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September 23, 2025

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

Attention: Jo-Anne Galarneau
Executive Director and Board Secretary

Re: Application for Capital Expenditures for the Life Extension of Bay d'Espoir Unit 7 – Request for Additional Information – Hydro's Reply – Revision 1

Newfoundland and Labrador Hydro ("Hydro") filed its application for approval of the capital expenditures required for the life extension of Unit 7 of the Bay d'Espoir Hydroelectric Generating Facility ("Bay d'Espoir Unit 7") on June 20, 2025 ("Life Extension Application").

On August 8, 2025, the Board of Commissioners of Public Utilities ("Board") requested analysis of an additional alternative to address the life extension of Bay d'Espoir Unit 7, specifically the uprate of Unit 7. The Board stipulated that this analysis should include:

1) Cost estimates, including capital cost and cost per MW and MWHR for the additional capacity and energy;
2) Quantification of the impact of the increased capacity on the available Bay d'Espoir hydrologic capacity, including during efficient operation, in support of system peak and when called upon during an extended outage of the Labrador-Island Link;
3) Comparison of efficiency over the operating range of Unit 7 for the status quo, like-for-like replacement and the uprate alternatives. The comparison should explain the efficiency relationship that exists between the alternatives as shown in Figure 3-3 of the Hatch Update Report by discussing the most efficient operating point for each alternative, the volume of water used at the most efficient operating point and at maximum power output, and how each alternative performs relative to the other alternatives at power outputs below and above its most efficient operating point; and
4) Quantification of the impact of the increased energy and capacity available from the like-for-like replacement and the uprate alternatives on the Bay d'Espoir operating regime for all units, including any significant difference compared to the operating regime for the status quo alternative. Also, explain the impacts of a new Unit 8 on the Bay d'Espoir operating regime for all 7 existing units.

Hydro's report to the Board on the requested analysis, along with supporting documentation, is attached hereto.

The Board also noted Hydro's reference to planned discussions with interested groups, including the Miawpukek First Nation ("MFN"). The Board required Hydro to advise whether MFN or any other Indigenous community has asserted that Hydro has a constitutional obligation to consult and accommodate its interests in relation to this application, and if so, to identify the Indigenous community and provide details of the scope of work and timelines needed to discharge any such duty.

On October 11, 2006, the Newfoundland and Labrador Court of Appeal upheld the decision of the Supreme Court of Newfoundland and Labrador, Trial Division that, notwithstanding the creation and recognition of the MFN under the *Indian Act*, the MFN did not establish that they had an Aboriginal or treaty right under section 35(1) of the *Constitution Act, 1982*.[1] The Court of Appeal's ruling confirmed that the trial judge did not err in considering and applying the evidence before them or in applying the pre-European contact test set out in *R. v. Van der Peet*, 1996 CanLII 216 (SCC), [1996] 2 S.C.R. 507 ("*Van der Peet*"). The appeal was dismissed in its entirety and leave to appeal to the Supreme Court of Canada was dismissed.

To date, *Drew* has not been overturned by the Newfoundland and Labrador Court of Appeal or the Supreme Court of Canada. Similarly, the *Van der Peet* test still serves as the test for determining section 35(1) rights. The Government of Newfoundland and Labrador's position is that there are no Indigenous communities in the region that have a constitutional right to consultation and accommodation.

Confidentiality

The appendices to Hydro's report contain commercially sensitive information that, if made public, would undermine Hydro's ability to obtain goods and services at the lowest possible cost and therefore negatively impact Hydro's customers. As with its other filings, Hydro has considered the practices of other utility regulators in Canada in determining the level of redaction to apply to the information. The information Hydro requests to be kept confidential is that which could be reasonably expected to:

- **i.** Result in undue material financial loss or gain to a person or party directly affected by the hearing or other proceeding;
- **ii.** Cause significant harm or prejudice to a party's competitive or negotiating position; or
- **iii.** Interfere with the contractual obligations of a party.

The information redacted within the appendices includes breakdowns of cost estimates for the alternatives considered for Unit 7, including engineering, construction, escalation, and Owner's costs. This information has been redacted as, if available, it would allow the extrapolation of the same information for the projects proposed in the Life Extension Application and the 2025 Build Application.[2] That information, if available to suppliers or potential suppliers, could provide the suppliers with a competitive advantage and potentially influence future bidding strategies or negotiations. The availability of the information could enhance the suppliers' ability to command higher prices, limit competitive pressure, and ultimately drive an increase in costs for the utility and its customers. Particularly for projects with substantial capital expenditures such as these, Hydro believes that maintaining the confidentiality of information such as this directly supports the best interests of its customers.

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[1] *Newfoundland v. Drew et al.*, 2006 NLCA 53 ("*Drew*").
[2] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine," Newfoundland and Labrador Hydro, March 21, 2025.

The information redacted within the appendices is consistent with the remainder of the Life Extension Application and 2025 Build Application record. For further details on the rationale for redaction, please refer to Hydro's response to the Confidential Information Inquiry.[3]

Should you have any questions or comments, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

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

Encl.

Board of Commissioners of Public Utilities
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Stephen F. Fitzgerald, KC, Browne Fitzgerald Morgan & Avis
Sarah G. Fitzgerald, Browne Fitzgerald Morgan & Avis
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Newfoundland Power Inc.
Dominic J. Foley
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Regulatory Email

[3] "Application for Capital Expenditures for the Purchase and Installation of Bay d'Espoir Unit 8 and Avalon Combustion Turbine – Confidential Information Inquiry – Hydro's Reply," Newfoundland and Labrador Hydro, May 9, 2025.

Revision History

Revision No.	Revision Date	Location	Reason
1	23-Sept-2025	Figure 1, p. 6.	Corrected misaligned text boxes in Figure 1.

Bay d'Espoir Unit 7 Additional Analysis Report

Original Submission: September 22, 2025

Revision 1: September 23, 2025

A report to the Board of Commissioners of Public Utilities

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1.0 Introduction

The Hydrology and Feasibility Study for Potential Bay d'Espoir Hydroelectric Generating Station Unit No. 8 ("Hydrology and Feasibility Study"), completed by Hatch Ltd. ("Hatch") and filed with the 2025 Build Application,[1] confirmed that the optimized generating capacity increase at the Bay d'Espoir plant is 150.1 MW with the addition of Bay d'Espoir Unit 8.[2] This finding establishes a limit on efficient incremental capacity available in the Bay d'Espoir system, for consideration across the Bay d'Espoir system, including both Unit 7 and the planned Unit 8.

Additionally, the Uprate Report, also completed by Hatch,[3] identified that an increase in the capacity of Unit 7 may result in less efficient operation over the typical and planned operating range of the unit[4] resulting in increased water usage in a hydrologically constrained system.

In the Uprate Report, while suggesting further study of the overall system, Hatch stated that any increase in the capacity of Unit 7 may directly impact the capacity available from Unit 8. Hatch noted:

> Since there is a finite amount of hydraulic capacity available in the Bay d'Espoir system to be utilized for the purposes of additional generating capacity, it may be more cost-effective to utilize that hydraulic capacity in a new purpose-built Unit #8 rather than through a modification of Unit #7.[5]

Overall, Hydro does not see merit in including a capacity increase to Bay d'Espoir Unit 7 due to:

- **i.** The impacts the increase would have on overall system hydrology and efficiency;
- **ii.** Project delays for both the Life Extension of Unit 7 and the construction of Unit 8; and
- **iii.** The increased costs and potential reliability impacts.

These reasons are discussed throughout Hydro's analysis, detailed in the sections that follow.

[1] "2025 Build Application – Bay d'Espoir Unit 8 and Avalon Combustion Turbine," Newfoundland and Labrador Hydro, sch. 1, att. 2.
[2] While this is slightly below Unit 8's full capacity of 154.4 MW due to modeling constraints, Newfoundland and Labrador Hydro ("Hydro") expects that full capacity can be achieved through broader system optimization.
[3] "Uprate Report," Hatch Ltd, June 27, 2024, provided in "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024), app. C, att. 2.
[4] *Supra,* f.n. 3, sec. 3.1.1, pp. 3–5.
[5] *Supra,* f.n. 3, sec. 3.1.4, p. 6.

2.0 Efficiency of Unit 7 Alternatives

In assessing the impact of allocating the 150 MW of incremental capacity available across Units 7 and 8, Hydro must analyze any potential uprate of the Bay d'Espoir system holistically in consideration of the hydrological optimization of the Bay d'Espoir system. The potential uprate capacity for Unit 7 would provide marginal incremental capacity in the range of 20–26 MW; additional generation is required to meet system reliability requirements as outlined through Hydro's *Reliability and Resource Adequacy Study* proceeding.[6] The uprate of Unit 7 would not eliminate nor delay the requirement for implementation of Unit 8. Instead, it would require revisiting the capacity of Unit 8 to understand the overall capacity addition and the impacts to the optimized generating capacity increase identified by Hatch in the Hydrology and Feasibility Study.

Hydro's comparison of the proposed project with the fourth alternative referenced by the Board of Commissioners of Public Utilities ("Board") follows.

2.1 Like-for-like Replacement Scenario

In this scenario, Hydro proceeds with the life extension of Unit 7 as proposed in its application currently before the Board ("Life Extension Application").[7] This life extension involves the replacement of the existing runner with a modern runner expected to provide greater efficiency throughout the operating range due to improvements in runner design technologies.[8] This scenario also includes Hydro's planned addition of Unit 8 at 150 MW nominal capacity, with a modern, efficient runner.

2.2 Unit 7 Uprate Scenario

In this scenario, Unit 7 is uprated by approximately 20 MW to 174 MW rated capacity. As a result of system hydrology on the Bay d'Espoir system and the optimized maximum capacity addition to the system of 150 MW, the uprating of Unit 7 may necessitate lowering the nominal capacity of Unit 8 by approximately 20 MW to 130 MW. A reduction to the capacity of Unit 8 to accommodate an increase in the capacity of Unit 7 would necessitate substantial re-engineering of Unit 8 and significant engineering

[6] Please refer to "2024 Resource Adequacy Plan – An Update to the Reliability and Resource Adequacy Study," Newfoundland and Labrador Hydro, rev. August 26, 2024 (originally filed July 9, 2024).
[7] "Life Extension Application – Bay d'Espoir Unit 7," Newfoundland and Labrador Hydro, June 20, 2025.
[8] Hatch estimated that a modern runner would produce an approximate 2% efficiency gain over the existing runner.

investigations for Unit 7. It would also further compound delays in the implementation of both projects without resulting in any appreciable increase in the capacity of the system as a whole.

2.2.1 Cost Estimate, Schedule and Implications of Uprate Scenario

In support of the analysis of the uprate scenario for Bay d'Espoir Unit 7, Hydro has developed preliminary cost estimates for both the uprating of Unit 7 and the associated capacity reduction of Unit 8.

The uprate estimate for Unit 7 assumes an increase in rated capacity to 174 MW with significant scope additions such as physical model testing, exciter and controls replacement, servomotors, and terminal station upgrades. It also accounts for increased front-end engineering and Owner's costs resulting from the two-year delay of the construction schedule proposed within Hydro's Life Extension Application, with completion anticipated in the third quarter of 2031. This delay is due to the time required to complete the planning, approval, and procurement for the additional scope. Escalation and interest during construction ("IDC") are factored in based on the revised cost and schedule profile. The total estimated incremental cost impact of the Unit 7 uprate is approximately $45 million. For additional information on the methodology, assumptions, and estimated cost breakdowns, please refer to Appendix A.

The estimate for Unit 8 reflects a reduction in nominal rated capacity from 150 MW to 130 MW, necessary to align with the optimized generating capacity increase of 150 MW identified by Hatch. While the downsizing of equipment such as the penstock, turbine-generator unit, and transformer results in some cost savings, these savings are offset by increased front-end engineering design and Owner's costs and a two-year delay in the project schedule. Escalation and IDC are included to reflect the financial impact of the delay. The net cost impact of the Unit 8 capacity reduction is approximately $38 million. For additional information on the methodology, assumptions, and estimated cost breakdowns, please refer to Appendix B.

Together, the combined cost impact of pursuing the uprate of Unit 7 and the corresponding rating reduction of Unit 8 is approximately $83 million higher than the like-for-like replacement scenario as shown in Table 1. This figure includes both the direct costs associated with the uprate and the indirect costs resulting from the required changes to Unit 8.

Table 1: Cost Estimate for Uprate of Unit 7

	Cost Estimate[9] ($ Million)	Cost per MW
Unit 7 Uprate	45	2.26
Resulting Capacity Reduction on Unit 8	38	
Total Cost of Unit 7 Uprate	**83**	**4.15**

The cost per MW associated with a 20 MW uprate of Unit 7 would therefore be $2.26 million per MW in isolation, or $4.15 million per MW considering the additional costs associated with Unit 8, which must be attributed to the Unit 7 uprate cost. As neither Unit 7 nor Unit 8 provides any additional energy to the Bay d'Espoir system, a cost per MWh cannot be produced.[10]

2.3 Efficiency of Alternatives Over Operating Range

The efficiency curves provided in Figure 3-3 of the Uprate Report were pictorial and provided as an illustrative example. To provide a comparison of the efficiency curves of the existing unit, a modern efficient runner, and the uprate designs, the efficiency and discharge rates for the runner options, provided in the American Hydro Report[11] and GE Hydro Report,[12] are presented in Table 2.

Table 2: Efficiency and Discharge Rates Comparison

	Generator Output							
	100 MW		130 MW		154.4 MW		160 MW	
Design Option	**Turbine Efficiency (%)**	**Discharge (m3/s)**	**Turbine Efficiency (%)**	**Discharge (m3/s)**	**Turbine Efficiency (%)**	**Discharge (m3/s)**	**Turbine Efficiency (%)**	**Discharge (m3/s)**
Existing Turbine	91.2	66.4	94.2	83.3	93.5	99.5	92.5	104.2
GE Hydro Option 1 (Efficiency Gain)	92.5	65.5	94.8	82.8	94.9	97.9	94.4	102.0
GE Hydro Option 2 (Uprate)	91.8	66.0	94.4	83.1	95.3	97.6	95.1	101.3
American Hydro (Uprate)	91.2	66.4	93.8	83.6	94.6	98.3	94.7	101.8

[9] These estimates are classified as Association for the Advancement of Cost Engineering Class 5 and are intended to provide indicative cost impacts for comparative planning purposes and are appropriate for screening-level analysis.
[10] While there is an average benefit due to the reduction in potential for spill, there is no firm energy benefit associated with the eighth unit. This is because, in a dry sequence, the reservoir would not be in a spill situation.
[11] "Hydraulic Performance Review for Bay d'Espoir Unit 7 Runner Upgrade," American Hydro Corporation, April 21, 2020 ("American Hydro Report") is provided as Attachment 1 to this report.
[12] "Bay d'Espoir Generating Station Unit 7 Runner Replacement" Generation Engineering, April 6, 2004 ("GE Hydro Report") is provided as Attachment 2 to this report.

GE Hydro Option 1 was developed as a like-for-like replacement for the existing runner and maintains the same output rating with higher efficiency. GE Hydro Option 2 and the American Hydro proposal represent higher capacity alternatives achieved by an uprate. These efficiency curves, along with the original Unit 7 efficiency curve, are presented in Figure 1. Efficiency and discharge rate for each configuration at its maximum efficiency point and at maximum output are provided in Table 3.

Table 3: Maximum Efficiency Point and Maximum Output Comparison

	Maximum Efficiency Point			Maximum Output		
Design Option	**Generator Output (MW)**	**Turbine Efficiency (%)**	**Discharge (m3/s)**	**Generator Output (MW)**	**Turbine Efficiency (%)**	**Discharge (m3/s)**
Existing Turbine	138.9	94.5	88.7	165.0	91.3	108.9
GE Hydro Option 1 (Efficiency Gain)	145.0	95.3	91.8	165.0	93.9	105.8
GE Hydro Option 2 (Uprate)	152.6	95.3	96.5	176.4	93.7	133.3
American Hydro (Uprate)	157.2	94.8	99.8	171.0	94.5	112.4

The rated output of Unit 7 is shown in Figure 1 as 154.4 MW and represents the maximum continuous rating of the unit. The unit rating is limited by the ratings of the generator and transformer, both are 172 MVA at 0.9 pf. The unit has been operated above its rating for short durations during testing at outputs up to 165 MW.

