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April 26, 2022

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 and Board Secretary

Dear Ms. Blundon:

**Re: Application for Approval to Purchase Last Stage Blades for Holyrood Thermal Generating Station Units 1 and 2**

Please find enclosed Newfoundland and Labrador Hydro's ("Hydro") application for approval to purchase one set of last stage blades to serve as capital spares for Units 1 and 2 at the Holyrood Thermal Generating Station ("Holyrood TGS"). This project is required to support the reliable and safe operation of the Holyrood TGS at full generation capacity until March 31, 2024.<sup>1</sup> The estimated cost of this project is \$1,578,900.

Should you have any questions, please contact the undersigned.

Yours truly,

**NEWFOUNDLAND AND LABRADOR HYDRO**

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

Encl.

ecc:

**Board of Commissioners of Public Utilities**

Jacqui H. Glynn  
PUB Official Email

**Consumer Advocate**

Dennis M. Browne, QC, Browne Fitzgerald Morgan & Avis  
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Lindsay S.A. Hollett  
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**Island Industrial Customer Group**

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

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<sup>1</sup> In the "Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information," Newfoundland and Labrador Hydro, February 4, 2022, p. 7, item 3, Hydro advised the Board of Commissioners of Public Utilities of its decision to extend operation of the Holyrood TGS as a generating facility to March 31, 2024.



# **Application for Approval to Purchase Last Stage Blades for Holyrood Thermal Generating Station Units 1 and 2**

**April 26, 2022**



**An application to the Board of Commissioners of Public Utilities**

**IN THE MATTER OF** the *Electrical Power Control Act, 1994*, SNL 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 to purchase one set of last stage blades (“LSB”) to serve as capital spares for Units 1 and 2 at the Holyrood Thermal Generating Station (“Holyrood TGS”) pursuant to s 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 is 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 *EPCA*.
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, which has three oil-fired generating units providing an installed capacity of 490 MW. The Holyrood TGS 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. The Holyrood TGS consists of three thermal generating units: Units 1 and 2, each providing a capacity of 170 MW, and Unit 3, providing a capacity of 150 MW. Each thermal generating unit is supplied with steam generated by a dedicated boiler for each unit. The steam is transferred from each boiler through high-energy piping to a steam turbine. Passage of steam through the various stages of the turbine rotor blades converts the energy of the steam into rotational

energy in the turbine, which drives a generator to convert the rotating energy into electrical power.

4. Hydro retained Hatch Ltd. (“Hatch”), with support from General Electric (“GE”), to complete the “HTGS Condition Assessment and Life Extension Study.”<sup>1</sup> As part of this assessment, in July 2021, Hatch considered the results of major inspections and non-destructive examinations (“NDE”) performed on the various stages of the Unit 1 turbine rotor blades as part of the 2021 Unit 1 major turbine overhaul project. The NDE showed a 3/8” linear crack on one of the LSB.
5. As detailed in Schedule 1 to this Application, cracking of turbine blades could lead to unacceptable operational vibration in the turbine, forcing the unit offline until replacement of the blades occurs. This could also lead to extensive damage to the unit and possible steam release into the powerhouse. GE, as the original equipment manufacturer, and Hatch recommended inspecting the Unit 1 LSBs within one year of the mitigating weld work that was completed as part of the 2021 Unit 1 major turbine overhaul project. They further recommended the subsequent replacement of the LSBs, the timing of which would be determined by the outcome of the inspection.
6. Procurement and installation of LSBs is estimated to take approximately 42–46 weeks; of that, the procurement period is approximately 30 weeks. Procurement of spares to have in place should additional cracks be found on Unit 1 significantly reduces the downtime necessary to replace the part.
7. The Holyrood TGS Unit 2 is an identical unit to Unit 1. While there has been no indication of cracks to that Unit’s LSB’s, Hydro believes that, as it is of identical design and has been subjected to near-identical operating conditions, procurement of the spare LSBs will also mitigate the risk of failure related to that unit.

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<sup>1</sup> “*Reliability and Resource Adequacy Study Review – Assessment to Determine the Potential Long-Term Viability of the Holyrood Thermal Generating Station,*” Newfoundland and Labrador Hydro, March 31, 2022, att. 1, att. 2, and att. 3.

