

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 pursuant to Subsection 41(3) of the Act, for the approval of the replacement of the excitation transformers at Bay d'Espoir.

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

THE APPLICATION OF NEWFOUNDLAND AND LABRADOR HYDRO (Hydro) STATES

THAT:

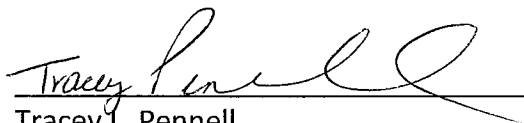
1. Hydro is a corporation continued and existing under the *Hydro Corporation Act, 2007*, is a public utility within the meaning of the Act and is subject to the provisions of the *Electrical Power Control Act, 1994*.
2. Hydro's fleet of hydraulic generating units includes 604 MW of generation at Bay d'Espoir. The plant produces an average of 2,650 GWh annually, making it the largest and an essential hydroelectric plant on the Island Interconnected System.
3. On January 30, 2014 the excitation transformer on Bay d'Espoir Unit 6 failed while the unit was on line, resulting in a forced outage. The transformer was replaced with the onsite spare excitation transformer and returned to service on February 2, 2014. On February 17, 2014, this spare transformer also failed while

the unit was on line, resulting in another forced outage. This unit remains out of service. Fluid samples were taken from all seven operating excitation transformers in Bay d'Espoir during 2013 to provide information on the condition of these transformers to refine the asset replacement plan. The results of the analysis of these samples were received in February 2014 and show that the excitation transformers on Unit 1 through 6 have approached their reliable service life and that Unit 7 has exceeded its normal reliable service life. The fluid analysis results show that the excitation transformers need to be replaced in an expedited manner to reduce the risk of another in-service failure and to ensure system reliability.

4. The excitation transformers are a critical component of the Bay d'Espoir generating station as they are used to convert the generator terminal voltage to a lower voltage that is used to supply the rectifier. Without the excitation transformers, the generating units are not able to produce electricity. Hydro is recommending replacement of the excitation transformers as this is the least cost option over the long term. Details regarding Hydro's proposal to replace the excitation transformers are contained in the attached project proposal document.
5. The completion of the excitation transformer replacement at Bay d'Espoir is required to ensure that Hydro can continue to provide safe, reliable and adequate service from this essential facility.

6. The estimated cost of this project is \$996,700.
7. The Applicant submits that the proposed capital works and expenditures are necessary to ensure that this generation facility can continue to provide service which is safe and adequate and just and reasonable as required by Section 37 of the *Act*.
8. Therefore, Hydro makes Application that the Board make an Order approving, pursuant to Subsection 41(3) of the *Act*, the capital expenditure of \$996,700 for the replacement of the excitation transformers at Bay d'Espoir 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 19 day of June, 2014.


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

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;

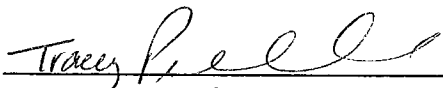
AND IN THE MATTER OF an Application by Newfoundland and Labrador Hydro pursuant to Subsection 41(3) of the *Act*, for the approval of the replacement of the excitation transformers at Bay d'Espoir.

AFFIDAVIT

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

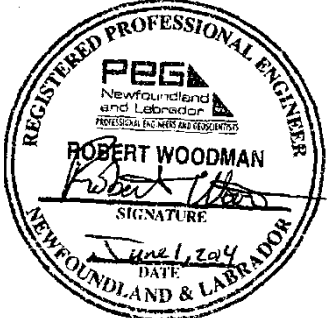
1. I am Vice-President of Newfoundland and Labrador Hydro, the Applicant named in the attached Application.
2. I have read and understand the foregoing Application.
3. I have personal knowledge of the facts contained therein, except where otherwise indicated, and they are true to the best of my knowledge, information and belief.

SWORN at St. John's in the)
Province of Newfoundland and)
Labrador)
this 19 day of June 2014,)
before me:)


Barrister – Newfoundland and Labrador


Robert J. Henderson

**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

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

Replacement of Excitation Transformers Bay d'Espoir

Newfoundland and Labrador Hydro

June 2014

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1 INTRODUCTION

In this 2014 Capital Budget Supplemental Application, Newfoundland and Labrador Hydro (Hydro) proposes to address a risk with the ability to provide generation capacity through the 2014/2015 winter period, which became evident from transformer fluid analysis and the on-line failure of two excitation transformers during the winter of 2014.

This project will improve the reliability associated with 604 MW of electrical generation at Hydro’s Bay d’Espoir generating station by replacing equipment that condition based testing shows is at or is approaching the end of its useful life. The failures in January and February of this year confirm the reliability risk of continuing to operate with these transformers in service and without sufficient spares.

On January 30, 2014 the excitation transformer on Bay d’Espoir Unit 6 failed while the unit was on line, resulting in a forced outage. The transformer was replaced with the onsite spare excitation transformer and returned to service on February 2. On February 17, this spare transformer also failed while the unit was on line, resulting in another forced outage. Given that there was insufficient time to replace the spare transformer after the first failure, the unit remains out of service until a temporary transformer is fabricated and installed. Test results have confirmed that it is not feasible to repair either of the failed transformers.

Excitation transformers are custom designed to supply a voltage that is calculated specifically for the generator that it supplies. Bay d’Espoir Units 1 through 6 have an excitation transformer secondary voltage of 153V. Bay d’Espoir Unit 7 has an excitation transformer secondary voltage of 559V. Given the custom design for excitation transformers, an existing transformer could not be purchased or borrowed from a supplier or another utility.

1 Fluid samples were taken from all seven operating excitation transformers in Bay d’Espoir
2 during 2013 to provide information on the condition of these transformers to refine the
3 asset replacement plan. The results of the analysis of these samples were received in
4 February of 2014, and were surprisingly poor.

5
6 The combination of the recent failures and the fluid analysis has created a need to expedite
7 the replacement of all seven excitation transformers at Bay d’Espoir.

2 PROJECT DESCRIPTION

The scope of this project is to replace the excitation transformer on each of the seven generating units at Bay d’Espoir. This includes replacing the original excitation transformers on Units 1 to 5 and 7, as well as replacing the temporary transformer on Unit 6. The temporary transformer installed on Unit 6 will be kept as a spare that is compatible with Units 1 to 6.

The Unit 7 transformer will be replaced as soon as possible and before the 2014/2015 winter operating season due to the criticality of this unit to the island electrical system and its extremely poor test results. Based on the fluid analysis results, Hydro will avoid the shutdown of Unit 7 until its excitation transformer has been replaced.

Two spare transformers that are compatible for Units 1 to 6 will be kept on site during the winter operating season to mitigate the risk of another failure during the period of peak system demand. Having an available spare will allow Hydro to replace a failed transformer in approximately four days after a failure. When additional transformers are delivered, the transformers in the worst condition will be replaced. The intent is to replace as many as possible prior to the 2014/2015 winter operating season and then replace the remaining transformers in 2015 during scheduled maintenance periods.

A temporary transformer that could be sourced quickly to replace the Bay d’Espoir Unit 6 excitation transformer is being secured and installed under a separate project through the Allowance for Unforeseen Events. The temporary transformer is designed for quick high volume fabrication. These transformers are typically used for distribution applications, where they can be replaced quickly with limited customer downtime. The temporary transformer is not capable of withstanding electrical fault conditions that can be experienced on an electrical generator. The more robust transformer design takes longer to fabricate. Therefore, the temporary transformer was purchased to reduce the unit

- 1 downtime, but will need to be replaced by a more robust transformer to provide long-term
- 2 reliable operation.
- 3
- 4 Efficiencies in engineering, project management, and bulk procurement, as well as disposal
- 5 of the existing transformers and their fluid, reduce the overall cost when all transformers
- 6 are replaced as part of one project.

3 BACKGROUND

The Bay d’Espoir excitation transformers are original equipment for all operating units installed between 1967 and 1977. Each excitation transformer is a part of the excitation system used to convert the generator terminal voltage to a lower voltage that is used to supply the rectifier. The excitation system is used to create a rotating magnetic field in the generator to enable conversion of the mechanical energy in the moving water into electrical energy. Without an excitation transformer, a generating unit is not able to produce electricity.

