DECISION **2020 NSUARB 139**
M09596

NOVA SCOTIA UTILITY AND REVIEW BOARD

IN THE MATTER OF THE PUBLIC UTILITIES ACT

- and -

IN THE MATTER OF AN APPLICATION by Nova Scotia Power Inc. for approval of 2020 Capital Work Order (P-128.20) – Wreck Cove Life Extension and Modernization (LEM) – Unit Rehabilitation and Replacement in the amount of $109,214,439

BEFORE:	Roberta J. Clarke, Q.C., Panel Chair Richard J. Melanson, LL.B., Member Steven M. Murphy, MBA, P.Eng., Member
APPLICANT:	**NOVA SCOTIA POWER INC.** Matthew Gorman, Regulatory Counsel
INTERVENORS:	**CONSUMER ADVOCATE** William L. Mahody, Q.C.
	INDUSTRIAL GROUP Nancy Rubin, Q.C.
	SMALL BUSINESS ADVOCATE E. A. Nelson Blackburn, Q.C.
BOARD COUNSEL:	S. Bruce Outhouse, Q.C.
FINAL SUBMISSIONS:	September 3, 2020
DECISION DATE:	**November 26, 2020**
DECISION:	**The Board approves parts of the work order. The Board does not approve the proposed penstock intake upgrade and provides guidance to NS Power for possible resubmission of that part of the project.**

Table of Contents

I INTRODUCTION

[1] Nova Scotia Power Inc. requested Board approval for a capital project entitled HYD WRC – Wreck Cove Life Extension and Modernization (LEM) – Unit Rehabilitation and Replacement in the amount of $109,214,439.

[2] The proposed scope of work includes (i) replacing the two Wreck Cove generator units; (ii) refurbishing the two Wreck Cove turbine units and replacing the turbine runners; (iii) refurbishing the spherical valves; and (iv) upgrading the penstock intake.

[3] Board Counsel engaged Midgard Consulting Inc. to review and provide comment on the application. Based on the evidence of Midgard and NS Power, the Board concludes that the proposed replacement of the two generator units, and the refurbishing of the two turbine units and the spherical valves are all justified.

[4] The Board finds that NS Power has not supported the proposed penstock intake upgrade with persuasive evidence to demonstrate it is necessary or prudent. The Board concludes that NS Power has not adequately analysed alternatives for this work, considering the level of risk and likelihood of consequences. The Board does not approve the proposed penstock intake component of the project. The Board has outlined its expectations of what NS Power should submit on a possible separate application for work on the penstock intake.

II BACKGROUND

[5] The Wreck Cove Hydro System, located in the Cape Breton Highlands of Nova Scotia, was commissioned in 1978. It is NS Power's largest hydroelectric system

and consists of two generating stations: the Gisborne Generating Station, with an installed capacity of 3.5 MW, and the Wreck Cove Generating Station, with an installed capacity of 212 MW.

[6] Water from the Cheticamp Flowage, Ingonish I, Ingonish II, Gisborne Flowage and MacMillan Flowage passes through the Gisborne unit, before entering the Wreck Cove Flowage Reservoir. Water from the Wreck Cove Reservoir then travels via Tunnel T-2 to Surge Lake, where it enters the Wreck Cove Generating Station through a 496m long concrete lined penstock before discharging into the Atlantic Ocean through the tailrace tunnel. Twenty earthen and rock filled dams maintain the reservoirs that provide water for generation at the Wreck Cove System. Diversions between reservoirs, or flowage, consists of five canals totaling 5,183m in length and two unlined tunnels that are 4,878m and 3,811m long, respectively.

III PROJECT DESCRIPTION AND JUSTIFICATION

[7] The application notes that the Wreck Cove generating station assets have been maintained for over 40 years. However, the company indicated that significant investment is now required as the station can no longer be operated reliably without a major overhaul. The scope of the proposed project includes (i) replacing the two Wreck Cove generator units; (ii) refurbishing the two Wreck Cove turbine units and replacing the turbine runners; (iii) refurbishing the spherical valves; and (iv) upgrading the penstock intake. The project is the first phase of the larger Wreck Cove LEM Project and comprises more than 80 percent of the total scope and cost of the LEM Project. The following phase of the LEM Project – Wreck Cove LEM – Balance of Plant (BoP) will primarily involve the

rehabilitation of the station breakers and switchgear, and the replacement of the cooling water systems at the plant, as well as plant system upgrades. The company will apply for approval of the BoP phase at a later date.

[8] NS Power's application states that Wreck Cove provides critical capacity required to meet varying electrical loads, including peak hour demand, contributing to overall system reliability. The application also notes that the energy generated from the facility contributes to NS Power's compliance with North American Electric Reliability Corporation (NERC) requirements, Northeast Power Coordinating Council (NPCC) requirements, Nova Scotia's *Greenhouse Gas Emissions & Air Quality Regulations* (Emissions Hard Caps), and Nova Scotia Renewable Electricity Standards (RES). The energy produced from Wreck Cove is expected to account for approximately seven percent of the RES compliant renewable energy produced in Nova Scotia from 2020 to 2029.