8. On February 4, 2022, Hydro advised the Board that it would be extending the Holyrood TGS readiness to operate to March 31, 2024.<sup>2</sup> Hydro made the decision to further extend the operations of the Holyrood TGS as a generating station to ensure reliable service for customers while the Muskrat Falls Project assets and the Labrador-Island Link are brought online and proven reliable. Taking steps to procure the spare LSBs at this time is necessary to reduce the risk to the required generation availability of the Holyrood TGS.
9. Procurement of one set of turbine LSBs is expected to cost \$1,578,900, with the LSBs received by March 2023.

**C. Hydro's Request**

10. Hydro submits that the proposed capital expenditures detailed above and further described in Schedule 1 to this application are necessary to ensure that Hydro can continue to provide service that is safe and adequate and just and reasonable as required by Section 37 of the *Act*.
11. Hydro requests that the Board make an order pursuant to Section 41(3) of the *Act* approving Hydro's purchase of one set of LSBs to serve as capital spares for Units 1 and 2 at the Holyrood TGS.

**D. Communications**

12. 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 on this 26th day of April 2022.

**NEWFOUNDLAND AND LABRADOR HYDRO**




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Shirley A. Walsh  
 Counsel for the Applicant  
 Newfoundland and Labrador Hydro,  
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 St. John's, NL A1B 4K7  
 Telephone: (709) 685-4973

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<sup>2</sup> In the "*Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information*," Newfoundland and Labrador Hydro, February 4, 2022, p. 7, item 3, Hydro advised the Board of its decision to extend operation of the Holyrood TGS as a generating facility to March 31, 2024.

# **Schedule 1**

**Holyrood Thermal Generating Station**

**Unit 1 and Unit 2 Turbine Last Stage Blades**



# **Holyrood Thermal Generating Station Unit 1 and Unit 2 Turbine Last Stage Blades**

**April 26, 2022**

**A report to the Board of Commissioners of Public Utilities**



1 **Executive Summary**

2 The Holyrood Thermal Generating Station (“Holyrood TGS”) steam turbines are exposed to several  
3 degradation mechanisms such as fatigue cracking, corrosion, erosion, wear, and creep.

4 In July 2021, as part of the “HTGS Condition Assessment and Life Extension Study,”<sup>1</sup> a detailed  
5 assessment of the turbine’s last stage blades (“LSB”) was completed. The study considered the results of  
6 major inspections and non-destructive examination (“NDE”) performed on the Unit 1 turbine blades,  
7 completed as part of the 2021 Unit 1 major turbine overhaul project. The NDE showed a 3/8” linear  
8 crack on one of the LSBs.

9 Cracking of turbine blades could lead to unacceptable operational vibration in the turbine, forcing the  
10 unit offline until replacement of the blades occurs. This could also lead to extensive damage to the unit  
11 and possible steam release into the powerhouse. General Electric (“GE”), the original equipment  
12 manufacturer (“OEM”), and Hatch Ltd. (“Hatch”) recommended inspecting the LSBs within one year of  
13 the mitigating weld work, completed as part of the 2021 Unit 1 major turbine overhaul project, as well  
14 as the subsequent replacement of the LSBs. The timing of the replacement would be determined by the  
15 outcome of the inspection.

16 As Units 1 and 2 are of identical design and have been subjected to near-identical operating conditions,  
17 Newfoundland and Labrador Hydro (“Hydro”) is proposing the purchase of one set of LSBs to serve as  
18 capital spares for Units 1 and 2.

19 This project is required to support the reliable and safe operation of the Holyrood TGS at full generation  
20 capacity until March 2024. This project was not considered for inclusion in Hydro’s “2022 Capital Budget  
21 Application,”<sup>2</sup> as the cracking on the Unit 1 LSBs was not known at the time the application was  
22 finalized. Inclusion in Hydro’s “2023 Capital Budget Application” would not provide sufficient time to  
23 procure spare LSBs before the Unit 2 turbine overhaul in 2023. Hydro, therefore, requests approval of  
24 this supplemental capital expenditure to enable Hydro to commence procurement in 2022, for delivery  
25 in advance of the scheduled Unit 2 turbine inspection in 2023.

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<sup>1</sup> “HTGS Condition Assessment and Life Extension Study,” Hatch Ltd., March 31, 2022, vol. I and vol. II.

<sup>2</sup> “2022 Capital Budget Application,” Newfoundland and Labrador Hydro, rev. September 17, 2021 (originally filed August 2, 2021).

- 1 This project to purchase spare LSBs is planned for completion in 2023 with a project estimate of
- 2 \$1,578,900.

