newfoundland labrador hydro
a nalcor energy company

Hydro Place. 500 Columbus Drive.
P.O. Box 12400. St. John's. NL
Canada A1B 4K7
t. 709.737.1400 f. 709.737.1800
www.nlh.nl.ca

October 21, 2015

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

ATTENTION: Ms. Cheryl Blundon
Director of Corporate Services & Board Secretary

Dear Ms. Blundon:

Re: **An Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41 (3) of the Act for the approval of the Internal Assessment and Repair of Transformer VBN T1 at the Voisey's Bay Nickel Terminal Station.**

Please find enclosed the original and 12 copies of the above-noted Application, plus supporting affidavit, project proposal, and draft order.

The proposed project involves the internal assessment and repair of transformer VBN T1 at the Voisey's Bay Nickel Terminal Station which is necessary for the supply of dependable and reliable power to the Island Industrial Customers. Hydro respectfully requests that this application be addressed in an expedited manner to ensure the project can be completed as per the project schedule.

Should you have any questions, please contact the undersigned.

Yours truly,

NEWFOUNDLAND AND LABRADOR HYDRO

Tracey L. Pennell
Legal Counsel

TLP/bs

cc: Gerard Hayes – Newfoundland Power
Paul Coxworthy – Stewart McKelvey Stirling Scales
Sheryl Nisenbaum – Praxair Canada Inc.
Thomas Johnson – Consumer Advocate
Thomas J. O'Reilly, Q.C. – Cox & Palmer

IN THE MATTER OF the *Electrical Power Control Act,* RSNL 1994, Chapter E-5.1 (the *EPCA*) and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the *Act*), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the *Act*, for approval of the Internal Assessment and Repair of the T1 Transformer at the Voisey's Bay Nickel Terminal Station.

TO: The Board of Commissioners of Public Utilities (the Board)

THE APPLICATION OF NEWFOUNDLAND AND LABRADOR HYDRO (Hydro) STATES THAT:

1. Hydro is a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the Act and is subject to the provisions of the *Electrical Power Control Act, 1994*.

2. Hydro is the primary generator of electricity in Newfoundland and Labrador. The Voisey's Bay Nickel Terminal Station (VBN) was established in 2012. This terminal station is the primary source of supply for Hydro's industrial customers located in Long Harbour, including Vale and Praxair. The terminal station contains two 230/13.8/13.8 kV power transformers, each with a 75/100/125 MVA primary winding and dual 37.5/50/62.5 MVA secondary windings. Each of the transformers is sized to provide the

projected load of the station, making the other transformer redundant. However, the failure of either of the transformers eliminates the redundancy within the station.

3. One of the two 230/13.8/13.8 kV power transformers, VBN T1, is experiencing low level gassing which is indicative of a newly formed fault condition. The Original Equipment Manufacturer (OEM) has performed diagnostic testing and a preliminary assessment on VBN T1. Based on the results of this assessment, VBN T1 has been removed from service and the OEM has recommended that a major internal assessment of VBN T1 be completed to determine the cause and nature of the issue.

4. Hydro is recommending that an internal assessment of VBN T1 with necessary repairs be completed. The diagnostic testing performed by the OEM indicates that the issue is most likely external to the windings and may be repairable during the internal inspection. If this is the case, repairs will be completed at site and the transformer will be returned to service. Details regarding Hydro's proposal to assess and repair VBN T1 at the VBN Terminal Station are contained in the attached project proposal document.

5. This project will maintain the reliability of this terminal station by ensuring that both of the power transformers are operational.

6. The estimated cost of this project is $500,100. These costs will be recovered from Hydro's Industrial Customer, Vale, through its specifically assigned charge in accordance with the rules of cost allocation that have been approved for Hydro by the Board following the conclusion of Hydro's current General Rate Application.

7. Hydro submits that the assessment and repairs of VBN T1 at the VBN Terminal Station is necessary to ensure that Hydro can continue to provide electrical service to its industrial customers that is safe and adequate and just and reasonable as required by Section 37

of the *Act*. An Engineering Report supporting this supplemental capital application is attached.