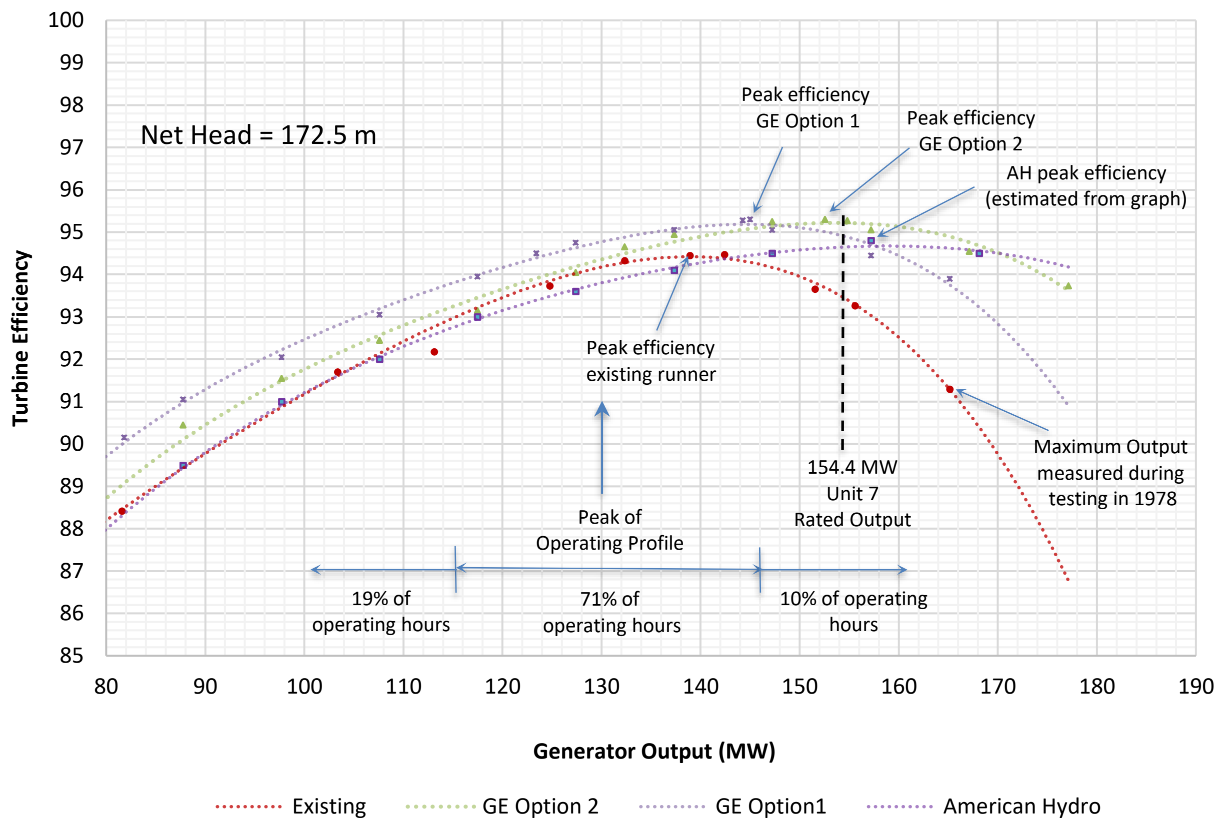

Figure 1: Comparison of Turbine Efficiency Curves

1 For reference, a histogram of the percent of annual operating hours versus the percent Unit output is
2 presented in Figure 2.

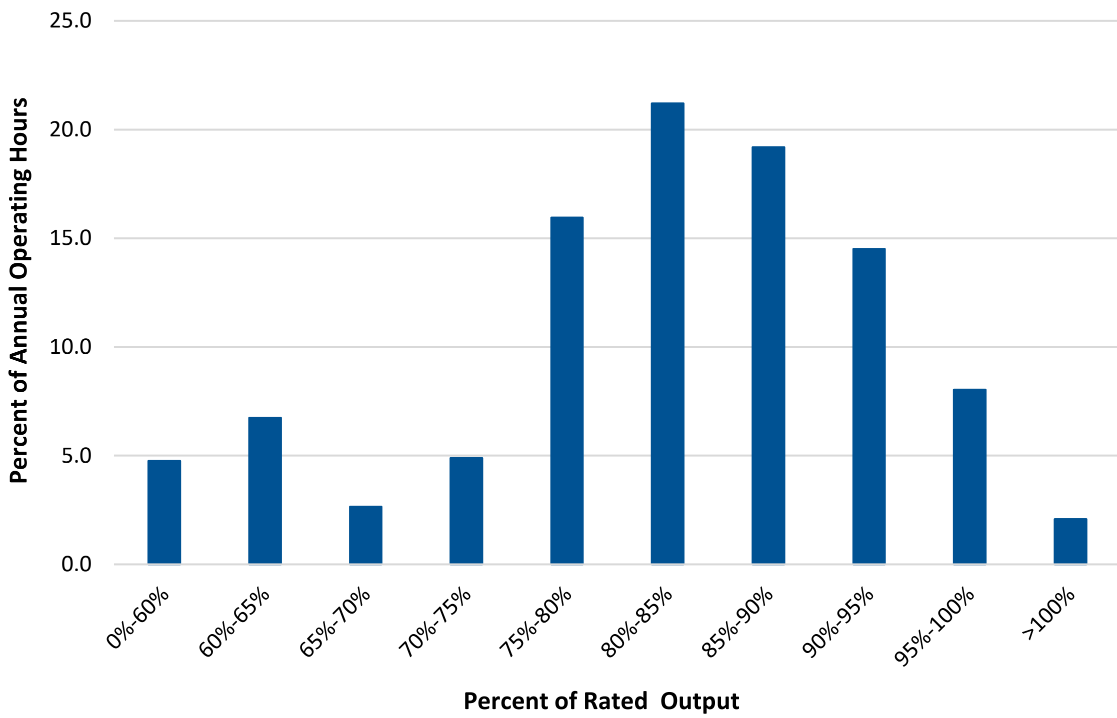

Figure 2: Percent Annual Operating Hours vs Percent of Rated Output – Unit 7[13]

As Unit 7 spends more than half its operating time between approximately 115 MW and 140 MW, the efficiencies at 130 MW provide a useful comparison point in the normal operating range. Comparing the two GE options at this operating point, the efficient replacement runner rated at 154.4 MW has an efficiency of 94.8%, compared to 94.4% for the uprate, and the uprate runner discharge is approximately 0.3 m^3/s higher.[14] Assuming continuous operation at this level, this discharge rate translates to approximately 4.1 GWh/year, valued at approximately $213,000 per year.[15]

At the most efficient operating point, an efficient replacement runner produces at an efficiency of 95.3%; the same is true of the uprate runner. Both options can achieve the same peak efficiency; however, the peak efficiency point occurs at a higher output for the uprate design. This results in lower efficiencies in the normal operating range and higher efficiency in the range in which the unit will be operated only when required for additional capacity. As suggested in the GE Hydro Report and the

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[13] Data represents a three-year average, excluding shutdown and sync condenser.
[14] $0.3m^3/s = 1.08\times10^{-3}$ MCM/hr.
[15] Based on Hydro's conversion factor of 0.4329 GWh/MCM, and 2025 All Hours marginal cost of energy of 5.189¢/kWh. 4.1 GWh x 5.189¢/kWh = $212,749.

Uprate Report, the intent with the planned replacement runner design is to better match the efficiency curve to the operating profile and improve the performance in the normal operating zone.

At maximum output, the efficient replacement runner produces with an efficiency of 93.9%, compared to 93.7% for the uprate. While the efficiencies are similar, they occur at significantly different loads. Comparing curves at the same load point at the top end of the curve provides a better understanding. For example, if the Option 1 curve were extended to 170 MW, it would have an efficiency of 92.8% compared to 94.5% for the uprate. The uprate has a better efficiency at the top end as the peak efficiency point is at a higher output level. It is worth noting that the unit is rarely operated at maximum output, as it cannot contribute to spinning reserves if there is no unloaded generation capacity available. Only during high system peaks, or during periods of high load during an extended Labrador-Island Link bipole outage, will the unit be called upon to operate at its rated output.

At all operating levels below approximately 145 MW, the efficient replacement runner outperforms the uprated runner. At 100 MW output, the modern runner produces an efficiency of 92.5%, compared to 91.8% for the uprate option, and discharges 0.5 m^3/s less water. Above 150 MW, the uprate design outperforms the replacement runner.

The selection of a replacement runner for Unit 7 should not be made in isolation. Both Unit 7 and the proposed Unit 8 will be required to fully utilize the capacity available in the Bay d'Espoir system. With the selection of a 150 MW rating for both units, the maximum output and normal operating points are closer together, reducing the variation in efficiency between the two points. Weighting the curve towards the normal operating point results in better efficiency, where the unit operates most frequently without a large decrease in efficiency at maximum output.

The proposed life extension of Unit 7, including a like-for-like replacement of the runner[16] with a 154 MW, modern, efficient runner ensures a wide, efficient operating range for the unit, that, in conjunction with a matching Unit 8, provides flexibility to operate the Bay d'Espoir Hydroelectric Generating Station under a wide range of system conditions, maximizing overall plant efficiency, hydrology, and providing operational flexibility.

[16] For details on the full scope of the proposed life extension of Unit 7, please refer to Hydro's Life Extension Application.

2.4 Impacts on Operating Regime

When planning the dispatch of generating units, Hydro must consider multiple factors, including unit efficiency and maintaining sufficient operating reserves during normal operation. Hydro has historically operated Unit 7 as base-loaded generation, operating within the most efficient range for the unit, or as a synchronous condenser in times of lower load demands.

Hydro plans for the availability of 10-minute and 30-minute operational reserves for the Newfoundland and Labrador Interconnected System. All hydroelectric generating stations on the Island, including the Bay d'Espoir plant, contribute to reserve requirements in some respect. The 10-minute reserve requirement takes into consideration each hydroelectric unit's start-up time, ramp rate, and availability. During normal operation of the Island Interconnected System, the historic generation of the Bay d'Espoir plant will not reflect full output because it would violate Hydro's operational reserve requirement. Maximized units severely reduce or eliminate reserve contribution capability. Because the Bay d'Espoir plant is the "swing plant" on the Island Interconnected System, these units often contribute heavily to Hydro's reserve requirements to allow other hydroelectric units on the Island to be optimized and system energy in storage to be effectively managed. The addition of Bay d'Espoir Unit 8 will positively contribute to Hydro's 10-minute reserve requirements and will be a material benefit for generation outage planning during Hydro's annual maintenance season.

This has historically resulted in operation of Unit 7 between 80% and 90% of rated output (approximately 120 MW to 140 MW) for approximately 40% of the time in operation, while operating up to its rated capacity when required to maintain generation and reserves during system peaks, approximately 8% of the time in operation. Operation within this range is hydrologically efficient, while providing sufficient unloaded generation capacity for spinning reserve requirements. Units 1–6 have historically been economically dispatched, providing flexible, efficient incremental generation to maintain generation and reserves as system load changes.

Under the like-for-like replacement scenario, Unit 7 would continue to be base-loaded, along with Unit 8. Due to the additional capacity afforded by Unit 8, this would likely result in less operation of Units 1–6. Units 1–6 would continue to be economically dispatched as required by the system and used to support reserve requirements.

Under the Unit 7 Uprate scenario, Unit 7 would continue to be base-loaded within the efficient range of its efficiency curve, likely within 80% to 90% of rated output. Unit 8, if included, would also be base-loaded within the efficient range of its efficiency curve. The additional capacity of Unit 7, or the combined additional capacity of Unit 7 and Unit 8, would likely result in less operation of Units 1–6. Units 1–6 would continue to be economically dispatched as required by the system and used to support reserve requirements.

While the exact operating ranges of each unit would be dependent on the units' efficiency and system requirements at the time, it is not anticipated that the operating philosophy for each unit would materially change under any scenario considered; Unit 7 and 8 would remain as base-loaded units due to their higher efficiency and available operation as synchronous condensers, while Units 1–6 would continue to be economically dispatched to support system requirements.

3.0 Schedule Implications for Bay d'Espoir Facility

Pursuing a capacity increase for Unit 7 would require substantial additional engineering and design work to confirm the technical viability of the project and the potential MW available in the uprate. This would delay the start of the Unit 7 life extension project by approximately two years, with an anticipated additional year of construction due to increased scope. The result would be a delay of the in-service date from the fourth quarter of 2028 into the fourth quarter of 2031. Hydro's 2023 Condition Assessment concluded that refurbishment of Unit 7 is required by 2029 to ensure its continued reliability. Any delay in refurbishment presents a material risk to system reliability, as an unplanned outage of Unit 7 would remove a critical source of firm capacity from the Island Interconnected System. This could result in additional costs associated with the requirement for thermal capacity to displace capacity lost by a failure of Unit 7.

Further, delaying Unit 7 would also delay the integration of Unit 8 due to the additional engineering required for the reduction of Unit 8 capacity and the coordination of site work between the two projects. The schedule impact would need to be assessed, but it is anticipated that it would result in a one to two-year delay.

4.0 Conclusion

Hydro's analysis, supported by analysis from Hydro's independent experts, has concluded that Hydro's planned life extension of Unit 7 and installation of Unit 8 at a rated nominal output of 150 MW represents the most optimal solution for the Island Interconnected System. An uprate of Unit 7 would result in additional estimated costs of $45 million on its own, and $83 million when considering the associated impacts on the implementation of Unit 8. Given the determination that the optimized capacity addition on the Bay d'Espoir system is approximately 150 MW, uprating of Unit 7 may constrain the available capacity for Unit 8 and has the potential to result in overall less efficient use of Bay d'Espoir's hydrologic resources. Proceeding with the planned life extension of Unit 7 and the addition of Unit 8 is the most prudent and timely path, ensuring cost efficiency, reliability, and hydrological sustainability.

Hydro notes that the addition of Unit 8 itself effectively constitutes an uprating of the Bay d'Espoir system. Hatch confirmed that the maximum optimized incremental capacity available from the system is approximately 150 MW. Hydro considers the addition of Unit 8 to be the most efficient and optimal method of achieving this uprate, rather than pursuing a modification to Unit 7 which has the potential to negatively impact overall system efficiency and risk delaying the refurbishment of existing capacity.

Pursuing the Unit 7 uprate scenario would increase costs by $83 million while impacting system efficiency and delaying critical capacity addition. Hydro therefore does not believe it is prudent to further explore the uprating of Unit 7 and recommends proceeding with the proposed life extension of Unit 7, including the replacement of the existing runner with a modern, more efficient design.

In addition to the costs and hydrological considerations, uprating of Unit 7 would necessitate delays in the Unit 7 life extension project, which increases the risk of asset failure and poses reliability risks associated with the loss of critical generation on the Island. Reliability risks would be further exacerbated by the associated delays in the implementation of Bay d'Espoir Unit 8, which is required to meet growing demand on the Island Interconnected System.

Hydro's recommended approach is to proceed with the life extension of Unit 7, which includes pursuing efficiency improvements in the new turbine runner design, to maintain system reliability in the near term while enabling the full capacity development of Unit 8. This approach ensures optimal usage of the available hydrology of the Bay d'Espoir system to provide an additional 150 MW of fully dispatchable capacity and mitigates the cost and reliability impacts of delays in the in-service date of Unit 7 and Unit 8.

Appendix A

Cost Memo – Cost Impact of Uprating BDE Unit 7

MEMO

Date: September 16, 2025

To: John Walsh, Director, Major Projects and Asset Management

From: Doug Maloney, Senior Estimator, Major Projects and Asset Management

Copy: Tony Scott, Project Controls Manager, Major Projects and Asset Management

Marc Cullen, Program Manager, Major Projects and Asset Management

Mark Howell, Project Manager, Major Projects and Asset Management

Samantha Tobin, Senior Manager, Resource & Production Planning

Matthew Halloran, Manager, Regulatory Engineering

Subject: Cost Impact of Uprating BDE Unit 7

Background

The capital cost estimate for BDE Unit 7 Life Extension was completed in Q2 2025. In August 2025, the Public Utilities Board requested an estimate of the cost impact to uprate the unit. In response to this request, a high level review of the change to the cost estimate was completed. The methodology, assumptions, results and risks are outlined below.

Methodology

The methodology used for the review of the uprating of Unit 7 included the following:

- Review of project components impacted by uprating
- Review of schedule impacts
- Review of impacts to owners cost and FEED
- Review of impact to escalation and interest during construction

Assumptions

- Estimate is based on uprating to a 174MW unit.
- This is a standalone estimate and does not consider any cost impacts to or arising from other BDE projects due to schedule changes. Impact on the overall BDE program is excluded.
- FEED cost is assumed to double based on change in scope.
- Other owner's costs are also increased due to schedule delays and increase scope.
- New items include
  - Physical model testing
  - Exciter and controls replacement
  - Servomotors
  - Terminal station upgrades
  - Isolated phase bus
  - Transformer
- There are no changes to the Unit 7 powerhouse, controls and utilities.
- Contingency and base management reserve are prorated on increase in base costs
- Escalation and Interest During Construction are increased based on increased costs and change in schedule and cost profile

Schedule Assumptions

The following schedule assumptions are applicable to the uprate:

- RFP to engage consultant to support FEED and proceed with uprate planning - Q4 2025
- FEED consultant engaged - Q2 2026
- Studies and FEED work complete - [redacted]
- Submit application - [redacted]
- A 2-year delay is assumed for most of the major components and contractor activities.
- Contractor Mobilization - [redacted]
- Construction Complete - Q3 2031- considering the increased scope related to uprating the unit, a two-year construction project spanning two full construction season outages is assumed.

Results

The estimated change in cost is $45.18 million. Details are shown in Table 1.