These transformers were originally filled with Pyranol (pure PCB) as the insulating/cooling fluid. In the early 1990s, a program to remove PCBs from these transformers was performed. This process involved draining the PCB oil and replacing it with a fluid called Transclene. Transclene is a trade name for a chemical called perchloroethylene. Transclene was the selected replacement fluid for the following reasons:

1. To extend the life of the transformers until the end of their design useful life (PCB equipment was replaced due to environmental regulations);
2. Transclene was able to leach PCB molecules from the PCB soaked wood and paper insulation inside the transformer;
3. Transclene is a transformer oil with similar insulating and heat transfer properties of Pyranol that could remain in service until the transformer is retired; and
4. Transclene has superior flame retardant properties.

In December of 2013, a fluid analysis condition assessment was performed on all seven excitation transformers in-service. These results, provided in Appendix A, were reviewed by Hydro engineers to assess the remaining life of the transformers from a furan (calculated DP) perspective. Due to the results of the recent fluid analysis, a spare excitation transformer is being sourced to add to inventory for Unit 7. Two excitation transformers that can be used on Bay d’Espoir Units 1 through 6 are being purchased and will be set up as

1 inventory critical spare items in the event of another failure. These same transformers are
2 proposed to be removed from inventory for installation as part of this project to reduce
3 material delivery time. The same material supply contract for these spare transformers
4 includes optional pricing for the purchase of sufficient transformers to complete this project
5 when approved.

6
7 The replacement of these transformers was previously included in Hydro's five-year capital
8 plan beginning in 2016. The December 2013 fluid analysis was performed in a planned
9 manner to ensure that these assets are replaced at the appropriate time to balance
10 between an acceptable reliability risk and extending the life as long as reasonably possible.
11 The fluid analysis results show that these transformers need to be replaced in an expedited
12 manner to reduce the risk of another in-service failure.

13
14 These transformers have operated reliably since the fluid retrofit, requiring only fluid top-up
15 and normal preventative maintenance. In December of 2013, fluid analysis was conducted
16 on these transformers as a condition assessment activity for the development of the capital
17 plan, to align transformer replacement based on asset condition. On January 30, 2014, the
18 excitation transformer for Unit 6 failed while the unit was on line. This transformer was
19 replaced with the spare transformer and the unit was returned to service on February 1,
20 2014. On February 17, 2014, the spare transformer failed while the unit was on line. These
21 are the only two outages caused by excitation transformer failures in the past five years for
22 all of Hydro's generating units.

23
24 The chemical perchloroethylene is harmful to human health primarily from inhaling the
25 chemical fumes. In high concentrations, or where ventilation is poor, perchloroethylene can
26 cause respiratory distress and even death. For this reason, when working with this fluid,
27 workers wear a chemical suit and self-contained breathing apparatus (SCBA) to prevent
28 exposure. The chemical has to be stored and disposed of properly. As well, the chemical and
29 transformer shell have to be disposed of as PCB waste given the presence of PCB from the

1 original Pyranol fluid. Replacing all transformers in this planned approach will utilize
2 synergies from economics of scale by disposing of the fluid and transformers in bulk.

3

4 The 1990s retrofit was a common utility practice. Hydro is currently having difficulty
5 sourcing perchloroethylene to maintain transformer fluid levels. Chemical suppliers state
6 that most transformer owners have removed their perchloroethylene-filled transformers
7 from service. For this reason, most chemical suppliers have discontinued supplying this
8 chemical due to the low demand.

9

10 An external contractor was engaged to safely perform testing activities, to determine if the
11 original failed transformer is repairable. Hydro personnel determined that the second failed
12 transformer was unrepairable (since it had an electrical short to ground). Their report is
13 included as Appendix C.

4 PROJECT ALTERNATIVES

Alternatives to installing new transformers were considered. Due to the fact that excitation transformers are custom designed to match the generator that they are associated with, exhaustive efforts to locate an existing transformer were not successful. Hydro was advised by a transformer manufacturer that was approached to re-core (rehabilitate) its existing transformers, that this option is not feasible. After exploring possible alternatives, Hydro has concluded that there are no viable alternatives to purchasing new transformers.

In addition to replacement options, several life extension options were considered. Typically, when acid levels are high, a fluid replacement is performed. Given that the fluid in these transformers is Perchloroethylene, disposing of the fluid and replacing it in kind is of similar cost to replacing the transformer complete with a safe fluid. Due to the powerhouse location of these transformers, only non-ignitable fluids can be used. Even with perchloroethylene, which has superior cooling qualities to other non-PCB fluids, the transformers operated ten degrees Celsius higher (though within the design operating range) than they did with the original Pyranol fluid. Using oil with lower heat transfer properties would further raise the operating temperature which would accelerate further aging. This is considered a short-term solution to replacing the transformers and at a similar near-term cost.

Refilling with fresh perchloroethylene and an acid scavenger is not an acceptable option for two major reasons. First, there are significant health and safety issues involved with handling these chemicals. Second, due to low demand in industry for this chemical, there are limited quantities available.

Replacing all the transformers in this project is prudent for two reasons. First, the economies of scale achieved by replacing them in bulk help to keep the replacement costs as low as possible. Second, the acid scavenger that would have to be used to prevent further accelerated aging of this transformer has health concerns that are identified in the

- 1 Material Safety Data Sheets in Appendix D. These health issues require special handling
- 2 procedures and Personal Protective Equipment. The chemical has to be imported and there
- 3 are strict controls around importing this chemical into Canada. Given the cost of a new
- 4 transformer and the short reliable service life expectancy (expect less than five years) from
- 5 adding an acid scavenger in combination with annual fluid analysis, the most reasonable
- 6 option is to replace the transformer.

5 PROJECT COST

The estimated cost to complete all work associated with replacing the excitation transformers at Bay d'Espoir is \$966,700. Table 1 provides a detailed breakdown of the costs to be incurred to replace all seven excitation transformers.

Table 1: Excitation Transformer Replacement Project Costs

Project Cost:(\$ x1,000)	<u>2014</u>	<u>2015</u>	<u>Beyond</u>	<u>Total</u>
Material Supply	400.0	147.0	0.0	547.0
Labour	127.4	142.9	0.0	270.3
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	3.2	1.8	0.0	5.0
Interest and Escalation	0.0	10.0	0.0	10.0
Contingency	106.1	58.3	0.0	164.4
TOTAL	636.7	360.0		996.7

5.1 Project Schedule

This project is being proposed to improve the generation supply reliability of the island electrical system in advance of the 2014/2015 winter operating season. This transformer equipment will take between twenty-two and twenty-four weeks for manufacture and delivery. Based on equipment condition and the priority for replacement, it is recommended that at least Units 1, 2 and 7 are replaced before the 2014/2015 winter operating season. The Unit 6 transformer is expected to be replaced with a temporary transformer with a return to service in July of 2014. Spare transformers onsite will reduce the operational risk for Units 3, 4 and 5 until they can be replaced at the first opportune time based on system demand. To ensure that equipment is delivered and installed on the highest priority units prior to the 2014/2015 winter operating season, timely approval of this project is required.

6 CONCLUSION

A new excitation transformer is required to be installed on each of the Bay d’Espoir hydraulic generating units as soon as possible to ensure continued generation reliability through the 2014/2015 winter operating season. The results of the most recent fluid analysis and the two recent transformer failures highlight the urgent need to replace these transformers due to the deteriorated condition of their insulation. This deteriorated insulation poses a high risk of failure.

This project is considered the least cost approach for these transformer replacements and it will improve the reliability of the generation supply on the island electrical system. Replacing these transformers in a planned and clustered approach provides savings through equipment bulk ordering of equipment, and installation efficiency gains by performing similar work in a short period of time.

Replacing these transformers through a supplementary capital project is required to reduce the risk of failure when the generation is required to meet customer demand. As well, further in-service failures would lead to more replacements in an emergency situation which both increases cost and reduces reliability.