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1 **1.0 Introduction**

2 The Holyrood TGS consists of three thermal generating units: Units 1 and 2, each providing a capacity of  
3 170 MW, and Unit 3, providing a capacity of 150 MW. Each thermal generating unit is supplied with  
4 steam generated by a dedicated boiler for each unit. The steam is transferred from each boiler through  
5 high-energy piping to a steam turbine. Passage of steam through the various stages of the turbine rotor  
6 blades converts the energy of the steam into rotational energy in the turbine, which drives a generator  
7 to convert the rotating energy into electrical power.

8 Hatch, with support from GE, completed a detailed assessment of the turbine’s LSBs in 2021 as part of  
9 the “HTGS Condition Assessment and Life Extension Study.” This assessment considered the results of  
10 major inspections and NDEs performed on the various stages of the Unit 1 turbine rotor blades as part  
11 of the 2021 Unit 1 major turbine overhaul project. The NDE showed a 3/8” linear crack on one of the  
12 LSBs.

13 GE engineering provided an interim solution by welding the defective blade in the summer of 2021 and  
14 recommended re-inspecting the LSBs within a year of operation. The primary purpose of the re-  
15 inspection is to detect the initiation or propagation of cracks on the LSBs and to perform corrective  
16 action before critical conditions are reached. GE has stated that if the crack is found again during the  
17 next inspection, or if additional cracks are detected at that time, it would not recommend operating the  
18 turbine until the LSBs are replaced. The next inspection is planned for the 2022 annual Unit 1 outage  
19 and is expected to occur in June 2022. This inspection will be completed with the rotor in place via the  
20 LP section access doors, as shown in Figure 2.

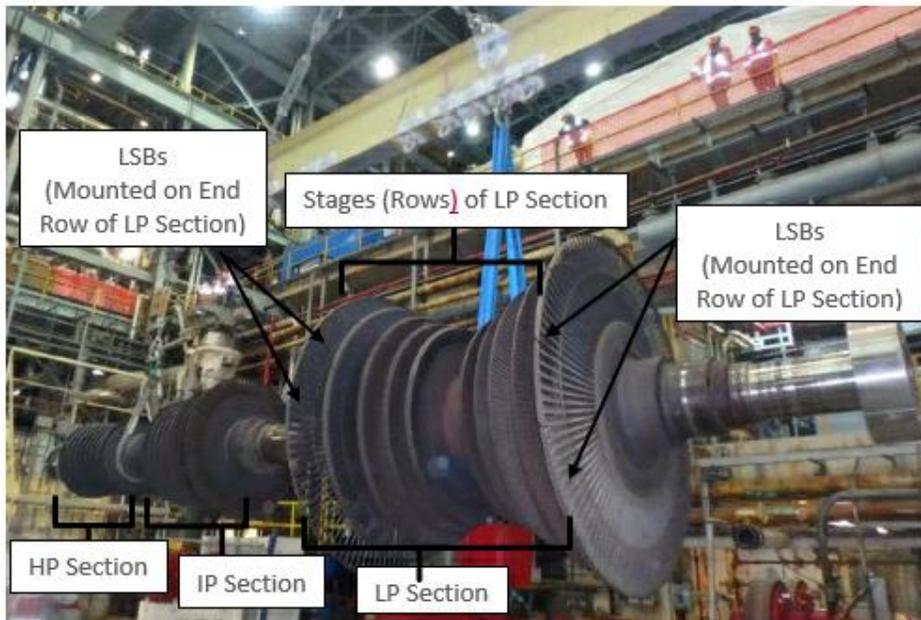
21 The LSBs of Units 1 and 2 turbines are approximately 53 years old. Cracking initiation indicates that the  
22 LSBs have deteriorated to a critical condition, which could lead to failure. If additional cracking is found  
23 in the LSBs, it will be necessary to replace these blades to continue the safe and reliable operation of the  
24 turbine.

1 Due to the long-lead time of approximately 30 weeks to manufacture and supply the LSBs and given  
2 Hydro’s current commitment to have the Holyrood TGS fully available for generation until  
3 March 31, 2024,<sup>3</sup> this project is required to commence in 2022.

## 4 **2.0 Background**

### 5 **2.1 Existing System**

6 GE manufactured the Unit 1 and 2 turbines in 1969. The turbine consists of a high pressure (“HP”)  
7 section, an intermediate pressure (“IP”) section, and a low pressure (“LP”) section. Each section contains  
8 blades mounted to the turbine rotor in rows (Figure 1). The passage of steam through the blades in each  
9 row (stage) converts the energy of the steam into rotational energy in the turbine. The LP section is a  
10 “parallel flow” design. The LSBs are mounted on both end rows of the LP section. Steam enters the  
11 middle of the LP section through the crossover pipes (Figure 2) and passes through the blades in both  
12 directions of the LP section simultaneously until reaching the LSBs. The turbine rotor is directly coupled  
13 to the generator rotor (Figure 2 and Figure 3).