[9] The application states that completion of the currently proposed project will allow the Wreck Cove Generating Station to maintain reliable operation. Furthermore, the project is intended to:

- assist with variable renewable energy integration,
- allow the company to continue to meet its capacity and operating reserves and other NERC/NPCC requirements,
- help ensure compliance with emissions requirements and RES requirements, and
- enable NS Power to maintain essential grid services.

NS Power also stated that the project will increase annual generation and the flexible operating range of the Wreck Cove units, which will help offset fuel and power purchase

costs with zero emission generation. NS Power conservatively estimated that the wider operating range will increase Wreck Cove system annual generation from 300 GWh to a forecast 315 GWh, which will create a fuel and power purchase cost savings.

[10] NS Power engaged GTA Hydro, an engineering firm with expertise in the life cycle of hydraulic generating units and their auxiliary components, to review Wreck Cove Generating Station condition assessment work undertaken from 2012 to 2018 and provide recommendations based on the current condition of the station components. GTA Hydro recommended replacement of the Wreck Cove generators, refurbishment of the turbines and spherical valves, and replacement of the turbine runners. NS Power engaged another engineering firm, Hatch, to provide an assessment of the penstock intake. Hatch recommended an upgrade in order to modernize the design and update the penstock intake to meet industry standards. NS Power stated that the scope of work for the proposed project has been selected so that key components on each unit (generator, turbine, spherical valve) can be overhauled simultaneously, minimizing construction mobilization requirements and allowing NS Power to utilize one vendor to complete the overhaul.

[11] Prior to confirming the proposed project scope, the company assessed three alternatives:

> **Option 1** – (i) replacement of the generators; (ii) refurbishment of the majority of the turbine components and replacement/installation of new turbine runners with a wider efficiency range; (iii) refurbishment of the spherical valves; and (iv) upgrade of the penstock intake.
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> **Option 2** – (i) replacement of the generators; (ii) refurbishment of the majority of the turbine components, including the existing turbine runners; (iii) refurbishment of the spherical valves; and (iv) upgrade of the penstock intake.
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> **Option 3** – Decommission the Wreck Cove Generating Station and the Wreck Cove Hydro System. [Emphasis in original]
>
> [Exhibit N-2, p. 31]

[12] The application stated that although the initial capital cost of refurbishing the runners (Option 2) is lower than replacing the runners, refurbishing the runners is not the lowest cost option for customers when lifecycle costs are considered.

[13] The 2020 ACE Plan budgeted amount for this phase of the Wreck Cove LEM project was $109,691,967. In its application, NS Power explained the decrease of approximately $477K from the 2020 ACE Plan is due to final refinement of costs after the 2020 ACE Plan was filed. The Board understands that the actual scope of work will not be fully known until the generating units and turbines are dismantled and fully inspected to determine the full scope of refurbishment needs.

IV REVIEW PROCESS

[14] NS Power requested confidential treatment of certain information contained in its application. In a letter dated February 27, 2020, the Board questioned the need for confidential treatment of several items in the application. NS Power responded with revisions to its request on February 28, 2020, and the Board subsequently granted the company's revised confidentiality request on March 3, 2020.

[15] The Small Business Advocate (SBA), the Industrial Group, and the Consumer Advocate (CA) filed notices of their intention to intervene in the review of this project. In addition, Board Counsel retained Midgard Consulting Inc. (Midgard) as an expert to review NS Power's application.

[16] On March 27, 2020, the Board issued a Notice of Paper Hearing and a Hearing Order, which established a timeline for the review of this application.

[17] Notice of the application was sent to the Assembly of Nova Scotia Mi'kmaq Chiefs, Kwilmu'kw Maw-klusuaqn Negotiation Office and the Chiefs of the 13 First Nations in Nova Scotia, none of whom chose to participate in the proceeding.

[18] NS Power submitted its responses to Information Requests (IRs) from the SBA, the CA, Midgard and Board staff on May 21, 2020. Midgard then filed its Evidence on June 4, 2020, and NS Power filed Reply Evidence on August 6, 2020. The SBA and CA filed submissions on August 20, 2020, to which NS Power filed its Reply Submission on September 3, 2020.

V MIDGARD EVIDENCE

[19] Midgard was engaged by Board Counsel to review NS Power's application and provide an opinion on the economic and technical merits of the application.

[20] Overall, Midgard found that the proposed Wreck Cove generator works are supported. Midgard stated that NS Power may not have fully justified its decision to replace, rather than extensively rehabilitate, the generators. However, Midgard noted that it is likely these two options are comparable in terms of effort and outcome.

[21] Midgard also concluded that the proposed turbine works are supported. Midgard noted that the condition of the turbine runners may not necessarily warrant their replacement. Nevertheless, considering the stage of the runners' service life and NS Power's proposed change in operational mode of the turbines, Midgard stated that replacement with a turbine design that provides a wider operating range appears prudent. In the context of runner replacement, Midgard stated that replacement and refurbishment of ancillary equipment is justified. Furthermore, Midgard noted that it could be considered

good practice to proactively replace the related instrumentation systems as part of the project.