The estimated cost to complete the work is \$996,700.

APPENDIX A

SD Myers Test Results



February 12, 2014

Somkene Mbakwe
 Newfoundland & Labrador Hydro
 Bay d'Espoir Warehouse
 1 Camp Boggy Road
 Milltown, Bay d'Espoir, NL A0H1W0

Dear Mr. Mbakwe:

I am writing to report the AGE (allyl glycidyl ether) acid scavenger test results of the perchloroethylene fluid from your transformers (sample draw date 12/18/13):

SD Myers Inc. TC Number	Equipment ID	AGE concentration (ppm)	Recommendation
9001	Unit #1	0	Replace transformer; see comments
9002	Unit #2	0	Replace transformer; see comments
9003	Unit #3	0	Replace transformer; see comments
9004	Unit #4	330	Replace transformer; see comments
9005	Unit #5	330	Add 2000 ppm AGE; retest in 1 year
9006	Unit #6	0	Replace transformer; see comments
9007	Unit #7	0	Replace transformer; see comments

Notes:

- ppm = parts per million
- >1500 ppm AGE is Acceptable (2000 to 2500 ppm is optimum)
- >1000 ppm, but ≤1500 ppm AGE is Questionable
- ≤1000 ppm AGE is Unacceptable
- If ≤1500 ppm, but >0 ppm, AGE content should be replenished.
- If AGE content is depleted (0 ppm), the transformer may be unreliable and should be replaced.

Comments:

TC 9005 This transformer requires the addition of AGE acid scavenger. It is important that this maintenance be done in order to prevent irreversible damage to the metals in the transformer from the build up of acids. If AGE acid scavenger is not added, acids will eventually form due to the breakdown of the fluid and attack the metals in the transformer, making the transformer unreliable.



TC 9001, 9002, 9003, 9006, 9007 We recommend that these transformers be replaced, due to the absence of AGE acid scavenger. Because the AGE acid scavenger has become depleted, the acids that have formed due to the breakdown of the fluid may have attacked the metals in the transformer. Such damage is irreversible, putting the transformer at risk of failure. In addition, TC 9007 has very high furans (16,744 ppb), indicating that the paper insulation has reached the end of its useful life.

TC 9004 We recommend that this transformer be replaced, due to the unacceptably high acid number (0.12 mg KOH/g) of the fluid. We would consider this transformer to be unreliable, since the acid may have attacked the metals in the transformer, such as the braised joints where the leads come out of the windings.

Please contact me if you have any questions. Thank you for your business.

Sincerely,

Andy Shkolnik
Technical Support Scientist
andy.shkolnik@sdmyers.com

Andy
Shkolnik

Digitally signed by Andy
Shkolnik
DN: cn=Andy Shkolnik,
o=S. D. Myers, Inc., ou,
email=andy.shkolnik@sd
myers.com, c=US
Date: 2014.02.12 16:46:13
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Maintenance Assessment Report

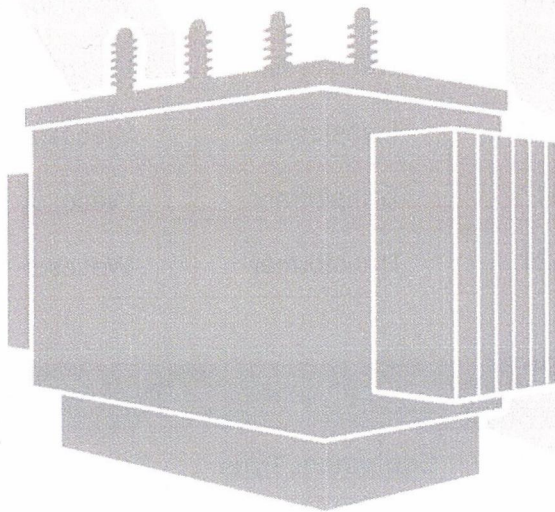
Newfoundland & Labrador Hydro

St. Johns, NL

MAR# 8002260-1213

Issue Date:
February 17, 2014

Based on Inspection Date:
December 18, 2013



INTELLIGENT TRANSFORMER MANAGEMENT[®]



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OVERVIEW OF MAINTENANCE ASSESSMENT REPORT:

Customer has requested a Maintenance Assessment Report for 7 units tested as part of sales order 703876. Draw date for all samples is December 18, 2013. All analysis and recommendations provided within this report are based solely on the information and data provided and available on that date.

These units are identified below and are placed in categories and in the approximate order of priority in terms of attention needed. Not all categories may be used in one report. The categories, in order of priority, are as follows: *investigate*, *immediate retest*, *resample*, *shortened retest & maintenance*, *shortened retest*, *maintenance*, and *normal monitoring*. Individual assessments are then presented for the units in the report.

One unit with a recommendation for immediate retesting

TC #	Sub Name	Unit No.	Serial No.	Equipment Type	Fluid Type	Page
9007	-	#7	288954	Transformer	Wecosol	4

Five units with recommendations for both shortened retest intervals and for maintenance

TC #	Sub Name	Unit No.	Serial No.	Equipment Type	Fluid Type	Page
9003	-	#3	590011	Transformer	Wecosol	6
9006	-	#6	679204	Transformer	Wecosol	8
9004	-	#4	659420	Transformer	Wecosol	10
9001	-	#1	590647	Transformer	Wecosol	12
9005	-	#5	708621	Transformer	Wecosol	14

One unit with a recommendation for a shorter retesting interval only

TC #	Sub Name	Unit No.	Serial No.	Equipment Type	Fluid Type	Page
9002	-	#2	590638	Transformer	Wecosol	16

Abbreviation Key:

Classifications

AC – Acceptable QU – Questionable UN – Unacceptable RS – Resample

Tests

LS – Liquid Screen Tests DGA – Dissolved Gas Analysis KF – Karl Fischer Moisture Content
ICP – ICP Dissolved Metals Analysis LPF – Liquid Power Factor INH – Oxidation Inhibitor Content
FUR – Furans Content

TC 9007 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9007	-	#7	Transformer	288954	1,175	13,800	559
LS	DGA	KF	ICP	LPF	INH	FUR	
QU		QU				UN	

Recap Service Recommendations/Priorities for Maintenance:

1. Retest furans immediately. The recent furan analysis indicates significant cellulosic insulation damage. The furans analysis should be retested immediately to verify this result.
2. Retest Karl Fischer moisture content six months. The moisture content is questionable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within six months.

Maintenance Assessment:

1. Retest furans analysis immediately.

The total furans level is high enough (16,774 ppb) to indicate that the cellulosic insulation may have deteriorated and reached the end of its useful life, and therefore, so has the transformer. The unit could suddenly fail due the mechanical weakness of the damaged insulation. These values should be confirmed with an immediate retest. Assuming the very high furans content is confirmed with a furans analysis retest, then the transformer should be considered unreliable and should be replaced, repaired, or rewound.

2. Retest Karl Fischer moisture content six months.

A parts per million of moisture in the questionable range is an indication of either an incursion of moisture into the unit or possibly due to sampling the transformer during or shortly after a period of changing load and operating temperature. In this case, it currently appears to be due to an incursion of moisture into the unit.

Even so, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For questionable results, a retest within six months is usually appropriate.

Besides the immediate follow up furan test and the six month follow up Karl Fischer test, this unit should not be considered reliable, and it should be monitored closely.

Moisture content is questionable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9007	65 °C	31.5	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

TC 9003 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9003	-	#3	Transformer	590011	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
QU		UN				UN	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest Karl Fischer moisture content three months.* The moisture content is unacceptable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within three months.
2. *Retest furans analysis three months.* The furans analysis is unacceptable and indicates deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within three months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.
3. *Leak repair.* A leak was noted from the pressure relay piping at the bottom of unit. Progress of the leak should be monitored by periodic inspections until maintenance can be performed. The leak repair project should be undertaken within three to six months to minimize release of fluid.
4. *Low liquid level/Add liquid.* The fluid level gauge indicates that the liquid level is low. After verification that the gauge is reading correctly, fluid should be added to restore the proper liquid level.

