

**NEWFOUNDLAND AND LABRADOR
BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

AN ORDER OF THE BOARD

NO. P.U. 6(2023)

1 **IN THE MATTER OF the Electrical Power**
2 **Control Act, 1994**, SNL 1994, Chapter E-5.1
3 (the “**EPCA**”) and the **Public Utilities Act**,
4 RSNL 1990, Chapter P-47 (the “**Act**”), as
5 amended, and regulations thereunder; and
6

7 **IN THE MATTER OF** an application by
8 Newfoundland and Labrador Hydro for approval
9 of capital expenditures for section replacement
10 and weld refurbishment of Penstock 1 at the Bay
11 d’Espoir Hydroelectric Generating Facility, pursuant
12 to subsection 41(3) of the **Act**.
13
14

15 **DECISION SUMMARY**

16
17 The Board will approve the application filed by Newfoundland and Labrador Hydro for approval
18 of capital expenditures in the amount of \$50,606,700 for section replacement and weld
19 refurbishment of Penstock 1 at the Bay d’Espoir Hydroelectric Generating Facility.
20

21 **APPLICATION**

22
23 On December 7, 2022 Newfoundland and Labrador Hydro (“Hydro”) filed an Application, seeking
24 approval of capital expenditures in the amount of \$50,606,700 to undertake remedial work on
25 Penstock 1 at the Bay d’Espoir Hydroelectric Generating Facility (the “Application”). The
26 Application proposes capital expenditures of \$2,105,000 in 2023, \$13,172,600 in 2024 and
27 \$35,329,100 in 2025. Hydro’s Application states that Penstock 1 urgently needs service life-
28 extending work following a series of ruptures caused by weld failures beginning in 2016. The
29 project and the 2023 expenditures proposed in the Application are supplemental to Hydro’s 2023
30 Capital Budget application in the amount of \$90,828,700 approved in Order No. P.U. 2(2023).
31

32 The Consumer Advocate, Dennis Browne, K.C. (the “Consumer Advocate”), Newfoundland Power
33 Inc. (“Newfoundland Power”), and a group of industrial customers (the “Island Industrial

1 Customer Group”) participated in the Application.¹ On January 25, 2023 Hydro responded to 34
2 Requests for Information filed by the Board and Newfoundland Power.

3
4 On January 31, 2023 Newfoundland Power and the Island Industrial Customer Group filed
5 comments. The Consumer Advocate filed comments on February 1, 2023. The intervenors did
6 not object to the Application but raised other issues for the consideration of the Board. On
7 February 7, 2023 Hydro filed its reply, noting that no party objected to the Application and
8 requested approval of Application as submitted.

9
10 On March 29, 2023 Hydro filed an additional memorandum from its consultant, Kleinschmidt
11 Canada Inc. (“Kleinschmidt”). The intervenors did not file any comments on this memorandum.

12

13 **BOARD DECISION**

14

15 **Bay d’Espoir and Penstock 1**

16

17 The Bay d’Espoir Hydroelectric Generating Facility (“Bay d’Espoir”) is the largest of Hydro’s
18 generating facilities, providing 613 MW of electrical capacity and 2,560 GWh of energy.
19 Powerhouse 1 at Bay d’Espoir has six generating units which together are capable of producing
20 up to 459 MW of capacity. Water is supplied to these generating units by Penstocks 1, 2 and 3.

21

22 Penstock 1 has been in service since 1967 supporting Units 1 and 2, which together produce 153
23 MW of generation. Penstock 1 is approximately 1,200 meters long and ranges in diameter from
24 17 feet at the intake to 13.5 feet at the powerhouse bifurcation.² The penstock is constructed
25 from a series of steel cans that vary in length and plate thickness. It is buried along its entire
26 length, generally by two feet of soil and at least one foot of riprap.

