change in production requirements, additional capital work is required to extend its operational life.[3]

2.0 Holyrood Production

The actual output for 2019 was 1,329 GWh as compared to the 1,209 GWh forecast in the 2020 CBA and 467 GWh forecast for 2019 in the "2019 Capital Budget Application" ("2019 CBA"). As of March 31,

[2] ibid.
[3] As noted in the "Reliability and Resource Adequacy Study 2019 Update," Newfoundland and Labrador Hydro, November 15, 2019, p. 12.

2020, the year-to-date output for Holyrood TGS was approximately 585 GWh and the forecast for the remainder of 2020 is approximately 400 GWh to 610 GWh.[4]

The lower Holyrood production forecasts for 2019 and 2020 from the recent CBAs were based on anticipated in-service dates of the LIL. At the time of filing the 2020 CBA, Holyrood TGS production was expected to be at a minimum in early 2020, operating in parallel with LIL imports. This mode of operation was expected for the remainder of the 2019–2020 operating season and for the next operating season, with final shutdown on March 31, 2021.

The material change in production requirements from what was planned when filing its recent capital budget applications have prompted the requirement for the additional capital work to reliably extend its operational life until March 31, 2022. The capital upgrades outlined in the supplemental projects are required to maintain the rated capacity of the Holyrood TGS in the short-term.[5]

3.0 Proposed Capital Projects

Hydro's current application includes four capital projects with a total estimated capital cost of approximately $7.6 million. These include:

1) Boiler Condition Assessment and Miscellaneous Upgrades;
2) Overhaul Unit 2 Turbine Valves;
3) Overhaul Unit 3 Boiler Feed Pump West; and
4) Overhaul Unit 2 Generator.

The "Reliability and Resource Adequacy Study – 2019 Update" ("RRA 2019 Update") identified these projects as being required in 2020 for the reliable operation of the Holyrood TGS, whether online in generation mode or in hot-standby mode, should the operation of the Holyrood TGS be extended to

[4] Hydro forecast 587 GWh production at Holyrood TGS for all of 2020 in its 2019 CBA and 450 GWh production in 2020 in its "2018 Capital Budget Application."
[5] The estimated production assumes average hydrology and expected availability of other generating units. Actual production required will be highly dependent on the availability and reliability of the LIL. Holyrood operation will be minimized to the extent possible, using imports when technically and economically feasible.

March 31, 2022.[6] The 2021 projects identified in the RRA 2019 Update are being considered for inclusion in Hydro's 2021 Capital Budget Application.

As previously noted, the requirement for the capital work identified in this application is twofold: (i) the higher than anticipated levels of production at the Holyrood TGS in 2019 and 2020, and (ii) the short-term extension of the Holyrood TGS to March 31, 2022. Failure of any of the components included in this application while in service could result in forced unit outages several weeks to several months in duration. Undertaking this work at this time contributes to Hydro's ability to meet customer demand during peak periods.

The requirement for these projects has been verified by Hydro's engineering consultant, Wood Canada Limited. Correspondence to this effect is contained in Attachment 1.

A brief description of each project follows. Individual project descriptions and justifications are attached in appendices A through D.

3.1 Boiler Condition Assessment and Miscellaneous Upgrades

The Holyrood TGS boilers and associated high-energy piping are exposed to multiple aggressive wear mechanisms and require regular inspection and analysis to monitor wear rates and plan interventions. Hydro is aware of condition-based deficiencies from the 2019 inspection work, and failure of any steam system in service could result in forced outages.

The scope of this proposed project includes Level 2 condition assessments on internal components of the main steam generators (boilers) and associated external high energy piping to identify required refurbishment or replacement work. Additionally, Hydro will complete required miscellaneous upgrades of condition based deficiencies identified in the 2019 Condition Assessment and Miscellaneous Upgrades project.

Boiler Condition Assessment and upgrade projects have been ongoing since 2017 and have historically resulted in safe and reliable operation of the Holyrood TGS boilers and high energy piping. This project is required to support appropriate levels of safety and reliability, contributing to Hydro's ability to meet customer demand during peak periods.

[6] "Reliability and Resource Adequacy Study – 2019 Update," Newfoundland and Labrador Hydro, vol. III, app. A, pp. A-4 to A-5.

The budget estimate for this project is $3,056,700. Further information and justification for this project is provided in Appendix A.

3.2 Overhaul Unit 2 Turbine Valves

The Holyrood TGS Unit 2 turbine was manufactured by General Electric in 1969. The turbine has a number of major turbine valves, as follows:

- Control Valves (6) – Flow regulation, turbine speed control and over-speed protection;
- Main Stop Valve (1) – Isolation , shut-down, and emergency shut down;
- Reheat Stop/Intercept Valves (2) – Isolation and emergency shut-down;
- Blowdown Valve (1) – Emergency pressure release; and
- Extraction Steam Non-return Valves (7) – Prevent return of cool water from feed-water preheater, and over-speed protection.

The proposed project consists of a total disassembly, detailed internal inspection, refurbishment, and reassembly of all major steam valves. Valve refurbishment includes replacement of any damaged components identified in the inspections.

The Unit 2 turbine valves are critical to the unit's operation and were last overhauled in 2017. They are due for overhaul in 2020 based on a three-year overhaul cycle recommended by the Original Equipment Manufacturer and industry standard practice.

The budget estimate for this project is $2,919,500. Further information and justification for this project is provided in Appendix B.

3.3 Overhaul Unit 3 Boiler Feed Pump West

Unit 3 has two boiler feed pumps, west and east. The west boiler feed pump was placed in service in 1980. It receives water from the deaerator tank and feeds it to high pressure heaters before proceeding to the boiler. Individually, Unit 3's west and east feed pumps each support 80 MW of generation for Unit 3. With both pumps in operation the unit can operate at its rated capacity of 150 MW.

The Unit 3 west boiler feed pump was last overhauled in 2013 and was due for its six-year overhaul in 2019. This six-year frequency has historically yielded acceptable levels of reliability and safety. In 2019,

Hydro assessed the risk of deferral of this project to 2020 and determined that the risk was acceptable; however, the risk of a continued deferral would not be acceptable.

Feed water pumps are exposed to high wear conditions including high temperature, high pressure, and high flow velocity making them susceptible to failure after more than six years in operation. Failure of these pumps while in operation would result in the reduction of 70 MW from Unit 3 generating capacity for several weeks while the failed pump is replaced. Overhaul at this time is required to ensure the continued operation of this unit to support the safe and reliable provision of service to meet customer demand during peak periods.

The budget estimate for this project is $367,900. Further information and justification for this project is provided in Appendix C.

3.4 Overhaul Unit 2 Generator

The Holyrood TGS generators are complex mechanical and electrical systems. To maintain safe and reliable operation, the generators are overhauled on a six-year cycle. The last overhaul for Unit 2 was in 2014. The current proposal maintains the six-year overhaul cycle which has been determined appropriate given the unit's operating history.

Continuing operation of the generator at the currently projected loading without performing an overhaul could increase the likelihood of the generator failing while in operation, which could result in forced outages that could range from several days to 18 months in duration. An overhaul, which entails the disassembly of the unit, is the only way to assess and restore components which prevent the release of hydrogen, lube oil, and water and are subject to wear and deterioration. Rotating components, which spin at 60 times per second, also require detailed and specialized inspection to verify their integrity and ensure continued safe and reliable operation.

The budget estimate for this project is $1,294,100. Further information and justification for this project is provided in Appendix D.

4.0 Conclusion

At the time of submission of the 2020 CBA, Hydro intended to transition the Holyrood TGS to standby production through 2020. As such, Hydro did not propose these projects at that time as the work was not necessary based on the production plan that was in place and the intended shutdown of the plant

on March 31, 2021. However, given the higher than anticipated level of production that occurred in 2019 and is expected for 2020, as well as the extension of the Holyrood TGS to March 31, 2022, these capital works are required to ensure ongoing reliable operation of the Holyrood TGS.

Holyrood Supplemental Projects Overview Report

Appendix A: Boiler Condition Assessments and Miscellaneous Upgrades – Holyrood Thermal Generating Station

April 7, 2020

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Executive Summary

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS") at its rated output, Newfoundland and Labrador Hydro ("Hydro") is proposing to continue with the annual Boiler Condition Assessments and Miscellaneous Upgrades project.

