

REDACTED

Request IR-1:

Please provide cost breakdown for the item, Installation of New Vibration Mitigation System, \$1,670,755, in the Capital Project Detailed Estimate, p.3 of the Application file. Please list the associated works, materials, personnel, hourly rates, hours, units, unit costs, number of units, etc.

Response IR-1:

\$ [REDACTED] of \$1,670,755 in the line item Installation of New Vibration Mitigation System in the Capital Project Detailed Estimate is the contractor installation of the 288 custom Preformed Line Products (PLP) dampers and 1,164 PLP airflow spoilers using a third-party helicopter company. It was completed on a time and materials basis; please refer to the summary in the table below.

Contracts – Installation of New Vibration Mitigation System	Amount (\$)
Contractor Labour	[REDACTED]
Travel Expenses – LOA (Living Out Allowance)	
Equipment	
Rebillable Expenses (Helicopters, Traffic Control, Trucking, Civil Work)	
Specialty Materials (Conductor Carts)	
Total*	

* Small differences in totals are attributable to rounding

Please refer to Partially Confidential Attachment 1 for the contractor invoice with a further breakdown, including units, hours, and rates.

The remaining \$ [REDACTED] comprised of external services to monitor work safety and quality control during the installation and to complete an as-built survey of the final conductor elevation for the Transport Canada permit application.



Locke's Electrical Limited

10 Lintrose Place
Mount Pearl NL A1N 5K2

Tel: (709)745-1635
Fax: (709)463-8287

INVOICE

Customer

Nova Scotia Power Incorporated
1223 Lower Water Street, PO Box 910
Halifax NS B3J 3S8
Canada

Invoice #

25-10555-R1

Page 1 of 1

Order#

2161106

Invoice Date

2025/07/31

Project

NS Power - Canso Causeway

Billing Period

From 25/05/26 to 25/06/21

Description

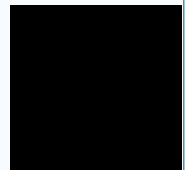
Quantity

Unit Price

Amount

To invoice for all services performed
for the Canso Causeway project.

Labour
LOA
Equipment
Rebillable Expenses
Specialty Materials



GST/HST #

103370623RT0001

Total Sale

GST/HST

Continued ...

Invoice Total

30 Days A/R



Nova Scotia Power
Invoice Details
May 25, 2025 to June 21, 2025

Page 1 / 4

Labour Expenses

<i>Position</i>	<i>Type</i>	<i>Hours</i>	<i>Rate</i>	<i>Total</i>
HSE	S/T	70.00		
	O/T	11.00		
QA/QC	S/T	70.00		
	O/T	11.00		
Project Manager	S/T	148.00		
	O/T	21.00		
	D/T	14.00		
Construction Manager	S/T	158.00		
	O/T	22.00		
	D/T	14.00		
General Foreman	S/T	129.00		
	O/T	10.00		
	D/T	6.00		
	HGT S/T	4.00		
	CART	56.00		
Working Foreman	S/T	228.00		
	O/T	15.00		
	D/T	20.00		
	HGT S/T	8.00		
	CART	99.00		
Lead Hand	S/T	122.00		
	O/T	22.00		
	D/T	14.00		
	HGT S/T	4.00		
	CART	13.00		
PLT	S/T	412.00		
	O/T	62.00		
	D/T	34.00		
	HGT S/T	22.00		
	CART	31.00		
APP4	S/T	129.00		
	O/T	16.50		
	D/T	14.00		
	HGT S/T	4.00		
	CART	15.00		

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Nova Scotia Power
Invoice Details
May 25, 2025 to June 21, 2025

Page 2 / 4

Labour Expenses (continued)

<i>Position</i>	<i>Type</i>	<i>Hours</i>	<i>Rate</i>	<i>Total</i>
APP2	S/T	214.00		
	O/T	47.00		
	D/T	18.00		
	CART	33.00		
Crane Operator	S/T	232.50		
	O/T	61.50		
	D/T	18.00		
APP6	S/T	113.00		
	O/T	28.00		
	D/T	6.00		
	CART	38.00		
Total Labour Expense		2837.50		

Travel Expenses - LOA

<i>Position</i>	<i>Type</i>	<i>Qty</i>	<i>Rate</i>	<i>Total</i>
HSE	Daily	6.00		
QA/QC	Daily	6.00		
Project Manager	Daily	19.00		
Construction Manager	Daily	20.00		
General Foreman	Daily	21.00		
Working Foreman	Daily	38.00		
Lead Hand	Daily	19.00		
PLT	Daily	59.00		
PLT Apprentice 3Ryan M:	Daily	19.00		
PLT Apprentice 2Marc Tir	Daily	32.00		
Crane Operator	Daily	32.00		
PLT Apprentice 4	Daily	19.00		
Total Travel Expense				