8. Hydro therefore makes Application for an Order pursuant to section 41(3) of the Act approving the internal assessment and repairs of VBN T1 at the VBN Terminal Station at an estimated capital cost of $500,100 as set out in this Application and in the attached project description and justification document.

DATED at St. John's, in the Province of Newfoundland and Labrador, this 21st day of October, 2015.

Tracey L. Pennell
Counsel for the Applicant
Newfoundland and Labrador Hydro
500 Columbus Drive P.O. Box 12400
St. John's,
Newfoundland and Labrador
A1B 4K7
Telephone: (709) 778-6671
Facsimile: (709) 737-1782

A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

	Electrical
	Mechanical
	Civil
	Protection & Control
	Transmission & Distribution
	Telecontrol
	System Planning

Transformer T1
Major Internal Assessment and Repairs
Voisey's Bay Nickel Terminal Station

October 2015

newfoundland labrador hydro
a nalcor energy company

SUMMARY

The Voisey's Bay Nickle Terminal Station (VBN) was established in 2012. This terminal station is the primary source of supply for Hydro's industrial customers located in Long Harbour including Vale and Praxair. The terminal station contains two 230/13.8/13.8 kV power transformers, each with a 75/100/125 MVA primary winding and dual 37.5/50/62.5 MVA secondary windings.

This proposal is requesting the approval of a project to perform a major internal assessment and identified repairs on transformer VBN T1. This transformer has shown some low level gassing which is indicative of a newly formed fault condition. Diagnostic testing and a preliminary assessment of the unit by the Original Equipment Manufacturer (OEM) have been performed. Based upon the results of the preliminary assessment, the transformer has been removed from service. The preliminary assessment from the OEM also recommends that a major internal assessment be completed.

The diagnostic testing results indicate that the issue is most likely external to the windings and may be repairable during the internal assessment. If this is the case, repairs will be completed at site and the transformer will be returned to service. If this is not the case, more extensive repairs may be required.

As the exact scope of work required to repair the transformer is unavailable at present, this proposal has been developed using the most likely outcome where any repairs possible will be completed immediately following the internal assessment while the OEM is on site. This would allow the transformer to be placed back in service in as timely a fashion as possible. The estimated cost of this project is $500,100.

If the findings of the OEM are such that more significant work is required, Hydro will contact the Board of Commissioners of Public Utilities (the Board) to discuss next steps to returning the transformer to service.

TABLE OF CONTENTS

1 INTRODUCTION

The VBN terminal station was established in 2012. This terminal station is the primary source of supply for Hydro's industrial customers located in Long Harbour including Vale and Praxair.

A single line diagram of the terminal station is provided in Figure 1.