This project has been completed on an annual basis since 2017 and has been integral in supporting the safe and reliable operation of steam supply systems at Holyrood TGS. The latest Condition Assessment and Miscellaneous Upgrades project was completed in 2019 and the results of the inspections have been used to develop the Miscellaneous Upgrades portion of the proposed scope of work. As Holyrood TGS is expected to continue operating through March 2022, Hydro believes it is prudent to extend this program in 2020.

The boilers and associated high-energy piping are exposed to multiple aggressive wear mechanisms and require regular inspection and analysis to monitor wear rates and plan interventions. Failure of any steam system while in service could result in generation outages with duration of weeks or months, depending on the magnitude of the failure. The continuation of the Boiler Condition Assessment and Miscellaneous Upgrades program into 2020 is required to support Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

The budget estimate for this project is $3,056,700. The project is expected to be complete prior to the 2020–2021 winter operating season.

Contents

List of Appendices

1.0 Introduction

In 2017, Hydro commenced a three-year Condition Assessment and Miscellaneous Upgrades program. The final year was in 2019. The scope for the project included a Level 2 Condition Assessment related to internal components of the main steam generators (boilers) and associated external high energy piping. Throughout the duration of the Condition Assessment and Miscellaneous Upgrades program, Hydro has proposed and executed various upgrades and replacements to support the reliable operation of the steam generation equipment.

2.0 Background

2.1 Existing System

Holyrood TGS is equipped with three horizontal steam turbine generating units. All three units can be used for power production and Unit 3 is also capable of functioning as a synchronous condenser to assist with system voltage regulation. Each unit is supplied with steam by one of three boilers, each of which is dedicated to a generating unit and fired with bunker C fuel.

The existing main steam generators (boilers) and associated high energy piping (main steam piping, hot reheat piping, cold reheat piping, and high pressure feed water piping) are exposed to high wear mechanisms including high temperatures, high pressure, corrosive fluids and erosive flows.

2.2 Operating Experience

Boilers 1 and 2 were designed by Combustion Engineering and began operating in 1969 and 1970, respectively. Each of these units has operated for approximately 210,000 hours since they were put in service. Boiler 3 was designed by the Babcock & Wilcox Company and began operating in 1979. This unit has operated for approximately 170,000 hours since it was put in service.

2.3 Maintenance History

The boilers and associated steam supply systems have been the focus of annual Boiler Condition Assessment and Miscellaneous Upgrade projects since 2017. A specialized boiler service contractor has been retained under a maintenance service agreement to perform all remedial work on the boiler including the annual Boiler Condition Assessment and Miscellaneous Upgrades projects. Deficiencies discovered in past condition assessments have included:

- Thinning of the boiler tube walls;
- Cracking of various components that are subject to thermal cycling;
- Critical damage to material or failure of structural components;
- Critical damage to refractory materials;
- Duct erosion; and
- Soot blockages.

Deficiencies identified during inspections are typically corrected during the next available outage period unless they are determined to be critical, in which case they are addressed immediately.

3.0 Analysis

3.1 Identification of Alternatives

Hydro considered the following options:

1) Deferral, and
2) Continuation of the Boiler Condition Assessment and Miscellaneous Upgrades program.

3.2 Evaluation of Alternatives

3.2.1 Deferral

Under this alternative, systems would be operated until they failed, at which time repairs would be completed. Accessing internal boiler system components requires extensive periods of down-time, as well as significant effort in the form of scaffolding and disassembly work. Deferral of the project increases the risk of failure while in-service, which could result in unit outages during Hydro's 2020-2021 winter operating season. As such, this alternative is not viable as it presents an unacceptable risk to Hydro's ability to safely and reliably meet customer needs during peak periods.

3.2.2 Continuation of the Boiler Condition Assessment and Miscellaneous Upgrades Program

Under this alternative, the condition of internal components of the main steam generators (boilers) and associated external high energy piping are assessed annually through inspections which are conducted during repair of deficiencies which were previously identified. High-risk issues are corrected immediately

upon identification. Annual inspection and assessment of the condition of high-wear boiler system components enables early identification of areas that may fail in the near-term, allowing for planned intervention. Areas of moderate wear are monitored annually and wear rates are trended, allowing for longer-term planning of interventions where appropriate. Hydro has found this approach to be effective in supporting the safe and reliable operation of the Holyrood TGS boilers. As such, Hydro proposes to continue this approach in 2020.

3.3 Recommended Alternative

Hydro recommends the extension of the Boiler Condition Assessment and Miscellaneous Upgrades program in 2020.

Boiler and high energy piping components are subject to a high-wear operating environment and require regular inspection and analysis to monitor wear rates. This approach allows Hydro to complete repairs in a planned, measured manner while continuing to safely and reliably operate the Holyrood TGS boilers. As boilers age, internal deterioration related to pipe wall thinning, thermal cracking of internal headers, and weld deficiencies are experienced. Such deteriorations need to be remediated on an annual basis to reduce risk of failures during operation. Hydro's experience with this approach has proven effective; therefore, Hydro proposes to continue the Boiler Condition Assessment and Miscellaneous Upgrade Program in 2020.

4.0 Project Description

This project includes a Level 2 Condition Assessment on the internal components of the main steam generators (boilers) to determine what, if any, refurbishment or replacements are required. Additionally, Hydro will complete Miscellaneous Upgrades identified during in the 2019 Condition Assessment and Miscellaneous Upgrades project as detailed in Appendix A-1 to this report.

Hydro has identified all known equipment requiring immediate replacement in Appendix A-1. However, it is possible that additional components may be identified as requiring immediate replacement during the 2020 condition assessment, which, if approved, will occur during the scheduled annual outages. To enable timely completion of necessary work, Hydro proposes to complete any items identified as requiring immediate refurbishment or replacement during the 2020 Condition Assessment during the 2020 outage. For those that are material in dollar value and meet capitalization criteria, Hydro proposes

to communicate these items to the Board of Commissioners of Public Utilities in its 2020 Capital Expenditures and Carryover report.

The detailed scope of the boiler Condition Assessment follows the Inspection and Test Plan ("ITP") that was prepared for Holyrood TGS by the Original Equipment Manufacturer ("OEM") for Unit 1 and Unit 2 boilers, Alstom, and engineering consulting firm AMEC NSS. The ITP covers all boiler pressure parts and high energy piping. Inspection and test scope, assessment methods, and intervals were developed based on recommendations of the OEM and AMEC NSS. Hydro will contract a specialized boiler service company to complete boiler and high-energy piping assessments and repairs. Hydro personnel will assist the service company when required, oversee the work protection application, and provide overall management and liaison for the upgrades.

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	169.0	0	0	169.0
Labour	375.1	0	0	375.1
Consultant	0.0	0	0	0.0
Contract Work	2,163.0	0	0	2,163.0
Other Direct Costs	0.0	0	0	0.0
Interest and Escalation	78.9	0	0	78.9
Contingency	270.7	0	0	270.7
Total	**3,056.7**	**0**	**0**	**3,056.7**

The assessment and upgrade work will take place during the outage period for the three boilers. The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Task	Start Date	End Date
Planning	Project Planning	April 2020	April 2020
Procurement	Purchase Long Lead Parts	April 2020	April 2020
Construction	Unit 3 Outage Work	April 2020	June 2020
Construction	Unit 1 Outage Work	June 2020	August 2020
Construction	Unit 2 Outage Work	July 2020	October 2020
Construction	Total Plant Outage Work	July 2020	August 2020
Construction	Inspection Report	June 2020	November 2020
Closeout	Prepare Closeout Documentation	November 2020	January 2021

5.0 Conclusion

To support the continued safe and reliable operation of the Holyrood TGS through the 2020–2021 winter operating season, Hydro recommends continuing the Boiler Condition Assessment and Miscellaneous Upgrades program in 2020. This program has historically been effective for Hydro and supports the optimal timing of refurbishment and replacement. This measured, planned approach is prudent and supports the safe and reliable operation of the boilers and high energy piping.