Table 1 – Estimated Change in Cost due to Unit 7 Uprate

Unit 7 Life Extension Estimate		Unit 7 Uprate Estimate			
Item	Estimate ($CAD)	Unit 7 Uprate Description	Unit 7 Uprate ($CAD)	Assumptions / Comments	Change in Cost
Runner Replacement	[redacted]	Runner Replacement	[redacted]	[redacted]	[redacted]
		Model Testing			
Stator Rewind	[redacted]	Stator Rewind			
Rotor Re-insulate Poles		Rotor Re-insulate Poles			
Subtotal, Major Refit		Subtotal, Major Refit			
Thrust Collar and Thrust Ring		Thrust Collar and Thrust Ring			
Head Cover Replacement		Head Cover Replacement			
Bottom Ring		Bottom Ring			
Line Boring		Line Boring			
Machining Stay Ring Flanges		Machining Stay Ring Flanges			
Facing Plates		Facing Plates			
Turbine Shaft		Turbine Shaft			
Generator Shaft		Generator Shaft			
Wicket Gates		Wicket Gates			
Servo Motors and Dashpot		Servo Motors and Dashpot		[redacted]	
Operating Ring		Operating Ring			
Links, Levers and Pins		Links, Levers and Pins			
Subtotal, Misc Refit		Subtotal, Misc Refit			

BDE Unit 7 Uprate Estimate

Unit 7 Life Extension Estimate: Item	Estimate ($CAD)	Unit 7 Uprate Estimate: Unit 7 Uprate Description	Unit 7 Uprate ($CAD)	Assumptions / Comments	Change in Cost
Spiral Case Leakage	[redacted]	Spiral Case Leakage	[redacted]		[redacted]
Relief Valve		Relief Valve			
Governor Upgrade		Governor Upgrade			
Exciter Controls		Exciter and Exciter Controls		[redacted]	
Turbine Bearing Replacement		Turbine Bearing Replacement			
Synchronous Condenser Level Controls		Synchronous Condenser Level Controls			
Turbine Pit Hoist		Turbine Pit Hoist			
Generator Dust Collector		Generator Dust Collector			
Cooling Water Piping Mods		Cooling Water Piping Mods			
HP Lift System Refurbishment		HP Lift System Refurbishment			
Controls Upgrade Scope		Controls Upgrade Scope			
Asbestos & Lead Abatement		Asbestos & Lead Abatement			
		Terminal Station Upgrades		[redacted]	
		Transmission changes		[redacted]	
		New Isolated Phase Bus		[redacted]	
	-	New transformer		[redacted]	
Subtotal, Upgrades	[redacted]	Subtotal, Upgrades			

Unit 7 Life Extension Estimate

Item	Estimate ($CAD)
Brake shoes and seals	[redacted]
Bearing pads and springs	[redacted]
Set of seals (BR,HC,WG)	[redacted]
Slings	[redacted]
Misc Tooling	[redacted]
Subtotal, Spare Parts	[redacted]
CON Labour - Crane Operator & Labourer	[redacted]
Commissioning	[redacted]
Subtotal, Direct Construction Costs	[redacted]
Owner's Cost: FEED	[redacted]
Owner's Cost: Early Execution	[redacted]
Owner's Cost: Project Phase	[redacted]
Crane Testing and Certification	[redacted]
Accommodations & Turnarounds	[redacted]
Emergency Response	[redacted]
Lockouts Team	[redacted]
Camp Construction	[redacted]
EPCM	[redacted]
Subtotal, Hydro's Indirect Cost	[redacted]

Unit 7 Uprate Estimate

Unit 7 Uprate Description	Unit 7 Uprate ($CAD)	Assumptions / Comments	Change in Cost
Brake shoes and seals	[redacted]		[redacted]
Bearing pads and springs	[redacted]		[redacted]
Set of seals (BR,HC,WG)	[redacted]		[redacted]
Slings	[redacted]		[redacted]
Misc Tooling	[redacted]		[redacted]
Subtotal, Spare Parts	[redacted]		[redacted]
CON Labour - Crane Operator & Labourer	[redacted]		[redacted]
Commissioning	[redacted]	[redacted]	[redacted]
Subtotal, Direct Construction Costs	[redacted]		[redacted]
Owner's Cost: FEED	[redacted]	[redacted]	[redacted]
Owner's Cost: Early Execution	[redacted]		[redacted]
Owner's Cost: Project Phase	[redacted]	[redacted]	[redacted]
Owner's Cost - 2 years delay up front	[redacted]	[redacted]	[redacted]
Owner's Cost - 1 year delay to start of construction	[redacted]	[redacted]	[redacted]
Crane Testing and Certification	[redacted]		[redacted]
Accommodations & Turnarounds	[redacted]	[redacted]	[redacted]
Emergency Response	[redacted]	[redacted]	[redacted]
Lockouts Team	[redacted]	[redacted]	[redacted]
Camp Construction	[redacted]		[redacted]
EPCM	[redacted]	[redacted]	[redacted]
Subtotal, Hydro's Indirect Cost	[redacted]		[redacted]

BDE Unit 7 Uprate Estimate

Unit 7 Life Extension Estimate

Item	Estimate ($CAD)
Found Work Allowance	[redacted]
Subtotal Base Cost Estimate	
Project Contingency	
Subtotal Base Cost Estimate (with Contingency)	
Escalation	
IDC	
Subtotal, Planned Project Budget	
Management Reserve, Base, P85	
Management Reserve, Strategic , P85	
Subtotal, Management Reserve	
TOTAL Cost Estimate (Authorized Budget upon Approval)	85,346,227

Unit 7 Uprate Estimate

Unit 7 Uprate Description	Unit 7 Uprate ($CAD)	Assumptions / Comments
Found Work Allowance	[redacted]	10% of refits, upgrades, CON Labour - Crane Operator & Labourer, and Commissioning
Subtotal Base Cost Estimate		
Project Contingency		Prorated from base case
Subtotal Base Cost Estimate (with Contingency)		
Escalation		
IDC		
Subtotal, Planned Project Budget		
Management Reserve, Base, P85		Prorated from base case
Management Reserve, Strategic , P85		Leave as is
TOTAL Cost Estimate (Authorized Budget upon Approval)	130,524,023	

Change in Cost
[redacted]
45,177,795

Estimate Class

This change in estimated cost is considered Class 5, which is due to the high-level factoring and assumptions employed.

Additional Risks

Additional risks associated with uprating Unit 7 include:

- Impacts on other BDE projects
- Unit 7 could fail before refurbishment if the life extension project is delayed
- Impact of shifting construction to 2030 may impact overall plans within Hydro for both capital and operating work.
- Equipment lead times could change, impacting both schedule and the overall estimate

Appendix B

Cost Memo – Cost Impact of Capacity Reduction of BDE Unit 8

MEMO

Date: September 16, 2025

To: John Walsh, Director, Major Projects and Asset Management

From: Doug Maloney, Senior Estimator, Major Projects and Asset Management

Copy: Tony Scott, Project Controls Manager, Major Projects and Asset Management

Marc Cullen, Program Manager, Major Projects and Asset Management

Stephen Parsons, Project Manager, Major Projects and Asset Management

Samantha Tobin, Senior Manager, Resource & Production Planning

Matthew Halloran, Manager, Regulatory Engineering

Subject: Cost Impact of Capacity Reduction of BDE Unit 8

Background

The capital cost estimate for BDE Unit 8 at a nominal 150 MW was completed in Q4 2024. In August 2025, the Public Utilities Board requested an estimate of the cost impact to uprate BDE Unit 7. Considering that BDE water resources are unchanged, an uprating of Unit 7 would likely result in a capacity reduction of Unit 8. As a result, Hydro completed a high level review of the cost impact of reducing the capacity of Unit 8 to 130 MW. The methodology, assumptions, results and risks are outlined below.

Methodology

The methodology used for the review of the capacity reduction of BDE Unit 8 included the following:

- Review of project components impacted by capacity reduction
- Review of impacts to owner's cost and FEED
- Review of impact to escalation and interest during construction

Assumptions

- This is a standalone estimate and does not consider any cost impacts to, or arising from, other BDE projects due to schedule changes. Impact on the overall BDE program is excluded.
- The costs for the penstock, turbine/generator unit, and transformer are reduced, based on a factor developed from the reduced vs original power rating.
- A 2-year delay to the project in 2025 is assumed. The estimated cost for this delay is calculated by shifting the spend profile by 2 years.
- Two additional years of Owner's Cost is assumed, with each year at 50% of the original 2025 estimated spend amount due to the delay in project execution.
- 15 additional months of FEED are assumed, with each month at 50% of the original 2025 estimated monthly spend amount.
- There are no changes to the following:
    - Unit 7 powerhouse
    - Turbine-generator engineering and installation
    - Controls and utilities
    - Terminal station
    - Transmission line
    - Contingency
    - Management Reserve

Results

The components that were adjusted for reduced capacity are shown in Table 1.

Reduce Capacity of Unit to 130 MW	**Previous**	**Reduced Capacity Case**	**Change**
Reduced diameter of penstock:			
Work Item 1.2.1 Intake & Embedded Penstock - Construction	[redacted]	[redacted]	[redacted]
Work Item 1.3.2 Penstock Route - Mass Excavation	[redacted]	[redacted]	[redacted]
Work Item 1.3.3 Steel Penstock - Installation	[redacted]	[redacted]	[redacted]
Work Item 1.3.4 Penstock - Backfill	[redacted]	[redacted]	[redacted]
TG Unit cost - equipment cost decreased to 130MW unit	[redacted]	[redacted]	[redacted]
Transformer	[redacted]	[redacted]	[redacted]
2 additional years of Owners Cost (assume each year at 50% of the original 2025 spend)	[redacted]	[redacted]	[redacted]
15 additional months of Front-End Engineering & Design (FEED) (assume monthly spend at approximately 50% of the original 2025 monthly spend)	[redacted]	[redacted]	[redacted]

Table 1 – Components Adjusted for Unit 8 Capacity Reduction

The total estimated change in cost is $38.388 million as summarized in Table 2.

Reduce Capacity of Unit to 130 MW	**Previous**	**Reduced Capacity Case**	**Change**
Base Cost	[redacted]	[redacted]	[redacted]
Owners Cost	[redacted]	[redacted]	[redacted]
Engineering, Procurement & Construction Management including FEED	[redacted]	[redacted]	[redacted]
Design Development Allowance	[redacted]	[redacted]	[redacted]
Contingency Allowance	[redacted]	[redacted]	[redacted]
Escalation	[redacted]	[redacted]	[redacted]
Interest During Construction	[redacted]	[redacted]	[redacted]
		TOTAL CHANGE	**$38,387,819**

Table 2 – Estimated Change in Cost due to Unit 8 Capacity Reduction

Estimate Class

This change in estimated cost is considered Class 5, which is due to the high-level factoring employed.

Additional Risks

Additional risks associated with reducing capacity of Unit 8 include:

- The potential impact of delaying construction on overall plans within Hydro for both capital and operating work.
- Equipment lead times could change, impacting both schedule and the overall estimate.

Attachment 1

American Hydro Report

newfoundland labrador hydro

American Hydro

A Wärtsilä Company

American Hydro Corporation
135 Stonewood Road
P. O. Box 3628
York, PA 17402
USA

T +1 717 755 5300
F +1 717 755 8927

April 21st, 2020

Brent Peddle
Manager – Long Term Asset Planning
Newfoundland & Labrador Hydro
500 Columbus Drive
PO Box 12000
St. John's, NL A1B 4K7

SUBJECT: Hydraulic Performance Review for Bay d'Espoir Unit 7 Runner Upgrade
American Hydro Corporation Reference: PRO 3938

Dear Brent:

American Hydro (AH) is pleased to offer this hydraulic performance review showing the potential for power increase of the Bay d'Espoir Unit 7. AH offers unmatched capabilities and experience to engineer, manufacture, and rehabilitate hydro turbines to the highest standards. Over the past 33 years, AH has designed and supplied more than 725 runners for turbine unit upgrades.

This review limited its maximum potential for power increase to the maximum capacity of the existing transformer of 190 MVA with a PF of 0.9 for a runner potential power output of 174 MW or 236,575 HP. As also explained in our hydraulic study there is a potential to exceed the 190 MVA but this would require excavation and replacement of the discharge ring and the upper section of the draft tube.

If required AH could be available for further discussion with Joe Hill, Manager of Hydraulic Design and Robert Rittase, Senior Staff Engineer of Hydraulic Design. In addition, we would be happy to share additional info regarding reference projects where an updated runner design with CFD analysis and model testing has been able to afford power increases up to 20%.

Should you have any questions or concerns, please contact Scott Parsons, our Regional Sales Manager, at 902-240-1558 or scott.parsons@ahydro.com. We look forward to discussing our proposal with you.

Sincerely,

Gerard J. Russell
President

cc: Scott Parsons, American Hydro

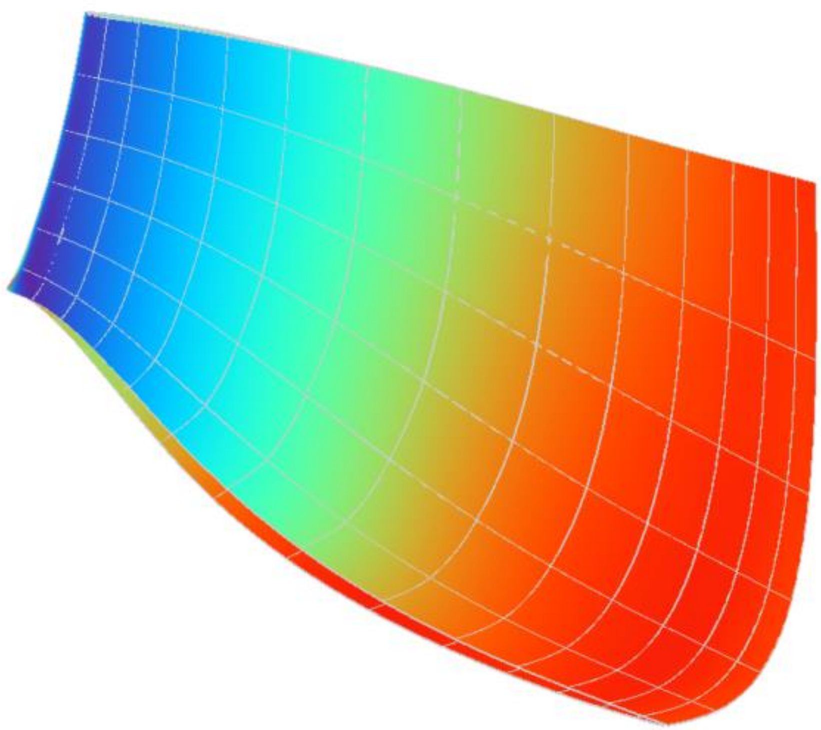
American Hydro
A Wärtsilä Company

Bay D'Espoir Upgrade Analysis

AH is pleased to have the opportunity to evaluate a capacity upgrade for the Bay D'Espoir Plant Unit 7. Based on the drawings provided to AH, this turbine has a fairly modern design that can support high efficiency, high capacity, and excellent cavitation performance. With only a runner upgrade, this plant could realize gains of at least 10% capacity. The efficiency of the existing machine is unknown to AH, but with a new runner and wicket gates efficiency gains of 1-3% would be expected.

AH approaches each project with a custom runner design to confirm proposed performance. At this time, AH has developed a runner design and conducted preliminary CFD analysis of the runner to confirm cavitation performance. For a firm proposal AH would additionally conduct a Numerical Model Test of the entire turbine at prototype scale using modern CFD methods. This provides excellent correlation to Scale Model Test data and Field Test data, while providing AH engineers a tool for very rapid turbine optimization.

A 3D view of the preliminary runner CFD results for Bay D'Espoir is shown below, with color gradients based on pressure distribution.



CFD results of preliminary runner design for Bay D'Espoir at 174 MW showing pressure distribution gradient

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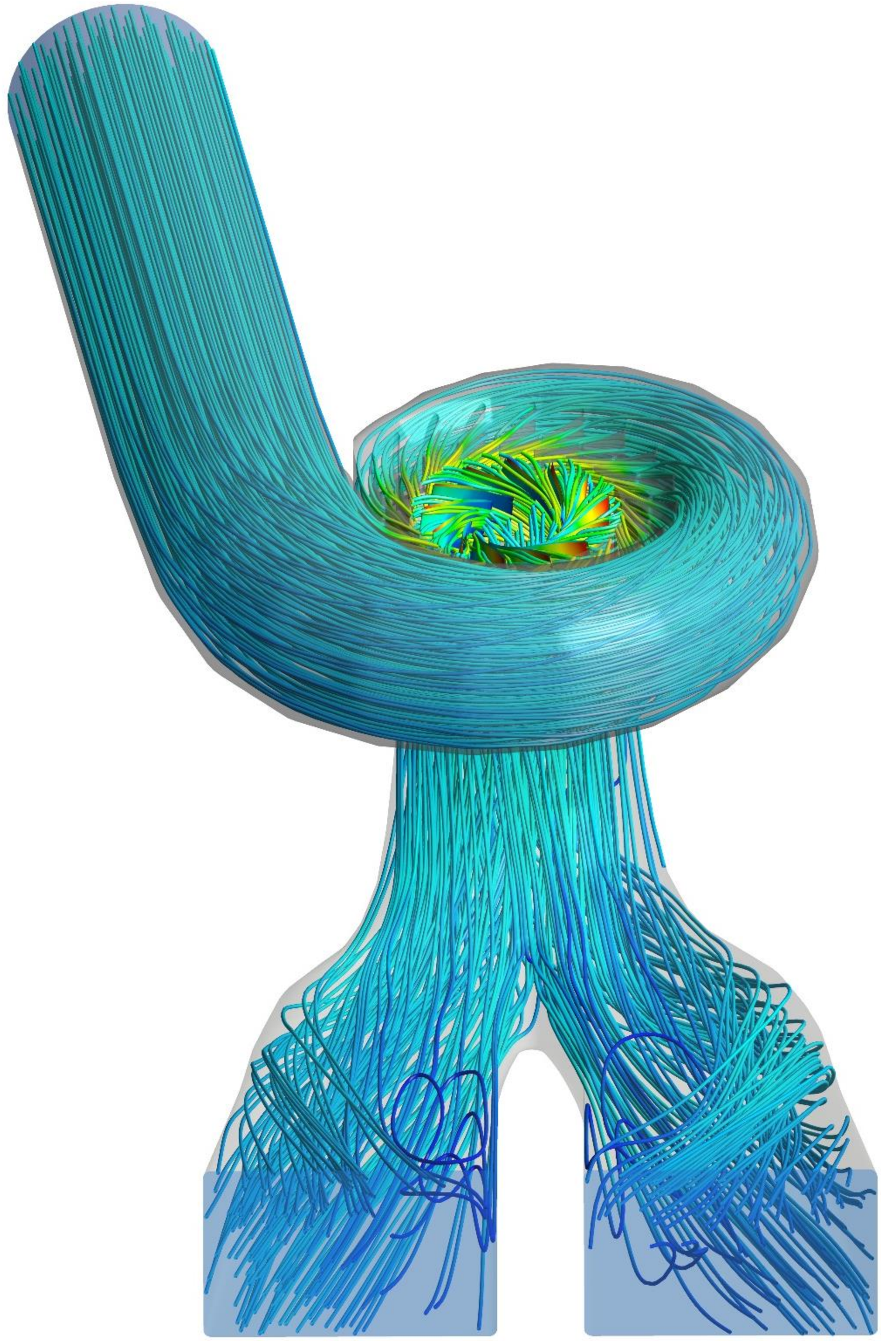
An example of full CFD analysis that will be conducted upon a proposal is below in the following figures.