27

28 Bay d’Espoir is critical to the reliable operation of the Island Interconnected system and the
29 generation capacity supplied by Units 1 and 2 at Bay d’Espoir is necessary for Hydro to meet
30 current customer requirements.³ Analysis completed by Hydro showed that the established
31 planning criteria are not satisfied with Penstock 1 removed from the system. In addition, Hydro’s
32 expansion planning model analysis showed that the replacement and refurbishment of
33 Penstock 1 is the least-cost option to bring Hydro’s expected level of reliability back within
34 acceptable parameters.⁴ Newfoundland Power noted the importance of Bay d’Espoir to the
35 Island Interconnected system, particularly in the context of the current circumstances associated
36 with the Labrador Island Link and the Holyrood Thermal Generating Station. Hydro and the
37 Consumer Advocate also commented on the criticality of Bay d’Espoir to the reliable operation
38 of the Island Interconnected system. The Board accepts that Bay d’Espoir is a critical generating
39 facility and that Penstock 1 which supplies Units 1 and 2 is required for Hydro to meet established
40 planning criteria and satisfy current customer requirements.

¹ The Island Industrial Customer Group consists of Corner Brook Pulp and Paper Limited, Braya Renewable Fuels (Newfoundland) LP, and Vale Newfoundland and Labrador Limited.

² Application, Schedule 1, page 1.

³ Application, Schedule 1, page 9.

⁴ Application, Schedule 1, page 10 and PUB-NLH-009.

1 Penstock 1 Ruptures

2

3 Over the period 2016 to 2019, Penstock 1 experienced four ruptures caused by failures in the
4 longitudinal weld seams in the 17-foot diameter section causing Units 1 and 2 to be unavailable
5 for service for extended periods as set out below.

6

- 7 • May 21, 2016 - A rupture occurred which was found to be most likely caused by a local
8 defect in either the penstock base metal or a weld, exacerbated by watering-
9 up/dewatering cycles.⁵ Repairs were completed and the penstock was returned to service
10 on June 3, 2016.
- 11 • September 14, 2016 - A rupture occurred and a subsequent root cause analysis revealed
12 partial depth cracking in approximately 950 meters of longitudinal weld seams.⁶ After
13 weld refurbishment work to minimize the risk of these cracks progressing, the penstock
14 was returned to service on November 30, 2016.
- 15 • November 4, 2017 - A rupture was discovered in the same location as the September 14,
16 2016 rupture. A consultant identified 31 failed welds, each of which represented a
17 potential rupture point.⁷ These failed welds were refurbished and the penstock was
18 returned to service. Investigation of the weld failures indicated that previous
19 refurbishment efforts had improved the overall condition and somewhat lowered the risk
20 of a rupture but it was concluded that the penstock had not been restored to stable and
21 reliable operating condition.⁸ As a result operational restrictions were implemented for
22 Units 1 and 2.⁹ Hydro also began annual inspections based on the recommendation of its
23 consultant.¹⁰
- 24 • September 22, 2019 - A rupture occurred approximately 80 feet downstream from the
25 sites of the earlier ruptures. This rupture occurred despite the operational restrictions put
26 in place following the 2017 rupture. Hydro's consultant determined that localized stresses
27 at the weld seams, exacerbated by corrosion and fatigue from cyclic stresses, were the
28 root cause of this rupture.¹¹

29

30 No ruptures have been experienced on Penstock 1 since September 2019.¹² However, annual
31 inspections in both 2021 and 2022 identified cracks in previously repaired longitudinal weld

⁵ Kleinschmidt, Crack Investigation and Repair Report, Penstock No. 1 Bay D'Espoir Hydroelectric Development, June 2016. Application, Schedule 1, Appendix. A.

⁶ Application, Schedule 1, page 3.

⁷ Hatch Ltd., Final Report for Repair and Failure Investigation, May 17, 2018, Application, Schedule. 1, Appendix D for discussion of the failures.

⁸ Application, Schedule 1, page 5.

⁹ Application, Schedule 1, page 5, and PUB-NLH-005.

¹⁰ Application, Schedule 1, page 7.