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Nova Scotia Power
Invoice Details
May 25, 2025 to June 21, 2025

Page 3 / 4

Equipment Expenses

<i>Unit</i>	<i>Description</i>	<i>Qty</i>	<i>Rate</i>	<i>Total</i>
PUV108	Pick up truck	123.00		
PUV111	Pick up truck	184.00		
PUV112	Pick up truck	184.00		
PUV113	Pick up truck	204.00		
PUV114	Pick up truck	184.00		
PUV115	Pick up truck	184.00		
PUV116	Pick up truck	184.00		
PUV117	Pick up truck	204.00		
PUV120	Pick up truck	184.00		
PUV085	Pick up truck	184.00		
HT549	Tilt Tag Trailer	184.00		
UV136	Rubber Tire Digger Derrick	100.00		
EX271	14.5-Ton Excavator	100.00		
TE243	125' Tracked Bucket	194.00		
TE242	100' Tracked Bucket	194.00		
TE241	80' General Digger	194.00		
TE230	105' Tracked Bucket	194.00		
TE238	65' Tracked Digger	194.00		
TE239	65' Tracked Digger	194.00		
Boat	Boat Rescue	194.00		
Cargo Trailer	Cargo Trailer	184.00		
Spacer Cart 1	Spacer Cart	184.00		
Spacer Cart 2	Spacer Cart	184.00		
Job Trailer	Office Trailer	194.00		
Cargo Trailer 2	Cargo Trailer	184.00		
Yard Rental	Yard	204.00		

Total Equipment Expense

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Nova Scotia Power
Invoice Details
May 25, 2025 to June 21, 2025

Page 4 / 4

Rebillable Expenses

<i>Description</i>	<i>Reference</i>	<i>Subtotal</i>	<i>Markup</i>	<i>Total</i>
Ascent Helicopters	2025-875			
Ascent Helicopters	2025-876			
Ascent Helicopters	2025-1037			
AWP Safety	142897			
AWP Safety	143087			
GAP Trucking	202500041			
Norvon	25181			
Scott-Vac	0720-25-04			
Turbine Crane	LOCKE-01			
Turbine Crane	LOCKE-02			
Strum	43070			
Specialty Materials	N/A		-	
Total Rebillable Charges				

Total Charges this Period: \$

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1 **Request IR-2:**

2
3 **Attachment 1, p.15 to p.88, the Havard Engineering report, is marked as a draft. Please**
4 **clarify whether a final version of the report exists.**

5
6 **(a) If there is a final version, please provide it for Board's review.**

7
8 **(b) If not, please explain why a final version has not been prepared.**

9
10 **Response IR-2:**

11
12 The Harvard Engineering report, although bearing a draft watermark, was confirmed by the Author
13 to be the final version. Accordingly, no further versions were prepared, and cannot be provided.

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Request IR-3:

Attachment 1, p.43 to p.44, the Havard Engineering report, Conclusion, Section 7 to 10, lists recommended action items. Please describe the work that NS Power performed under the proposed project.

Response IR-3:

Work was undertaken in line with recommendations laid out on page 43 and 44 of Attachment 1 to the application. A detailed breakdown of this work is described below.

- **2022 (Immediate Mitigation & Assessment):** Conducted climbing inspections to assess conductor and hardware condition (Rec. 1–2); completed armor rod installations (Rec. 3–4); installed additional vibration dampers (Rec. 5–6); and initiated engineering review of vibration performance and design assumptions (Rec. 7).
- **2023 (Validation & Solution Development):** Completed drone inspections and targeted repairs to validate and maintain conductor condition (Rec. 1–2, 3–4, 8); progressed evaluation and selection of long-term mitigation measures including special purpose dampers and air flow spoilers (Rec. 5–6, 9–10); engaged external experts for independent validation (Rec. 11); and developed and implemented a structured monitoring strategy post final project work on mitigation (Rec. 8, 12).
- **2024 (Final Validation & Implementation Readiness):** Performed final pre-work inspections confirming system condition (Rec. 1–2, 8); completed tower maintenance and structural checks (Rec. 13); finalized engineering modelling and validation of mitigation solutions (Rec. 7, 9); procured damping and air flow spoiler systems for deployment (Rec. 5–6, 10); completed laboratory validation (Rec. 11); and established implementation and contingency measures, including ongoing monitoring (Rec. 12, 14).

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Request IR-4:

Attachment 1, p.9, Section 8 Dampers & AFS noted following:

L8004 Canso strait crossing which is located adjacent to the L7004 crossing did not experience similar issues due to severe galloping. This was due to the installation of air flow spoilers to the phase conductors on L8004. This prevented galloping and is a convenient reference/benchmark as this mitigated L8004 crossing has been satisfactorily in service.