Appendix A: Boiler Condition Assessments and Miscellaneous Upgrades – Holyrood Thermal Generating Station

Appendix A-1: Upgrades Identified for 2020 Execution

newfoundland labrador hydro
a nalcor energy company

Description	Estimated Cost	Justification
Holyrood TGS Unit 1		
Internal boroscope inspection of Economizer Inlet Header including measurement of ligament cracks to track growth rate.	$37,500	Last inspected in 2017. B&W recommended re-inspection at three-year-intervals to monitor crack growth rate.
Full interior and exterior inspection of Deaerator Heater and Storage Tank.	$62,000	B&W recommend full inspection of similar B&W units at 5 year interval in order to evaluate Flow Accelerated Corrosion ("FAC") or other corrosion damage that could impact the integrity of the pressure boundary. Previous inspection was more than eight years ago.
Replacement of Sootblower 17R Aspirating Wallbox and Sleeve.	$22,000	Recommended based on condition assessed in 2019 when temporary repairs were performed to correct corrosion damage. Permanent repairs required to manage risk of sootblower impingement on wall tubes and jamming of moving parts on wall box if not replaced.
Condition Assessment of the East and West Air Heater Hoppers and Drains and Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	$30,000	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings . Prevous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Replacement of the following three Down Comer Supports and leaking Header Expansion Joints: • 10th Floor - Cold Reheat Support, West Clamshell, “10B” • 10th Floor- Cold Reheat Support, East Clamshell, “10C” • 8th Floor- East MS, Header Clamshell	$315,000	Recommended by B&W based on assesed condition at 2019 inspection to minimise risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Refurbishment of the following two observation ports: • 4th Floor - SW "A" Corner • 2nd Floor - SE "D" Corner	$96,500	Recommendated by B&W based on assessed-condition at 2019 inspection in order to: • Prevent leakage of toxic gas into occupiable space. • Maintain availability of sight lines into furnace.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	$47,500	Recommended by B&W engineering to support extension of life.
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	$142,000	Recommended by B&W based on assesed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Replacement of expansion joints at the following two locations on Superheater 1: • Outlet Header • Spacer Tube Antler	$30,500	Recommended by B&W based on assesed condition at 2019 inspection to minimise risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Inspection for Flow Accelerateed Corrosion of Economiser inlet piping bends on the 6th Floor.	$12,000	Recommended by B&W to prevent in-service failure based on wear rates determined through previous inspections. Projected wear rates determined from measurements made in 2017 indicate that wall thicknesses may fall below ASME minimum recommendations after the Winter 2019-2020 operating season.
Holyrood TGS Unit 2		
Measurement of Ligament Crack Growth by internal boroscope inspection on Economiser Inlet Header.	$37,500	Recommended by B&W to prevent in-service failure based on wear rates determined through previous inspections indicating that wall thicknesses may fall below ASME minimum recommendations after the Winter 2019-2020 operating season.
Condition Assessment of the East and West Air Heater Hoppers and Drains. Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	$30,000	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings . Prevous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Replacement of the following Down Comer Supports and leaking Header Expansion Joints: • 10th Floor CRH Support West Clamshell “10B” • 8th Floor West Hot Reheat (HRH) Header Clamshell • 8th Floor East MS Header Clamshell • 8th Floor West MS Header Clamshell	$315,000	Recommended by B&W based on assesed condition at 2019 inspection to minimise risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Refurbishment of the 2nd Floor SW "A" Corner Observation Ports.	$82,500	Recommendated by B&W based on assessed-condition at 2019 inspection in order to: Prevent leakage of toxic gas into occupiable space. • Maintain availability of sight lines into furnace.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	$47,500	Recommended by B&W engineering to support extension of life.

Description	Estimated Cost	Justification
Condition Assessment of Forced Draft Fans.	$45,500	Recommended by B&W engineering to support extension of life.
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	$142,000	Recommended by B&W based on assesed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Replacement of expansion joints at the following two locations on Superheater 1: • SH-1 Outlet Header 6th Floor West • Spacer Tube Antler	$30,500	Recommended by B&W based on assesed condition at 2019 inspection to minimise risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Inspection for Flow Accelerateed Corrosion of Economiser inlet piping bends on the 6th Floor at the North Side of the Boiler.	$12,000	Recommended by B&W at maximum 3.5 year intervals to minimise based on historic wear rates. Components were replaced in 2017 due to Flow Accelerated Corrosion.
Holyrood TGS Unit 3		
Inspection of Boiler Feed Pump Piping Discharge Eccentric Reducer and "Y" for Flow Accelerated Corrosion.	$26,000	Recommended by B&W to prevent in-service failure based on maintenance experience at HTGS . The "Y" Was replaced in 2016 due to advanced Flow Accelerated Corrosion.
Inspection of Main Steam Turbine Terminal to monitor Creep & Thinning.	$32,500	Recommended by B&W at 3-year intervals based on findings of inspections completed in 2017 in which minor degredation and thinning were found.
Condition Assessment of the East and West Air Heater Hoppers and Drains and Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	$30,000	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings . Prevous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Refurbishment of the 3rd Floor Southwest corner observation ports.	$82,500	Recommendated by B&W based on assessed-condition at 2019 inspection in order to: • Prevent leakage of toxic gas into occupiable space. • Maintain availability of sight lines into furnace.
Investion of Windbox Corner Attachment failures including design and install of improved attachment method.	$45,000	Required to improve reliability of Windbox corner attachments which are prone to failure most recently causing a forced outage in 2018
Full interior and exterior inspection of Deaerator Heater and Storage Tank.	$62,000	B&W recommend full inspection of similar B&W units at 5 year interval in order to evaluate FAC (Flow Accelerated Corrosion) or other corrosion damage that could impact the integrity of the pressure boundary. Previous inspection was more than eight years ago.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	$47,500	Recommended by B&W engineering to support extension of life.
Condition Assessment of Forced Draft Fans.	$45,500	Recommended by B&W engineering to support extension of life.
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	$146,000	Recommended by B&W based on assesed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Sampling and Analysis of Waterwall tubes including mechanical properties testing, deposition rate measurement and deposit chemical analysis.	$31,500	Recommended at three-year intervals by B&W to monitor deposit weight density and mechanical condition which will be used to inform chemical cleaning requirments.

Holyrood Supplemental Projects Overview Report

Appendix B: Overhaul Unit 2 Turbine Valves – Holyrood Thermal Generating Station

April 7, 2020

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Executive Summary

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS") at rated output, Newfoundland and Labrador Hydro ("Hydro") is proposing to overhaul the Unit 2 turbine valves.

Hydro's historic experience with the turbine valves has demonstrated that overhaul every three years is appropriate based on the observations made during previous overhauls. Additionally, this cycle is consistent with the Original Equipment Manufacturer's ("OEM") recommendations. The Holyrood TGS Unit 2 turbine valves were last overhauled in 2017 and have operated at similar levels in the past three years as they have in previous overhaul cycles and, based on forecast Holyrood TGS production, are expected to continue operating at similar levels in the near-term. As such, they are due for overhaul in 2020.

Turbine valves are exposed to high temperatures, high pressure, and high flow velocity; all of this contributes to significant wear on the equipment. If an overhaul is not completed at this time, the valves could fail while in operation. Such failure could result in forced unit outages resulting in the loss of up to 170 MW for several weeks to several months in duration, depending on the magnitude of the failure. An overhaul is necessary at this time to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

The budget estimate for this project is $2,919,500. The project is expected to be complete prior to the 2020–2021 winter operating season.

Contents

1.0 Introduction

Unit 2 turbine is a critical asset which is required for the generation of 170 MW of power from Unit 2. Proper function of the turbine valves is required for safe and reliable control of the turbine. The turbine is equipped with valves that are critical to operation of the unit, and are exposed to several high wear mechanisms including high temperatures, high pressure, and high flow velocity. The turbine valves also have increased forces and loading induced upon them during severe system events such as unit trips. Hydro performs valve overhauls on a three-year cycle. The Unit 2 valves were last overhauled in 2017.

2.0 Background

2.1 Existing System

The Unit 2 turbine was manufactured by General Electric ("GE") in 1969. The turbine was supplied with major turbine valves. The valves and the associated functions are summarized as follows:

- Control Valves – Flow regulation, turbine speed control and over-speed protection;
- Main Stop Valve – Isolation, shut-down, and emergency shut down;
- Reheat Stop/Intercept Valves – Isolation and emergency shut-down;
- Blowdown Valve – Emergency pressure release; and
- Extraction Steam Non-return Valves – Prevent return of cool water from feed-water preheater, and over-speed protection.

2.2 Operating Experience

Unit 2 turbine valves went into service in 1971 and have experienced approximately 210,000 hours of operation. The turbine valves have operated reliably throughout their operational life as a result of Hydro's execution of the original equipment manufacturer ("OEM") recommended overhaul schedule and completion of necessary upgrades which were identified during the overhauls.