[22] With regard to the proposed spherical valve works, Midgard found that work to be only partially supported. Midgard noted that the spherical valves are key pieces of equipment for the Wreck Cove Generating Station, and the continued good operation of the valves is critical to the plant's operation. However, Midgard stated that the need to return the valves to "as new" condition is not fully supported, given that the valves have been kept in very good condition. Nonetheless, Midgard indicated that, in the context of a replacement of the turbine-generator units, returning the spherical valves to "as new" condition (such that their life expectancy matches the turbine-generators they protect) could be considered to be good practice.

[23] Finally, regarding the proposed project work scope, Midgard found that the proposed penstock intake work is not supported. Midgard stated that NS Power has attempted to justify this particular work based on reasons of safety, economics, operational efficiency, and conformance with industry best practice. Midgard concluded that only the justification of safety (i.e., risk mitigation) appeared to have any support for this component of the proposed project. However, Midgard indicated that this justification was only partially supported, as NS Power had not justified that the proposed costly and complex design solution is required to mitigate safety risks. Midgard believes that NS Power could have considered simpler and less expensive options to address safety concerns.

[24] Midgard also expressed some concerns related to NS Power's project execution plan. Midgard noted that the proposed Wreck Cove LEM is a complex project

that must be executed within a constrained space. It will affect most major components of an underground power plant that was originally commissioned more than 40 years ago. In Midgard's opinion, the project may therefore represent a uniquely challenging undertaking for NS Power, complete with significant execution risks. Midgard stated that unless these risks are identified and mitigated with careful planning and an effective execution strategy, the project presents the potential for uncontrolled cost and schedule overruns. Based on its review of the application, Midgard believes that NS Power's proposed project plan does not recognize and mitigate a number of high-risk areas. As such, Midgard suggested alternative approaches that could be considered by NS Power.

VI INTERVENOR SUBMISSIONS

[25] In his Closing Submission, the SBA submitted that it is difficult to accurately assess the cost-effectiveness of the proposed penstock intake work, as NS Power did not complete a separate related economic analysis. The SBA also expressed concerns about potential cost overruns and scope expansion for the project. He therefore recommended the following, should the Board approve NS Power's application:

- NSPI should be required to present to the Board a breakdown of all specific activities and related costs needed to complete Phase I;
- NSPI should begin engagement of third parties early on to minimize potential scoping issues;
- NSPI should be required to come to the Board immediately should out-of-scope issues arise;
- The Board should only approve Phase II when Phase I is close to completion, such that materialization of out of scope items or delays are avoided; and
- Starting with the current Integrated Resource Plan that is being conducted, NS Power should be required to include a report outlining what is required to meet RES standards and where NSPI's individual assets fit into the overall plan to provide stakeholders context for the resource need.

[Exhibit N-22, p.2]

[26] The CA supported the proposed generator and turbine components of the project. However, he recommended that the Board withhold approval for the portion of work related to the spherical valve works and penstock intake works and direct NS Power to evaluate alternative mitigation options for potential future capital project submissions.

[27] The CA also expressed concern that NS Power had overstated the contingency for this project and used an excessive cost of replacement power. He noted that an excessive contingency factor reduces the chance that NS Power would be required to file an Authorization to Overspend (ATO) application, even if cost overruns are caused by a failure in planning or management. Accordingly, the CA recommended that the Board consider reducing the contingency factor to 10% for all costs, or to 15% of the supplier portions of the budget.

[28] The CA also stated that NS Power's assumption that replacement energy for Wreck Cove would cost about as much as the fuel of the Port Hawkesbury Biomass plant is unreasonable. In this regard, he noted that NS Power did not provide an economic analysis model (EAM) study using a replacement energy cost with a mix of generation sources, as suggested by the Board in the 2019 ACE Plan decision. The CA indicated that his contingency and replacement energy concerns do not affect the decision as to which parts of this particular project should be approved, but both should be addressed in NS Power's planning and project evaluation.

VII NS POWER REPLY EVIDENCE AND SUBMISSIONS

[29] In its Reply Evidence, NS Power addressed some of the concerns expressed by Midgard. With respect to the proposed spherical valve works, the company

noted that a 2011 report by Landsvirkjun Power stated that, in order to reduce the risk of penstock rupture, the renewal of the spherical valves should be seriously considered. NS Power also stated that returning the spherical valves to factory condition during a major overhaul is the safest approach and in accordance with good utility practice. The company also indicated that the LEM presents a unique opportunity to refurbish the 40-year-old spherical valves, while minimizing costs to customers compared to doing so after completion of the LEM.

[30] Regarding the proposed penstock intake work, NS Power's Reply Evidence stated that the work is justified on the basis of safety, as this portion of the project addresses potential safety hazards to operating personnel. The company noted that though the penstock intake currently meets operating requirements, there is no mitigation in place should a significant flooding event occur. NS Power stated that the proposed penstock intake works will provide emergency closure in the event of a significant flood, are required to protect NS Power personnel and the reliability of the station, and will bring the penstock intake to a level of safety acceptable to the company. NS Power also stated the proposed penstock intake works conform with industry best practice, create operational efficiencies, and are considered the only technically feasible alternative for emergency closure at the Wreck Cove station.