[N-2, Attachment 1, p.9]

Further at Attachment 1, p.146, the AAB Report, Section 1, Project Description and Scope noted following:

The first power line, a 345 kV double circuit line designated L8004, was constructed in 1983 using self-damping conductors. In 1984, severe galloping led to conductor damage and flashovers. This issue was resolved by adding air flow spoilers to the conductors, which prevented further galloping and maintained the span's stability against aeolian vibrations.

[N-2, Attachment 1, p.146]

- (a) Please explain whether NS Power was aware of the galloping issues associated with L8004 line crossing at Canso Strait.**
- (b) Please explain why the original crossing design for L7005 did not incorporate airflow spoilers, given the prior issues experienced on the adjacent L8004 line crossing.**
- (c) Please describe the original design approval process and explain whether NS Power identified or considered these issues during its review of Hatch's design.**

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1 Response IR-4:

2
3 (a) Yes, NS Power identified the 1984 galloping issues on L-8004 as there were line trips due
4 to conductor galloping and phases coming in contact with each other.

5
6 (b) Galloping and aeolian vibrations are two separate phenomenon, and through consultations
7 with different external experts, both these terms are frequently used. The definitions for
8 each are provided below:

9
10 Galloping on high-voltage transmission lines is a large-amplitude, low-frequency
11 oscillation of overhead conductors, typically caused by wind acting on ice- or snow-coated
12 conductors.

13
14 Aeolian vibration is a wind-induced vibration where alternating vortices form and shed
15 from the conductor surface, causing it to oscillate at relatively high frequencies with small
16 amplitudes.

17
18 Air flow spoilers on L-8004 were implemented as a corrective retrofit following galloping-
19 related phase slapping and line tripping in 1984, which was largely attributed to insufficient
20 phase spacing under galloping conditions in the original design.

21
22 Unlike the case of L-8004, for L-7005, there is no recorded historical evidence of phase
23 slapping due to galloping. The primary concern on L-7005 was uncontrolled aeolian
24 vibrations due to inadequate damping and dampers slipping on conductor and causing
25 damage to outer layers of conductor.

26
27 Damages observed on conductor and fatigue on existing dampers led external experts to
28 conclude that the crossing is experiencing uncontrolled aeolian vibration combined with
29 some galloping during colder weather with ice accumulation on conductor.

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1 Incorporating Air Flow Spoilers (or similar devices) in the original design without evidence
2 on a precautionary basis would have introduced significant design and cost impacts.
3 Maintaining the required electrical clearances to comply with Transport Canada
4 obligations over the Strait of Canso would have driven an increase in tower height, with a
5 comparable increase in overall project cost.

6
7 To understand the cost impact, NS Power considered the effect of installing spoilers and
8 mid-span dampers on the L7005 crossing. Ultimately, it was found that the conductors
9 would sag approximately 6.67 m more with these devices installed than without them.

10
11 If spoilers and mid-span dampers had been included in the original design as a precaution,
12 the additional sag would have required taller towers, larger foundations, and designs
13 capable of handling higher wind and ice loads to maintain the required clearance over the
14 water. This would have significantly increased project costs.

15
16 L8004 and L7005 Canso crossing spans were originally designed to maintain the minimum
17 vertical clearance in accordance with the Canadian Navigable Waters Act under the
18 authority of Transport Canada.

19
20 In September 2023, Transport Canada advised that the minimum vertical clearance
21 requirements had been reduced for the Strait of Canso. This change allowed NS Power to
22 lower the conductor further on the water crossing span and accommodate the additional
23 conductor sag caused by the vibration mitigation measures, while still meeting clearance
24 requirements. Without this change, the mitigation solution would have required the already
25 very tall towers to be built even taller to maintain the original clearance, resulting in a much
26 more expensive solution.
27

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1 Based on the information and past operating experience available at the time, the primary
2 galloping-related risk would have been effectively mitigated through phase spacing design,
3 and there was limited indication to support additional measures such as air flow spoilers to
4 address aeolian vibration. As a result, the original design followed a risk-based approach
5 consistent with standard engineering practice, balancing reliability, constructability, and
6 cost.

7
8 (c) Below is the process undertaken during the original crossing design
9

- 10 • Hatch (the line design engineer), Salvi (hardware subject matter expert), and
11 Sediver (damping subject matter expert) collaboratively developed the conductor
12 design and damping parameters through the formal engineering process.
- 13 • ZTT (the conductor supplier) reviewed the damping solution and made technical
14 recommendations to improve effectiveness; these were formally acknowledged by
15 NS Power and escalated to Salvi via Sediver for technical review.
- 16 • Salvi performed testing on ZTT's conductor and validated damper effectiveness
17 against applicable standards, providing technical confirmation of the damping
18 approach.

19
20 Hatch remained engaged throughout and contributed to subsequent refinement of damping
21 criteria, which were accepted by NS Power.