2.3 Maintenance History

Holyrood TGS turbine valves are overhauled in three-year cycles based on Hydro's historic operating experience, and in accordance with the OEM recommendations and industry standard practice. Valves undergo regular testing during operation to ensure that they are working properly. The Unit 2 turbine valves were last overhauled in 2017 by GE. During that overhaul, the service contractor identified conditions that indicated refurbishment of certain equipment was required. Examples of findings from previous valve overhaul projects are provided in Figures 1 through 4.

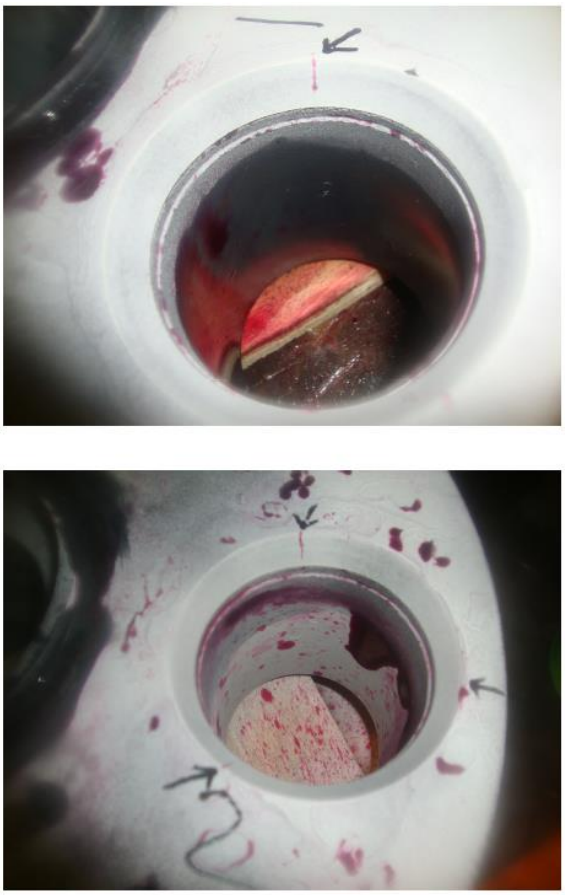

Figure 1: Cracks in Unit 2 Main Stop Valve Bypass Seats Revealed Through Dye Penetrant Inspection

Figure 2: 17" Crack on Main Valve Seat

Figure 3: Control Valve with Broken Stem

Figure 4: Intercept Valve Cavitation

In April 2019, the control valve camshafts at Holyrood TGS Unit 2 failed and caused a unit trip that required an extended forced outage of 22 days. Upon inspection, Hydro determined that the camshafts had bent and the camshaft bearings had seized. The camshafts were straightened at a local shop and reinstalled with new bearings. This repair requires additional inspection during the overhaul to ensure the repairs made in 2019 are still supporting the equipment and the continued reliability of Unit 2.

3.0 Analysis

3.1 Identification of Alternatives

Hydro evaluated the following alternatives:

1) Deferral;
2) Condition-based refurbishment; and
3) Overhaul.

3.2 Evaluation of Alternatives

3.2.1 Deferral

Deferring this project would increase the risk of turbine valve failure while in operation, which could result in collateral damage and a loss of 170 MW of generation for several weeks. The OEM has previously advised that delaying valve overhauls will increase the likelihood of an over-speed event and therefore increase the likelihood of a valve failure. Data obtained through preventive maintenance activities is not comprehensive enough to allow Hydro to make an accurate prediction regarding the likelihood of failure in advance of the next planned overhaul. As such, Hydro has determined that this alternative poses an unacceptable level of risk to supply.

3.2.2 Condition-Based Refurbishment

The condition of the turbine valves cannot be adequately determined through external inspection or monitoring instrumentation. In order to assess the condition of the turbine valves, disassembly and reassembly of the turbine valves is required. This work is required for, and constitutes roughly half the cost of, refurbishment. Over the life of the turbine valves, condition-based refurbishment would have a higher cost than overhaul due to the high proportion of the total cost that is related to disassembly and reassembly work. As such, condition-based refurbishment of the turbine valves is not recommended.

3.2.3 Overhaul

Hydro has historically overhauled the turbine valves every three years. Hydro's experience with these units is that a three year overhaul cycle has supported reliable performance of Holyrood TGS Unit 2. This alternative consists of planned disassembly, detailed internal inspection, and reassembly of all major steam valves. Valve components which have been identified as damaged in the inspections are replaced. As Hydro's last overhaul of the Unit 2 turbine valves was in 2017, they are due for overhaul in 2020. This

alternative aligns with OEM recommendations and past practice and allows Hydro to manage risk within an acceptable level.

3.3 Recommended Alternative

Hydro recommends overhauling the Holyrood TGS Unit 2 turbine valves at this time.

Proper function of the valves is essential for safe and reliable operation of the turbine. Degradation or failure of turbine valves could allow the turbine to go into over speed, leading to a catastrophic failure of the unit. Without regular overhauls, turbine valves are at an elevated risk of malfunction. Common sources of turbine valve failure include:

- Oxide scale build-up impeding valve movement and reducing response time;
- Erosion and wear of sealing surfaces impeding control and isolation effectiveness; and
- Cracking and other fatigue compromising pressure-containing components.

Overhauling the valves in accordance with the OEM recommendations will ensure that the valves are in good operating condition, contributing to the continued safe and reliable operation of the Unit 2 turbine.

4.0 Project Description

4.1 Scope

The scope of this project consists of disassembly, detailed internal inspection, and reassembly of all major steam valves. Valves will be refurbished through replacement of any damaged components identified in the inspections. Major steam turbine valves include:

- Six control valves;
- One main stop valve;
- Two reheat stop/intercept valves;
- One blowdown valve; and
- Seven extraction steam check valves.

The overhaul will be performed by an experienced turbine valve overhaul contractor. Plant personnel will assist as required, oversee the work protection application, and provide additional support as required.

4.2 Estimate

The estimate for this project is shown in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	6.0	0	0	6.0
Labour	313.1	0	0	313.1
Consultant	18.0	0	0	18.0
Contract Work	2,200.0	0	0	2,200.0
Other Direct Costs	0.0	0	0	0.0
Interest and Escalation	128.7	0	0	128.7
Contingency	253.7	0	0	253.7
Total	**2,919.5**	**0**	**0**	**2,919.5**

4.3 Schedule

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Task	Start Date	End Date
Planning	Preparation of documentation	April 2020	May 2020
Construction	Mobilize contractors, perform pre-shutdown checks, isolations	July 2020	July 2020
Construction	Remove, dismantle, and inspect generator	July 2020	July 2020
Construction	Complete repairs, adjustments	July 2020	September 2020
Construction	Re-assemble, perform operational checks, remove isolations, demobilize contractors	September 2020	November 2020
Closeout	Prepare closeout documentation	December 2020	January 2021

5.0 Conclusion

The Holyrood TGS Unit 2 turbine valves were last overhauled in 2017. To support the continued safe and reliable operation of Holyrood TGS Unit 2 at its rated output of 170 MW, Hydro recommends overhauling the Unit 2 turbine valves in 2020. This planned overhaul is consistent with previous overhaul cycles that have demonstrated that such frequency is appropriate. Additionally, it is consistent with the

established OEM three-year overhaul frequency that has historically supported the safe and reliable operation of Holyrood TGS Unit 2.

Holyrood Supplemental Projects Overview Report

Appendix C: Overhaul Unit 3 Boiler Feed Pump West - Holyrood Thermal Generating Station

April 7, 2020

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Executive Summary

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS") at rated output, Newfoundland and Labrador Hydro ("Hydro") is proposing to overhaul the Holyrood TGS Unit 3 boiler feed pump west.

Hydro's historic experience with the boiler feed pumps has demonstrated that overhaul every six years is appropriate based on the observations made during previous overhauls. Additionally, this cycle is consistent with Original Equipment Manufacturer ("OEM") recommendations. As the Holyrood TGS Unit 3 boiler feed pump west was last overhauled in 2013 and has operated at similar levels in the past six years as it has in previous overhaul cycles, it was due for overhaul in 2019. Hydro did not complete an overhaul at that time as it was anticipated that production requirements from the Holyrood TGS would be materially reduced through 2020 and subsequent years. However, as a result of changes in Holyrood TGS forecast production requirements, Hydro proposes to complete the overhaul of the Unit 3 boiler feed pump west during 2020.