[31] NS Power also suggested that implementing alternative risk reduction refurbishment activities as proposed by Midgard would increase the safety of the station by minimizing the likelihood of a spherical valve rupture; however, none of those would minimize the consequences should a rupture occur.

[32] The company further stated that, without cost support for Midgard's proposed alternative design solutions, NS Power could not confirm whether they would be less costly than the proposed penstock intake works. NS Power acknowledged that Midgard's alternative measures could potentially be marginally less costly than the proposed penstock intake works. However, the company noted that Midgard's alternatives do not accomplish the same outcome. It stated that these works would not eliminate the risk of a flood and therefore would not alleviate the need for the emergency closure that the proposed intake gate would provide should a flood occur.

[33] The company also stated the proposed penstock intake works will reduce the consequence of all 13 failure modes identified by Hatch in Table 4-1 of its report and the three failure modes identified by Landvirkjun. Further, NS Power noted that even with the proposed spherical valve refurbishments included in this project, the failure modes still exist, and the risk will not be mitigated without a means to stop the flow of the water, such as the installation of the proposed penstock intake gate:

> It was determined that even with a more reliable valve, failure modes still existed which could result in flooding of the powerhouse without a means to stop the flow at the penstock intake. A review of industry standards concluded that while there is a requirement to have at least one means of emergency closure upstream from the wicket gates of a generating unit, it is also common practice for hydro power plants to have emergency closure capabilities at the intake side of the penstock, regardless of whether turbine inlet valves are present.
>
> A review of similar powerhouse arrangements across the industry also found that even where inlet valves were provided, intake gates were almost always provided for emergency closure of the penstock.
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> At Wreck Cove, while the addition of emergency closure capabilities at the penstock is not a strict requirement, it would provide the benefit of mitigating the risks which exist due to failures at or upstream of the inlet valves.
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> [Exhibit N-21, pp. 25 - 26]

[34] NS Power also stated that investment in the penstock intake to achieve operational efficiencies is one of many additional benefits associated with completing this

project, but is not a primary justification. NS Power stated that it currently requires multiple days to build a cofferdam and install stop logs to dewater the penstock. It is impractical to install penstock intake stop logs during the winter months (November to May), which limits the construction window for penstock or turbine work to less than six months of the year. This restriction also makes any forced outages requiring dewatering extremely difficult and costly during the winter period. The company also noted that one of the benefits of the proposed penstock intake works will be the ability to dewater the penstock during any season.

[35] NS Power also took issue with Midgard's assertion that the company did not adequately evaluate alternatives for the proposed penstock intake gates. The company stated that, prior to the development of the Hatch Report, various design alternatives were reviewed and examined by both Hatch and NS Power but were discounted because of issues related to maintenance, lack of emergency closure capabilities and complexity. In addition, NS Power noted that alternative designs were eliminated as a result of not meeting the requirements set out in the Landsvirkjun report, creating additional risk factors, or being unsuitable for the Wreck Cove penstock. The company further noted that the proposed penstock intake works were selected because they meet the emergency requirements as set out in the Landsvirkjun report to mitigate the consequences of a flood and are consistent with common industry practice.

[36] In response to Midgard's concerns regarding project execution, NS Power stated that the company had put forward a fully vetted and comprehensive project plan and schedule. NS Power also indicated that, in addition to following established company project execution practices, it will be engaging an experienced vendor to design, plan and

execute project work. All this will be closely monitored by NS Power and will be subject to contractual commitments regarding work specifications, project updates, and deliverables. NS Power also stated that company management will be responsible for executing the project within the parameters of the Board approved capital cost, using reasonable judgement, project management, and decision making consistent with good utility practice. Should the project scope change or the project forecast exceed the greater of $250,000 or five percent of the approved amount, NS Power stated that it will be responsible to file an ATO in accordance with the Capital Expenditure Justification Criteria (CEJC) and must justify the cost overruns.

[37] In its Reply Submission, NS Power disagreed with the SBA's assertion that the company should have been more proactive about the penstock intake issues. NS Power also disagreed that a separate EAM is required for the penstock intake component of the project. The company stated that it was proactive with respect to the penstock intake issues and managed the risks in accordance with good utility practice and the CEJC criticality ranking. The company further noted that, while its current maintenance strategy for the penstock decreases the likelihood of a rupture and potential flooding, it does not eliminate the risk, which increases as the system ages. With respect to a separate EAM for the penstock intake, NS Power indicated that it had met all capital application requirements as set out in its CEJC, and a separate EAM for a component of a larger capital project is not necessary to assess the economics of the project.

[38] Regarding the SBA's concerns related to potential project cost overruns, NS Power's response is summarized below:

- A breakdown of all project specific activities and costs has already been provided in GTA's Basis of Design Report and in the project technical specifications and cost

estimates. NS Power is also undergoing a project RFP process, and has included contingencies within its project cost estimates. For these reasons, the company argued that further cost reporting, as recommended by the SBA, is not required.