Maintenance Assessment:

1. *Retest Karl Fischer moisture content three months.*

Unacceptable baseline moisture content, such as the current results indicate, may be due to an incursion of moisture into the transformer. Unacceptable moisture content may also be due to sampling the transformer during or shortly after a period of changing load and operating temperature. However, it currently appears that this moisture profile may be the result of a migration of moisture into the unit. Therefore, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For unacceptable results a retest within three months is appropriate.

2. *Retest furans analysis three months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. The furans content is higher than expected for a typical, normally operating unit, and indicates significant thermal damage and/or deterioration of the cellulosic insulation. The concentration of 2-furaldehyde (2FAL) suggests severe local or moderate general deterioration of the cellulosic insulation. As a fault continues it causes the insulation to breakdown and become brittle. The furans content is an indicator concerning the degree to which the cellulosic insulation has already broken down. We are not able to give a meaningful estimate of the degree of polymerization (DP) or % life remaining in units with this insulation (55C) and fluid type. Based on the total furans level (1,075 ppb), it would appear that this unit has lost some integrity of its insulation.

The appropriate response to high or increasing furans analysis results is to retest at a shortened interval in order to monitor the condition and generation rate for the furanic compounds. At this level of furans, a retest within three months is appropriate.

3. Leak repair.

A leak was noted at the pressure relay piping at the bottom of unit. Prior to beginning the leak repair work, qualified personnel should carefully inspect the equipment and its installation to determine how best to minimize the length of outage needed. This leak presents an environmental issue and potential hazard due to release of the insulating liquid. Repairing the leak now is also important to ensure that long-term damage to the equipment, such as that caused by low liquid levels, does not occur.

4. Low liquid level/Add liquid.

The liquid level gauge indicates that the dielectric liquid level is low. Prior to adding fluid, qualified personnel should inspect the equipment to verify that the fluid level gauge is functioning properly. If the liquid level is indeed low, qualified personnel should add liquid to the proper level. If the proper liquid level is not restored, this may result in damage to the equipment, making it unreliable. If not using the exact same dielectric fluid, compatibility with the existing fluid should be verified before proceeding.

Besides the three month follow up Karl Fischer test, the three month follow up furan test, addressing the leak situation, and addressing the low liquid level, this unit should be monitored closely.

Moisture content is unacceptable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9003	65 °C	48.5	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

TC 9006 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9006	-	#6	Transformer	679204	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
UN		UN				UN	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest Karl Fischer moisture content three months.* The moisture content is unacceptable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within three months.
2. *Retest furans analysis three months.* The furans analysis is unacceptable and indicates deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within three months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.
3. *Low liquid level/Add liquid.* The fluid level gauge indicates that the liquid level is low. After verification that the gauge is reading correctly, fluid should be added to restore the proper liquid level.

Maintenance Assessment:

1. *Retest Karl Fischer moisture content three months.*

Unacceptable baseline moisture content, such as the current results indicate, may be due to an incursion of moisture into the transformer. Unacceptable moisture content may also be due to sampling the transformer during or shortly after a period of changing load and operating temperature. However, it currently appears that this moisture profile may be the result of a migration of moisture into the unit. Therefore, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For unacceptable results, a retest within three months is appropriate.

2. *Retest furans analysis three months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. The furans content is higher than expected for a typical, normally operating unit, and indicates significant thermal damage and/or deterioration of the cellulosic insulation. The concentration of 2-furaldehyde (2FAL) suggests severe local or moderate general deterioration of the cellulosic insulation. As a fault continues it causes the insulation to breakdown and become brittle. The furans content is an indicator concerning the degree to which the cellulosic insulation has already broken down. We are not able to give a meaningful estimate of the degree of polymerization (DP) or % life remaining in units with this insulation (55C) and fluid type. Based on the total furans level (2,117 ppb), it would appear that this unit has lost some integrity of its insulation.

The appropriate response to high or increasing furans analysis results is to retest at a shortened interval in order to monitor the condition and generation rate for the furanic compounds. At this level of furans, a retest within three months is appropriate.

3. Low liquid level/Add liquid.

The liquid level gauge indicates that the dielectric liquid level is low. Prior to adding fluid, qualified personnel should inspect the equipment to verify that the fluid level gauge is functioning properly. If the liquid level is indeed low, qualified personnel should add liquid to the proper level. If the proper liquid level is not restored, this may result in damage to the equipment, making it unreliable. If not using the exact same dielectric fluid, compatibility with the existing fluid should be verified before proceeding.

Besides the three month Karl Fischer retest, the three month furan retest, and addressing the low liquid level, this unit should be monitored closely.

Moisture content is unacceptable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9006	65 °C	50	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

Acid Number is unacceptable: Sample results for acid number and the SDMI classifications for wecosol are as follows:

TC#	Acid No. mg KOH/g	AC	QU	UN
9006	0.420	≤ 0.09	—	> .09

TC 9004 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9004	-	#4	Transformer	659420	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
UN		UN				QU	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest Karl Fischer moisture content three months.* The moisture content is unacceptable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within three months.
2. *Retest furans analysis six months.* The furans analysis is questionable due to deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within six months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.
3. *Leak repair.* A leak was noted from the pressure relay piping at the bottom of unit. Progress of the leak should be monitored by periodic inspections until maintenance can be performed. The leak repair project should be undertaken within three to six months to minimize release of fluid.
4. *Low liquid level/Add liquid.* The fluid level gauge indicates that the liquid level is low. After verification that the gauge is reading correctly, fluid should be added to restore the proper liquid level.

Maintenance Assessment:

1. *Retest Karl Fischer moisture content three months.*

Unacceptable baseline moisture content, such as the current results indicate, may be due to an incursion of moisture into the transformer. Unacceptable moisture content may also be due to sampling the transformer during or shortly after a period of changing load and operating temperature. However, it currently appears that this moisture profile may be the result of a migration of moisture into the unit. Therefore, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For unacceptable results, a retest within three months is appropriate.

2. *Retest furans analysis six months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. This baseline data shows an elevated amount of furans. This indicates apparent thermal damage and/or deterioration of the cellulosic insulation.

The appropriate response when there are abnormal furans results is to retest at a shortened interval. Based on the furan profile, a retest within six months is appropriate for this unit.

3. Leak repair.

A leak was noted at the pressure relay piping at the bottom of unit. Prior to beginning the leak repair work, qualified personnel should carefully inspect the equipment and its installation to determine how best to minimize the length of outage needed. This leak presents an environmental issue and potential hazard due to release of the insulating liquid. Repairing the leak now is also important to ensure that long-term damage to the equipment, such as that caused by low liquid levels, does not occur.

4. Low liquid level/Add liquid.

The liquid level gauge indicates that the dielectric liquid level is low. Prior to adding fluid, qualified personnel should inspect the equipment to verify that the fluid level gauge is functioning properly. If the liquid level is indeed low, qualified personnel should add liquid to the proper level. If the proper liquid level is not restored, this may result in damage to the equipment, making it unreliable. If not using the exact same dielectric fluid, compatibility with the existing fluid should be verified before proceeding.

Besides the three month Karl Fischer retest, the six month furan retest, addressing the leak situation, and addressing the low liquid level, normal monitoring is indicated, this unit should be monitored closely.

Moisture content is unacceptable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9004	58 °C	43	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

Acid Number is unacceptable: Sample results for acid number and the SDMI classifications for wecosol are as follows:

TC#	Acid No. mg KOH/g	AC	QU	UN
9004	0.120	≤ 0.09	–	> .09

TC 9001 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9001	-	#1	Transformer	590647	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
UN		AC				UN	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest furans analysis three months.* The furans analysis is unacceptable and indicates deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within three months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.
2. *Low liquid level/Add liquid.* The fluid level gauge indicates that the liquid level is low. After verification that the gauge is reading correctly, fluid should be added to restore the proper liquid level.