Boiler feed pumps are exposed to high temperatures, high pressure, and high flow velocity; all of this contributes to significant wear on the equipment. If an overhaul is not completed at this time, the pump could fail while in operation. Such failure would result in the reduction of 70-80 MW from Unit 3 generating capacity for several weeks. An overhaul is necessary at this time to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods.

The budget estimate for this project is $367,900. The project is expected to be complete prior to the 2020–2021 winter operating season.

Contents

1.0 Introduction

The Holyrood TGS Unit 3 boiler feed pump west is one of two pumps that supply the high-pressure feed water required for steam production in Boiler No. 3. The pump receives water from the deaerator tank and feeds it to high pressure heaters and then the boiler. Boiler feed pumps have historically been overhauled every six years. Individually, each pump supports 70-80 MW of generation and, operating together, they support the full generation capability of Unit 3 (150 MW).

Unit 3's boiler feed pump east was last overhauled in 2014 and will be included in Hydro's 2021 Capital Budget Application.

2.0 Background

2.1 Existing System

The Holyrood TGS Unit 3 boiler feed pump west, shown in Figure 1, was placed in service in 1980. The pump has eleven stages of impellers and is driven by a 3,000 horse power motor. It is capable of pumping 4,119 litres per minute at a pressure of 18,616 kPa. It draws feed water at a temperature of 148°C before pumping it to the high pressure heaters.

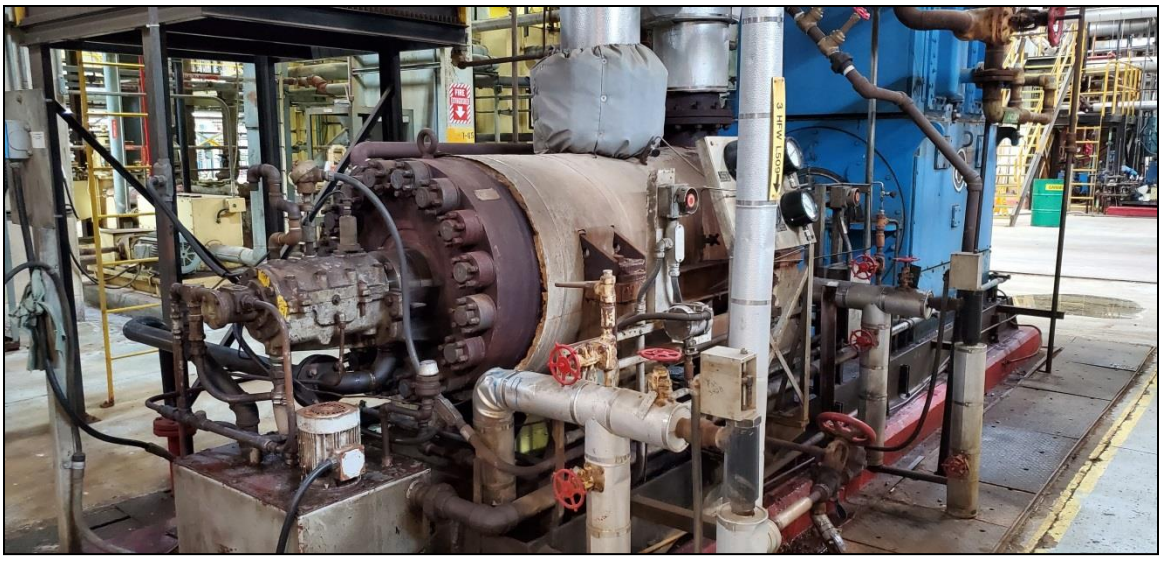

Figure 1: Unit 3 Boiler Feed Pump West

2.2 Operating Experience

Holyrood TGS Unit 3 has operated approximately 3,100 hours since this boiler feed pump was last overhauled. The six-year frequency of boiler feed pump overhauls has contributed to reliable operation of Unit 3.

2.3 Maintenance History

Unit 3's boiler feed pump west was last overhauled in 2013. At that time, Hydro replaced the volute impeller cartridge with a refurbished spare and the existing volute impeller cartridge was removed, refurbished, and stored as a spare for use in the next boiler feed pump overhaul.

Based on the six-year frequency, the next overhaul was due in 2019. At that time, it was anticipated that the Holyrood TGS would transition from normal production to standby over the 2019 to 2020 time period and, as such, would have lower levels of production. As a result of this planned transition, it was determined, both prior to the 2019 and 2020 Capital Budget Applications, that it was appropriate to extend the overhaul period.

Hydro completes annual preventative maintenance work for the parts that can be accessed and can be worked on without outage or disruption in operation. Preventative maintenance activities include, but are not limited to, the following:

- Checking oil levels;
- Checking coupling alignment;
- Checking holding down bolts;
- Checking for oil leaks;
- Checking glands;
- Checking oil pump and filter housing for loose fittings;
- Checking for oil and water leakage; and
- Checking oil pump coupling, bolting etc.

3.0 Analysis

3.1 Identification of Alternatives

The following alternatives were considered:

1) Deferral;
2) Condition-based refurbishment; and
3) Overhaul.

3.2 Evaluation of Alternatives

3.2.1 Deferral

Given the higher than anticipated levels of production both to date and throughout 2020 at the Holyrood TGS, as well as extension of the plant to March 31, 2022, a continued extension of this overhaul beyond seven years poses an unacceptable level of risk for this pump. The other boiler feed pump for Unit 3, the east boiler feed pump, was last overhauled in 2014 and in 2020 is also due for overhaul. A boiler feed pump failure while in operation could result in a loss of 70-80 MW of generation capacity for several weeks while the pump is repaired. Additionally, not completing the overhaul at this time could put Hydro in the position to have to use its only spare volute impeller cartridge, leaving no spare available in the event of a failure at the east boiler feed pump. Hydro has determined that this alternative poses an unacceptable level of risk to supply.

3.2.2 Condition-Based Refurbishment

Hydro collects some condition-related data while the pump is in-service from installed instrumentation. Additional data is collected through measurement and testing performed during annual preventative maintenance. To date, the data collected through each of these means has not proven to be adequately comprehensive to inform an accurate prediction as to the likelihood of failure in advance of the next planned outage or if the unit can operate reliably through to the next planned outage. Hydro has determined that, due to the limited information available, making decisions based on asset condition is not a viable alternative for boiler feed pumps.

3.2.3 Overhaul

Overhaul consists of the disassembly, inspection, reassembly, and re-commissioning of the boiler feed pump west. Boiler feed pumps operate under high wear conditions. The six-year overhaul cycle was

recommended by the OEM and supported by Hydro's third-party consultant, Wood Canada Limited, which was engaged by Hydro to provide an opinion on this and other projects. Additionally, as operation since the last overhaul in 2013 has been typical to that of previous cycles and forecast operation is expected to remain consistent with previous years, overhaul at this time is prudent and necessary. Many components of the pump can erode, crack, or otherwise fail, leading to poor pump performance or sudden failure. In some circumstances, failures of certain components have resulted in collateral damage to the pump barrels, requiring additional repair and associated costs. Therefore, overhaul is required to support the continued safe and reliable operation of Holyrood TGS Unit 3.

3.3 Recommended Alternative

Hydro recommends the overhaul of the Unit 3 boiler feed pump west.

Failure of Holyrood TGS boiler feed pump west while in service could result in a reduction of 70-80 MW of generation capability for several weeks. Overhauling the pump at this time is necessary to ensure it is in good operating condition. The requirement for overhaul of the west boiler feed pump in 2020 is further reinforced by the east boiler feed pump being at the end of its overhaul cycle as well.[1] If the overhaul of the boiler feed pump west is not completed this year, both pumps would be beyond the recommended overhaul frequency going into Hydro's 2020–2021 winter operating season. As Holyrood TGS is now expected to operate through March 2022, and on the basis that Hydro has only one spare volute impeller cartridge to serve both pumps, Hydro recommends the refurbishment alternative to manage risk within an acceptable level.

4.0 Project Description

4.1 Scope

This project consists of the disassembly, inspection, reassembly, and re-commissioning of Holyrood TGS Unit 3 boiler feed pump west. During overhaul, parts, including the volute impeller cartridge, are replaced as necessary. If required, the volute impeller cartridge would be replaced with a refurbished cartridge that is currently in Hydro's spares inventory. The volute impeller cartridge which is removed from the pump would then be refurbished and returned to inventory as a critical spare to support both

[1] Overhaul of the Unit 3 boiler feed pump east will be proposed in Hydro's 2021 Capital Budget Application.

of the Unit 3 boiler feed pumps prior to the next winter operating season. Figure 2 shows the volute impeller cartridge.