- Should the project scope change or the project forecast exceed five percent of the approved amount, NS Power will be responsible to file an ATO in accordance with the CEJC and must justify the cost overruns. As such, there is no reason for the company to report to the Board immediately when out-of-scope issues arise.

- The proposed project and the future BoP are two separate projects, with different scopes, and will each be justified based on their own merits. The BoP project is required regardless of the completion of the scope of the project proposed under the current application. For those reasons, NS Power submitted that the Board should not adopt the SBA's recommendation to only approve the BoP project when the larger LEM Project is close to completion.

- The company reports in its annual 10-Year System Outlook on how RES compliant resources such as wind, hydro, and biomass contribute to NS Power's RES requirements. NS Power will continue to provide these details in the 10-Year System Outlook process. As such, NS Power stated that a new report, as suggested by the SBA, is not necessary.

[39] In response to the CA's Closing Submission, NS Power stated that there is no basis to support the CA's recommendation to withhold Board approval of the proposed spherical valve and penstock intake work. Specifically related to the proposed penstock intake works, NS Power's Reply Submission reiterated its Reply Evidence:

> However, and as stated in NS Power's Reply Evidence, (1) the design solutions proposed by Midgard may reduce the likelihood of a rupture, but they will not prevent the consequences should a failure occur; and (2) although it is possible the alternative proposed by Midgard could be marginally less costly than NS Power's proposed penstock intake works, it does not accomplish the same outcome: Midgard's proposed option would not eliminate the consequence of a flood and therefore does not alleviate the need for the emergency closure that the intake gate will provide should a flood occur. Midgard has provided no evidence contesting NS Power's evidence that the penstock intake works will provide emergency closure in the event of a significant flood and are required to protect NS Power personnel and the reliability of the station.
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> [Exhibit N-24, p. 11]

[40] Regarding the CA's concerns about the project contingency amount, NS Power stated that even though some aspects of project design are complete, detailed engineering has yet to be completed for Unit 1, Unit 2 and the penstock intake

rehabilitation. In addition, the company indicated that the contingency for the project has been confirmed by third party consultants to be within a reasonable range.

[41] Further, with respect to the CA's concern about NS Power's Replacement Energy Cost (REC) calculation, the company noted that rather than providing two EAMs (one using the Biomass REC and one using a mixed resource REC), it provided one EAM which combined both REC calculations. The company stated that biomass does not have sufficient excess energy to replace Wreck Cove's energy over a 40-year period. For this reason, NS Power developed an EAM which included the Biomass REC until Wreck Cove is forecast to be de-rated beyond 60 GWh/year, at which point a mixed resource REC was used for the remainder of the replacement energy requirement.

VIII ANALYSIS AND FINDINGS

Replacement Energy Cost

[42] The Board notes that NS Power used a different REC approach than the Board had suggested in the 2019 ACE Plan decision. The Board understands the explanation offered by NS Power for its approach. The difference would not impact the outcome in this application, and in these circumstances, the Board accepts the REC calculation.

Generator and Turbine Work

[43] The Board understands that the two Wreck Cove generators have experienced long term problems resulting from design flaws with both their stators and rotors. GTA Hydro's findings confirm that the turbines and generators have reached a point where a full unit rehabilitation is required. No Intervenor voiced any serious concern

with respect to the proposed generator and turbine works. Midgard also concluded that the proposed generator and turbine works are supported.

[44] The Board finds that the proposed scope of the generator and turbine work is supported, and essential for the continued reliable operation of the Wreck Cove generating station.

Spherical Isolation Valves

[45] The flow of water from the Wreck Cove Reservoir into the smaller Surge Lake is regulated with an intake gate located at the Wreck Cove Reservoir side of the T-2 tunnel. The intake structure includes an electrically operated wheeled vertical lift gate to cut off the flow to Surge Lake when necessary. Since this intake gate can be remotely operated from the Wreck Cove Administration Building, it can be closed relatively quickly in the event of an emergency. The T-2 intake gate also allows NS Power to dewater Surge Lake and the penstock when needed.

[46] The water from Surge Lake enters through the penstock intake structure and flows through a 496 m concrete lined penstock towards the powerhouse which is located underground. Before entering the powerhouse, the water flowing through the penstock divides into two 2.4 m wide steel pipes, each 55 m in length. The water then enters the turbines through 1.8 m wide spherical isolation valves, one for each of the two units. The water leaves the turbines and flows through a 1,706 m long tailrace tunnel to the Atlantic Ocean.

[47] The spherical isolation valves are used to isolate the turbines from the penstock, and therefore play a critical role in stopping water from entering the turbine units and the powerhouse in an emergency. In its application, NS Power notes that if

these valves are unable to operate, the units cannot generate. The isolation valves also allow the company to perform maintenance work on a unit, while the other is in operation.

[48] The Board agrees with Midgard's observation that the condition of the spherical valves is of critical importance since there is no isolation capability at the upstream end of the penstock.