Example of full turbine CFD results from analyses AH performs as part of every proposal and contract

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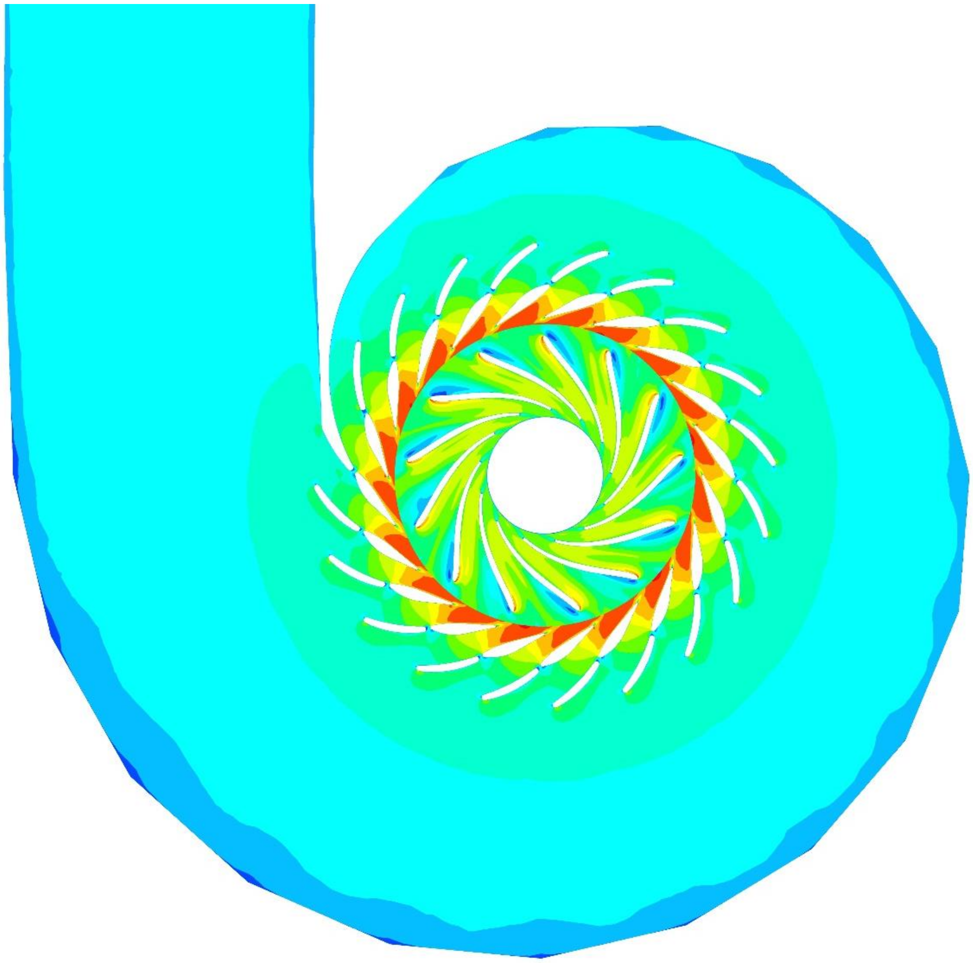
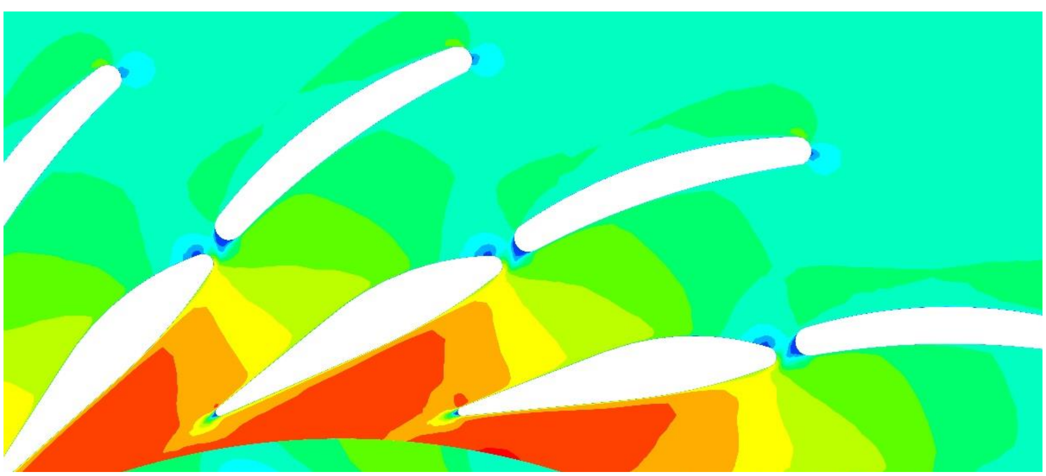


Example of velocity contours in spiral case. Such analyses are used to accurately evaluate velocity profiles and performance of existing components



Example showing velocity contours in stay vane/wicket gate cascade. AH routinely uses this data to optimize wicket gate profiles and evaluate stay vane modifications

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Based on the information provided, AH has determined a reasonable upgrade limit to be 171 MW electrical output, about a 10% increase from the existing 155 MW. This assumes the generator can safely operate at 190 MVA @ 0.9 PF and 98% efficiency. AH assumes that minimum tailwater of 1.22 m is a normal occurrence due to tidal effects, this was used as the minimum tailwater elevation for cavitation analysis. Additional capacity could be managed with possible modifications to the discharge ring, a higher generator rating, or if the generator can be operated at a power factor higher than 0.9. Operating data and assumptions from the existing and new units are in the table below.

	Existing	**Proposed**
Net Head	173.5 m	173.5 m
Minimum Tailwater Elevation	1.22 m	1.22 m
Maximum Tailwater Elevation	3.35 m	3.35 m
Generator Rating	172,000 kVA @ 0.9 PF	190,000 kVA @ 0.9 PF
	154,800 kW	171,000 kW
Speed	225 RPM	225 RPM

AH has upgraded several turbines that are very similar in specific speed to Bay D'Espoir. Based on the performance data obtained from model testing and field testing these projects, we have developed expected performance curves for the upgraded Bay D'Espoir. For comparison, we have estimated the performance of the existing turbine based on the existing rating of 154,800 kW. The expected performance curve is shown below.

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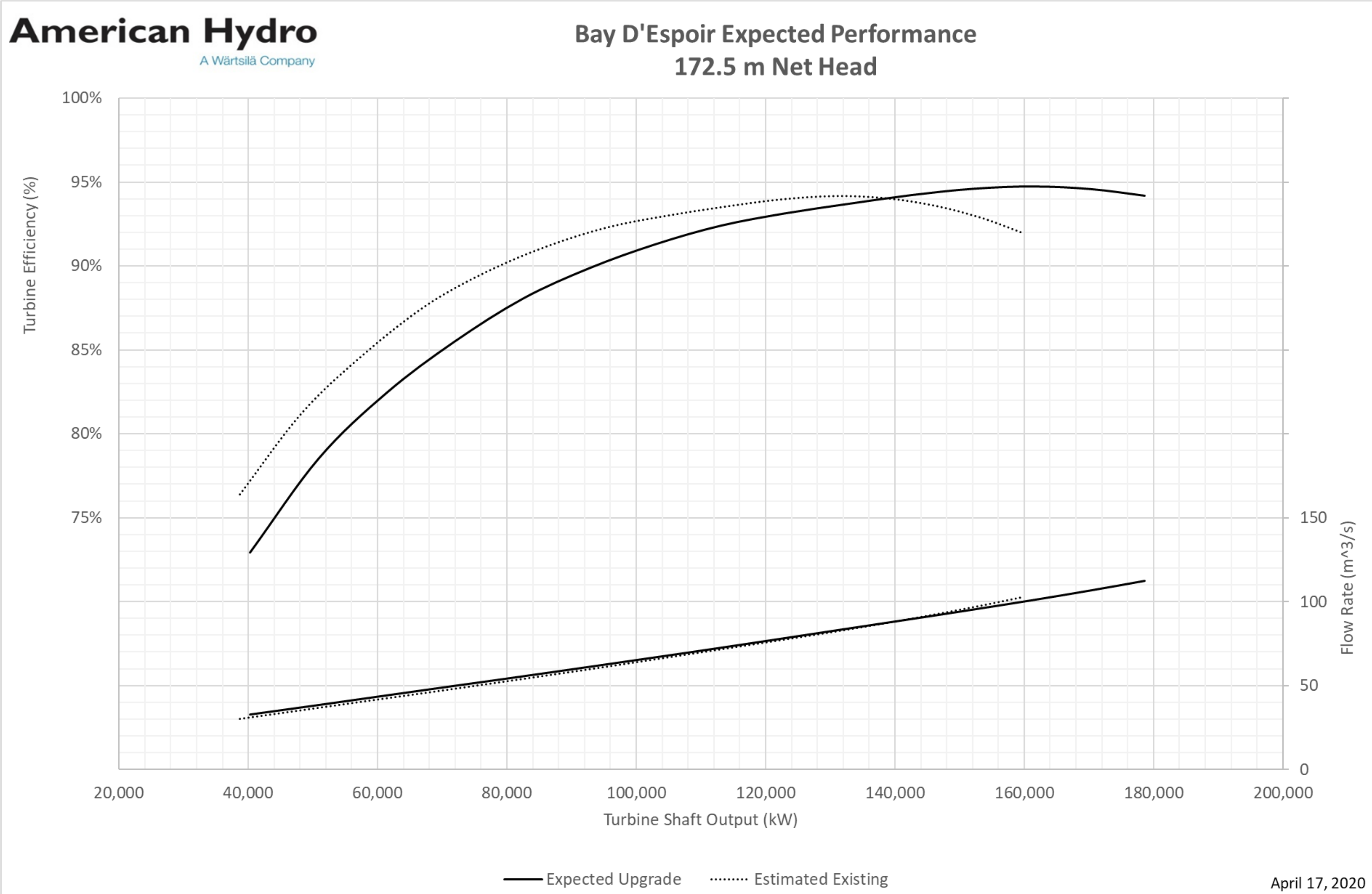

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Attachment 2

GE Report

Eng. Ser. Tech. Ref. Lib.
2.2.5.24

scanned copy in e-Library (Jan 2006)

FILE: 123.80.20/45.00

Jan 14/2006; Email to B. Woodman, Matt Lambert & Rod Wilcott.

HYDRO
THE POWER OF COMMITMENT

BAY D'ESPOIR GENERATING STATION

UNIT 7 RUNNER REPLACEMENT

REGISTERED PROFESSIONAL ENGINEER
J. E. ... LAM
SIGNATURE
PROVINCE OF NEWFOUNDLAND

Approved: M. Rana

Generation Engineering
2004-04-06

SUMMARY

This report presents the capital costs for a replacement runner for Bay D'Espoir Unit 7 and the benefits which would result. A runner of modern design can offer increased capacity, efficiency and improved cavitation resistance. As part of the runner replacement project, the existing floating rim generator rotor would be strengthened, to eliminate the potential risk of rotor unbalance and unit outage as a result of an overspeed, a situation which has occurred several times in that past. The report does not contain recommendations pertaining to the viability of the project, as this will be determined by System Planning.

TABLE OF CONTENTS

1. INTRODUCTION

Discussions with GE Hydro concerning Unit 7 were initiated in the fall of 2000, to discuss our concern with the floating rim rotor. Unit 7 was constructed with a floating rim type spider, which is much less rigid than more conventional designs. This type of spider construction was used at many installations at about that time. This has caused serious problems on a number of occasions following over speed events. When subjected to an over speed, the floating rim sometimes does not return to its original position, resulting in a dynamic unbalance, which causes unacceptably high vibration. The vibration must be corrected by rebalancing the rotor, a time consuming process which removes the unit from production until it can be completed.

During these discussions, GE Hydro indicated that it might be possible to increase the unit's capacity by as much as 10% by replacing the runner. Discussions proceeded over the following year and a half and have culminated in the receipt of two proposals from GE Hydro , dated 2002-04-16 and 2002-05-29. In both cases, the proposed runner would fit within the existing turbine without significant modifications. This report contains the proposals from GE Hydro, with an estimated cost to modify the unit as proposed by GE Hydro and an analysis of the benefits these modifications will provide.

All costs presented in this report are in January 2004 Canadian dollars.

2. FIRST PROPOSAL BY GE HYDRO

This proposal was dated 2002-04-16. The performance curve for this runner is presented in Figure 1. It indicates a slight increase in capacity (about 2.2 MW) and a slight increase in

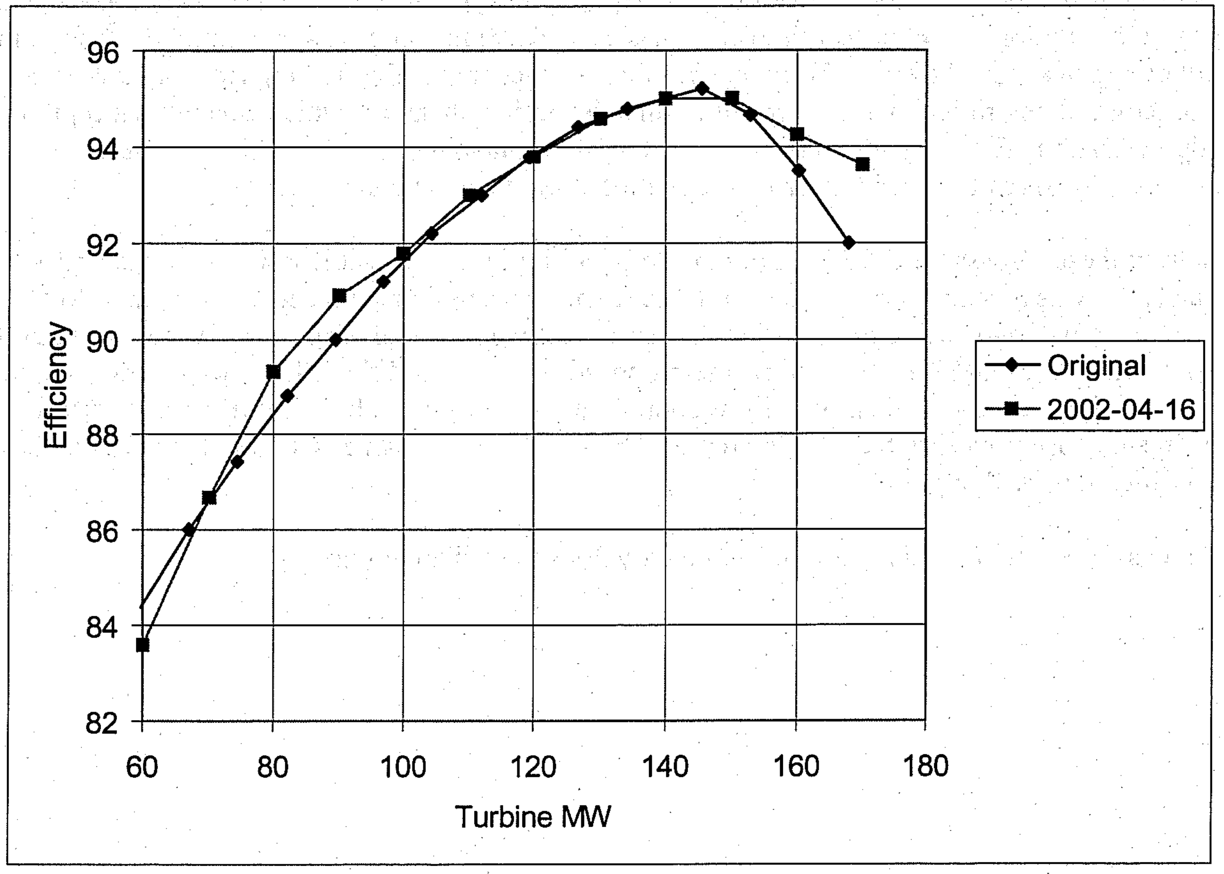


Figure 1

efficiency between 70 and 100 MW and above 150 MW. (The "Original" performance curve was obtained from the Dominion Engineering Works proposal for unit 7. It has not been verified by field testing.) GE Hydro prepared the new performance estimates based on a tail water elevation of 0.61 m, which is lower than generally encountered at Bay D'Espoir. GE Hydro was informed that, based on a review of several years of operating data, the minimum, average and maximum tail water elevations are 0.8, 2.2 and 3.2 m, respectively. GE Hydro reconsidered the performance predictions made and responded with a second proposal.

3. SECOND PROPOSAL BY GE HYDRO

This proposal was dated 2002-05-29. The performance curve for this runner is shown in Figure 2. It indicates that GE Hydro had revised their original proposal to accentuate increased capacity and efficiency at high output.