Figure 2: Refurbished Volute Impeller Cartridge

Disassembly and reassembly will be executed by internal resources. The overhaul will be performed by an experienced feed water pump service contractor. The service contractor will be engaged to do the following:

- Perform a detailed condition assessment of the assembly of the entire pump through on-site inspection;
- Provide recommendations and guidance with respect to on-site disassembly and reassembly; and
- Off-site condition assessment and refurbishment of the volute impeller cartridge, if required.

Plant personnel will assist as required, oversee the work protection application, and provide additional support as required.

4.2 Estimate

The estimate for this project is shown in Table 1

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	5.0	0.0	0.0	5.0
Labour	120.4	0.0	0.0	120.4
Consultant	22.0	0.0	0.0	22.0
Contract Work	180.0	0.0	0.0	180.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	7.8	0.0	0.0	7.8
Contingency	32.7	0.0	0.0	32.7
Total	**367.9**	**0.0**	**0.0**	**367.9**

4.3 Schedule

If approved, the overhaul will take place during the planned Unit 3 outage. Following the overhaul, the pump will be returned to service and the volute impeller cartridge will be refurbished and placed into inventory as a critical spare. The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity	Task	Start Date	End Date
Planning	Preparation of documentation	April 2020	May 2020
Construction	Mobilize contractors, perform pre-shutdown checks, and isolations	April 2020	May 2020
Construction	Dismantle, inspect, and reassemble pump using spare volute impeller cartridge	April 2020	May 2020
Construction	Refurbish old volute impeller cartridge and place in spare inventory	April 2020	September 2020
Closeout	Prepare closeout documentation	July 2020	January 2021

5.0 Conclusion

To support the continued safe and reliable operation of Unit 3 at the Holyrood TGS at rated output during the 2020–2021 winter operating season, Hydro recommends refurbishing the Unit 3 boiler feed pump west in 2020. The boiler feed pumps are typically overhauled on a six-year frequency; however, the Unit 3 boiler feed pump west was last overhauled in 2013. Based on historic and forecast production, an overhaul of the Unit 3 boiler feed pump west is required at this time.

Holyrood Supplemental Projects Overview Report

Appendix D: Overhaul Unit 2 Generator

Holyrood Thermal Generating Station

April 7, 2020

A report to the Board of Commissioners of Public Utilities

newfoundland labrador hydro
a nalcor energy company

Executive Summary

To support the continued safe and reliable operation of the Holyrood Thermal Generating Station ("Holyrood TGS") at rated output, Newfoundland and Labrador Hydro ("Hydro") is proposing an overhaul of the Holyrood TGS Unit 2 generator.

Hydro's experience with the Holyrood TGS generators has demonstrated that overhaul every six years is appropriate based on the condition of the equipment during previous overhauls. As the Holyrood TGS Unit 2 generator has operated at similar levels in the past six years as it has in previous overhaul cycles, it is appropriate to overhaul the generator in 2020. A six-year overhaul cycle is consistent with Original Equipment Manufacturer ("OEM") recommendations.

The Unit 2 generator was last overhauled in 2014 and is therefore due for overhaul in 2020. This overhaul is necessary at this time to maintain Hydro's safety and reliability standards, including Hydro's ability to meet customer demand during peak periods. If the overhaul is not completed at this time, there is a risk that the generator could fail while in operation, resulting in a forced unit outage, which could have duration of several weeks to several months.

The budget estimate for this project is $1,294,100. The project is expected to be completed prior to the 2020–2021 winter operating season.

Contents

1.0 Introduction

The three major components of the Holyrood TGS units are the power boiler, turbine, and generator. The turbine and generator are shown in Figure 1. Through combustion of No. 6 fuel oil, the power boiler provides high-energy steam to the turbine. The turbine is directly coupled (or connected) to the generator and provides the rotating energy necessary for the generator to produce rated output power. To maintain safe and reliable operation, the generators are overhauled on a six-year cycle. The last overhaul for the Unit 2 generator was in 2014. Given that its operation during the past six years has been consistent with previous overhaul cycles, an overhaul is required at this time.

Figure 1: Holyrood TGS Unit 2 Turbine Generator

2.0 Background

2.1 Existing System

The Holyrood TGS generators are complex mechanical and electrical systems. The Unit 2 generator is comprised of two primary components, a rotor and stator. The rotor is coupled to, and driven by, the steam turbine and rotates inside the stator to produce electricity in the stator windings. The generator is pressurized and cooled by hydrogen gas to provide maximum efficiency. Brushes electrically connect the rotor windings, through collector rings, to the exciter. The exciter energizes the rotor windings, which creates the rotating field for electricity generation. The individual stator and rotor windings are separated by insulation strips and held in place by a system of wedges.

The generator is supported by two journal bearings. Hydrogen seals utilize oil to ensure that the hydrogen does not escape between the rotor and stator components at both ends of the generator. Hydrogen coolers utilize cooling water to maintain the hydrogen temperature within the generator.

2.2 Operating Experience

The Unit 2 generator went into service in 1971 and has experienced approximately 210,000 hours of operation since that time. Holyrood TGS has been in normal production up to this point in time, with an average annual production of 1,500 GWh per year over the past five years. During its lifetime, standard OEM recommendations were followed for maintenance and capital work and, to date, the unit has not experienced any failures.

2.3 Maintenance History

The frequency of generator overhauls at Holyrood TGS is every six years. This was developed by Hydro in consultation with the OEM, General Electric ("GE"), and engineering consulting firm Wood Canada Limited.

The Unit 2 generator has undergone multiple overhauls since it was originally placed in service, with the last overhaul taking place in 2014. Over its lifetime no rewinds or other significant upgrades were deemed required for reliable operation; the windings are original to the unit. Standard six-year overhauls are required during the operational life of the unit to maintain the asset life and reduce the risk of failure and subsequent unit rewind. To mitigate risks associated with the age of the generator, Hydro recently began performing electrical testing on the windings more frequently than the recommended six-year interval with the aim of identifying insulation breakdown prior to failure. However, testing is limited to those that can be performed without dismantling the generator. Test results to date have not identified any imminent issues; however, due to the age of Unit 2's generator, insulation breakdown can occur rapidly and with little notice.

3.0 Analysis

3.1 Identification of Alternatives

Hydro considered the following alternatives:

1) Deferral;
2) Condition-based refurbishment; and

3) Overhaul.

3.2 Evaluation of Alternatives

3.2.1 Deferral

Deferral of this project will result in increased risk of failure and forced outage. Accepting an increased risk of failure by not completing the overhaul in 2020 could result in catastrophic collateral damage to the generator and a loss of 175 MW of generation capacity for a period of several weeks to more than a year, depending on the magnitude of the failure. If a failure during operation were to occur, it could result in forced outages for customers for an extended period of time.

3.2.2 Condition-Based Refurbishment

The condition of several critical components of this unit cannot be assessed without shutting down and dismantling the unit. For components that can either be assessed without material interference in the operation of the unit or can be assessed during planned outages, Hydro has completed testing where possible. Condition-based refurbishment is not appropriate for this unit due to the nature of the components of the unit requiring shut down and dismantling in order to assess the condition.

3.2.3 Overhaul

This alternative consists of overhauling the Unit 2 generator in 2020, six years since the last overhaul, on the basis that production since the last overhaul has been consistent with historic levels of production. The overhaul will include disassembly of generator components, removal of the generator rotor from the stator, cleaning, detailed visual inspection and Non-Destructive Evaluation ("NDE"), mechanical integrity testing, replacement or refurbishment of components found to be damaged, reassembly, and recommissioning.

The six-year overhaul frequency has been established based on historical performance and developed in consultation with the OEM and thermal generation engineering firms. This alternative allows Hydro to effectively plan the intervention and manage risk within an acceptable level.

3.3 Recommended Alternative

Hydro recommends the overhaul of the Unit 2 generator.

Disassembly of the unit is the only way to fully assess and restore components of the unit which prevent the release of hydrogen, lube oil and water; these components are subject to wear and deterioration.

Rotating components, which spin at 60 times per second, also require detailed and specialized inspection to verify integrity and ensure continued safe and reliable operation. These components include the rotor wedges and retaining rings that secure the rotor windings.