¹¹ SNC- Lavalin, Bay d'Espoir Penstock 1-2019 Failure Investigation Report, March 19, 2020, Application, Schedule 1, Appendix F.

¹² PUB-NLH-001.

1 seams in the 17-foot diameter section of the penstock. These cracked welds have been
2 repaired.¹³

3
4 As set out below Hydro has spent almost \$13 million related to the ruptures in Penstock 1 and
5 there were 31 weeks of consequent unplanned outages.¹⁴

Date	Event	Outage (weeks)	Cost (\$000)
May 2016	Penstock rupture	3	100
Sept 2016	Penstock rupture, weld refurbishment	10	7,100
Nov 2017	Penstock rupture, weld refurbishment with reinforcement plates	5	4,600
2019	Annual Inspection	2	180
Sept 2019	Penstock rupture	2	245
2020	Annual Inspection	2	180
2021	Annual Inspection	2	180
May 2021	Crack Repairs	2	57
2022	Annual Inspection	2	180
April 2022	Crack Repairs	1	44
	Total	31	12,886

6 In addition as a result of the operational restrictions implemented in 2018 Penstock 1 is watered-
7 up at all times and dewatered only during maintenance activities. This avoids cyclic stresses that
8 are produced when Units 1 and 2 operate in the “rough zone”, between 25MW and 40MW,
9 where they produce higher vibrations. Operating in this zone increases the risk of crack
10 propagation through the penstock, particularly through the thinner walls of the 17-foot diameter
11 section. While the operational limits afford some degree of protection to the structural integrity
12 of Penstock 1, it requires that Hydro keep Units 1 and 2 operating above the operational
13 minimum of 50 MW at all times outside of planned maintenance. These restrictions have an
14 operational impact, especially during lower loading periods when the Energy Control Centre must
15 keep these units online. As a result, they cannot be utilized for economic dispatch, which
16 potentially results in less efficient operation of Units 1 and 2 and the Bay d’Espoir generating
17 resources as a whole.¹⁵

18

19 The evidence is clear that the issues with Penstock 1 which have been ongoing since 2016 have
20 resulted in significant costs and the unavailability of Units 1 and 2 for significant periods. In
21 addition, since 2018, the operational flexibility of Units 1 and 2 has been limited due to the
22 operational restrictions. Hydro has engaged multiple consultants and conducted several studies
23 to evaluate the options for the life extension of Penstock 1 and all of these studies identified the

¹³ Application, Schedule 1, page 8.

¹⁴ Application, Schedule 1, page 9.

¹⁵ NP-NLH-001.

1 need to complete refurbishment work. The identified deficiencies in the design of Penstock 1
2 include joint peaking issues that contribute to fatigue in the weld area, out of roundness, and
3 steel plate thickness issues in the upper 17-foot diameter section. A detailed penstock inspection
4 in 2021 identified cracks in 14 cans, all at previously refurbished welds including cracks around
5 five reinforcing plates. More than 60 feet of cracks were repaired.¹⁶ Based on the evidence these
6 previously refurbished welds were less than five years old which, coupled with the failure of a
7 previously repaired weld in 2019, suggests that the current weld repairs lack long term reliability,
8 may have short life expectancy and likely carry an increased risk of failure following repair.¹⁷ With
9 its elevated probability of failure demonstrated by four failures in recent years, new cracks
10 discovered in 2021, and the high consequence of a failure, it was recommended that the status
11 quo option be ruled out as it exceeds what should be tolerated for risk.¹⁸ The Board accepts that
12 maintaining the status quo would be associated with high levels of risk due to the high probability
13 of multiple weld failures and associated costs over the next 30 years.