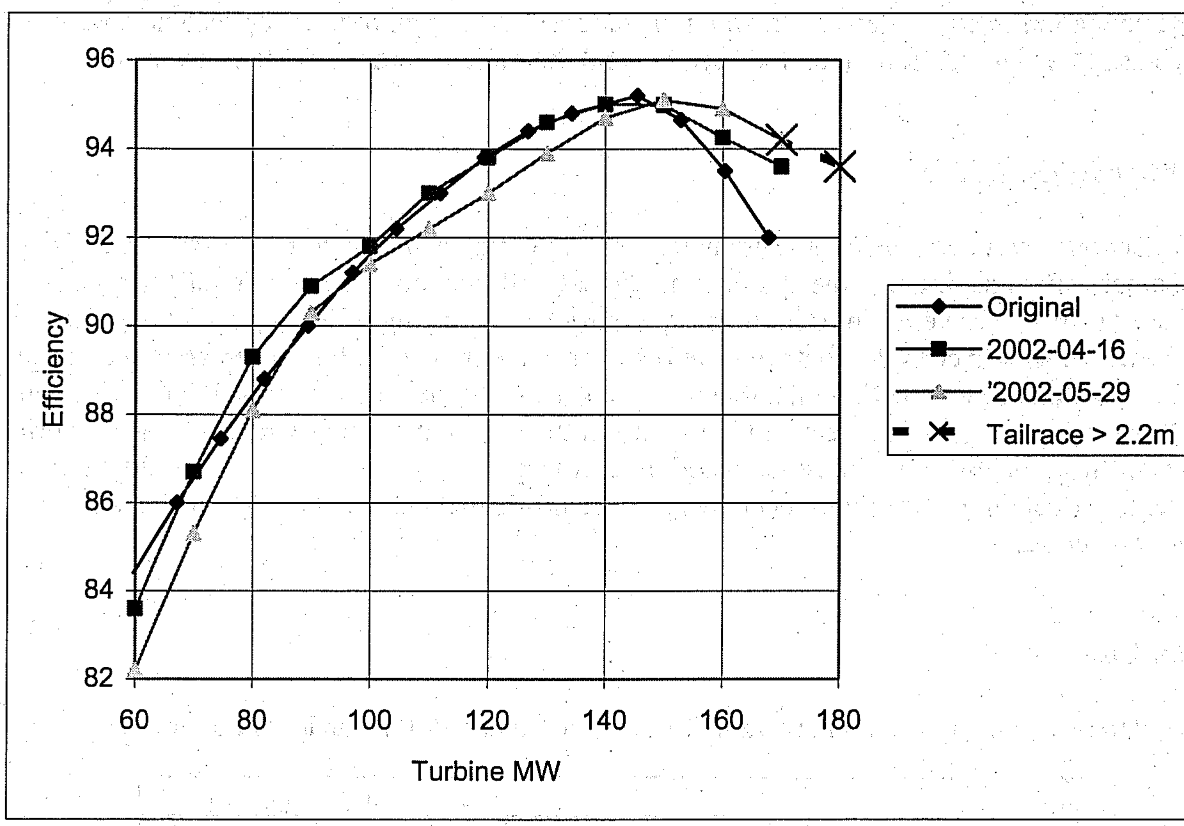


Figure 2

The curve has the same shape as the 2002-04-16 proposal but has been shifted to the right. Note also the section of this curve to the extreme right which has been identified as "Tailrace >2.2m". GE Hydro has offered a runner which can produce significantly more MWs, depending on tail water elevation, as shown in Table 1.

Tail water Elevation (m)	Turbine MW
0.8	170
2.2	180
3.2	188

Table 1

The output is limited by the requirement to provide cavitation protection for the runner. As water flows through the runner the pressure decreases as energy is extracted from the water by the runner. Pressure decreases and under certain operating conditions can drop below the pressure at which water will boil. Bubbles form and collapse violently at a point where the pressure increases beyond the boiling point. This violent collapse of the bubbles is called cavitation and it can result in severe damage to the runner. One of the ways that cavitation can be prevented is by providing tail water protection. That is, the runner is positioned sufficiently lower than the minimum expected tail water elevation to ensure that the pressure at any point in the runner will not decrease below the point at which bubbles can form. The original runner was designed to operate cavitation free at expected tail water elevations. The design of the proposed new runner has been stretched to the limit and, in effect, beyond the limit at some tail water elevations.

Generator Rotor Spider

Unit 7 generator was designed and constructed with a floating rim. The term "floating rim" is just another way of saying that the spider is much less stiff than more conventional designs. This has caused problems several times in the past, requiring rebalancing following a unit trip and overspeed. We should consider that we have been fortunate in that we have been able to balance the unit to within acceptable (but on some occasions, less than desirable) limits quickly. We can expect this to occur again and we should also expect the situation to recur with sufficient severity that a significant delay would be experienced in returning the unit to service. This could have a detrimental affect on our ability to meet energy demands if such an event occurs during a peak production period.

Capital Cost

The capital cost estimate is summarized in Table 2, in January 2004 Canadian dollars.

Item	Capital Cost
Supply runner, spider, misc materials	$2,000,000
Install runner, spider, misc materials	$275,000
Engineering and Project Management	$155,000
Hydro forces	$175,000
Environment	0
Contingency	$261,000
Allowance for Funds During Construction	Not Included
Corporate Overheads	$172,000
Escalation	Not Included
Total	$3,038,000

Table 2

This is a prefeasibility class estimate and has an accuracy of + or - 15%. See Appendix I for the project cash flow.

4. DISCUSSION

Capacity Increase

The extent to which the capabilities of the proposed new runner could be exploited is limited by the need to provide cavitation protection. Expressed another way, the maximum output is limited by the tail water elevation. Tail water elevation at Bay D'Espoir Unit 7 is affected by three principal variables: total flow through Units 1-6 in Powerhouse 1, flow through Unit 7 in Powerhouse 2 and tide. Hourly operating data for a recent three year interval (1999-01-01 to 2002-04-26) was reviewed and Table 3 indicates the number of hours Unit 7 operated at various tall water elevations for that period.

Tail water Elevation Greater Than (m)	Number of Hours	Percent of Time
0.8	37481	98%
1	36346	95%
1.2	34503	91%
1.4	32035	84%
1.6	28533	75%
1.8	24702	65%
2	20756	55%
2.2	14916	39.2
2.4	10671	28.0
2.6	7203	18.9
2.8	4271	11.2
3.0	2197	5.8
3.2	726	1.9

Table 3

From this data a tail water elevation duration curve was plotted, to indicate how the additional capacity offered by the proposed new runner is limited by tail water elevation. This is presented in Figure 3

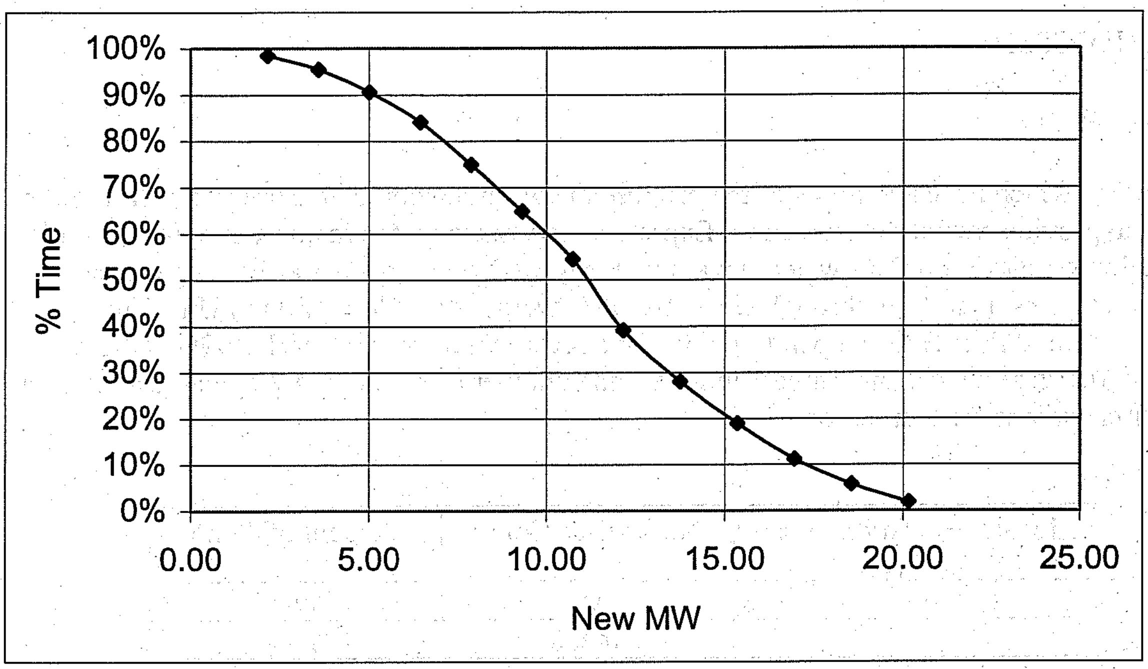


Figure 3

As an illustration of the significance of this curve, what it indicates is that we could make use of 15 additional MW of capacity only 20% of the time and 5 additional MW of capacity 90% of the time. The limitations inherent in the design of the proposed runner are apparent from this curve, especially when one considers that high tide will not necessarily coincide with system peak, which is when the additional capacity offered by the proposed runner would be of most use. Similarly, a coincidence of the required maximum output from Unit 7 with high flow rates through Units 1-6 may not occur, limiting the usefulness of the increased capacity. There is additional energy associated with this new runner in that its slight improvement in efficiency at the lower part of mid range and at the high range would improve energy production. However, as operating data indicates that Unit 7 operates only 5% of the time in this range, the energy gained through efficiency improvement would be negligible. As Unit 7 runner has not exhibited any significant corrosion, erosion or cavitation problems, there is no financial benefit to be gained by replacing the runner to address such issues.

To summarize, although GE Hydro has offered a runner with greater capacity, tail water elevation severely limits the usefulness of this additional capacity. Efficiency improvements offered are also marginal and there are no existing physical problems which would benefit from the installation of a new runner. The amount of additional capacity offered is considered to be 5 MW.

Energy Production Increase

The runner proposed by GE Hydro offers increased efficiency over a segment of the operating range, optimized based on the weighting factors provided in the original unit specification (circa 1974). GE Hydro structured its proposal in this way to facilitate comparison of the proposed runner with the originals, in the absence of absolute field test data. A review of production records for a recent three year interval (1999-01-01 to 2002-04-26) indicates that the actual operating mode is quite different from that originally expected, as indicated by the weighting factors. See Table 4

Turbine Output (MW)	Original Weighting Factor	Actual Operating factor
77	0.10	0.095
116	0.20	0.027
135	0.40	0.716
154	0.30	0.161

Table 4

The guaranteed efficiency of the original runner and of the proposed runner were compared using the Actual Operating Factor to determine the net efficiency gain of the proposed new runner. That efficiency gain, which translates directly into increased energy production, is an increase of 0.6825 % increase. (See Appendix IV for an explanation of how this increase was calculated.)There is potential to increase this by optimizing the runner design to suit our mode of operation.

Verification Of Improvements

The increase in capacity offered can be easily verified by field testing. The efficiency improvement offered is quite another matter. The correct procedure would be to test the unit before and after modification to verify that the promised improvement has been realized. The best test method which could be employed has an uncertainty, or inaccuracy, of about ± 1%. Therefore, the uncertainty band above the efficiency curve of the existing runner encompasses the efficiency curve of the new runner and vice versa. There is no way to test the unit and prove that the efficiency gain has been realized. There is no doubt that modern numerical design techniques have improved runner design and field testing of modern units has shown that turbine efficiencies have increased measurably over that past quarter century. However, if we proceed with this project, we will have to accept the efficiency improvement on faith.

Greenhouse Gas Emissions

Installation of a new runner will result in higher efficiency, which can be converted into an equivalent reduction of fuel consumption at the Holyrood Thermal Generating Station. Hydro may be able to take advantage of these reductions as carbon credits when the greenhouse gas emission reductions under the Kyoto agreement are implemented.

Other Potential Modifications

The GE Hydro has indicated that efficiency could be improved by a further 0.2% if the wicket gates were replaced by ones of revised design. The cost and benefits of this option have not been estimated, but should be investigated should this project be considered viable.

5. CONCLUSIONS

1. The project is technically feasible although a careful review will be required to ensure that GE Hydro has not pushed the envelope too close on cavitation limits.

2. The increased capacity offered has limited usefulness because of tail water elevation restrictions at higher outputs. The useful increase in capacity is 5 MW.

3. If it is decided to replace the runner, the rotor spider should be replaced to ensure that the frequency of vibration excursions caused by the floating rim does not increase, causing operational problems

4. The runner design proposed by GE Hydro was based on the efficiency weighting factors contained in the original request for proposals for the plant (circa 1974). Analysis of production records for recent years indicates that the actual mode of operation is very different. The increase in weighted efficiency of the proposed runner is 0.6825%.

6. RECOMMENDATIONS

1. The financial benefits which would accrue from replacing the existing runner should be analyzed by System Planning to determine if the project is financially viable.

2. If a decision is made to replace the runner with one having greater capacity, the generator rotor should be strengthened, consistent with conventional design standards.

3. The cavitation characteristics of the proposed runner should be carefully reviewed before proceeding with the project.

4. The production records for the most recent 10 year interval should be analyzed to establish new efficiency weighting factors. This should be reviewed with ECC to determine their preferred range of Unit operation (MW). This should then be discussed with GE Hydro with a view to modifying the proposed design to optimize the efficiency to achieve greater energy production. It should be possible to increase the efficiency gain proposed by GE Hydro (0.6825 %) to between 0.8% and 1.2%.

5. Should this project proceed, proposals should be invited from several manufacturers and

the specification should be structured to permit separate awards of the rotor spider strengthening and runner replacement. This will ensure that Hydro obtains the best alternatives for both components, which will not necessarily be proposed by one manufacturer.

6. The possibility of replacing the existing wicket gates with more hydraulically efficient units should be investigated.

APPENDIX I
Project Cash Flow

Prepared by: J. Mallam

CAPITAL BUDGET PROPOSAL

Capital Cost Estimate & Cash Flow Requirements
2004 Fiscal Year : Prepared: 25-Mar-04
AFUDC= 0.00% Annual 0.00% Mthly 0.00% Qtrly

BDE #7 Runner Replacement
In-Service: 31-Aug-05

Escalation % 2002 = 2003 = 2004 = 2005 = 2006 = 2007 = 2008 = (Est. Base: Jan-02

Period	Constr. Servcs	Equip. Purch.	Matrls Purch.	Constr. Internal	Land & Survey	External Eng.	Environ-ment	Eng.& Mgmt.	Proj./Constr Mgmt.	Inspection & Comm.	O/H @ 6.00%	Cont @ 10%	Sub Total	Escln	AFUDC	Total Project	Cash Flow (Excl AFUDC)
2004 Jan											0	0	0	0	0	0	0
Feb											0	0	0	0	0	0	0
Mar								5			0.3	0	5.3	0	0	5.3	5.3
Apr								5			0.3	0	5.3	0	0	5.3	5.3
May								5			0.3	0	5.3	0	0	5.3	5.3
Jun								5			0.3	0	5.3	0	0	5.3	5.3
Jul								5			0.3	0	5.3	0	0	5.3	5.3
Aug											0	0	0	0	0	0	0
Sep								5			0.3	0	5.3	0	0	5.3	5.3
Oct											0	0	0	0	0	0	0
Nov		200						5			12.3	0	217.3	0	0	217.3	5.3
Dec								5			0.3	0	5.3	0	0	5.3	217.3
Total 2004	0	200	0	0	0	0	0	40	0	0	14.4	0	254.4	0	0	254.4	254.4
2005 Jan								5			0.3	0	5.3	0	0	5.3	5.3
Feb		200						5			12.3	0	217.3	0	0	217.3	5.3
Mar								10			0.6	0	10.6	0	0	10.6	222.6
Apr		200						10			12.6	0	222.6	0	0	222.6	10.6
May								10			0.6	0	10.6	0	0	10.6	222.6
Jun	100	600		30				10			44.4	0	784.4	0	0	784.4	42.4
Jul	150	550						10		5	42.9	0	757.9	0	0	757.9	757.9
Aug	25			60				10		5	21.7	261	382.7	0	0	382.7	821.5
Sep				55				10		5	4.2	0	74.2	0	0	74.2	377.4
Oct				30				5		5	2.4	0	42.4	0	0	42.4	42.4
Nov		250						5		5	15.6	0	275.6	0	0	275.6	10.6
Dec											0	0	0	0	0	0	265
Total 2005	275	1800	0	175	0	0	0	90	0	25	157.6	261	2783.6	0	0	2783.6	2783.6
Beyond											0	0	0	0	0	0	0
Total Proj.	275	2000	0	175	0	0	0	130	0	25	172	261	3038	0	0	3038	3038

APPENDIX II
GE Hydro Proposals

Second Proposal

gilles.girard@ps.ge.com 05/29/2002 05:17 PM

John,

I have finally received information from our Dominique Bourque in hydraulic engineering (in all fairness to her she has been working very hard on numerous other projects at the same time).

Please see attached documents.

The maximum output of the generator is 185 MW. The maximum output of the turbine has been limited to 188 MW in order not to exceed the power that can be taken by the modified generator

The runaway speed as well as the hydraulic thrust of the new runner have been checked with the generator designers who confirmed that both were acceptable for the modified generator which we proposed with our 14 February 2002 proposal.

On the other hand, we must increase the wicket gate opening which will result in extra costs (see below)

Dominique has also performed some transient analysis calculations in order to check the over pressure and overspeed during load rejection. She concluded that we would have to modify the servomotor closing time curve so that the overspeed and over pressure are acceptable. As a result of this, we also have some additional cost detailed below to cover the necessary changes.