Maintenance Assessment:

1. *Retest furans analysis three months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. The furans content is higher than expected for a typical, normally operating unit, and indicates significant thermal damage and/or deterioration of the cellulosic insulation. The concentration of 2-furaldehyde (2FAL) suggests severe local or moderate general deterioration of the cellulosic insulation. As a fault continues it causes the insulation to breakdown and become brittle. The furans content is an indicator concerning the degree to which the cellulosic insulation has already broken down. We are not able to give a meaningful estimate of the degree of polymerization (DP) or % life remaining in units with this insulation (55C) and fluid type. Based on the total furans level (2,000 ppb), it would appear that this unit has lost some integrity of its insulation.

The appropriate response to high or increasing furans analysis results is to retest at a shortened interval in order to monitor the condition and generation rate for the furanic compounds. At this level of furans, a retest within three months is appropriate.

2. *Low liquid level/Add liquid.*

The liquid level gauge indicates that the dielectric liquid level is low. Prior to adding fluid, qualified personnel should inspect the equipment to verify that the fluid level gauge is functioning properly. If the liquid level is indeed low, qualified personnel should add liquid to the proper level. If the proper liquid level is not restored, this may result in damage to the equipment, making it unreliable. If not using the exact same dielectric fluid, compatibility with the existing fluid should be verified before proceeding.

Besides the three month furan retest and addressing the low liquid level, this unit should be monitored closely.

Acid Number is unacceptable: Sample results for acid number and the SDMI classifications for wecosol are as follows:

TC#	Acid No. mg KOH/g	AC	QU	UN
9001	0.110	≤ 0.09	—	$> .09$

TC 9005 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9005	-	#5	Transformer	708621	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
QU		QU				QU	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest Karl Fischer moisture content six months.* The moisture content is questionable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within six months.
2. *Retest furans analysis six months.* The furans analysis is questionable due to deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within six months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.
3. *Low liquid level/Add liquid.* The fluid level gauge indicates that the liquid level is low. After verification that the gauge is reading correctly, fluid should be added to restore the proper liquid level.

Maintenance Assessment:

1. *Retest Karl Fischer moisture content six months.*

A parts per million of moisture in the questionable range is an indication of either an incursion of moisture into the unit or possibly due to sampling the transformer during or shortly after a period of changing load and operating temperature. In this case, it currently appears to be due to an incursion of moisture into the unit.

Even so, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For questionable results, a retest within six months is usually appropriate.

2. *Retest furans analysis six months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. This baseline data shows an elevated amount of furans. This indicates apparent thermal damage and/or deterioration of the cellulosic insulation.

The appropriate response when there are abnormal furans results is to retest at a shortened interval. Based on the furan profile, a retest within six months is appropriate for this unit.

3. Low liquid level/Add liquid.

The liquid level gauge indicates that the dielectric liquid level is low. Prior to adding fluid, qualified personnel should inspect the equipment to verify that the fluid level gauge is functioning properly. If the liquid level is indeed low, qualified personnel should add liquid to the proper level. If the proper liquid level is not restored, this may result in damage to the equipment, making it unreliable. If not using the exact same dielectric fluid, compatibility with the existing fluid should be verified before proceeding.

Besides the six month Karl Fischer retest, the six month furan retest, and addressing the low liquid level, this unit should be monitored closely.

Moisture content is questionable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9005	75 °C	30.5	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

TC 9002 MAINTENANCE ASSESSMENT

TC#	Sub Name	Unit#	Equipment Type	Serial#	kVA	HighVolt	LowVolt
9002	-	#2	Transformer	590638	340	13,800	153
LS	DGA	KF	ICP	LPF	INH	FUR	
UN		UN				UN	

Recap Service Recommendations/Priorities for Maintenance:

1. *Retest Karl Fischer moisture content three months.* The moisture content is unacceptable with regard to parts per million (ppm) of moisture detected. The appropriate response is to retest the Karl Fischer moisture content within three months.
2. *Retest furans analysis three months.* The furans analysis is unacceptable and indicates deterioration or overheating of the cellulosic insulation. The furans analysis should be retested within three months to confirm whether active deterioration is proceeding and to establish a generation rate for furanic compounds.

Maintenance Assessment:

1. *Retest Karl Fischer moisture content three months.*

Unacceptable baseline moisture content, such as the current results indicate, may be due to an incursion of moisture into the transformer. Unacceptable moisture content may also be due to sampling the transformer during or shortly after a period of changing load and operating temperature. However, it currently appears that this moisture profile may be the result of a migration of moisture into the unit. Therefore, in order to better clarify the issue of moisture, the recommended response would be to retest the Karl Fischer moisture content at a shortened interval when the load and temperature of the unit are as level as feasible or as close to peak as possible. For unacceptable results, a retest within three months is appropriate.

2. *Retest furans analysis three months.*

While many types of service can reduce furans in the fluid, the damage to the cellulosic insulation is irreparable. The furans content is higher than expected for a typical, normally operating unit, and indicates significant thermal damage and/or deterioration of the cellulosic insulation. The concentration of 2-furaldehyde (2FAL) suggests severe local or moderate general deterioration of the cellulosic insulation. As a fault continues it causes the insulation to breakdown and become brittle. The furans content is an indicator concerning the degree to which the cellulosic insulation has already broken down. We are not able to give a meaningful estimate of the degree of polymerization (DP) or % life remaining in units with this insulation (55C) and fluid type. Based on the total furans level (1,444 ppb), it would appear that this unit has lost some integrity of its insulation.

The appropriate response to high or increasing furans analysis results is to retest at a shortened interval in order to monitor the condition and generation rate for the furanic compounds. At this level of furans, a retest within three months is appropriate.

Besides the three month Karl Fischer retest and the three month furan retest, close monitoring is recommended.

Moisture content is unacceptable: Sample results and the SDMI classifications for wecosol fluid-filled equipment are as follows:

TC#	Sample Temp	ppm	AC	QU	UN
9002	65 °C	61	< 30 ppm	≥ 30, < 35 ppm	≥ 35 ppm

Acid Number is unacceptable: Sample results for acid number and the SDMI classifications for wecosol are as follows:

TC#	Acid No. mg KOH/g	AC	QU	UN
9002	0.150	≤ 0.09	–	> .09

Maintenance Assessment date: February 17, 2014

Draw date: December 18, 2013

Recap date: February 13, 2014

If you have any questions about the report, please don't hesitate to contact me. Thank you again for the opportunity to serve you.

Sincerely,

David Broadbent

Sr. Technical Specialist

330-630-7000 ext. 3387

dave.broadbent@sdmyers.com

sk/Dave
Broadbent

Digitally signed by sk/Dave
Broadbent
DN: cn=sk/Dave Broadbent, o=S
D Myers, ou=Technical Specialist,
email=dave.broadbent@sdmyers.
com, c=US
Date: 2014.02.17 09:47:10 -05'00'



Executive Summary - Final Recap

February 13, 2014

Page 1

Customer 8002260 - Newfoundland & Labrador
Hydro

City/State St. Johns, NL

Sales Order 703876

Total TC's 7

Sub Name / Unit No	Serial No	TC No	Draw Date	Equipment / Liquid Type	kVA Rating	Gals.	LS	KF	DGA	LPF	INH	ICP	FUR	PCB Class	PCB Date	Service Recommendations
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The following pieces of equipment require a monitoring interval shorter than one year:

#1	590647	9001	12/18/13	Transformer / Wecosol	340	160	UN	AC					UN	Non-PCB	12/18/13	See Furan Data / Retest 3 Mo. Low Liquid Level
#2	590638	9002	12/18/13	Transformer / Wecosol	340	160	UN	UN					UN	Non-PCB	12/18/13	See KF Data / Retest 3 Months See Furan Data / Retest 3 Mo.
#3	590011	9003	12/18/13	Transformer / Wecosol	340	160	QU	UN					UN	Non-PCB	12/18/13	See KF Data / Retest 3 Months See Furan Data / Retest 3 Mo. Repair - Leaks Low Liquid Level
#4	659420	9004	12/18/13	Transformer / Wecosol	340	160	UN	UN					QU	Non-PCB	12/18/13	See KF Data / Retest 3 Months See Furan Data / Retest 6 Mo. Repair - Leaks Low Liquid Level
#5	708621	9005	12/18/13	Transformer / Wecosol	340	160	QU	QU					QU	Non-PCB	12/18/13	See KF Data / Retest 6 Months See Furan Data / Retest 6 Mo. Low Liquid Level
#6	679204	9006	12/18/13	Transformer / Wecosol	340	160	UN	UN					UN	Non-PCB	12/18/13	See KF Data / Retest 3 Months See Furan Data / Retest 3 Mo. Low Liquid Level
#7	288954	9007	12/18/13	Transformer / Wecosol	1175	212	QU	QU					UN	Non-PCB	12/18/13	See Furan Data / Retest Immediately See KF Data / Retest 6 Months