**Figure 1: Turbine Rotor (Removed from Unit 1).**

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<sup>3</sup> In the “Reliability and Resource Adequacy Study Review – Additional Considerations of the Labrador-Island Link Reliability Assessment and Outcomes of the Failure Investigation Findings – Additional Information,” Newfoundland and Labrador Hydro, February 4, 2022, p. 7, item 3, Hydro advised the Board of Commissioners of Public Utilities of its decision to extend operation of the Holyrood TGS as a generating facility to March 31, 2024.

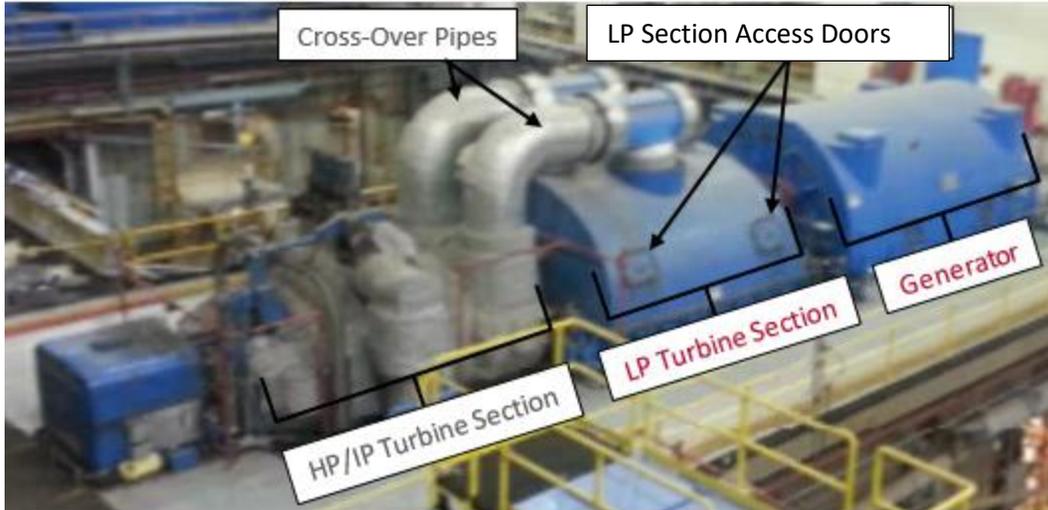


Figure 2: Turbine Generator

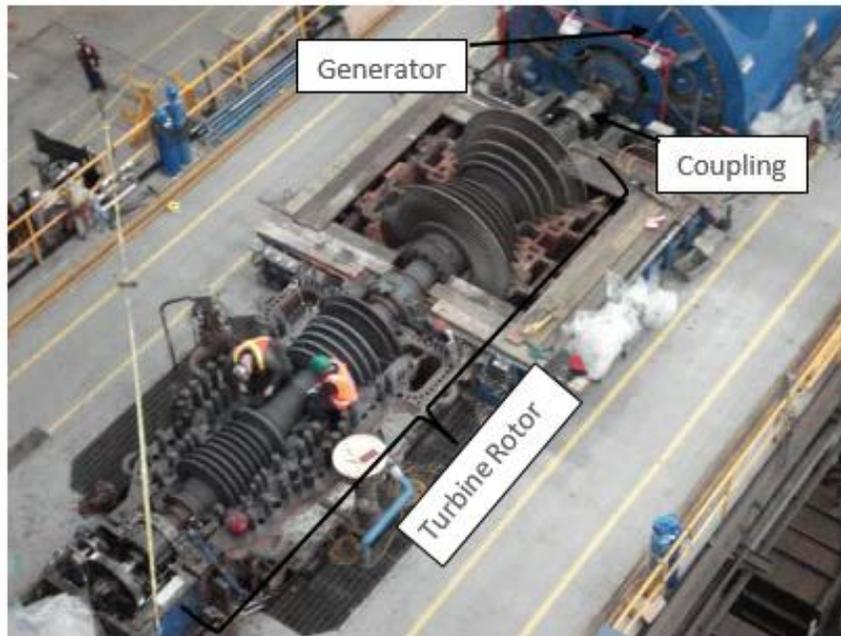


Figure 3: Turbine-Generator (with Turbine Casings Removed).