[49] The Board understands that spherical isolation valves are extremely important for the safety of the Wreck Cove powerhouse, especially to prevent or reduce the consequences of powerhouse flooding. According to the information provided in the Landsvirkjun and Hatch reports, reliable operation of the isolation valves is important in order to mitigate the consequences of a number of the failure modes analyzed in these reports, notably those related to possible penstock ruptures.

[50] Therefore, the Board finds that the proposed refurbishment of the spherical isolation valves is justified.

Penstock Intake Structure

[51] The penstock intake structure feeds water from Surge Lake to the powerhouse. The existing intake does not include a gate, and, therefore, water flow through the penstock can only be controlled upstream of Surge Lake, by the remotely operated T-2 intake gate. The penstock intake includes a set of steel stoplogs that facilitate the dewatering of the penstock, but in order to complete dewatering, Surge Lake must be dewatered as well. The water level of Surge Lake can be lowered either by passing the water through the turbines, or through a valve-controlled drain line in the bottom of the lake.

[52] NS Power has proposed to replace the existing penstock intake with a new intake structure that would include a concrete tower with a wheeled gate and hoist system.

NS Power has stated that the proposed intake structure would significantly alleviate consequences of powerhouse flooding associated with penstock failure. NS Power also stated that the benefits of the proposed intake structure include:

1. Reduced outage time required to dewater the penstock (hours vs. multiple days);
2. Emergency closure limiting the impacts of a valve failure, penstock failure, or bypass piping failure;
3. Ability to dewater the penstock during any season; and
4. Reduced dewatering effort and cost when isolation for the penstock is required.

[Exhibit N-2, pp. 29 – 30]

[53] The Board notes that NS Power attempted to justify the proposed penstock intake work based on reasons of safety, economics, operational efficiency, and conformance with industry best practice. The company provided numerous references to the reports prepared by its consultants to support the conclusion that the proposed penstock intake work is the only reasonable option available to address these items. The Board finds that NS Power's position is not fully supported by these reports.

[54] In its application, NS Power stressed that emergency closure capabilities of the proposed penstock intake are industry standard. Midgard challenged the company on this point, arguing that NS Power had not justified its position that the proposed intake work is required to align with industry best practice. As noted above, NS Power in its Reply Evidence confirmed that the Wreck Cove Generating Station satisfies current industry standards of having one means of emergency closure upstream from the wicket gates of a generating unit (the spherical isolation valves), and that the addition of emergency closure capabilities at the penstock is not a strict requirement.

[55] In addition, the Board finds that NS Power has not provided persuasive evidence to show that dewatering costs and efforts have a substantial role in the justification of the penstock intake work. As noted by Midgard, NS Power's application lists only three penstock intake isolation events that have occurred since 2009. Therefore, except for emergency closure ability, the level of related potential benefits noted above would appear to be relatively minor.

[56] In its Reply Evidence, NS Power stressed that the primary reason for the proposed penstock intake work is safety:

> **Penstock Intake** – NS Power has addressed the CA's concerns, above, related to the penstock intake and reinforcement of the penstock. In addition, NS Power's Reply Evidence provides further justification for the Company's investment in the penstock intake gate, which the Company confirms: (1) is justified primarily based on safety; (2) was recommended by Landsvirkjun, KGS, and Hatch to address safety risks; (3) that installation of a penstock intake gate, as set out in its Project Application, is the only technically feasible option to address such risks; and (4) remains the most cost effective and technically feasible option, after examination of a number of other alternatives such as sectional gates, slide gate, bonneted gate, butterfly valve, and downstream sealing gate, all of which were discounted for the reasons outlined in NS Power Reply Evidence.
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> [Exhibit N-24, p. 13]

[57] The reports prepared by Landsvirkjun, KGS, and Hatch show that a new gated intake structure would significantly lower safety risks related to powerhouse flooding. However, in the Board's opinion, they do not provide sufficient data to support the view that the penstock intake work proposed by NS Power represents an optimal solution.

[58] The risk assessment performed in 2011 by Landsvirkjun reviewed different flooding risk case studies and rated each one according to the probability of occurrence and worst-case consequences. The Board has summarized the following from the Landsvirkjun report:

- Only one of the case studies resulted in a suggested measure "to install intake gates that can close against flow". Case 22, triggered by the turbine valve main

seal failure and with an assessed risk rating of 12, would cause some flooding in the powerhouse and only minor consequences for persons in the powerhouse. The risks associated with this case study would be alleviated by the proposed refurbishment of the spherical isolation valves.

- Case 16, with the highest risk rating of 20, would be caused by a rupture of the penstock upstream of the turbine inlet valve due to penstock pressure pulsations triggered by turbine inlet valve seal. If this occurs, the powerhouse would be filled with water in a very short time. All suggested measures for risk reductions associated with this Case are related to the modifications of the turbine spherical isolation valves.

- There are also other cases, with risk ratings from 8 to 16, where intake gates could help to mitigate the severity of the powerhouse flooding. All suggested measures for risk reduction to "green level" include procedures and/or work that is not related to the penstock intake gate work itself.

[59] Similarly, the Board notes that the Hatch report did not consider a broad range of flood mitigation options and concentrated on the penstock intake gate solutions.