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Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
Sub-Name Unit No. #1

Location INDOOR
Other

NAMEPLATE DATA

Manufacturer	CGE	Equipment Type	TRANSFORMER
Manufacture Date	01/01/1966	Transformer Class	
Serial No.	590647	Impedance %	8.50
KVA Rating	340	Phase/Cycle	3/60
High Voltage	13,800	Liquid Type	WECOSOL
Low Voltage	153	Gallons	160
Weight	6,900	Other Access	

ADDITIONAL EQUIPMENT

Radiators	No	Conservator Tank	No
Fans	No	LTC Compartment	No
Water Cooled	No	Bushing Location	Top Encl.
Oil Pumps	No	Breather	Free
Top FPV (inch)	0.00	Hose Length (feet)	
Bottom FPV (inch)	0.00	Service Online	Yes
InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS
12/18/13	LOW	58	58	1.50	GOOD	NONE

FIELD SERVICE

DATE	SERVICE
------	---------

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.110 UN		38	AC		PALE YELO	1.486 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
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LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	2.290	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 590647
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #1

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		27	N/A AC	N/A

RECOMMENDATION RETEST 1 YEAR

The moisture content in this baseline data is acceptable based on the equipment class and liquid type. Normal monitoring is indicated.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	2,000	ND	ND	2,000

RECOMMENDATION RETEST 3 MONTHS

THE TOTAL FURAN LEVEL INDICATES SIGNIFICANT DAMAGE TO THE CELLULOSIC INSULATION OF THE UNIT. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS SEVERE LOCAL OR MODERATE GENERAL DETERIORATION OF THE CELLULOSIC INSULATION. IF APPLICABLE, THE DISSOLVED GAS ANALYSIS RESULTS SHOULD BE CONSULTED TO AID DIAGNOSIS.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
Sub-Name Unit No. #2

Location INDOOR
Other

NAMEPLATE DATA

Manufacturer	CGE	Equipment Type	TRANSFORMER
Manufacture Date	01/01/1966	Transformer Class	
Serial No.	590638	Impedance %	8.50
KVA Rating	340	Phase/Cycle	3/60
High Voltage	13,800	Liquid Type	WECOSOL
Low Voltage	153	Gallons	160
Weight	6,900	Other Access	

ADDITIONAL EQUIPMENT

Radiators	No	Conservator Tank	No
Fans	No	LTC Compartment	No
Water Cooled	No	Bushing Location	Top Encl.
Oil Pumps	No	Breather	Free
Top FPV (inch)	0.00	Hose Length (feet)	
Bottom FPV (inch)	0.00	Service Online	Yes
InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS
12/18/13	NORMAL	65	65	2.00	GOOD	NONE

FIELD SERVICE

DATE	SERVICE
------	---------

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.150 UN		43	AC		PALE YELO	1.484 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	9.540	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 590638
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #2

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		61	N/A UN	N/A

RECOMMENDATION RETEST 3 MONTHS

The moisture content is unacceptable based on the equipment class and liquid type. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	1,444	ND	ND	1,444

RECOMMENDATION RETEST 3 MONTHS

THE TOTAL FURAN LEVEL INDICATES SIGNIFICANT DAMAGE TO THE CELLULOSIC INSULATION OF THE UNIT. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS SEVERE LOCAL OR MODERATE GENERAL DETERIORATION OF THE CELLULOSIC INSULATION. IF APPLICABLE, THE DISSOLVED GAS ANALYSIS RESULTS SHOULD BE CONSULTED TO AID DIAGNOSIS.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

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Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
 Sub-Name Unit No. #3

Location INDOOR
 Other

NAMEPLATE DATA

ADDITIONAL EQUIPMENT

Manufacturer	CGE	Equipment Type	TRANSFORMER	Radiators	No	Conservator Tank	No
Manufacture Date	01/01/1966	Transformer Class		Fans	No	LTC Compartment	No
Serial No.	590011	Impedance %	8.50	Water Cooled	No	Bushing Location	Top Encl.
KVA Rating	340	Phase/Cycle	3/60	Oil Pumps	No	Breather	Free
High Voltage	13,800	Liquid Type	WECOSOL	Top FPV (inch)	0.00	Hose Length (feet)	
Low Voltage	153	Gallons	160	Bottom FPV (inch)	0.00	Service Online	Yes
Weight	6,900	Other Access		InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

FIELD SERVICE

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS	DATE	SERVICE
12/18/13	LOW	65	65	0.00	GOOD	YES/PRESSURE RELAY		

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.060 AC		53 AC			PALE YELO	1.511 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	2.180	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 590011
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #3

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		49	N/A UN	N/A

RECOMMENDATION RETEST 3 MONTHS

The moisture content is unacceptable based on the equipment class and liquid type. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	1,075	ND	ND	1,075

RECOMMENDATION RETEST 3 MONTHS

THE TOTAL FURAN LEVEL INDICATES SIGNIFICANT DAMAGE TO THE CELLULOSIC INSULATION OF THE UNIT. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS SEVERE LOCAL OR MODERATE GENERAL DETERIORATION OF THE CELLULOSIC INSULATION. IF APPLICABLE, THE DISSOLVED GAS ANALYSIS RESULTS SHOULD BE CONSULTED TO AID DIAGNOSIS.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

Appendix A, Page 28 of 35

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
Sub-Name Unit No. #4

Location INDOOR
Other

NAMEPLATE DATA

Manufacturer	CGE	Equipment Type	TRANSFORMER
Manufacture Date	01/01/1968	Transformer Class	
Serial No.	659420	Impedance %	8.80
KVA Rating	340	Phase/Cycle	3/60
High Voltage	13,800	Liquid Type	WECOSOL
Low Voltage	153	Gallons	160
Weight	6,900	Other Access	

ADDITIONAL EQUIPMENT

Radiators	No	Conservator Tank	No
Fans	No	LTC Compartment	No
Water Cooled	No	Bushing Location	Top Encl.
Oil Pumps	No	Breather	Free
Top FPV (inch)	0.00	Hose Length (feet)	
Bottom FPV (inch)	0.00	Service Online	Yes
InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS
12/18/13	LOW	58	58	2.50	GOOD	YES/PRESSURE RELAY

FIELD SERVICE

DATE	SERVICE
------	---------

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.120 UN		38	AC		PALE YELO	1.490 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	0.473	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 659420
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #4

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		43	N/A UN	N/A

RECOMMENDATION RETEST 3 MONTHS

The moisture content is unacceptable based on the equipment class and liquid type. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	490	ND	ND	490

RECOMMENDATION RETEST 6 MONTHS

THE TOTAL FURAN LEVEL IS HIGH ENOUGH THAT THE INTEGRITY OF THE CELLULOSIC INSULATION IS QUESTIONABLE. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS EITHER MODERATE LOCALIZED OR SLIGHT GENERALIZED DETERIORATION OF THE CELLULOSIC INSULATION.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO
Sub-Name

City St. Johns, NL
Unit No. #5

Location INDOOR
Other

NAMEPLATE DATA

Manufacturer	CGE	Equipment Type	TRANSFORMER
Manufacture Date	01/01/1968	Transformer Class	
Serial No.	708621	Impedance %	8.60
KVA Rating	340	Phase/Cycle	3/60
High Voltage	13,800	Liquid Type	WECOSOL
Low Voltage	153	Gallons	160
Weight	6,900	Other Access	