## 1 2.2 Operating Experience

- 2 The steam turbines at the Holyrood TGS are exposed to several degradation mechanisms such as fatigue
- 3 cracking, corrosion, erosion, wear, and creep.

1 Hydro performs turbine inspections on a three-year cycle and major turbine overhauls on a nine-year  
2 cycle. The HP and IP blades can be accessed for inspection by removing the HP/IP hood (upper half of  
3 the casing). The LSBs can be accessed for inspection by removing the access doors on the LP hood  
4 (Figure 2). The turbine overhaul scope includes the removal of the turbine casings, rotor, diaphragms,  
5 and bearings. Visual inspections, NDE, and any replacement or refurbishment required to ensure safe  
6 and reliable operation are completed during the major turbine overhaul. The last major turbine  
7 overhauls on Units 1 and 2 were completed in 2021 and 2013, respectively.

8 The LSBs are larger in length than other blades of the turbine LP section; therefore, they are subjected  
9 to higher bending stresses due to the impact of steam flow. In general, statistics show that LP turbine  
10 blades are more susceptible to failure compared to those of the HP and IP. Fatigue cracking is the main  
11 degradation mechanism affecting the turbine LP blades, and it takes place because of vibration arising  
12 from the fluctuation of bending stress due to the asymmetric flow of steam through the blades. Once a  
13 crack has been initiated, the component is assumed to have reached a critical condition of failure since  
14 crack growth takes place rapidly. No cracks were found on the turbine blades in previous overhauls;  
15 however, initiation of cracking was found in 2021 on the Unit 1 LSBs. With no evidence of impact or  
16 other physical damage due to contact with the blade that could cause the cracking on these blades, it is  
17 apparent that the mode of failure is related to fatigue associated with the operating hours of the unit.  
18 As Unit 2 is an identical unit with a similar operating history, similar issues may be found on the Unit 2  
19 LSBs during the scheduled overhaul in 2023.<sup>4</sup>

## 20 **3.0 Analysis**

### 21 **3.1 Identification of Alternatives**

22 The following alternatives were considered:

- 23 • Deferral; and
- 24 • Purchase spare turbine LSBs.

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<sup>4</sup> Hydro determined, in consultation with the OEM, that conducting the major overhaul earlier than currently scheduled, and incurring the associated costs, was not necessary, as there are no current indications of issues with the LSBs on Unit 2.

1 **3.2 Evaluation of Alternatives**

2 **3.2.1 Deferral**

3 The OEM has recommended that, in the event further cracking is found on Unit 1, the Unit should not  
4 be returned to service without replacement of the LSBs. It is expected that procurement and installation  
5 of LSBs would take approximately 42-46 weeks; should cracking occur during in-service operation of  
6 Units 1 and 2, extensive downtime would be required.

7 As Hydro has committed to extend the availability of the Holyrood TGS' three units for generation until  
8 March 31, 2024, this project must be undertaken to reduce an unacceptable risk to the safety and  
9 reliability of the Holyrood TGS..

10 **3.2.2 Purchase Spare Turbine LSBs**

11 As the entire Unit 1 turbine LSBs have been exposed to the same operating conditions as the cracked  
12 blade, Hydro believes it is reasonable to assume cracking on additional LSBs may be identified in future  
13 inspections. Given that Unit 2 is of identical design and has been subjected to near-identical operating  
14 conditions, Hydro believes procurement of spare LSBs is a prudent approach to mitigate the risk of  
15 failure of the LSBs on either unit. As the delivery period for the LSBs is approximately 30 weeks, the  
16 purchase of spare turbine LSBs will significantly reduce the downtime if a replacement of defective LSBs  
17 is required. If cracking of LSBs occurs in either Unit 1 or Unit 2 turbines and spare LSBs are available,  
18 restoring the unit generation availability can be achieved in 12–16 weeks compared to 42–46 weeks. In  
19 its “HTGS Condition Assessment and Life Extension Study,” Hatch acknowledged the discovery of cracks  
20 during the 2021 Unit 1 turbine inspection and has agreed with the OEM’s recommendation to procure a  
21 spare set of LSBs to reduce downtime in case of a blade failure.<sup>5</sup>

22 **3.3 Recommended Alternative**

23 Hydro determined that the viable alternative is the purchase of one set of turbine LSBs to be retained as  
24 capital spares. This spare set of LSBs can be used for Unit 1 or Unit 2 turbines at the Holyrood TGS, as  
25 both units are identical. This alternative allows Hydro to manage the acceptable risk, maintaining the  
26 required generation availability of Holyrood TGS until March 31, 2024.