The price modifications are as follows:

- Increasing wicket gate opening

  This consists of adding stroke to the servomotors as well as changing the pistons rods. The price includes engineering as well as refurbishment of the existing servomotors

  - Engineering $ 24,960.00
  - Servo refurbishment & New Piston Rods $ 86,910.00

- Modifications to prevent exceeding actual runaway speed and casing pressure rise

  - New check valves, flow control valve

and Dashpot modification
$ 14,360.00
-
Site work to perform modifications
$ 4,050.00

Freight for all above: $ 3,780.00

Grand Total: $ 134,060.00

I hope the above will meet your new requirements as well as your expectations

Regards

Gilles

-----Original Message-----
From: JMallam@nlh.nf.ca [mailto:JMallam@nlh.nf.ca]
Sent: Tuesday, May 07, 2002 1:50 PM
To: Girard, Gilles (PS, Hydro)
Cc: RBesaw@nlh.nf.ca
Subject: Bay D'Espoir Unit 7

I have reviewed your submission dated 2002-04-16. The 0.61 m tailwater level is too low to use as a reference. Typically, the minimum level is 0.8 m, the maximum 3.2 m and the average 2.2 m. This plant is located a short distance from the ocean so the tailrace is tidal and, being long, is also affected by total plant output. The tailraces from powerhouse 1(units 1-6) and powerhouse 2 (unit 7), merge several hundred yards downstream of the plants and share a common tailrace from there to the ocean.

At powerhouse 1, the minimum tailwater level is 0.2 m, the maximum 3.0 m and the average 2.0 m.

Please review these tailwater levels and reassess what output could be achieved within the physical constraints of the existing discharge ring and draft tube, without inducing cavitation and giving due consideration to the range of tailwater levels created by tidal action and the operation of both powerhouses.

John Mallam
Newfoundland and Labrador Hydro
(709) 737-1712

Hydraulic-Writeup rev1.do CS-7004to7005.pdl

Introduction

GE Hydro is proposing to replace the existing Francis runner of Unit 7 at the Bay d'Espoir Powerplant. The new runner will develop the following turbine output values for the various net heads and tailwater levels:

	Net Head: 172.517 m	Net Head: 174.45 m
Tailwater levels: 0.8 m (min)	Turbine Output: 170 MW	Turbine Output 173 MW
2.2 m (average)	180 MW	182 MW
3.2 m (max)	188 MW	188 MW

The main advantages of this new runner is to provide a turbine output increase when compared to the original rating, a gain in weighted turbine efficiency and an excellent cavitation behaviour.

Hydraulic Runner Design

GE Hydro will design one new runner specifically for the operating requirements. The new replacement runner will have 15 blades and a throat diameter of 3454.4 mm (136 inches). No modifications to the existing waterpassage components are required with our new proposed runner. The runner will rotate at the existing speed of 225 rpm.

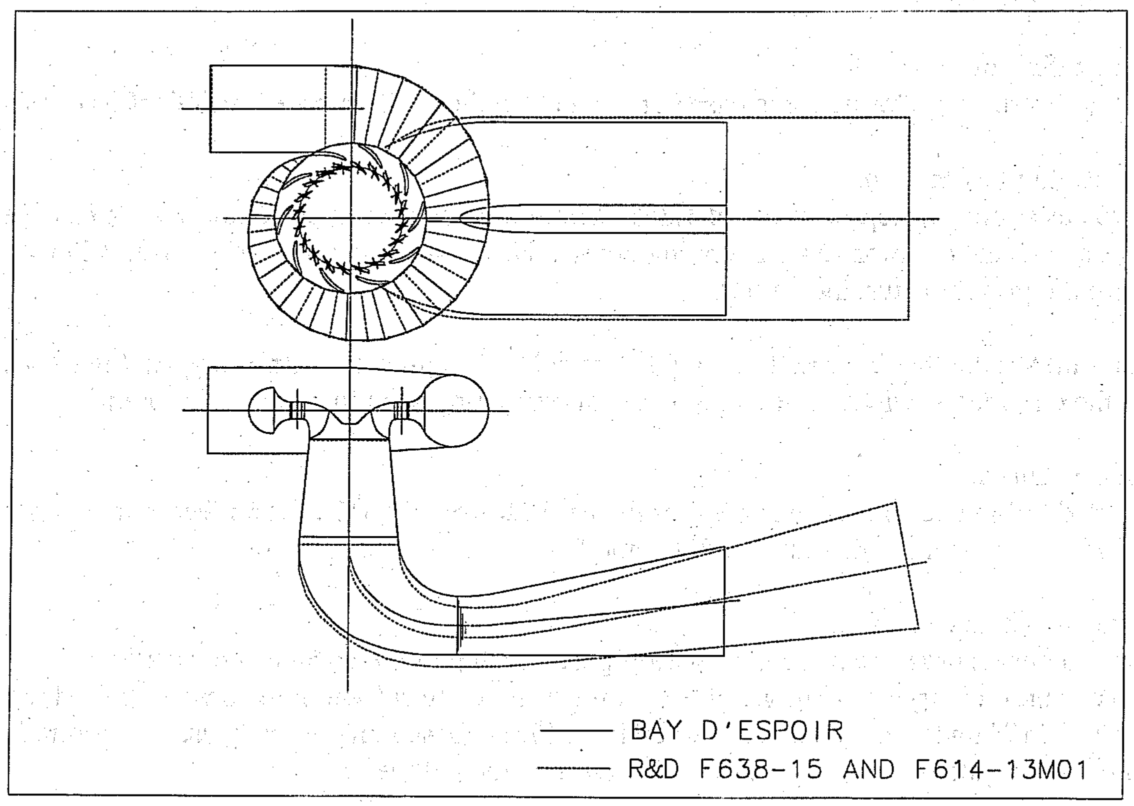
Reference models

The runner designations of GE Hydro's reference for this project are F-638-15 and F-614-13m01. These two runners were designed and model tested in 2001 within our R&D program. The model assembly used for the testing is essentially homologous to the Bay d'Espoir U7 waterpassage with the exception of the draft tube and wicket gate profile. Based on the model test results, GE Hydro has established the turbine performance that a modern runner designed for the Bay d'Espoir operating conditions would develop.

		MODEL R&D F-638-15	MODEL R&D F-614-13M01	BAY D'ESPOIR U7
THROAT DIAMETER (D_{TH})	[mm]	350.0 (model)	350.0 (model)	3454.4
SPEED COEFFICIENT AT MAX. EFF.	n11	59.74	60.26	59.175
POWER COEFFICIENT AT MAX. EFF.	P11	7.00	5.982	5.366
DISCHARGE COEFFICIENT AT MAX. EFF.	Q11	0.757	0.651	0.586
MAXIMUM MODEL EFFICIENCY	%	94.43	93.75	93.75
CASING TYPE		Full spiral case	Full spiral case	Full spiral case
CASING INLET DIAMETER:	% D_{th}	108.824	108.824	108.824
CASING AXIS DISTANCE:	% D_{th}	137.729	137.729	137.729
NUMBER OF STAY VANES	% D_{th}	10	10	10
NUMBER OF WICKET GATES	% D_{th}	20	20	20
WICKET GATE HEIGHT	% D_{th}	21.232	21.232	21.232

		Model R&D F-638-15	Model R&D F-614-13M01	Bay D'Espoir U7
Wicket gate circle diameter	% D_{th}	130.33	130.33	130.33
Runner inlet diam. (at crown)	% D_{th}	111.72	102.136	109.332
Runner exit diam. (at band)	% D_{th}	115.756	110.142	114.073
Runner band height	% D_{th}	26.547	25.793	24.013
Draft tube type		Elbow	Elbow	Elbow
Draft tube cone angle	% D_{th}	5.094°	5.094°	5.372°
Draft tube depth	% D_{th}	324.242	324.242	308.824
Draft tube length	% D_{th}	720.0	720.0	476.471
Draft tube exit height	% D_{th}	167.273	167.273	138.971
Draft tube exit width	% D_{th}	254.546	254.546	242.647
Number of pier		0	0	1
Pier distance from unit C.L.	% D_{th}	-	-	137.50
Pier width	% D_{th}	-	-	35.294

Water passage comparison between:
Bay d'Espoir U7 and R&D (runners: F-638-15, F614-13m01)



Model test
No model test is included in our proposal. The turbine performance has been established using close reference models. However, if Newfoundland Hydro requested a model test, GE Hydro will provide the associated schedule and costs.
Loss Analysis of the existing waterpassage.
In order to determine the efficiency loss of the existing assembly of unit 7, a detailed loss analysis was done.
Spiral Case
The model casing of our reference model are homologous to the Bay d'Espoir U7 casing. No efficiency correction is made.
Distributor
The stay ring, stay vanes, distributor height and wicket gate circle dimensions of our reference model are homologous to the Bay d'Espoir prototype. The wicket gate profile is however not homologous. A correction to the efficiency has been applied to account for the difference between the profiles.

Runner
No efficiency correction is made for the runner since GE Hydro is providing a new runner
Draft Tube
The existing draft tube is an elbow type. The draft tube depth and diffusion rate were reviewed and found to be acceptable.

Net Head Definition
The proposed turbine performance is based on the net head definition stated in IEC 60041 (1991)

Model to Prototype Step-Up
GE Hydro has applied a step-up value of 1.35% from model to prototype conditions. It has been applied as a constant addition to all operating points. No power step-up has been used when calculating the prototype turbine output.

It is important to note that in order to obtain the calculated step-up on the prototypes, the surface finish of the distributor, wicket gates, stay vanes and stay ring need to be in a fair condition.

Performance Curve
The expected turbine performance curves for the net heads of 172.517 m (566 feet) and 174.45 m (572.34 feet) are shown on diagram CS-7004 and CS-7005.

Maximum wicket gate opening
According to our records, the maximum wicket gate opening of the turbine is presently 23°. Based on our preliminary calculations, this opening will not be sufficient to achieve the turbine output of 188 MW under the rated net head of 172.517 m. Based on our analysis, the required maximum wicket gate opening to achieve this output value will be 28°.

New Wicket Gate Option
If new wicket gates were provided for unit 7, an efficiency gain of approximately 0.2% could be expected. This efficiency gain has not been included in the expected turbine performance efficiency. Cost for this furniture could be provided to Newfoundland Hydro upon request.

Cavitation
The new runner is guaranteed against excessive pitting due to the action of cavitation. The amount of cavitation pitting damage on the new runner will not exceed the following metal loss value:

Mass of material removed for a period of 8000 hours: $0.157 \times D_{TH}^2 = 1.87$ kg

In accordance with International Practice, the following conditions apply to our cavitation guarantee:

- The cavitation guarantee duration of operation is 8000 hours and the cavitation guarantee period is 2 years. Temporary abnormal operation shall be limited according to the recommendations described in IEC 609, article 8.2.

- The measurement and calculation of the amount of cavitation pitting shall be in accordance with IEC 609: "cavitation pitting and evaluation in hydraulic turbines, storage pumps and pump turbines.
- Our loss figures relate to weight loss caused by cavitation action only. Wear due to erosion by suspended material in the water or by chemical composition of the water is not included under the cavitation-pitting guarantee.
- GE Hydro shall be afforded the opportunity to check the machine after a reasonable operating period to be agreed with the client, and to carry out within an agreed period any work he considers necessary. If such repairs or changes are of minor nature, the cavitation period may by mutual agreement be considered as uninterrupted.
- If the runner fails to meet the guarantee for material loss as stated above, GE Hydro will repair all the damaged areas by welding and grinding.

The guarantee shall be renewed each time the turbine fails to meet the cavitation pitting guarantee.

<u>Runaway Speed</u>
Under the maximum net head of 175.68 m (576.4 ft), the new replacement runner for unit 7 will have a maximum runaway speed value of 405 rpm.

<u>Hydraulic Thrust</u>
The existing maximum hydraulic thrust value of 675 000 lb (3.0 MN) will not be exceeded.

<u>Transient Calculations</u>
Preliminary calculations, using an assumed closing law, were performed during the bid stage and the results were found acceptable for the speed and pressure rise. Detailed transient analysis will be performed at contract stage to confirm the values.

Guaranteed Turbine Performance and Prototype Field Test

<u>Guaranteed Turbine Performance</u>

It is proposed by GE Hydro to perform a pre and post Index Test to verify the turbine performance efficiency. This method is proposed to control project costs. GE Hydro would however be open to other alternative methods such as model test or prototype field efficiency test.

Turbine performance guarantees would consist in an average guaranteed weighted efficiency incremental value between the existing and new runner.

The new replacement runner will develop under the rated net head of 172.517 m, a guaranteed output value of 180 MW under an average tailwater level of 2.2 m.

An average guaranteed weighted efficiency incremental value between the new runner and the existing one has been established using the following method:

Method Pre and Post Index Test: Average Guaranteed Weighted Efficiency Incremental Value							
		Existing runner				New proposed runner	
Weighting Factor		Turbine Output				Turbine Output	
(value given in original contract)	% Rated Output *(value given in original contract)*	MW	Prototype Turbine Efficiency *(value given in the original contract)*	Step-up used between model and prototype	**Model Turbine Efficiency** *(value measured on original model test)*	**MW**	**Model Turbine Efficiency** %
			%	%	**%**		
w = 0.3	100	154.36	94.31	2.0	**92.31**	**180**	**92.18**
w = 0.0 (Peak)	-	141.59	95.10	2.0	**93.10**	**155.353**	**93.75**
w = 0.4	87.5	134.97	94.98	2.0	**92.98**	**157.5**	**93.72**
w = 0.2	75	115.58	92.83	2.0	**90.83**	**135**	**93.1**
w = 0.1	50	77.18	87.96	2.0	**85.96**	**90**	**88.9**
Expected Model Mean Weighted Efficiency:					**91.65**		**92.65**
Guaranteed weighted efficiency incremental value between the existing runner and the new one:					**1.00%**		

The acceptance of the new runner is based on the gain in efficiency. The absolute efficiency level (given in the above table and on curve CS-7004) is only given for information purposes. The justification of offering an incremental improvement value between the existing runner and the new one is due to the fact that it is very difficult to predict the efficiency step-up value for runner replacement projects due to the influence of the surface finish of old water passages. Moreover in the past, the specified step-up formulas (like full Moody) were also giving unrealistic values. Therefore, direct comparisons with existing prototype performance values give incorrect comparisons. The elimination of the issue of the magnitude of the possible efficiency step-up value has the advantage to compare correctly the efficiency gain between an existing and new runner.

Turbine Performance Efficiency verified by pre and post index test

As mentioned in the above section, a pre and post Index Test will be performed to verify the turbine performance efficiency.

We have included below information regarding the execution of the tests

- The index test would be performed with great care, using calibrating instruments of acceptable accuracy. Repetition of data collection at operating points would be done as required to help assure that test results are repeatable.

- Post upgrade Index Testing would be completed as soon as practical but within one year after start of commercial operation of the installed upgrade. The testing would be performed by GE Hydro using the IEC 60041 publication. A detailed test procedure would be supplied to Newfoundland Hydro prior to testing.

- Pre-Upgrade Index testing would be performed as close as practical prior to turbine upgrade outage period.

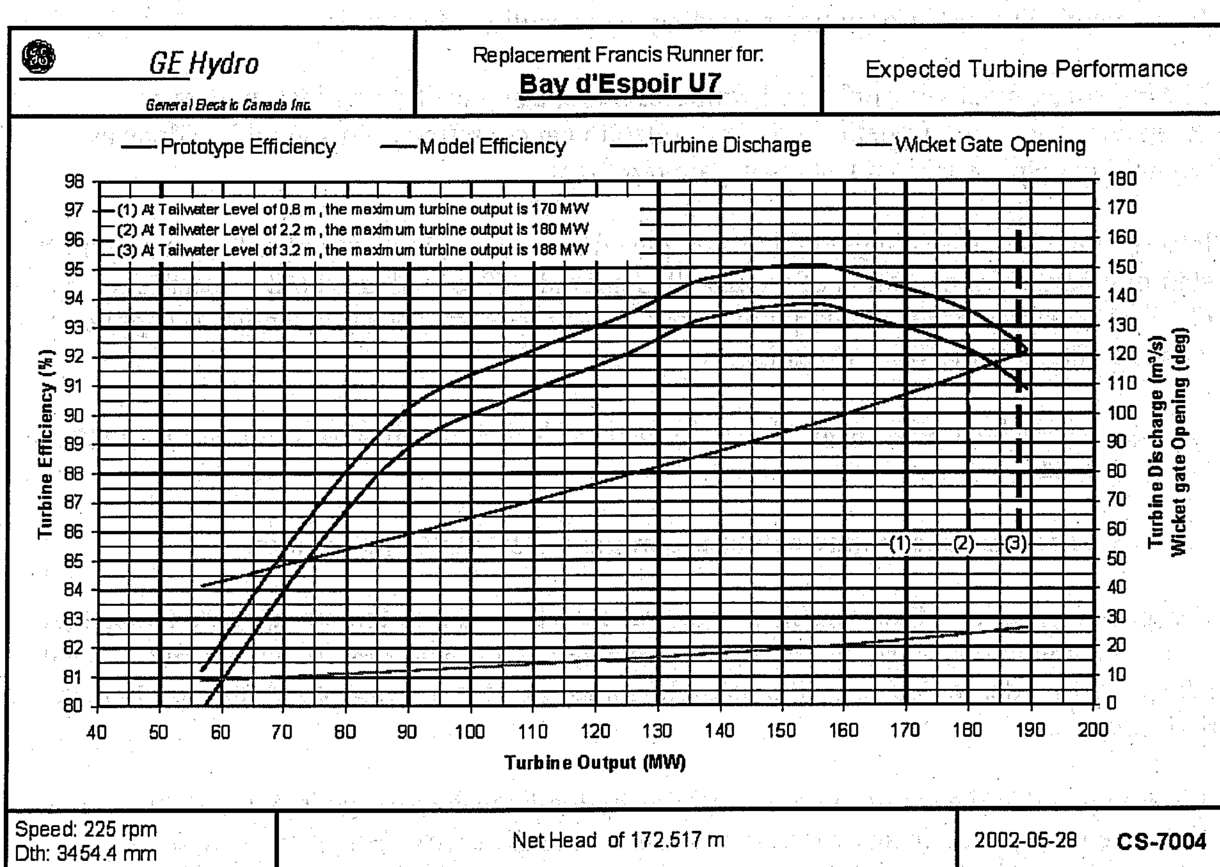
- The total efficiency uncertainty will be according to IEC 60041 publication

- Complete inspection of the machine would be done just prior to the pre-upgrade Index Test. If unusual conditions exist, discussions between GE Hydro and Newfoundland Hydro would take place in order to decide on the possible impact that the machine condition would have on performance.