14

15 While there are no upfront capital costs associated with maintaining the status quo, the evidence
16 demonstrates that the significant risk of further ruptures is associated with potentially significant
17 costs for each rupture and potentially significant impacts on reliability depending on the time of
18 the year of the failure and its severity. Even a minor rupture during peak winter demand would
19 result in significant repair costs and the need to replace 153 MW of lost generation. According to
20 Hydro's initial estimates, a 4-week repair would potentially cost \$12.5 million but subsequent
21 increases in the estimated replacement energy cost suggest that the cost of a rupture could be
22 much higher.¹⁹ In addition, maintaining the status quo would require that the operating
23 restrictions on Units 1 and 2 be continued, which would adversely impact Hydro's ability to use
24 these generation resources for economic dispatch in the long term. Further annual inspections
25 would continue to be required. The Board is satisfied that maintaining the status quo with respect
26 to Penstock 1 presents an unacceptable risk given the history of ruptures and the potentially
27 significant costs and reliability impacts of a rupture. As a result, the Board concludes that it is
28 appropriate to consider the alternatives of refurbishment and/or replacement of Penstock 1 to
29 reduce risk and allow Units 1 and 2 to return to normal operations.

30

31 **Alternatives**

32

33 In 2017 Hydro began evaluating long-term solutions for the issues with Penstock 1, when it
34 commissioned the first Hatch Report. This report described 15 alternatives.²⁰ Hatch's 2019
35 Report reviewed three of these 15 options.²¹ The 2019 Hatch Report recommended
36 refurbishment of the penstock, however, after further review of the rupture in a previously
37 rewelded longitudinal seam, Hatch concluded in its 2020 report that rewelding and

¹⁶ Kleinschmidt Report, Application, Schedule 1, Appendix K, page 47 of 187.

¹⁷ Kleinschmidt Report, Application, Schedule 1, Appendix L, page 50 of 212.

¹⁸ Kleinschmidt Report, Application, Schedule 1, Appendix L, page 5 of 212.

¹⁹ The original estimate is set out in the Application, Schedule 1, page 13. Hydro increased its estimated cost per MWH from \$153/MWH to \$252/MWH in NP-NLH-002.

²⁰ Application, Schedule 1, Appendix D, pages 35-36 of 42.

²¹ Hatch Report – Upgrade Report – Penstock 1 Life Extension – Bay d'Espoir, Application, Schedule 1, Appendix I, page 26 of 51.

1 refurbishment would not provide an acceptable level of long-term reliability and recommended
2 the replacement of the 17-foot diameter section and weld refurbishment of the full penstock.²²

3
4 In 2021, Kleinschmidt was engaged to study the options for Penstock 1 and as a part of its review
5 addressed the status quo as well as the three options reviewed by Hatch. As already discussed
6 Option 1, maintaining the status quo, was not recommended due to unacceptable levels of risk.
7 The other options involved refurbishment or replacement of the penstock. In addition,
8 Kleinschmidt was also asked to review advancing technology with respect to structural lining to
9 determine whether recent developments might change its recommendations.²³ The evidence in
10 relation to the options demonstrates:

- 11
12 • Option 2: Weld replacement and installation of a protective coating on the interior of the
13 penstock at an estimated cost of \$28.7 million. The risk of weld failure would be reduced
14 with this option, however, the weld peaking, fatigue and failure of refurbished and non-
15 refurbished welds in the 17-foot diameter section would remain over the next 30 years
16 and weld repairs would be expected every three to five years.²⁴ As well, the penstock
17 interior would need to be recoated in approximately 15 to 20 years and there would be
18 risks involved in applying this coating.²⁵ Furthermore the operational restrictions and
19 yearly inspections would need to continue.
- 20 • Option 3: Replacement of the 17-foot diameter section of Penstock 1 and weld
21 refurbishment of the 15-foot and 13.5-foot diameter sections at an estimated cost of
22 \$50.6 million. This is the only option to fully address the design issues of the 17-foot
23 diameter section, including the out of roundness, wall thickness, flexibility, weld peaking
24 and weld corrosion.²⁶ The new 17-foot diameter section would be designed to current
25 standards and would have an operational life of 80 to 100 years and the planned
26 refurbishment of the 15-foot and 13.5-foot diameter sections would have an operational
27 life of 30 to 50 years.²⁷ Operational constraints could be lifted, allowing a return to normal
28 operations and increased operational flexibility. Additionally, inspections would be
29 required at three to five year intervals rather than annually after the first two years.²⁸
30 Long term maintenance and monitoring cost would be the lowest of the refurbishment
31 options.²⁹
- 32 • Option 4: Reinforcement to the penstock interior in addition to weld replacement and
33 protective coating work at an estimated cost of \$37 million. This is a technically viable
34 option but does not provide sufficient value to merit the added expense of approximately
35 \$8 million.³⁰ While the additional reinforcement is intended to mitigate weld peaking by