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<sup>5</sup> “HTGS Condition Assessment and Life Extension Study,” Hatch Ltd., March 31, 2022, vol. I.

1 **4.0 Project Description**

2 **4.1 Scope**

3 The project scope includes the procurement of one set of turbine LSBs to be held as capital spares that  
 4 can be used for either Unit 1 or Unit 2 turbines at the Holyrood TGS.

5 **4.2 Estimate**

6 The estimate for this project is shown in Table 1.

**Table 1: Project Estimate (\$000)**

<b>Project Cost</b>	<b>2022</b>	<b>2023</b>	<b>Beyond</b>	<b>Total</b>
Material Supply	0.0	1,420.0	0.0	<b>1,420.0</b>
Labour	11.6	1.8	0.0	<b>13.4</b>
Consultant	0.0	0.0	0.0	<b>0.0</b>
Contract Work	0.0	0.0	0.0	<b>0.0</b>
Other Direct Costs	5.8	0.0	0.0	<b>5.8</b>
Interest and Escalation	0.7	67.0	0.0	<b>67.7</b>
Contingency	0.9	71.1	0.0	<b>72.0</b>
<b>Total</b>	<b>19.0</b>	<b>1,559.9</b>	<b>0.0</b>	<b>1,578.9</b>

7 **4.3 Schedule**

8 The anticipated project schedule is shown in Table 2.

**Table 2: Project Schedule**

<b>Activity</b>	<b>Start Date</b>	<b>End Date</b>
<b>Planning</b>		
Prepare planning documentation	July 2022	July 2022
<b>Procurement</b>		
Order turbine LSBs	July 2022	July 2022
Receive turbine LSBs on site	February 2023	March 2023
<b>Closeout</b>		
Prepare closeout documentation	April 2023	May 2023

1 **5.0 Conclusion**

2 This project is required to procure one set of turbine LSBs for use as capital spares for Unit 1 or Unit 2  
3 turbines at the Holyrood TGS.

4 The NDE of the Unit 1 turbine during its major overhaul in 2021 showed cracking of one of the LSBs. As  
5 these blades have been in service for 53 years and all the LSBs have been exposed to the same operating  
6 conditions, Hydro believes it is reasonable to assume that additional cracking will be initiated in the LSBs  
7 and potentially propagated to critical failure. The failure of turbine blades while rotating at high speeds  
8 leads to increased vibrations of the rotor. This could cause damage to turbine components and possible  
9 leakage of steam into the powerhouse, creating a major safety hazard. Given the identical design and  
10 similar operating conditions of Units 1 and 2, Hydro believes procurement of spare LSBs is a prudent  
11 approach to mitigate the risk of failure of LSBs on either unit.

12 This project was not considered for inclusion in Hydro’s “2022 Capital Budget Application,” as the  
13 cracking on the Unit 1 LSBs was not known at the time the application was finalized. Inclusion in Hydro’s  
14 “2023 Capital Budget Application” would not provide sufficient time to procure spare LSBs before the  
15 Unit 2 turbine overhaul in 2023, as the turbine LSBs have a long procurement period of approximately  
16 30 weeks. The purchase of spare turbine LSBs will significantly reduce the downtime if the replacement  
17 of defective LSBs is required.

18 Given Hydro’s current commitment to maintaining the full generation availability of the Holyrood TGS  
19 until March 31, 2024, Hydro, is requesting approval of this supplemental capital expenditure to enable  
20 procurement to commence in 2022.



# Affidavit

**IN THE MATTER OF** the *Electrical Power Control Act, 1994*, SNL 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 to purchase one set of last stage blades ("*LSB*") to serve as capital spares for Units 1 and 2 at the Holyrood Thermal Generating Station ("*Holyrood TGS*") pursuant to s 41(3) of the *Act*.

**AFFIDAVIT**

I, Robert Collett, of St. John's in the province of Newfoundland and Labrador, make oath and say as follows:

1. I am Vice President, Engineering and NL System Operator for Newfoundland and Labrador Hydro, the applicant named in the attached application.
2. I have read and understand the foregoing application.
3. To the best of my knowledge, information, and belief, all of the matters, facts, and things set out in this application are true.

**SWORN** at St. John's in the )  
Province of Newfoundland and )  
Labrador this 30 day of )  
April, 2022 before me: )

Swalsh  
Barrister – Newfoundland and Labrador

R. Collett  
Robert Collett, P. Eng.