It is industry practice to overhaul generators periodically. Other than completion of overhauls on a six-year frequency, no significant upgrades were deemed required for reliable operation of the Unit 2 generator. Unit 2's generator rotor and stator windings are original to the unit. The periodic overhaul alternative will include extensive inspection and testing of the rotor and stator, which cannot be performed without disassembly. This data will supplement the existing testing performed during annual outages when disassembly is not an option and allow more accurate assessment of the remaining service-life of the electro-mechanical generator components.

Continuing to operate the generator at the current projected loading without performing an overhaul could increase the likelihood of the generator failing while in operation, which has the potential for forced outages ranging from several weeks to 18 months in duration. Completing the Unit 2 generator overhaul in 2020 will support the safe and reliable operation of Holyrood TGS Unit 2 at rated output.

4.0 Project Description

4.1 Scope

The scope of the Holyrood TGS Unit 2 generator overhaul consists of:

- Disassembly of generator end shields, hydrogen seals, hydrogen coolers, and bearings;
- Removal of the generator rotor from the stator;
- Cleaning of internal components;
- Detailed visual inspection and NDE of internal components including:
  - Bearings;
  - Oil deflectors;
  - Hydrogen seals;
  - Retaining rings, and;
  - Hydrogen coolers.

- Detailed measurement of clearances and alignments;
- Mechanical integrity testing of windings and core wedges, and
- Replacement or refurbishment of components found to be damaged.

The overhaul will be performed by an experienced, specialized thermal generator service company contracted by Hydro. Hydro personnel will assist the service company as required, oversee the work protection application, and provide overall management and liaison for the overhaul work.

4.2 Estimate

The project estimate in provided in Table 1.

Table 1: Project Estimate ($000)

Project Cost	2020	2021	Beyond	Total
Material Supply	20.0	0	0	20.0
Labour	141.2	0	0	141.2
Consultant	7.0	0	0	7.0
Contract Work	957.0	0	0	957.0
Other Direct Costs	0.0	0	0	0.0
Interest and Escalation	56.3	0	0	56.3
Contingency	112.6	0	0	112.6
Total	**1,294.1**	**0**	**0**	**1,294.1**

4.3 Schedule

The overhaul will require approximately eight weeks to complete on the basis of one shift per day, six days per week. The anticipated project schedule is provided in Table 2.

Table 2: Project Schedule

Activity	Task	Start Date	End Date
Planning	Preparation of documentation	April 2020	May 2020
Construction	Mobilize contractors, perform pre-shutdown checks, and isolations	July 2020	July 2020
Construction	Remove, dismantle, and inspect generator	July 2020	July 2020
Construction	Complete repairs and adjustments	July 2020	September 2020
Construction	Re-assemble, perform operational checks, remove isolations, and demobilize contractors	September 2020	October 2020
Closeout	Prepare closeout documentation	September 2020	December 2020

5.0 Conclusion

To support the continued safe and reliable operation of Holyrood TGS Unit 2 at rated output, Hydro recommends overhauling the Unit 2 generator in 2020. Completing the overhaul in 2020 aligns with the established six-year overhaul frequency, which has historically yielded acceptable levels of safety and reliability and allows Hydro to manage risk within an acceptable level.

Holyrood Supplemental Projects Overview Report

Attachment 1: Wood Canada Limited Correspondence Regarding Technical Consulting Services for the Holyrood Thermal Generating Station

newfoundland labrador hydro
a nalcor energy company

3 April 2020

205882-2.3.1

Mr. Jeff Vincent
Senior Manager, Thermal Generation
Holyrood TGS PO Box 12400
Hydro Place, 500 Columbus Drive
St. John's, NL
A1B 4K7

Dear Mr. Vincent:

Re: Holyrood Thermal Generating Station Supplemental Capital Projects

Wood is engaged by Newfoundland and Labrador Hydro (NLH) to provide technical consulting services for the Holyrood Thermal Generating Station (HRD). At the request of NLH, Wood provides the following opinion on four maintenance projects to be conducted in 2020.

1. **Unit 2 Generator Overhaul**
2. **Unit 2 Turbine Valve Overhaul**
3. **Boiler Condition Assessment and Miscellaneous Upgrades**
4. **Unit 3 Boiler Feed Pump West**

Overall, Wood believes that HRD is in fair to good condition and capable of reliable and safe operation to end of baseload production (year 2021, 2022, or 2023), and to operate in a cold standby mode beyond that. This capability depends on maintaining appropriate inspection, overhaul, maintenance, and capital investment activities.

Wood recommends that while the units at HRD are operating in a generating mode comparable to its historical manner, then the current inspection, overhaul and maintenance time-based cycles should be followed. When the units enter cold standby mode, those cycles should be adjusted to incorporate equivalent operating hours.

1. Unit 2 Generator Overhaul

The recommended inspection/overhaul cycle for generators was changed from nine years (typical of newer generators) to six years in 2012, based on the generator ages and on the condition assessments by GE and Wood generator experts in 2010/11. Unit 1 generator had inspections/overhauls in 2012 and then again in 2018. Unit 2's last inspection/overhaul was in 2014, so its normal six-year cycle would be 2020 as is proposed.

No generator rotor or stator rewinds have been done on Units 1 or 2 or are being proposed for Unit 2 in 2020. The scope of the Unit 2 work in 2020 has been identified as:

- Disassembly of generator end shields, hydrogen seals, hydrogen coolers, and bearings.
- Removal of the generator rotor from the stator.
- Cleaning of internal components.
- Detailed visual inspection and NDE of internal components including:
    - bearings.

PO Box 9600
133 Crosbie Road
St. John's, NL
A1A 3C1
Tel: (709)724-1900
Fax: (709)739-5458
woodplc.com

Wood Canada Limited

- oil deflectors.
- Replacement or refurbishment of components found to be damaged.

Based on review of the GE inspection reports since 2011, Wood recommends that the scope of proposed work is should be executed in 2020 to ensure continued reliable and safe operation until end of baseload production and afterwards, which may include operation as a synchronous condenser.

2. Unit 2 Turbine Valve Overhaul

The current inspection/overhaul cycle for steam turbine valves is three years and continuation of this cycle is critical to the safe and reliable operation of the steam turbines. The last Unit 2 turbine valve inspection / overhaul was in 2017, so completion of this work in 2020 is recommended.

The scope of work consists of a total disassembly, detailed internal inspection, and reassembly of all major steam valves. Valves will be refurbished through replacement of any damaged components identified in the inspections. Major steam turbine valves include:

- 6 x Control valves
- 1x Main stop valve
- 2x Reheat stop/intercept valves
- 1x Blowdown valve, and
- 7x Extraction steam check valves

3. Boiler Condition Assessment and Miscellaneous Upgrades

Wood, as part of the 2019 Condition Assessment and Life Extension study, reviewed the Electric Power Research Institute (EPRI) Level 2 condition assessments and B&W regulatory/annual inspection reports since 2011. NLH has done significant amounts of work in recent years that has improved both reliability and safety, particularly for Units 1 and 2 boilers.

Recent B&W work in 2018 and 2019 identified several boilers and auxiliaries' issues with Unit 3 boiler, as well as those remaining with Units 1 and 2. The proposed 2020 project (List of work scope in Attachment 1) is expected to address these.

Hydro has proposed for 2020 a Level 2 Condition Assessment on internal components of the main steam generators (boilers) to detail required refurbishment or replacement work. Additionally, Hydro would complete upgrades identified during the 2019 Condition Assessment and Miscellaneous Upgrades project. While Hydro, through the previous assessments, identified known equipment for immediate replacement, it is possible that additional components may require replacement as a result of the Condition Assessment work. The plant plans to follow the Inspection and Test Plan ("ITP") that was prepared for Holyrood TGS by Alstom (OEM for Unit 1 and Unit 2 boilers) and engineering consulting firm AMEC NSS. The ITP covers all boiler pressure parts and high energy piping. Inspection and test scope, assessment methods and intervals were developed using the OEM and consultant's knowledge and experience.

Wood fully supports and recommends that the work in Attachment 1 be undertaken in 2020, particularly in light of the uncertainty about the timing and future roles of the Units. If Holyrood

generation were to end completely in March 2021, then Wood would recommend that all work on regulatory issues and on addressing identified safety issues (such as identified and expected piping thicknesses below minimum ASME levels) should proceed in 2020 and the remaining work be scaled back, but that is not believed to be the case.

4. Unit 3 Boiler Feed Pump West

The current inspection/overhaul cycle for boiler feed pumps is six years and the last overhaul of Unit 3 boiler feed pump west was 2013. This pump was originally planned to be overhauled in 2019 but was delayed a year to 2020.