- It is assumed that the condition of the turbine hydraulic waterpassage is fair, without excessive roughness. In any case, before conducting the Index Test prior to the runner removal, an inspection of all the hydraulic waterpassages including the Winter Kennedy piezometer taps and the piezometers taps at the turbine intake casing. The same type of inspection would also take place just prior to performing the Index Test of the new runner.

- GE Hydro and Newfoundland Hydro would have to agree on the generator performance curve prior to Index testing.

- A representative of Newfoundland Hydro would be at the plant site to witness both the up-grade and post-grade testing, as well as the waterpassage inspections. Prior to this testing, GE Hydro would furnish details of all test equipment, hardware and software. GE Hydro will furbish Newfoundland Hydro a complete report of each Index test performed.


GE Hydro
General Electric Canada Inc.
Replacement Francis Runner for:
Bay d'Espoir U7
Expected Turbine Performance
Prototype Efficiency
Model Efficiency
Turbine Discharge
Wicket Gate Opening
(1) At Tailwater Level of 0.8 m, the maximum turbine output is 170 MW
(2) At Tailwater Level of 2.2 m, the maximum turbine output is 180 MW
(3) At Tailwater Level of 3.2 m, the maximum turbine output is 188 MW
Turbine Efficiency (%)
Turbine Discharge (m³/s)
Wicket gate Opening (deg)
Turbine Output (MW)
(1)
(2)
(3)
Speed: 225 rpm
Dth: 3454.4 mm
Net Head of 172.517 m
2002-05-28
CS-7004

First Proposal

GRANITE CANAL
RECEIVED
FEB 15 2002

GE Hydro

Gilles Girard
Director Sales and Marketing, Canada

Geneal Electric Canada Inc.
795 George V, Lachine
Québec, Canada H8S 4K8

Thursday February 14, 2001

Newfoundland and Labrador Hydro
P.O. Box 12400
St John's, Newfoundland, Canada
A2B 4 K7

Att'n: Mr. Robert Beasaw
Project engineer

Subject: Bay d'Espoir Unit 7
Runner Replacement

Dear Bob,

Per our discussion of last year, we have prepared a proposal for the replacement of the runner for Unit 7 at Bay d'Espoir and we are pleased to submit herewith two (2) copies of our proposal.

As you will see in our proposal, the maximum turbine output can be increased to 168 MW, which represents a substantial increase over the actual rating of the unit. Also, the peak efficiency of the new runner can be achieved at a rating of 147.74 MW which also represents an added benefit to Newfoundland and Labrador Hydro. The overall efficiency of the turbine has also been improved over the operating range of the unit as you can see on the expected turbine performance curved attached to our proposal

During the Granite Canal negotiations, you had also mentioned that some generator work is required on that generator. During the course of last year, we had done a study for Newfoundland and Labrador Hydro to come up with a solution to your problems. Since, we are proposing to up-rate the turbine, we also looked at the impact of this increase on the generator with a view of fixing the problem of rim shifting on the existing unit. Our proposal also includes a solution to this problem.

Bob, I would be happy to meet with you and your colleagues to discuss this proposal. We believe that Newfoundland and Labrador Hydro could benefit from a runner replacement on unit 7 at Bay d'Espoir which, when combined with the generator work, will result in substantial increased benefits for that unit.

I am looking forward to hear from you.

Yours truly

Gilles Girard
Director Sales and Marketing, Canada

gilles.girard@ps.ge.com
Ph 514-485-4049

1. Introduction

GE Hydro is proposing to replace the existing Francis runner of Unit 7 at the Bay d'Espoir Powerplant. The new runner will develop a rated turbine output of 168 MW under a net head of 172.517 m and a tailwater level of 0.61 m or higher. The main advantages of this new runner is to provide a turbine output increase of 8.8% when compared to the original rating, a gain in weighted turbine efficiency and an excellent cavitation behaviour.

1.1 Hydraulic Runner Design

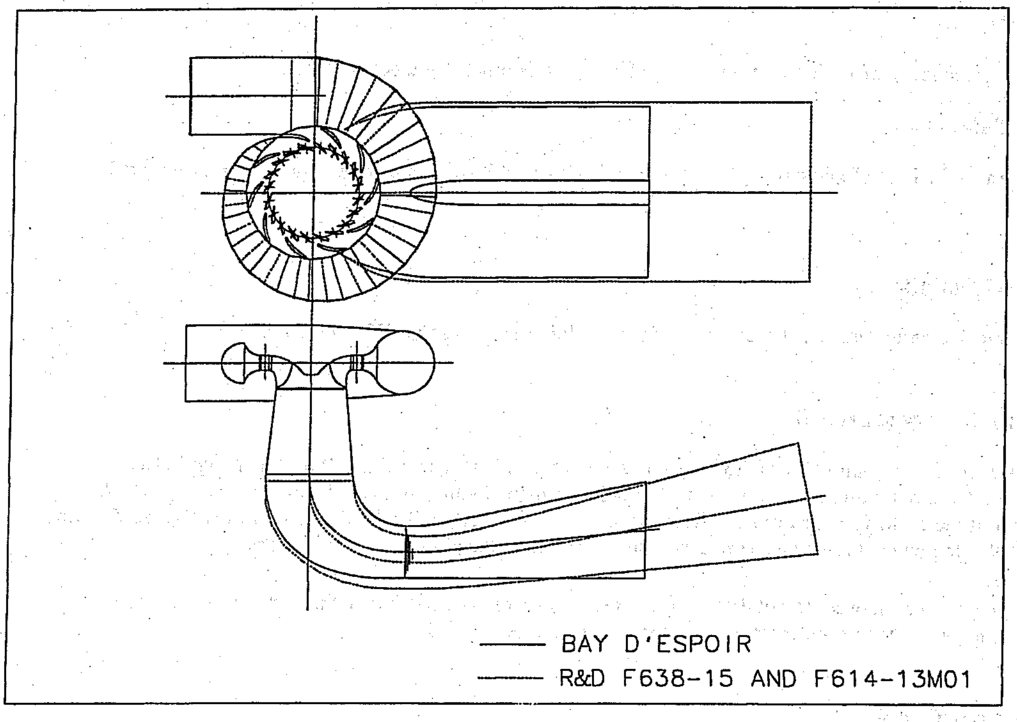
GE Hydro will design one new runner specifically for the operating requirements. The new replacement runner will have 15 blades and a throat diameter of 3454.4 mm (136 inches). No modifications to the existing waterpassage components are required with our new proposed runner. The runner will rotate at the existing speed of 225 rpm.

1.1.1 Reference models

The runner designations of GE Hydro's reference for this project are F-638-15 and F-614-13m01. These two runners were designed and model tested in 2001 within our R&D program. The model assembly used for the testing is essentially homologous to the Bay d'Espoir U7 waterpassage with the exception of the draft tube and wicket gate profile. Based on the model test results, GE Hydro has established the turbine performance that a modern runner designed for the Bay d'Espoir operating conditions would develop.

		MODEL R&D F-638-15	MODEL R&D F-614-13M01	BAY D'ESPOIR U7
THROAT DIAMETER (D_{TH})	[mm]	350.0 (model)	350.0 (model)	3454.4
SPEED COEFFICIENT AT MAX. EFF.	n11	59.74	60.26	59.175
POWER COEFFICIENT AT MAX. EFF.	P11	7.00	5.982	5.366
DISCHARGE COEFFICIENT AT MAX. EFF.	Q11	0.757	0.651	0.586
MAXIMUM MODEL EFFICIENCY	%	94.43	93.75	93.75
CASING TYPE		Full spiral case	Full spiral case	Full spiral case
CASING INLET DIAMETER:	% D_{th}	108.824	108.824	108.824
CASING AXIS DISTANCE:	% D_{th}	137.729	137.729	137.729
NUMBER OF STAY VANES	% D_{th}	10	10	10
NUMBER OF WICKET GATES	% D_{th}	20	20	20
WICKET GATE HEIGHT	% D_{th}	21.232	21.232	21.232
WICKET GATE CIRCLE DIAMETER	% D_{th}	130.33	130.33	130.33
RUNNER INLET DIAM. (AT CROWN)	% D_{th}	111.72	102.136	109.332
RUNNER EXIT DIAM. (AT BAND)	% D_{th}	115.756	110.142	114.073
RUNNER BAND HEIGHT	% D_{th}	26.547	25.793	24.013
DRAFT TUBE TYPE		Elbow	Elbow	Elbow
DRAFT TUBE CONE ANGLE	% D_{th}	5.094°	5.094°	5.372°
DRAFT TUBE DEPTH	% D_{th}	324.242	324.242	308.824
DRAFT TUBE LENGTH	% D_{th}	720.0	720.0	476.471
DRAFT TUBE EXIT HEIGHT	% D_{th}	167.273	167.273	138.971
DRAFT TUBE EXIT WIDTH	% D_{th}	254.546	254.546	242.647
NUMBER OF PIER		0	0	1
PIER DISTANCE FROM UNIT C.L.	% D_{th}	-	-	137.50
PIER WIDTH	% D_{th}	-	-	35.294

Water passage comparison between:
Bay d'Espoir U7 and R&D (runners: F-638-15, F614-13m01)



1.1.2 Model test

No model test is included in our proposal. The turbine performance has been established using close reference models. However, if Newfoundland Hydro requested a model test, GE Hydro will provide the associated schedule and costs.

1.2 Loss Analysis of the existing waterpassage.

In order to determine the efficiency loss of the existing assembly of unit 7, a detailed loss analysis was done.

1.2.1 Spiral Case

The model casing of our reference model are homologous to the Bay d'Espoir U7 casing. No efficiency correction is made.

1.2.2 Distributor

The stay ring, stay vanes, distributor height and wicket gate circle dimensions of our reference model are homologous to the Bay d'Espoir prototype. The wicket gate profile is however not homologous. A correction to the efficiency has been applied to account for the difference between the profiles.

1.2.3 Runner

No efficiency correction is made for the runner since GE Hydro is providing a new runner

1.2.4 Draft Tube

The existing draft tube is an elbow type. The draft tube depth and diffusion rate were reviewed and found to be acceptable.

1.3 Net Head Definition

The proposed turbine performance is based on the net head definition stated in IEC 60041 (1991)

1.4 Model to Prototype Step-Up

GE Hydro has applied a step-up value of 1.35% from model to prototype conditions. It has been applied as a constant addition to all operating points. This step-up is lower than obtained by the method defined in IEC 995: "Determination of the prototype performance from model acceptance tests of hydraulic machines with consideration of scale effects". No power step-up has been used when calculating the prototype turbine output.

It is important to note that in order to obtain the calculated step-up on the prototypes, the surface finish of the distributor, wicket gates, stay vanes and stay ring need to be in a fair condition.

1.5 Performance Curve

The expected turbine performance curve for the rated net head of 172.517 m (566 feet) is shown on diagram CS-6961.

1.6 Maximum wicket gate opening

The existing maximum wicket gate opening of 23° will be sufficient to achieve the guaranteed output.

1.7 New Wicket Gate Option

If new wicket gates were provided for unit 7, an efficiency gain of approximately 0.2% could be expected. This efficiency gain has not been included in the expected turbine performance efficiency. Cost for this furniture could be provided to Newfoundland Hydro upon request.

1.8 Cavitation

The new runner is guaranteed against excessive pitting due to the action of cavitation. The amount of cavitation pitting damage on the new runner will not exceed the following metal loss value:

Mass of material removed for a period of 8000 hours: $0.157 \times D_{TH}^2 = 1.87$ kg

In accordance with International Practice, the following conditions apply to our cavitation guarantee:

- The cavitation guarantee duration of operation is 8000 hours and the cavitation guarantee period is 2 years. Temporary abnormal operation shall be limited according to the recommendations described in IEC 609, article 8.2.
- The measurement and calculation of the amount of cavitation pitting shall be in accordance with IEC 609: "cavitation pitting and evaluation in hydraulic turbines, storage pumps and pump turbines.
- Our loss figures relate to weight loss caused by cavitation action only. Wear due to erosion by suspended material in the water or by chemical composition of the water is not included under the cavitation-pitting guarantee.
- GE Hydro shall be afforded the opportunity to check the machine after a reasonable operating period to be agreed with the client, and to carry out within an agreed period any work he considers necessary. If such repairs or changes are of minor nature, the cavitation period may by mutual agreement be considered as uninterrupted.
- If the runner fails to meet the guarantee for material loss as stated above, GE Hydro will repair all the damaged areas by welding and grinding.

Our guarantee is related to weight loss caused by cavitation only. Wear due to erosion by suspended material in the water or by the chemical composition of the water is not included in our cavitation pitting guarantee.
The guarantee shall be renewed each time the turbine fails to meet the cavitation pitting guarantee.

1.9 Runaway Speed

Under the maximum net head of 173.736 m (570 ft), the new replacement runner for unit 7 will have a maximum runaway speed value of 405 rpm.

1.10 Hydraulic Thrust

The existing maximum hydraulic thrust value of 675 000 lb (3.0 MN) will not be exceeded.

1.11 Transient Calculations

Preliminary calculations, using an assumed closing law, were performed during the bid stage and the results were found acceptable for the speed and pressure rise. Detailed transient analysis will be performed at contract stage to confirm the values.

2. Guaranteed Turbine Performance and Prototype Field Test

2.1 Guaranteed Turbine Performance

It is proposed by GE Hydro to perform a pre and post Index Test to verify the turbine performance efficiency. This method is proposed to control project costs. GE Hydro would however be open to other alternative methods such as model test or prototype field efficiency test.

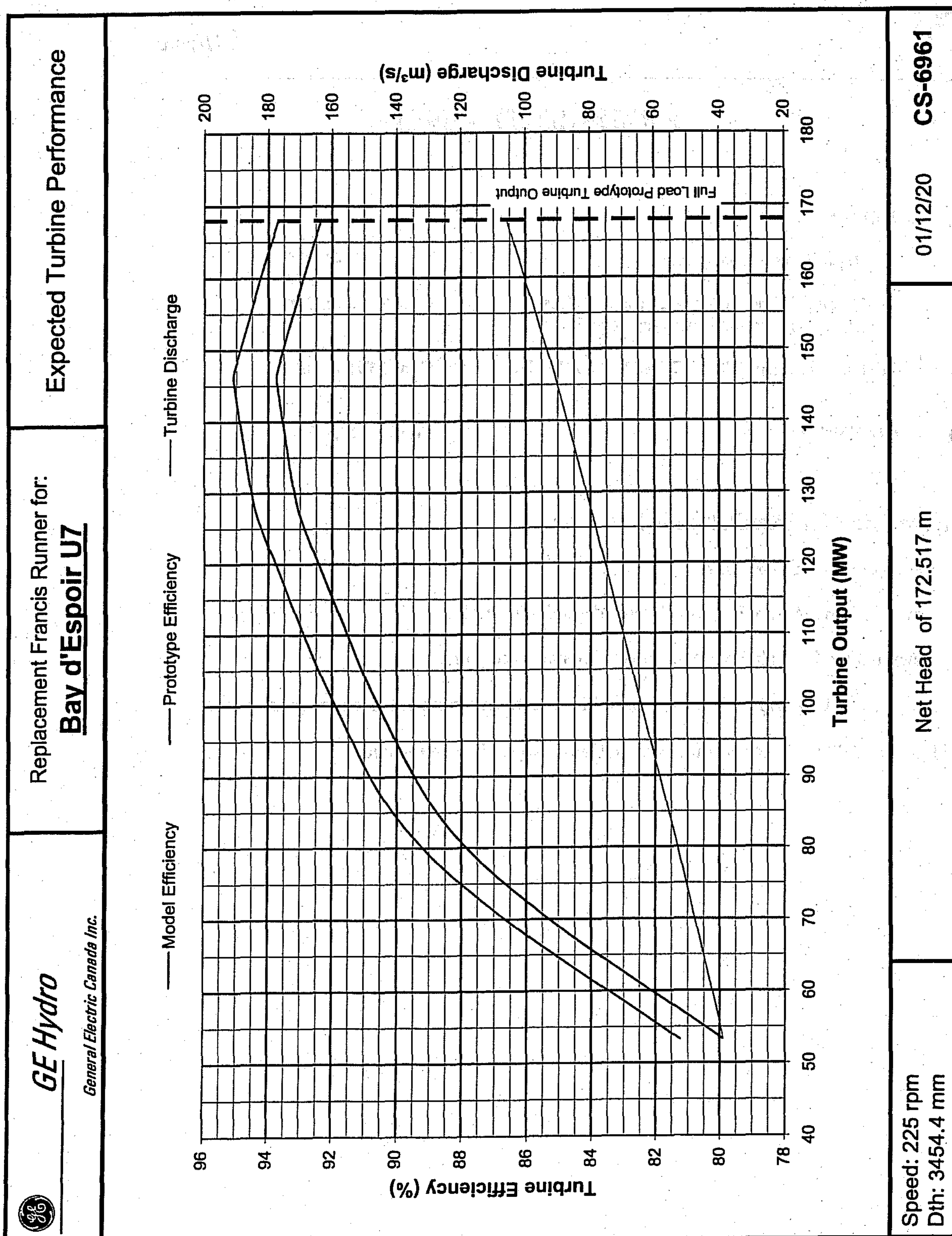
Turbine performance guarantees would consist in an average guaranteed weighted efficiency incremental value between the existing and new runner.