[60] The 2012 Wreck Cove GS Condition Assessment performed by KGS Group does not provide a detailed analysis of failure modes and consequences of penstock failures, but offers the following recommendations regarding the penstock inlet structure:

> Particular urgent attention should be given to the risk assessment associated with the absence of head gates at the penstock inlet structure, as the absence of effective mean of quickly stopping water flows in an emergency can lead to injury, fatalities and extensive plant destruction (e.g. Kainji in Nigeria, 2000 and Sayano-Shushenskaya in Russia, 2009). The study should address providing head gates at the penstock inlet structure, with an alarm system that would alert the operators that there is an issue with the penstocks (i.e., large drop in pressure) and which would have the capability to close the head gates automatically or by remote control in an emergency situation.
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> [Exhibit N-4, pp. 77-78]

[61] The basic measure to assess the need for a project justified on safety is to evaluate whether a risk level associated with not proceeding with such a project exceeds an industry standard or a risk level acceptable to NS Power. The Landsvirkjun report provides the following information:

> There is no authority in Nova Scotia that specifies requirements regarding accepted risk level in underground power plants.

> NS Power has not defined accepted risk level for their operations.
>
> [Exhibit N-12, p.11]

[62] NS Power stated that the proposed penstock intake work will bring the penstock intake to a level of safety acceptable to the company. It is difficult for the Board to assess the validity of this statement since the company did not define its level of acceptable risk.

[63] With respect to risk management suggestions proposed by Midgard, NS Power responded:

> (1) the design solutions proposed by Midgard may reduce the likelihood of a rupture, but they will not prevent the consequences should a failure occur; and
>
> (2) although it is possible the alternative proposed by Midgard could be marginally less costly than NS Power's proposed penstock intake works, it does not accomplish the same outcome: Midgard's proposed option would not eliminate the consequence of a flood and therefore does not alleviate the need for the emergency closure that the intake gate will provide should a flood occur.
>
> [Exhibit N-24, p. 11]

[64] In considering these arguments, the Board notes that it appears the penstock intake work proposed by NS Power would not reduce the likelihood of a penstock rupture. It may reduce the consequences if a rupture occurs. Further, while Midgard accepts NS Power's arguments that a penstock intake gate would help mitigate certain risks, it does not agree with the proposed scope of work:

> NSPI has not justified the penstock intake gate project. Though there are existing risks that would be mitigated by the presence of a penstock intake gate, the evidence provided suggests that a penstock intake gate is an unnecessarily complex and costly method of mitigating those risks. Less complex and expensive alternative solutions could have been considered.
>
> [Exhibit N-20, p. 36]

[65] The Board notes that, under NS Power's proposal, if the penstock were to rupture upstream of the spherical valves, the powerhouse could still be flooded with the large volume of water that would be contained within the penstock itself and with water

that flows in from Surge Lake while the proposed penstock gate would be in the process of closing. NS Power has provided no evidence that its proposed intake gate solution would eliminate the possibility of powerhouse flooding, especially if the intake gate fails to close.

[66] Generally, risk is assessed as a combination of the probability that a failure event would occur and the consequences of the failure. Thus, a risk could be lowered either by reducing the probability (likelihood) of a failure to occur, by decreasing the possible consequences, or by a combination of both. The Board believes that, in the case of any proposed risk mitigation measure, NS Power should first define an acceptable level of risk, and then evaluate potential measures that could lower the probability and/or consequences of potential failure events.

[67] The Board finds that neither the intake gate work proposed by NS Power, nor alternative measures presented by Midgard, would ever completely eliminate the risk identified by the company. A risk level acceptable to the company might be achieved by implementing a different set of measures that either lower the probability or lower the consequences of powerhouse flooding. NS Power has not presented any evidence that it thoroughly considered a set of potential measures, nor has it presented associated cost estimates for such measures. Further, NS Power did not provide evidence that a comprehensive analysis of potential failure modes and their consequences had been carried out as part of the planning for the penstock intake project.

[68] With respect to the need for an EAM, the Board agrees with the SBA that it is difficult to accurately assess the cost-effectiveness of the proposed penstock intake work without a separate economic analysis for that component of the Wreck Cove LEM

project. NS Power argued that a separate EAM is not needed, in part because it has already submitted a fully vetted economic analysis with respect to the whole Wreck Cove LEM project. The Board notes that, according to the EAM, NS Power provided with its application, the project would still be cost effective even if the company spent much more than currently anticipated. The fact that a project would still be cost effective even if more funds are used does not provide justification for the company to spend more than necessary on a project.

[69] The Board notes that a proper cost benefit analysis compares the costs of different reasonable alternatives with the benefits they would provide. Based on the information submitted in this proceeding, the Board finds that NS Power did not provide:

- an adequate comparison of all reasonable alternatives for the refurbishment of the penstock intake structure,
- a proper analysis of benefits provided by each of these alternatives,
- a proper review of other powerhouse flooding mitigation methods.

[70] The Board cannot evaluate a proper economic analysis of the proposed work until all the above preliminary work is completed by NS Power.