ADDITIONAL EQUIPMENT

Radiators	No	Conservator Tank	No
Fans	No	LTC Compartment	No
Water Cooled	No	Bushing Location	
Oil Pumps	No	Breather	Free
Top FPV (inch)	0.00	Hose Length (feet)	
Bottom FPV (inch)	0.00	Service Online	Yes
InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS
12/18/13	LOW	75	75	1.00	GOOD	NONE

FIELD SERVICE

DATE	SERVICE
------	---------

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.020 AC		48 AC			PALE YELO	1.496 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	0.284	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 708621
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #5

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		31	N/A QU	N/A

RECOMMENDATION RETEST 6 MONTHS

The moisture content is questionable based on the equipment class and liquid type. This may be due to an incursion of moisture or disruption in equilibrium due to changing load/temperature. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	318	ND	ND	318

RECOMMENDATION RETEST 6 MONTHS

THE TOTAL FURAN LEVEL IS HIGH ENOUGH THAT THE INTEGRITY OF THE CELLULOSIC INSULATION IS QUESTIONABLE. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS EITHER MODERATE LOCALIZED OR SLIGHT GENERALIZED DETERIORATION OF THE CELLULOSIC INSULATION.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

Appendix A, Page 32 of 35

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
 Sub-Name Unit No. #6

Location INDOOR
 Other

NAMEPLATE DATA

ADDITIONAL EQUIPMENT

Manufacturer	CGE	Equipment Type	TRANSFORMER	Radiators	No	Conservator Tank	No
Manufacture Date	01/01/1968	Transformer Class		Fans	No	LTC Compartment	No
Serial No.	679204	Impedance %	8.40	Water Cooled	No	Bushing Location	Top Encl.
KVA Rating	340	Phase/Cycle	3/60	Oil Pumps	No	Breather	Free
High Voltage	13,800	Liquid Type	WECOSOL	Top FPV (inch)	0.00	Hose Length (feet)	
Low Voltage	153	Gallons	160	Bottom FPV (inch)	0.00	Service Online	Yes
Weight	6,900	Other Access		InsulationType	55C	Power Available	Yes

VISUAL INSPECTION

FIELD SERVICE

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS	DATE	SERVICE
12/18/13	LOW	65	65	0.10	GOOD	NONE		

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.420 UN		43	AC		DARK YELO	1.487 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	27.300	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 679204
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #6

Gallons 160 High Volt. 13,800
 KVA 340 Low Volt. 153

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		50	N/A UN	N/A

RECOMMENDATION RETEST 3 MONTHS

The moisture content is unacceptable based on the equipment class and liquid type. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	ND	ND	2,117	ND	ND	2,117

RECOMMENDATION RETEST 3 MONTHS

THE TOTAL FURAN LEVEL INDICATES SIGNIFICANT DAMAGE TO THE CELLULOSIC INSULATION OF THE UNIT. THE CONCENTRATION OF 2-FURALDEHYDE (2FAL) SUGGESTS SEVERE LOCAL OR MODERATE GENERAL DETERIORATION OF THE CELLULOSIC INSULATION. IF APPLICABLE, THE DISSOLVED GAS ANALYSIS RESULTS SHOULD BE CONSULTED TO AID DIAGNOSIS.

CALCULATED DP N/A EST. LIFE REMAINING N/A

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

Appendix A, Page 34 of 35

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO City St. Johns, NL
 Sub-Name Unit No. #7

Location INDOOR
 Other

NAMEPLATE DATA

Manufacturer	CGE	Equipment Type	TRANSFORMER
Manufacture Date	01/01/1976	Transformer Class	
Serial No.	288954	Impedance %	5.42
KVA Rating	1,175	Phase/Cycle	3/60
High Voltage	13,800	Liquid Type	WECOSOL
Low Voltage	559	Gallons	212
Weight	10,800	Other Access	

ADDITIONAL EQUIPMENT

Radiators	No	Conservator Tank	No
Fans	No	LTC Compartment	No
Water Cooled	No	Bushing Location	Top Encl.
Oil Pumps	No	Breather	Free
Top FPV (inch)	0.00	Hose Length (feet)	
Bottom FPV (inch)	0.00	Service Online	Yes
InsulationType	65C	Power Available	Yes

VISUAL INSPECTION

DATE	LEVEL	SAMPLE TEMP	TOP TEMP	P/V	PAINT	LEAKS
12/18/13	NORMAL	65	65	2.50	GOOD	NONE

FIELD SERVICE

DATE	SERVICE
------	---------

Additional Information

Reason Not Tested

LIQUID SCREEN TEST DATA

DATE	SERVICE	ACID	IFT	DIEL 877	DIEL 1816	GAP	COLOR	SP. GRAV.	VISUAL	SEDIMENT
12/18/13		0.080 AC		57	AC		PALE YELO	1.491 QU	CLEAR AC	NONE AC

INHIBITOR CONTENT

DATE	PCT. BY WEIGHT
------	----------------

LIQUID POWER FACTOR

DATE	25 C	100 C
12/18/13	1.140	

KEY TO ABBREVIATIONS: AC - ACCEPTABLE QU - QUESTIONABLE UN - UNACCEPTABLE RS - RESAMPLE

NOTE: * After a result indicates that the test or service was performed by an outside source.

Customer 8002260 NEWFOUNDLAND & LABRADOR HYDRO S/N 288954
 Sub-Name Mfg. CGE
 Location INDOOR Unit No. #7

Gallons 212 High Volt. 13,800
 KVA 1,175 Low Volt. 559

KARL FISCHER TESTING MOISTURE CONTENT EXPRESSED IN PPM

DATE	AVG. TEMP	PPM	PCT. SATURATION	MOISTURE BY DRY WEIGHT PCT.
12/18/13		32	N/A QU	N/A

RECOMMENDATION RETEST 6 MONTHS

The moisture content is questionable based on the equipment class and liquid type. This may be due to an incursion of moisture or disruption in equilibrium due to changing load/temperature. A shorter test interval is recommended to monitor this unit.

FURAN ANALYSIS EXPRESSED IN PPB

DATE	5H2F	2FOL	2FAL	2ACF	5M2F	TOTAL
12/18/13	744	ND	15,906	ND	124	16,774

RECOMMENDATION IMMEDIATE RETEST

THE TOTAL FURAN LEVEL INDICATES THAT THE CELLULOSIC INSULATION HAS DETERIORATED AND WEAKENED MECHANICALLY TO THE POINT THAT THIS UNIT SHOULD BE CONSIDERED UNRELIABLE, AS IT COULD SUDDENLY FAIL. AN IMMEDIATE RETEST IS OFTEN RECOMMENDED TO CONFIRM THESE VERY HIGH FURAN LEVELS. PLANS TO REPAIR, REWIND, OR REPLACE THIS UNIT SHOULD BE INVESTIGATED.

CALCULATED DP <200 EST. LIFE REMAINING 0%

GAS-IN-OIL ANALYSIS GAS CHROMATOGRAPHY EXPRESSED IN PPM

DATE	HYDROGEN	OXYGEN	NITROGEN	METHANE	CARBON MONOXIDE	CARBON DIOXIDE	ETHANE	ETHYLENE	ACETYLENE	TOTAL COMBUST.	TOTAL GAS

ICP METALS-IN-OIL EXPRESSED IN PPM

DATE	ALUMINUM	IRON	COPPER

PCB CONTENT EXPRESSED IN PPM

DATE	1242	1254	1260	OTHER	TOTAL
12/18/13					ND

COLOR LABEL: Green

CLASS: NON-PCB

Results in mg/kg
 ND means None Detected
 (<2 mg/kg per ASTM D4059)

NOTE: * After a result indicates that the test or service was performed by an outside source.

APPENDIX B

Hydro Internal Expert Analysis of SD Myers Test Results

Hydro Internal Expert Analysis of SD Myers Test Results

BDE RT1 – RT7 Rectifying Transformers: Furan Analysis Interpretation and Recommendations

The results of the oil samples collected from RT1, RT2, RT3, RT4, RT5, RT6, and RT7 on December 18, 2013 were analyzed by Hydro's TRO G&T Equipment Engineer solely for the purpose of calculating degree of polymerization (DP) of each transformer's paper insulation and providing recommendations based on the DP values. The interpretation of other results from the oil samples are beyond the scope of this analysis. Below is the response.