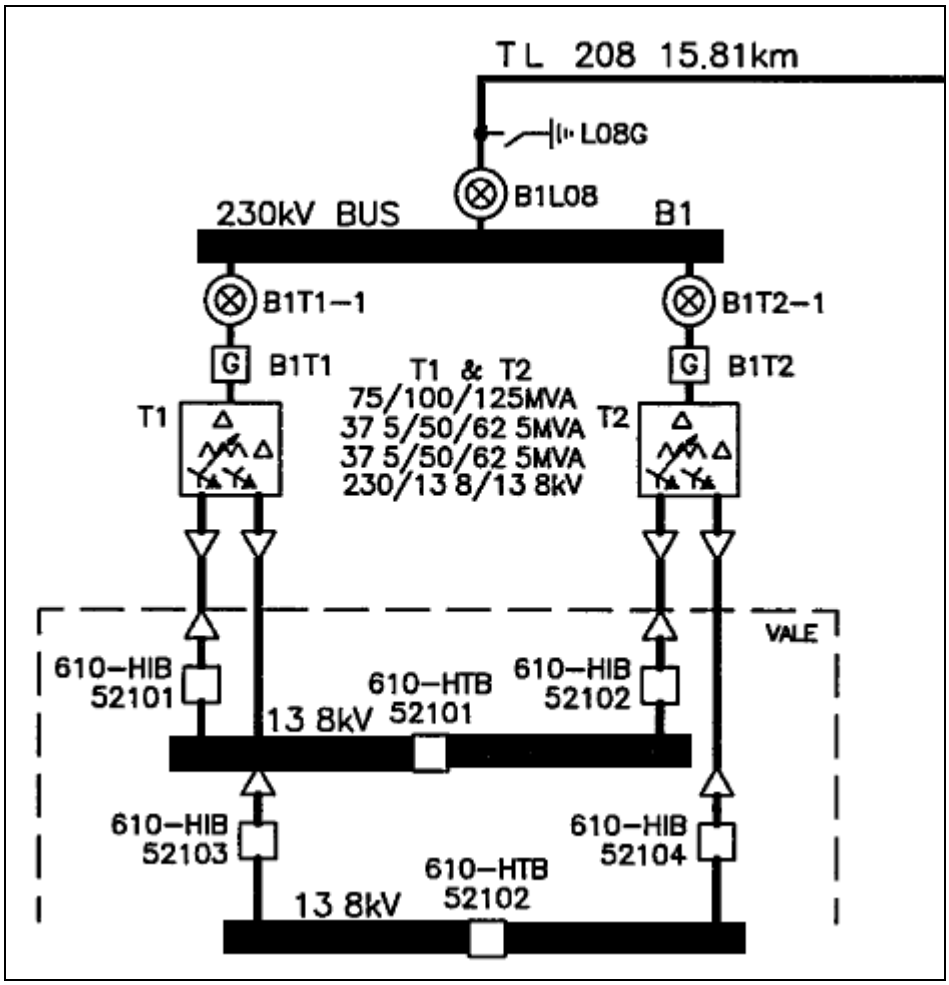

Figure 1 – Voisey's Bay Nickel Terminal Station Single Line Diagram

As indicated, the terminal station is supplied via a radial 230 kV transmission line, TL208, which provides an interconnection to Western Avalon Terminal Station (WAV). The terminal station contains two 230/13.8/13.8 kV power transformers, each with a 75/100/125 MVA primary winding and dual 37.5/50/62.5 MVA secondary windings. The station is sized such

that the total customer load can be borne by one transformer, so the second transformer is redundant.

Forecasted peak loads for the terminal station are provided in Table 1.

Table 1 – VBN Terminal Station – Forecasted Peak Loads[1]

Year	Vale Load (MW)	Praxair Load (MW)	Total Load (MW)
2016	30.0	6.0	36.0
2017	31.0	6.0	36.0
2018	51.0	6.0	57.0
2019	51.0	6.0	57.0
2020	51.0	6.0	57.0

In this Capital Budget Supplemental Application, Newfoundland and Labrador Hydro (Hydro) proposes to address a risk with its ability to supply customers supplied from the VBN terminal station. One of the two 230/13.8/13.8 kV power transformers is experiencing low level gassing which is indicative of a newly formed fault condition. Offline testing of the transformer has been conducted by the OEM. The results indicate that an internal assessment is required to determine the cause of the gassing. The results also indicate that the issue is most likely external to the windings and may be repairable during the internal assessment. If this is the case, repairs will be completed at site and the transformer will be returned to service. If this is not the case, then more extensive repairs may be required. The exact nature of these repairs will be determined during the internal assessment.

This project will maintain the reliability of this terminal station by ensuring that both of the power transformers are operational.

[1] As per Hydro's Operating Load Forecast, October 2015

2 PROJECT DESCRIPTION

The scope of work within this project includes the following:

- isolation of the transformer;
- draining of the transformer oil;
- internal assessment by the OEM;
- completion of repairs, if possible;
- filling the transformer with oil;
- electrical testing after filling; and
- review of electrical test results by a transformer consultant and a failure analysis of why the transformer developed gassing at this early stage in its service life.

Figure 2 provides a photo of this transformer which is located in the Voisey's Bay Nickel (VBN) Terminal Station.

Figure 2 – VBN Transformer T1

3 JUSTIFICATION

The VBN terminal station includes two 230/13.8/13.8 kV power transformers. Each of the transformers is sized to provide the projected load of the station. The failure of either of the transformers eliminates the redundancy within the station.

Testing of Transformer T1 indicates that this unit has developed a fault condition. An internal assessment is required to determine the nature of the issue, and repairs are planned to immediately follow the assessment.