²² Hatch 2020 Report – Upgrade Report – Penstock 1 Life Extension – Bay d’Espoir, Application, Schedule 1, Appendix J, page 8 of 51.

²³ NP-NLH-009

²⁴ Application, Schedule 1, page 17; Kleinschmidt Report, Application, Schedule 1, Appendix K, pages 51-52 of 187.

²⁵ Kleinschmidt Report, Application, Schedule 1, Appendix K, page 52 of 187.

²⁶ Application, Schedule 1, page 18; Kleinschmidt Report, Application, Schedule 1, Appendix K, page 53 of 187.

²⁷ Application, Schedule 1, pages 14-15.

²⁸ Kleinschmidt Report, Application, Schedule 1, Appendix K, page 53 of 187.

²⁹ Kleinschmidt Report, Application, Schedule 1, Appendix K, page 54.

³⁰ Application, Schedule 1, page 16; Kleinschmidt Report, Application, Schedule 1, Appendix K, page 57 of 187.

1 covering the refurbished welds and increasing stiffness, Kleinschmidt’s evidence
2 demonstrates that this would not adequately deal with the peaking and fatigue issues and
3 allow for lifting the operational constraints. This option is not recommended based on the
4 conclusion that the risk of weld failures in the 17-foot diameter section of Penstock 1 and
5 uncertainty around reliability would remain.³¹

- 6 • Structural Lining Option: Applying a structural lining to the penstock interior was
7 estimated to cost more than the replacement of the 17-foot diameter section of the
8 penstock. In addition this option would have potentially higher performance risks than
9 replacement, a shorter expected service life, and could potentially impact generation.³²

10
11 The Board notes that Options 2 and 4 and the installation of a structural lining involve significant
12 capital expenditures and they are not recommended by Hydro or its consultants. These options
13 have somewhat reduced risks as compared to the status quo but do not address the issues with
14 weld peaking, fatigue and design and would not eliminate the requirement for operational
15 restrictions and annual inspections.

16
17 In contrast, Option 3 which involves section replacement and weld refurbishment is the only
18 option to fully address the design issues in the 17-foot diameter section. While this is the most
19 expensive alternative, it has the lowest risk rating and highest level of reliability. This option
20 mitigates the risk of a rupture over the long term which would mitigate potentially substantial
21 repair and replacement energy costs and reliability impacts. The new 17-foot section would be
22 constructed to current standards and would allow the operational constraints currently in place
23 for Units 1 and 2 to be removed. The Board notes that the intervenors did not object to the
24 approval of the proposed section replacement and weld refurbishment of Penstock 1. According
25 to the Consumer Advocate the penstock life extension project is needed and the fact that Hydro
26 has employed the services of three different consulting firms with expertise in this area lends
27 confidence to the recommendation. The Board finds that the proposed section replacement and
28 weld refurbishment of Penstock 1 is reasonable and necessary to ensure the delivery of safe,
29 reliable service at the lowest possible cost and should be approved.