The new replacement runner will develop under the rated net head of 172.517 m, a guaranteed output value of 168 MW.

An average guaranteed weighted efficiency incremental value between the new runner and the existing one has been established using the following method:

Method Pre and Post Index Test: Average Guaranteed Weighted Efficiency Incremental Value							
		Existing runner				New proposed runner	
Weighting Factor		Turbine Output				Turbine Output	
(value given in original contract)	% Rated Output *(value given in original contract)*	MW	[redacted]	[redacted]	**Model Turbine Efficiency** *(value measured on original model test)* %	**MW**	**Model Turbine Efficiency** %
w = 0.3	100	154.36	[redacted]	[redacted]	**92.31**	**168.0**	**92.35**
w = 0.0 (Peak)	-	141.59	[redacted]	[redacted]	**93.10**	**147.74**	**93.75**
w = 0.4	87.5	134.97	[redacted]	[redacted]	**92.98**	**147.0**	**93.73**
w = 0.2	75	115.58	[redacted]	[redacted]	**90.83**	**126.0**	**92.95**
w = 0.1	50	77.1[illegible]	[redacted]	[redacted]	**85.96**	**84.0**	**88.60**
Expected Model Mean Weighted Efficiency:					**91.65**		**92.65**
Guaranteed weighted efficiency incremental value between the existing runner and the new one:					**1.00%**		

The acceptance of the new runner is based on the gain in efficiency. The absolute efficiency level (given in the above table and on curve CS-6961) is only given for information purposes. The justification of offering an incremental improvement value between the existing runner and the new one is due to the fact that it is very difficult to predict the efficiency step-up value for runner replacement projects due to the influence of the surface finish of old water passages. Moreover in the past, the specified step-up formulas (like full Moody) were also giving unrealistic values. Therefore, direct comparisons with existing prototype performance values give incorrect comparisons. The elimination of the issue of the magnitude of the possible efficiency step-up value has the advantage to compare correctly the efficiency gain between an existing and new runner.


GE Hydro
General Electric Canada Inc.
Replacement Francis Runner for:
Bay d'Espoir U7
Expected Turbine Performance
Model Efficiency
Prototype Efficiency
Turbine Discharge
Turbine Efficiency (%)
96
94
92
90
88
86
84
82
80
78
Turbine Discharge (m³/s)
200
180
160
140
120
100
80
60
40
20
Turbine Output (MW)
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Full Load Prototype Turbine Output
Speed: 225 rpm
Dth: 3454.4 mm
Net Head of 172.517 m
01/12/20
CS-6961

GE Hydro

PRICING SHEET - Turbine

A)	SUPPLY		
	- Replacement Runner (Only):	Cdn. $ 1,254,268.00	
	- Turbine Efficiency Pre and Post Index Test: (Please see Hydraulic write-up Page 6)	Cdn. $ 53,333.00	
B)	RUNNER REPLACEMENT INSTALLATION:	Cdn. $ 164,145.00	
C)	TRANSPORT:	Cdn.$ 33,333.00	

Above Price for Installation is based on:

- 6 days per week 10 hour shifts
- Newfoundland & Lab. Hydro will have the unit dismantled
- Newfoundland & Lab. Hydro to reassemble and startup unit
- Remove shaft, clean/inspect shaft, assemble shaft to new runner, place runner shaft assembly
- Based on 2002 current rates for Granite Canal Project in Newfoundland

GE Hydro

1. Introduction

GE Hydro has proposed to replace the existing turbine runner on unit #7 at Bay D'Espoir. The replacement runner will produce more power, be more efficient and have excellent cavitation behaviour.

2.1 Runner Characteristics

The new runner will have the following characteristics that may affect the generator design:

Rated speed –	225 rpm (unchanged)
Maximum overspeed –	405 rpm (increased from 380 rpm)
Hydraulic thrust -	< 675,000 lbs (below existing value)
Maximum turbine power -	168 MW (increased from 154.36 MW)

2.2 Effect on Generator design

The rated speed has not changed, therefore the basic generator electromagnetic is unaffected.

The increase in runaway speed (from 380 rpm to 405 rpm) would increase the maximum possible stress in the rotor rim and rotor poles by 13.5%. GE has reviewed the actual design and can confirm that the rotor rim and rotor poles can accept this increase in runaway speed without any modifications. It should be noted that the actual stress level in the rotor pole endplates will be higher than present design standards (GE Hydro estimates that ½ of the safety margin will be lost) but that this would be acceptable. GE Hydro can confirm the actual stress level at a later date.

The hydraulic thrust of the unit will not be greater than the existing runner, therefore the loads on the lower bracket and thrust bearing will not increase.

The increase in rated turbine power from 154.36 MW to 168 MW would require the generator rating to increase from 172 MVA to 184 MVA at a power factor of 0.9 (an increase of 7%). Records that GE have from the original testing of the unit #7 generator indicate there is presently margin in the operating temperature of both the rotor and stator. GE feels that the new rating of 184 MVA can be achieved with a temperature rise in both the stator and rotor below 65 C above cool air temperature.

The present equipment can accommodate the increase in mechanical power of 8.8 %.

Overall, the increase in turbine rating can be accommodated with no changes in the generator components.

2.3 Rotor Spider Design

Various correspondences have occurred between GE Hydro and Newfoundland Hydro over the subject of the rotor balance of Unit #7. GE Hydro would like to confirm that we feel the best solution to these issues is the shrinking of the rotor rim onto the rotor spider.

The study entitled "Rotor Rim Shrink Study" performed by GE Hydro in September, 2000 by Mr. Mike White and Mr. Wayne Martin examined the possibility of shrinking the rotor rim onto the present rotor spider. The conclusion stated that, with reinforcement, the present rotor spider could accept a rotor rim shrink that would be effective until 115 % of rated speed. The present industry standard for shrunk rotor rims is 125-130% of rated speed.

GE Hydro would like to propose that the rotor spider be completely replaced. The new rotor spider would be designed to transmit the increased power from the turbine and also be designed to allow the retained rotor rim to be shrunk to 130 % of rated speed.
The spider would also have a modern keying system between the rotor rim and rotor spider to maintain rotor balance at speeds above 130 % rated.

GE Hydro

PRICING SHEET - Generator

A) SUPPLY:

- **Spider Replacement:** **Cdn. $ 439,091.00**

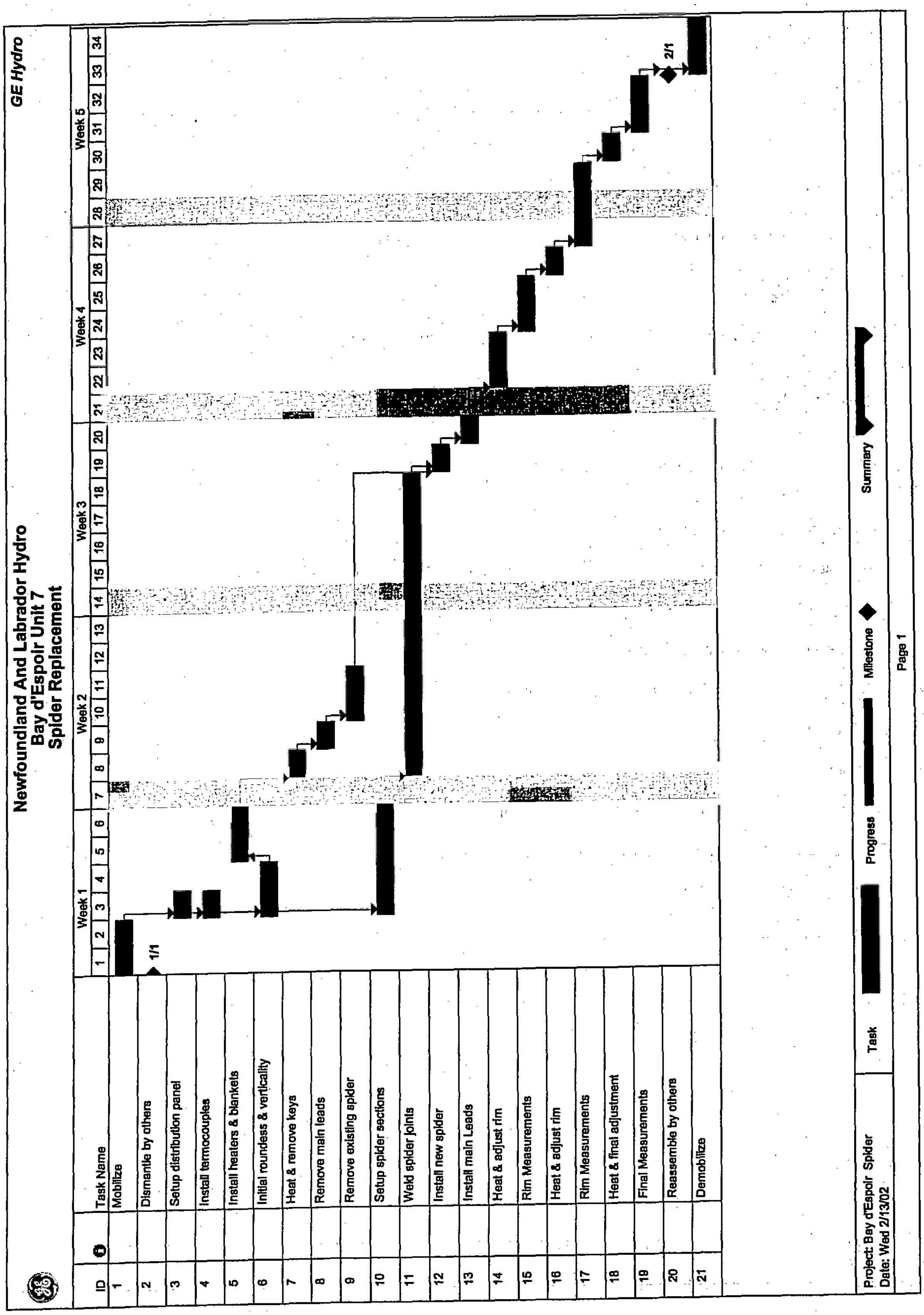
B) Installation:

- **Spider Replacement:** **Cdn. $ 239,641.00**

C) TRANSPORT: **Cdn.$ 33,333.00**

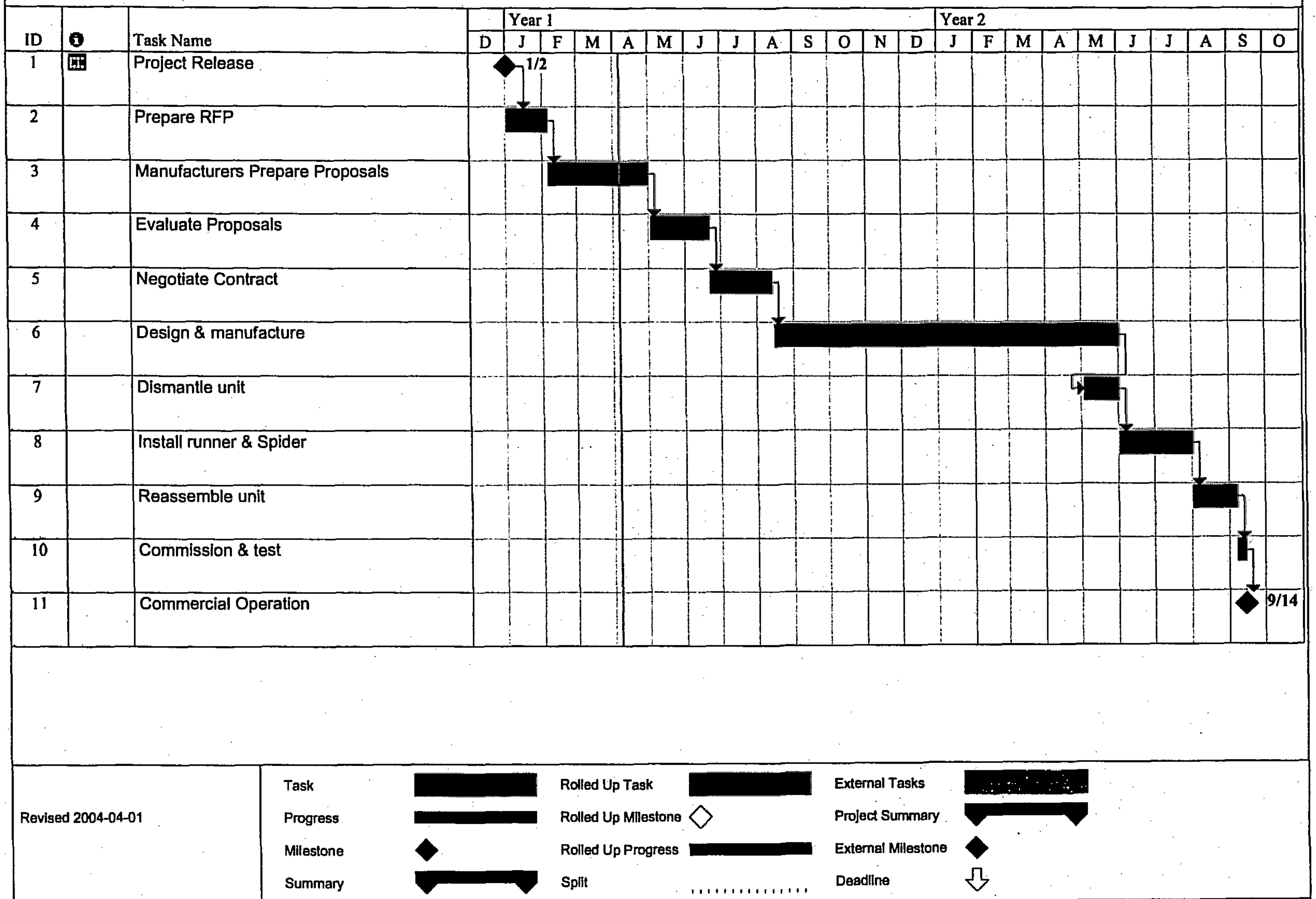
Above Price for Installation is based on:

- 6 days per week 10 hour shifts
- Newfoundland & Lab. Hydro will have the unit dismantled and placed in the erection bay
- Newfoundland & Lab. Hydro to reassemble and startup unit
- GE to send rep for startup and balancing
- Heaters and blankets included in price to be left at site
- Spider can be removed using the crane
- Customer will ream coupling holes during reassembly
- One initial heating cycle required for elevation and centering
- Rim can be adjusted by two additional heating cycles risk 10%
- Current union rates recorded for Granite Canal 2002
- Main leads and supports will be reused


Newfoundland And Labrador Hydro
Bay d'Espoir Unit 7
Spider Replacement
GE Hydro
ID
Task Name
Week 1
Week 2
Week 3
Week 4
Week 5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34
1 Mobilize
2 Dismantle by others
3 Setup distribution panel
4 Install termocouples
5 Install heaters & blankets
6 Initial roundess & verticality
7 Heat & remove keys
8 Remove main leads
9 Remove existing spider
10 Setup spider sections
11 Weld spider joints
12 Install new spider
13 Install main Leads
14 Heat & adjust rim
15 Rim Measurements
16 Heat & adjust rim
17 Rim Measurements
18 Heat & final adjustment
19 Final Measurements
20 Reassemble by others
21 Demobilize
1/1
2/1
Project: Bay d'Espoir Spider
Date: Wed 2/13/02
Task
Progress
Milestone
Summary
Page 1

APPENDIX III
Project Schedule

Bay D'Espoir Unit 7 Runner Replacement



Revised 2004-04-01

APPENDIX IV
Efficiency Increase Calculation

When Unit 7 was designed by Dominion Engineering Works (Now GE Hydro) in the mid 1970s, it was optimized to maximize the weighted average efficiency, based on weighting factors specified in Hydro's request for proposals. A review of operating records for a recent three year period indicated that the unit is operated in a different manner than was predicted by the weighting factors (see Table 4, page 7). The proposal submitted by GE Hydro was based on the original operating factor and the efficiency increase they predict for the new runner is the difference between the efficiency of the original runner and the proposed new runner at several operating points, multiplied by the original weighting factors. For the purpose of this analysis, this methodology was followed, but new weighting factors were derived based on the recent three year period of operating experience. The results are summarized in the table below:

From GE proposal 2002-05-29					
Turbine Output (MW)	Original Model Efficiency (%)	New Model Efficiency (%)	New Weighting Factor	Original Model Efficiency (%)	New Model Efficiency (%)
115.58	90.83	93.10	0.10	8.70	8.92
134.97	92.98	93.72	0.03	2.54	2.56
141.59	93.10	93.75	0.72	66.70	67.16
154.36	92.31	92.18	0.16	14.82	14.80
			Weighted efficiency:	92.7525	93.4349
			Difference:		**0.6825**

This analysis indicates that the energy production increase we would realize would be 0.6825%, not 1.00% as stated by GE Hydro. There is no doubt that GE Hydro could redesign the runner to increase its weighted efficiency, based on our new weighting factors and this should be investigated should this project proceed.