3.1 Existing System

The VBN terminal station was established in 2012. This terminal station is the primary source of supply for Hydro's industrial customers located in Long Harbour including Vale and Praxair. The terminal station is supplied via a radial 230 kV transmission line. The terminal station contains two 230/13.8/13.8 kV power transformers, each with a 75/100/125 MVA primary winding and dual 37.5/50/62.5 MVA secondary windings.

The transformers within this station have been in service and providing energy since 2012. The gassing issues were identified during routine transformer oil testing and dissolved gas analysis. There have been no major issues with the other transformer in the station.

There have been no major upgrades to this terminal station since its construction.

3.2 Operating Experience

There have been no other significant issues with the performance of this terminal station since its construction.

3.2.1 Industry Experience

The transformer was delivered in the middle of 2011 and the factory warranty on this unit was 18 months from delivery. The gassing was observed for the first time in 2015.

3.2.2 Vendor Recommendations

Testing of the transformer by the Original Equipment Manufacturer (OEM) has been performed and a major internal assessment is now recommended.

The diagnostic testing results indicate that the issue is most likely external to the windings and may be repairable during the internal assessment. If this is the case, repairs will be completed at site and the transformer will be returned to service. If this is not the case, then more extensive repairs may be required.

Appendix A provides a summary of the test results and analysis, including a graph of the Dielectric Frequency Response (DFR) test results for the high voltage to core connection highlighting the internal transformer issue.

3.2.3 Maintenance or Support Arrangements

Maintenance on the equipment within the terminal station is performed by Hydro personnel.

3.2.4 Maintenance History

The maintenance history for VBN transformer T1 is shown in the following table:

Table 2: Five-Year Maintenance History

Year	Preventive Maintenance ($000)	Corrective Maintenance ($000)	Total Maintenance ($ 000)
2015	1.4	5.2	6.6
2014	0	1.6	1.6
2013	0	0.5	0.5

3.2.5 Anticipated Useful Life

The actual useful life of a transformer depends upon various factors including its environment, electrical faults, and loading levels, but the anticipated useful life is generally

accepted to be up to 55 years. Hydro is obviously concerned with this gassing so early in the life of the transformer and will ensure a failure analysis is completed on the cause of the gassing.

3.3 Development of Alternatives

The design of the VBN terminal station is a two transformer design. Each of the transformers is capable of supplying the peak load for the station. In the event of an issue with one of the transformers, the station can continue to operate while the issue with the transformer is addressed. If both transformers are out of service, Hydro would be unable to supply the customers until one of them was repaired. During this time, Vale would be required to employ the 10.8 MW of available onsite diesel generation to supply essential loads. There is no additional spare transformer. The mobile transformer is not suitable as a temporary spare for this site.

The only viable alternative is to assess and repair Transformer T1.

4 CONCLUSION

The VBN terminal station includes two 230/13.8/13.8 kV power transformers. Each of the transformers is sized to provide the projected load of the station. The failure of either of the transformers eliminates the redundancy within the station.

Testing of transformer T1 indicates that this unit has developed a fault condition. An internal assessment is required to determine the nature of the issue.

The completion of an internal assessment will allow the issue with the transformer to be identified. Offline testing indicates that the issue is most likely external to the windings and may be repairable during the internal assessment. If this is the case, repairs will be completed at site and the transformer will be returned to service.

The estimated cost to complete the project is $500,100.

4.1 Budget Estimate

The estimated cost to complete the work associated with the internal assessment is detailed in Table 3. As the exact scope of work required to repair the transformer is unavailable at present, the budget estimate has been developed using the most likely outcome as suggested by interpretation of the initial test results. The repairs will be completed during the internal assessment. The estimated cost of this project is $500,100.

The estimate was developed to include the costs for the major assessment work, as well as a base of $50,000 for repairs. The internal labour costs include engineering, coordination, field support, project management, etc.