30 31 **OTHER ISSUES**

32
33 While the intervenors did not oppose the Application, they raised a number of other matters for
34 the consideration of the Board. The Consumer Advocate and Newfoundland Power both noted
35 that Hydro is expecting similar expenditures will be required in the future for Penstocks 2 and 3
36 at Bay d’Espoir. The Consumer Advocate requested that the Board order a technical conference
37 relating to life extension work at Bay d’Espoir to allow a better understanding of how future
38 capital projects fit with other work planned at the facility. Newfoundland Power commented that
39 the multi-year project for Penstock 1 is substantial and could be subject to delays and cost
40 overruns and that similar risks would be introduced should Hydro proceed with additional phases
41 of Bay d’Espoir penstock life extension. According to Newfoundland Power Hydro should be
42 directed to provide sufficient reporting to allow the Board to monitor the supply cost and

³¹ Kleinschmidt Report, Appendix K, page 57 of 187.

³² Kleinschmidt’s memorandum on March 29, 2023, page 14.

1 reliability risk associated with this project. In reply Hydro noted that there are established
2 processes to monitor its capital spending and that the detailed information provided in the
3 reports filed annually and biannually would provide the Board and the parties with the
4 information necessary to keep them informed on the progress of this project and the associated
5 costs. Hydro submitted that further reporting would not add any additional visibility than that
6 which is already provided.

7
8 The Board shares the concerns expressed by the Consumer Advocate and Newfoundland Power
9 in relation to the costs and risks associated with the Penstock 1 project and the additional costs
10 and risks associated with the additional life extension work that may be required with respect to
11 Penstocks 2 and 3 in the coming years. While the Board acknowledges the existing reporting
12 requirements, the Board believes that additional information specific to the Bay d’Espoir
13 penstock life extension work should be provided to ensure full transparency with respect to this
14 significant area of capital spending in relation to this critical asset. As a result, Hydro will be
15 required to file a report each year, beginning with its 2024 Capital Budget Application, addressing
16 the progress of the Penstock 1 work as well as its analysis, study and plans in relation to life
17 extension for Penstocks 2 and 3.

18
19 The Consumer Advocate also raised a number of matters which are not related to this
20 Application. The Consumer Advocate asked that the Board direct Hydro to incorporate projects
21 such as the one proposed in this Application in its Capital Budget Application process. The
22 Consumer Advocate also asked the Board to finalize the provisional Capital Budget Application
23 Guidelines and to initiate proceedings/hearing on the Reliability and Resources Adequacy Study.
24 The Consumer Advocate also commented on electrification and submitted that it is highly
25 questionable in light of Hydro’s ongoing reliability challenges from the Labrador Island Link and
26 now Bay d’Espoir. In reply Hydro submitted that these matters are not related to this Application
27 and explained that the proposals in this Application could not be included in its 2023 Capital
28 Budget Application due to the timing of the inspections and they could not wait for the 2024
29 Capital Budget Application due to the nature of the project and the associated urgency. The
30 Board accepts Hydro’s explanation for the timing of the Application and agrees that the
31 additional matters raised by the Consumer Advocate are not matters to be decided in this
32 Application.

1 **IT IS THEREFORE ORDERED THAT:**

2

3 1. The proposed capital expenditures in the amount of \$2,105,000 in 2023, \$13,172,600 in 2024
4 and \$35,329,100 in 2025 for the section replacement and weld refurbishment of Penstock 1
5 at the Bay d’Espoir Hydroelectric Generating Station are approved.

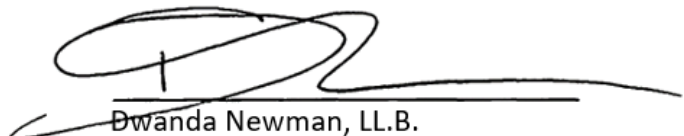
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7 2. Until further direction of the Board, Hydro shall file a report annually, beginning with its 2024
8 Capital Budget Application addressing the Penstock 1 project as well as planned life extension
9 work on Penstocks 2 and 3.


10

11 3. Hydro shall pay all expenses of the Board arising from this Application.

DATED at St. John’s, Newfoundland and Labrador, this 12th day of April 2023.


Dwanda Newman, LL.B.
Vice-Chair


John O'Brien, FCPA, FCA, CISA
Commissioner


Christopher Pike, LL.B., FCIP
Commissioner


Cheryl Blundon
Board Secretary