[71] NS Power also argued that the proposed penstock intake work also needs to be completed in order to protect personnel and the reliability of the generating station during the refurbishment of the Wreck Cove facility. The Board notes that the need for the intake gate work had been identified by Landsvirkjun in 2011, and that the company had ample time to submit the penstock intake project for Board approval in preparation for the upcoming refurbishment of the Wreck Cove Generating Station.

[72] Further, in recent years, NS Power has completed significant work related to safety of the Wreck Cove facility. In particular, the Board notes the following projects recently completed by the company:

- M08733 - CI 48791 - Wreck Cove Safety Standards Upgrades ($1,760,570)
- M07301 - CI 47814 - Wreck Cove Evacuation Tunnel Upgrade ($503,962)

[73] The safety related work completed under these projects included the addition of alternative egress routes from the lowest levels of the plant, sump pump and dewatering system upgrades, emergency egress dewatering, an auxiliary isolation valve power source, and upgrade of the refuge facility at the Wreck Cove powerhouse. In M08733, NS Power advised that the project addressed the four highest risk issues as they pertain directly to life safety, including measures that deal with consequences of penstock and pipe ruptures. The Board believes that this recent work has likely helped to mitigate some of the concerns that are meant to be addressed by the proposed penstock intake work.

[74] Based on the above, the Board finds that NS Power has not adequately addressed concerns regarding the necessity for the proposed penstock intake project. The Board finds that NS Power has failed to provide the following:

- A proper probability analysis of penstock failure modes and consequences, as well as possible measures to lower the level of risk of flooding in the powerhouse, including the impact on risk mitigation as a result of completing recent safety measures at the Wreck Cove facility.

- An analysis of all reasonable alternatives for the penstock intake gate which considers the cost of these options, as well as potential benefits, based on the above probabilistic analysis.

IX CONCLUSION

[75] The Board approves the proposed generator, turbine and spherical valve work associated with NS Power's application. As with all NS Power capital projects, the Board expects the company to manage this work appropriately to keep costs within the approved budget, while proactively undertaking cost minimization efforts throughout project implementation. Furthermore, as required by the CEJC, NS Power must submit an ATO application to the Board should project costs eventually exceed ATO thresholds. If an ATO application is required, it must be submitted to the Board no later than six months after project expenditures have exceeded the ATO threshold. The Board also reminds NS Power that approval of any required ATO request is not a foregone conclusion.

[76] The above notwithstanding, given the magnitude of this project and the number of scope items that remain unknown until the generator and turbine refurbishment work commences, the Board directs NS Power to:

- Provide the Board with quarterly reporting, commencing on March 31, 2021, on the use of any contingency and scope variation amounts; and
- Provide the Board with quarterly reporting, commencing on March 31, 2021, describing specific examples of cost minimization efforts during execution and construction of the project.

[77] The Board concludes that NS Power has not provided a proper justification for the proposed penstock intake work. As such, the Board does not approve this component of NS Power's application.

[78] NS Power is directed to revise its estimated project cost with the penstock intake gate element of the work (including related AFUDC and administrative overhead

costs) removed and advise the Board of the revised amount no later than December 10, 2020.

[79] NS Power may submit an application for the approval of penstock intake work. In preparing such an application, the Board expects the company to carry out and present the following:

1. A quantified analysis of the risks posed (which includes consideration of both probability and consequence). The analysis should include and/or consider the following:

    - A defined accepted risk level for operations in the Wreck Cove underground power plant.
    - The likelihood of different type of hazards should be defined in the quantitative probabilistic terms, whenever it is possible.
    - Safety related work completed or planned to be completed under the Wreck Cove Safety Standards Upgrades (M08733) and Wreck Cove Evacuation Tunnel (M07301) projects.
    - Safety related work planned to be completed under the Wreck Cove LEM project, including the proposed refurbishment of spherical isolation valves.

2. A concept development process to identify all feasible risk mitigation options. The Board notes that required work on the penstock intake structure is only one element available from the set of mitigation options. The analysis should include and/or consider the following:

    - Functional requirements of a powerhouse flood risk mitigation solution.
    - Risk mitigation options that have impact on water ingress and egress rates from the powerhouse.
    - Modification or development of emergency procedures.
    - Implementation of early detection systems.

3. A repeat of the quantified analysis from Step 1 for the facility with each mitigation option implemented, such that the residual risk for each mitigation option can be compared to the original risk before any mitigation. This analysis should comprehensively and objectively consider the strengths and weaknesses of each mitigation option. For example, the analysis should include and/or consider the following:

    - Incremental differences in flood risks without an intake gate and with different types of the intake gate.

- Flood impacts of the water already in the penstock, and any gate closure delays.

4. For all mitigation options that are found to be sufficiently effective in Step 3, an evaluation that compares the remaining options and scores them on the basis of key selection criteria (e.g. cost, technical feasibility, effectiveness etc.), ultimately selecting the most suitable option for the work on the penstock intake structure.

[80] An Order will issue once the Board receives the information provided in Paragraph [78].

DATED at Halifax, Nova Scotia, this 26th day of November, 2020.

Roberta J. Clarke, Q.C.

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Steven M. Murphy, MBA, P.Eng.