Table 3: Project Budget Estimate

Project Cost:*($ x1,000)*	**2015**	**2016**	**Beyond**	**Total**
Material Supply	0.0	0.0	0.0	0.0
Labour	132.6	0.0	0.0	132.6
Consultant	14.8	0.0	0.0	0.0
Contract Work	266.3	0.0	0.0	266.3
Other Direct Costs	1.6	0.0	0.0	1.6
Interest and Escalation	1.7	0.0	0.0	1.7
Contingency	83.1	0.0	0.0	83.1
TOTAL	**500.1**	**0.0**	**0.0**	**500.1**

4.2 Project Schedule

This project was not included in the 2015 Capital Budget application as the gassing was discovered in 2015, and therefore, the 2015 budget was already approved. This project was not submitted as part of the 2016 Capital Budget Application as Hydro cannot wait for the whole 2016 application to be contemplated. Hydro, therefore, seeks approval in a more timely fashion than that which can be afforded through the 2016 Budget process.

The schedule below lays out the timeline should the OEM be able to effect repairs following the assessment. If the assessment reveals more extensive repairs are required, a new schedule and any additional cost will be developed at that time. Should more work and a longer schedule be required, this will be discussed with the Board.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Scope, schedule, cost, risk, quality and communication planning	October 2015	October 2015
Procurement	Procurement – OEM for internal assessment	October 2015	October 2015
Construction	Internal assessment / repairs / return transformer to service	November 2015	November 2015
Closeout	Project Closeout	December 2015	December 2015

APPENDIX A

Transformer Test Results and Analysis

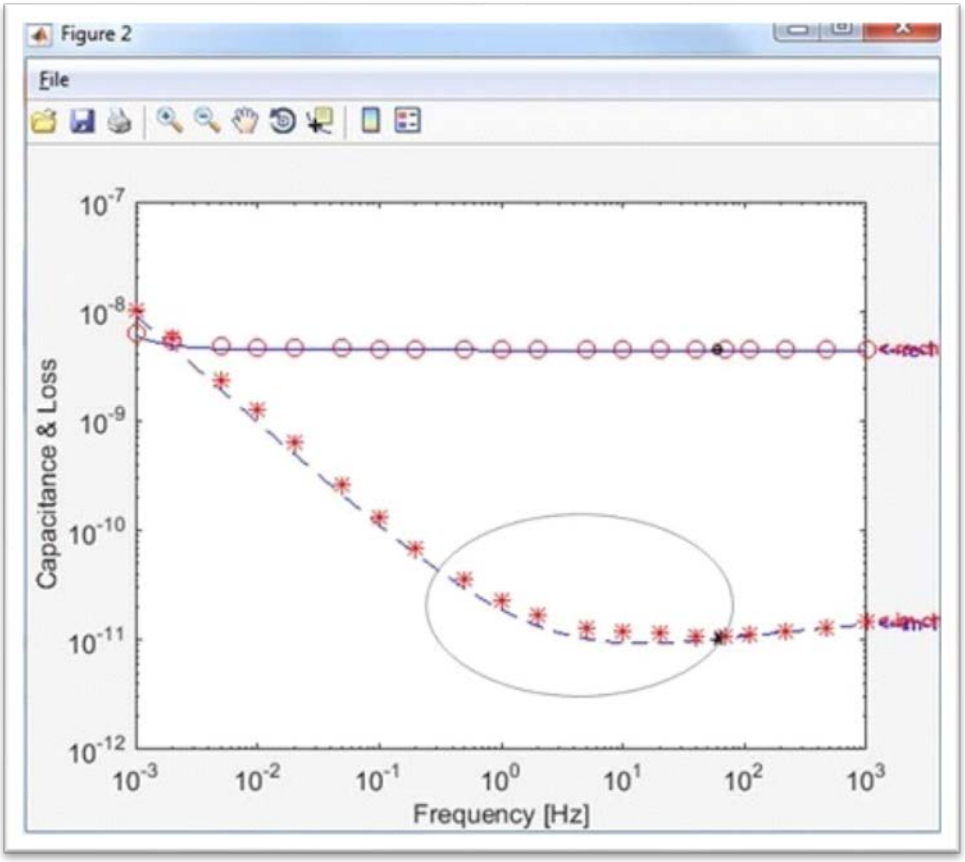

Figure A1 – Dielectric Frequency Response (DFR) Test Results

The OEM has provided the above graph and analysis. The graph compares the measured value to the calculated value for capacitance and dielectric loss (using the insulation dimensions from the design). The circled portion of the graph highlights a deviation between the measured values and the calculated values. As experts, the OEM indicates this small deviation is significant. The issue is most likely due to a problem with the high voltage leads. The OEM expert is suggesting that this abnormality could be carbon contamination (which is in line with the measured hydrogen gassing.)