Given that the overhaul has already been delayed one year and there is uncertainty about when end of steam will occur, Wood recommends execution of this work in 2020. This project scope consists of:

- the disassembly, inspection of Unit 3 boiler feed pump west.
- perform a detailed condition assessment of the whole pump assembly.
- the replacement of parts as necessary, including the volute-impeller cartridge using a previously refurbished cartridge currently in spare inventory.
- the reassembly, and re-commissioning of Unit 3 boiler feed pump west.
- the off-site condition assessment and refurbishment of the existing volute-impeller cartridge to be store in inventory as a critical spare.

Yours truly,

Blair Seckington

Blair Seckington
Director, Power Technology/Consulting,
Wood Canada Limited
Asset Solutions Americas

cc: Rick Hibbs
Jessica McGrath
Mike Taylor

Attachment 1: Boiler and Auxiliaries Work

Description	Justification
Holyrood TGS Unit 1	
Internal boroscope inspection of Economizer Inlet Header including measurement of ligament cracks to track growth rate.	Last inspected in 2017. B&W recommended re-inspection at three-year-intervals to monitor crack growth rate.
Full interior and exterior inspection of Deaerator Heater and Storage Tank.	B&W recommend full inspection of similar B&W units at 5-year interval in order to evaluate FAC (Flow Accelerated Corrosion) or other corrosion damage that could impact the integrity of the pressure boundary. Previous inspection was more than eight years ago.
Replacement of Sootblower 17R Aspirating Wallbox and Sleeve.	Recommended based on condition assessed in 2019 when temporary repairs were performed to correct corrosion damage. Permanent repairs required to manage risk of sootblower impingement on wall tubes and jamming of moving parts on wall box if not replaced.
Condition Assessment of the East and West Air Heater Hoppers and Drains and Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings. Previous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Replacement of the following three Down Comer Supports and leaking Header Expansion Joints: • 10th Floor - Cold Reheat Support, West Clamshell, “10B” • 10th Floor- Cold Reheat Support, East Clamshell, “10C” • 8th Floor- East MS, Header Clamshell	Recommended by B&W based on assessed condition at 2019 inspection to minimize the risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Refurbishment of the following two observation ports: • 4th Floor - SW "A" Corner • 2nd Floor - SE "D" Corner	Recommended by B&W based on assessed condition at 2019 inspection in order to: · Prevent leakage of toxic gas into occupiable space. · Maintain availability of sight lines into furnace.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	Recommended by B&W engineering to support extension of life.

Description	Justification
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	Recommended by B&W based on assessed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Replacement of expansion joints at the following two locations on Superheater 1: • Outlet Header • Spacer Tube Antler	Recommended by B&W based on assessed condition at 2019 inspection to minimize risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Inspection for Flow Accelerated Corrosion of Economiser inlet piping bends on the 6th Floor.	Recommended by B&W to prevent in-service failure based on wear rates determined through previous inspections. Projected wear rates determined from measurements made in 2017 indicate that wall thicknesses may fall below ASME minimum recommendations after the Winter 2019-2020 operating season.
Holyrood TGS Unit 2	
Measurement of Ligament Crack Growth by internal boroscope inspection on Economiser Inlet Header.	Recommended by B&W to prevent in-service failure based on wear rates determined through previous inspections indicating that wall thicknesses may fall below ASME minimum recommendations after the Winter 2019-2020 operating season.
Condition Assessment of the East and West Air Heater Hoppers and Drains. Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings. Previous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Replacement of the following Down Comer Supports and leaking Header Expansion Joints: • 10th Floor CRH Support West Clamshell “10B” • 8th Floor West Hot Reheat (HRH) Header Clamshell • 8th Floor East MS Header Clamshell • 8th Floor West MS Header Clamshell	Recommended by B&W based on assessed condition at 2019 inspection to minimize risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.

Description	Justification
Refurbishment of the 2nd Floor SW "A" Corner Observation Ports.	Recommended by B&W based on assessed condition at 2019 inspection in order to: · Prevent leakage of toxic gas into occupiable space. · Maintain availability of sight lines into furnace.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	Recommended by B&W engineering to support extension of life.
Condition Assessment of Forced Draft Fans.	Recommended by B&W engineering to support extension of life.
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	Recommended by B&W based on assessed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Replacement of expansion joints at the following two locations on Superheater 1: • SH-1 Outlet Header 6th Floor West • Spacer Tube Antler	Recommended by B&W based on assessed condition at 2019 inspection to minimize risk of leakage of toxic flue gas into the powerhouse along with resultant safety risk and PPE requirements Annual inspections are performed to identify leaks which occur frequently on these high-fatigue components. Previous similar upgrades have provided significant reduction in the amount of toxic gas released into the powerhouse.
Inspection for Flow Accelerated Corrosion of Economiser inlet piping bends on the 6th Floor at the North Side of the Boiler.	Recommended by B&W at maximum 3.5-year intervals to minimize based on historic wear rates. Components were replaced in 2017 due to Flow Accelerated Corrosion.
Holyrood TGS Unit 3	
Inspection of Boiler Feed Pump Piping Discharge Eccentric Reducer and "Y" for Flow Accelerated Corrosion.	Recommended by B&W to prevent in-service failure based on maintenance experience at HTGS. The "Y" Was replaced in 2016 due to advanced Flow Accelerated Corrosion.
Inspection of Main Steam Turbine Terminal to monitor Creep & Thinning.	Recommended by B&W at 3-year intervals based on findings of inspections completed in 2017 in which minor degradation and thinning were found.

Description	Justification
Condition Assessment of the East and West Air Heater Hoppers and Drains and Replacement of: corroded piping sections, bottom of hoppers and spool between hoppers and valves. Ferrous pipe and fitting materials will be upgraded to Stainless Steel.	Required to ensure reliability. Corrosion in this area is problematic. In 2019 many leaks were noted between the bottom of hoppers and the drain valves during water washes and chemical cleanings. Previous partial Stainless-Steel upgrades since 2016 have been successful in preventing corrosion with no significant corrosion observed on replaced components to date.
Refurbishment of the 3rd Floor Southwest corner observation ports.	Recommended by B&W based on assessed condition at 2019 inspection in order to: · Prevent leakage of toxic gas into occupiable space. · Maintain availability of sight lines into furnace.
Investigation of Windbox Corner Attachment failures including design and install of improved attachment method.	Required to improve reliability of Windbox corner attachments which are prone to failure most recently causing a forced outage in 2018
Full interior and exterior inspection of Deaerator Heater and Storage Tank.	B&W recommend full inspection of similar B&W units at 5-year interval in order to evaluate FAC (Flow Accelerated Corrosion) or other corrosion damage that could impact the integrity of the pressure boundary. Previous inspection was more than eight years ago.
Detailed Condition Assessment of Air Heater including OEM technical assistance, inspection and service guidance.	Recommended by B&W engineering to support extension of life.
Condition Assessment of Forced Draft Fans.	Recommended by B&W engineering to support extension of life.
Replacement of all Air Heater Stationary Circumferential Sealing Angles on the East and West Air Heaters at both the hot & cold ends.	Recommended by B&W based on assessed condition at 2019 inspection to prevent forced outages caused by jamming seals. Degraded Sealing Angles allow leakage past circumferential seals, reducing efficiency and accelerating degradation of the seals. Required to prevent forced outages caused by jamming seals.
Sampling and Analysis of Waterwall tubes including mechanical properties testing, deposition rate measurement and deposit chemical analysis.	Recommended at three-year intervals by B&W to monitor deposit weight density and mechanical condition which will be used to inform chemical cleaning requirements.

Affidavit

newfoundland labrador hydro
a nalcor energy company

IN THE MATTER OF the *Electrical Power Control Act,* RSNL 1994, Chapter E-5.1 (*"EPCA"*) and the *Public Utilities Act*, RSNL 1990, Chapter P-47 ("*Act"*), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro ("Hydro") for approval of certain capital projects necessary for the continued operation of the Holyrood Thermal Generation Station ("Holyrood TGS") pursuant to Subsection 41(3) of the *Act*.

AFFIDAVIT

I, Terry Gardiner, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am Vice President, Engineering and Technology of Newfoundland and Labrador Hydro, the Applicant named in the attached Application.

2. I have read and understand the foregoing Application.

3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the Province of Newfoundland and Labrador this 7th day of April 2020, before me:)

Barrister, Newfoundland and Labrador

Terry Gardiner, P. Eng.