VBN T1 Transformer Oil Reports

The dissolved gas analysis, fluid quality, moisture analysis, and furan analysis reports for this transformer are provided. Please note that the dissolved gas analysis provides a summary of five different samples from June, 2013 to February, 2015. Please also note the upward trend in Hydrogen, Methane, Ethane, and Ethylene. Normal aging produces gases, but at an extremely slow rate. Significant changes in the dissolved gas content of a transformer's oil are indicative of a newly formed fault condition.

Please also note that no issues were identified with the quality of the transformer oil (fluid quality and moisture analysis are acceptable). Furan analysis is a measurement of the quantity and type of furans present in the oil. During the natural aging of the transformer, the insulated kraft paper decomposes and releases polymeric chains into the oil. The furan analysis, as expected, confirms that this is not an issue.

GAS ANALYSIS

Lab Report Number	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Sample date	2015-02-27	2015-02-25	2015-02-04	2014-03-28	2013-06-25
Fluid temp	18	15	15	20	35
Hydrogen (H2)	85	65	80	0	0
Methane (CH4)	59	46	60	0	0
Ethane (C2H6)	18.0	17.0	16.0	0.0	0.0
Ethylene (C2H4)	7.0	4.0	5.0	0.0	0.0
Acetylene (C2H2)	0.0	0.0	0.0	0.0	0.0
Carbon Monoxide (CO)	536	487	513	66	46
Propylene (C3H6)	0	0	2	0	0
Carbon Dioxide (CO2)	1570	1510	1690	295	234
Oxygen (O2)	5050	7930	13700	5580	14500
Nitrogen (N2)	15500	20800	44000	13800	44200
Total heat gas	84	67	81	0	0
TDCG	705	619	674	66	46
Equivalent TCG	2.903	1.850	1.004	0.281	0.065
Total partial press	22.0	30.3	61.4	19.4	56.3
Est. safe handling limit	7.7	8.0	7.7	12.5	12.5
Calculated monitor ppm	182	153	172	12	8
CO2/CO	2.929	3.101	3.294	4.470	5.087
Oxygen/Nitrogen (O2/N2)	0.326	0.381	0.311	0.404	0.328
DGA retest days	365	365	90	365	365
DGA retest date	2016-02-27	2016-02-25	2015-05-05	2015-03-28	2014-06-25
DGA reference days	23.0	21.0	313.0	276.0	0.0
DGA result	1	1	2	1	1
DGA diagnosis			T1		

Gas Analysis Remarks

No recent significant abnormalities.

Resume normal sampling only when confident that it is safe.

FLUID QUALITY

Lab Report Number	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Sample date	2015-02-27	2015-02-25	2015-02-04	2014-03-28	2013-06-25
Fluid temp	18	15	15	20	35
Dielectric breakdown D1816 (2 mm)	59.0	61.0	58.0		
Dielectric breakdown D877				53.0	52.0
PF at 25 C	0.049	0.038	0.035	0.038	0.028
PF at 100 C	0.440	0.420	0.550	0.140	0.290
Acid number	0.000	0.000	0.000	0.000	0.000
Interfacial tension	39.5	40.6	40.5	40.7	42.2
Specific Gravity	0.875	0.875	0.878	0.875	0.877
Color	0.0	0.0	0.0	0.0	0.0
Oil quality index	0.0	0.0	0.0	0.0	0.0
PF100/PF25	8.980	11.053	15.714	3.684	10.357
Visual	CLEAR	CLEAR	CLEAR	CLEAR	CLEAR
Fluid quality retest days	365	365	365	365	365
Fluid quality retest date	2016-02-27	2016-02-25	2016-02-04	2015-03-28	2014-06-25
Fluid condition	1	1	1	1	1

Fluid Quality Analysis Remarks

No oil quality problems were detected.

MOISTURE ANALYSIS

Lab Report Number	*N/A*	*N/A*	*N/A*	*N/A*	*N/A*
Sample date	2015-02-27	2015-02-25	2015-02-04	2014-03-28	2013-06-25
Fluid temp	18	15	15	20	35
Moisture	2	2	1	2	3
Relative saturation	4	5	2	4	3
Dew point	-40	-40	-50	-40	-34
Moisture code	1	1	1	1	1

Moisture Remarks

The water content of the oil interpreted as acceptable.

FURANS

Lab Report Number	*N/A*
Sample date	2014-03-28
Fluid temp	20
2-furfural (2FAL)	0
5-methyl-2-furfural (5M2F)	0
5-hydroxymethyl-2-furfural (5H2F)	0
Furfuryl alcohol (2FOL)	0
2-acetylfuran (2ACF)	0

IN THE MATTER OF the *Electrical Power Control Act,* RSNL 1994, Chapter E-5.1 (the *EPCA*) and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the *Act*), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the Act, for approval of the Internal Assessment and Repairs of the T1 Transformer at the Voisey's Bay Nickel Terminal Station.

AFFIDAVIT

I, Robert J. Henderson, Professional Engineer, of St. John's in the Province of Newfoundland and Labrador, make oath and say as follows:

1. I am Vice-President of Newfoundland and Labrador Hydro, the Applicant named in the attached Application.

2. I have read and understand the foregoing Application.

3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the Province of Newfoundland and Labrador this 21st day of October, 2015, before me:)

Bobbi Sheppard
Commissioner for Oaths
Province of Newfoundland & Labrador
Expiry date: December 31, 2017

Robert J. Henderson

(DRAFT ORDER)
NEWFOUNDLAND AND LABRADOR
BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

AN ORDER OF THE BOARD

NO. P.U. __(2015)

IN THE MATTER OF the *Electrical Power Control Act*, RSNL 1994, Chapter E-5.1 (the *EPCA*) and the *Public Utilities Act*, RSNL 1990, Chapter P-47 (the *Act*), and regulations thereunder;

AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro (Hydro) pursuant to Subsection 41(3) of the Act, for approval of the Internal Assessment and Repairs of the T1 Transformer at the Voisey's Bay Nickel Terminal Station.

WHEREAS Newfoundland and Labrador Hydro ("Hydro") is a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the Act, and is subject to the provisions of the *EPCA;* and

WHEREAS Subsection 41(3) of the Act requires that a public utility not proceed with the construction, purchase or lease of improvements or additions to its property where:

a) the cost of construction or purchase is in excess of $50,000; or
b) the cost of the lease is in excess of $5,000 in a year of the lease,

without prior approval of the Board; and

WHEREAS in Order No. P.U. 50(2014) the Board approved Hydro's 2015 Capital Budget in the amount of $76,832,900; and

WHEREAS the Board approved supplementary 2015 capital expenditures:

(i) in Order No. P.U. 24(2015) in the amount of $1,536,300 to purchase critical spares for Hydro's Generating Stations,

(ii) in Order No. P.U. 27(2015) in the amount of $756,200 to replace the rectifier transformers on Units 1 and 2 at the Holyrood Thermal Generating Station, and

(i) in Order No. P.U. 29(2015) in the amount of $1,249,300 to refurbish the Hardwoods gas turbine engine serial number 202224; and

WHEREAS on October 21, 2015, Hydro applied to the Board for approval for the internal assessment and repair of transformer VBN T1 at the Voisey's Bay Nickel Terminal Station; and

WHEREAS the Board is satisfied that the 2015 supplemental capital expenditure for the internal assessment and repair of transformer VBN T1 at the Voisey's Bay Nickel Terminal Station is necessary to allow Hydro to provide service and facilities which are reasonably safe and adequate and just and reasonable.

IT IS THEREFORE ORDERED THAT:

1. The proposed capital expenditure of $500,100 for the internal assessment and repair of transformer VBN T1 at the Voisey's Bay Nickel Terminal Station is approved.

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

DATED at St. John's, Newfoundland and Labrador, this day of , .

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