DP values were calculated based on the furan concentrations measured in each of the oil samples. This provides an inferred DP value. Obtaining an actual DP value requires collecting samples of the transformer's paper insulation which is a destructive test that is typically performed only during transformer construction and de-commissioning. DP value is a measure of the mechanical strength of paper insulation and, as such, it is an indication of the remaining service life of a transformer since a transformer is considered to be at the end of its useful life when its DP falls to a value of 200 (i.e., its paper insulation gets very weak). Weak paper insulation is a problem since a transformer's windings (where the paper is located) experiences high mechanical forces during electrical transients (such as energization, de-energization, system disturbances, etc.) and weak paper could be damaged by these forces and that damage could result in the failure of the transformer. In short, the risk of transformer failure increases as DP decreases and that risk is considered unacceptable once DP falls below 200. New transformers typically have a DP value between 1,000 and 1,100. Below is a table which shows the inferred DP values calculated from the furan concentrations and the remaining life where end-of-life is defined as DP = 200.

Unit	Furan (2FAL) Concentration	Inferred Degree of Polymerization (DP)	Remaining Life (EOL: DP = 200)
RT1	2,000	345	16%
RT2	1,444	386	21%
RT3	1,075	423	25%
RT4	490	520	36%
RT5	318	574	42%
RT6	2,117	339	15%
RT7	15,906	88	-12%

As the table shows, RT7 is past its end-of-life, RT1, RT2, and RT6 are close to end-of-life, and RT3, RT4, and RT5 are more than 50% of the way to end-of-life. RT6 has since failed and this failure highlights the vulnerability of transformers whose DP values are low.

One of the criteria used by Hydro for the replacement of its power transformers is a DP value of 200. In order to ensure that the transformer is replaced by the time DP reaches

200, the criteria includes initiation of a project for replacement once DP drops below 400 since 2-3 years are needed to obtain project approval and then procure and install the new transformer.

Prior to using DP value in its transformer replacement criteria, Hydro experienced a transformer failure that was due to low DP. The transformer failed upon energization and required replacement.

Based upon the DP values inferred from the furan concentrations of the oil samples collected on December 18, 2013, recommendations are as follows:

- RT7 should be replaced as soon as is practically possible and the current RT7 should not be de-energized unless necessary since the DP value is low enough that any transient (including re-energization) poses an unacceptable risk of a failure that is essentially unrepairable;
- A planned capital project should be raised for the replacement of RT1 and RT2; and
- Annual furan analysis should be performed on RT3, RT4, and RT5 for the remainder of their life.

The above recommendations notwithstanding, consideration should be given to replacing RT3, RT4, and RT5 at the same time as RT1, RT2, RT6, and RT7 for the following reasons:

- These transformers are critical to the availability of its associated generator and hence a more conservative replacement criteria which requires replacement and project initiation at higher DP values may be justified; and
- These three transformers will likely require replacement within the next 5-10 years and it may be more cost-effective to procure them as part of an order assuming a lower price can be obtained via procuring a larger quantity.

APPENDIX C

Pennecon Inspection Report

Nalcor – Bay D’Espoir Exciter Transformer Inspection



PENNECON ENERGY TECHNICAL SERVICES



Prepared By: David Trask
Power Systems,
Manager
11/03/2014

Prepared For: Mr. Karl Inkpen

Manager, Work Execution
Hydro Generation
Newfoundland and Labrador Hydro - a
Nalcor Energy company

**Technical Services****Power Systems**

Karl Inkpen
Manager, Work Execution
Hydro Generation
Newfoundland and Labrador Hydro - a Nalcor Energy company

March 11, 2014**Reference: #6 Exciter Transformer Inspection & Testing – WTSA004469**

Dear Karl,

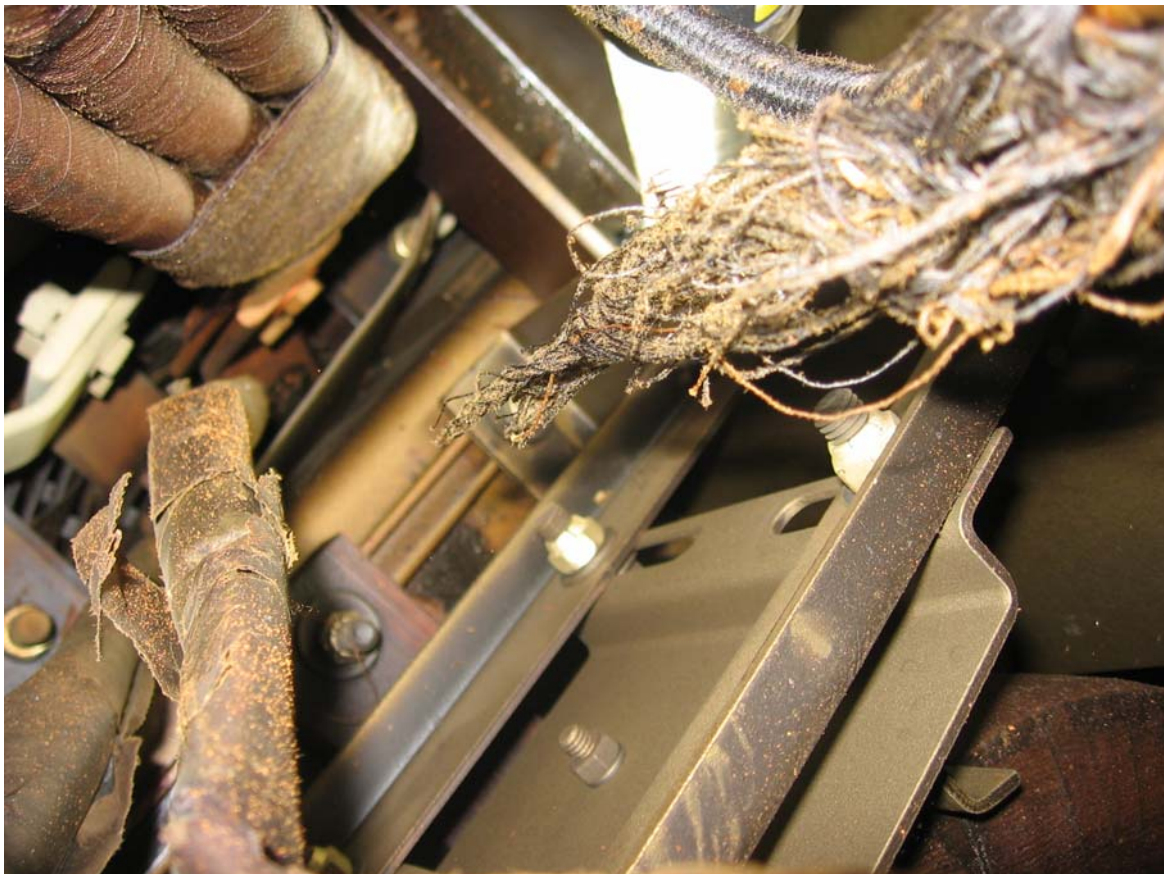
The following report is provided to Nalcor after Pennecon Energy completed an inspection on #6 exciter transformer at the Bay D'Espoir generating station. The scope of work included an internal inspection of the transformer windings to investigate the source of high resistance readings in the B Phase primary winding.

With the transformer oil removed from the unit inspection covers were removed by our team. Special safety provisions were employed for this work using SCBA's to limit personnel from the hazards of working with Perchloroethylene. Winding resistance electrical tests were performed to confirm the readings. The original readings that were provided were taken using an external connection to the HV bushing as the test points. The results of the testing (attached) confirm that the high reading in the B Phase was still present when connected internally at the winding. The picture below shows the lead configuration through the CT and onward to the winding connection.



In order to access any further test points the core would have to be removed. To accomplish this we would have to remove the top cover, let go the secondary & tertiary

winding bushing connections and also disconnect the CT secondary wiring. The condition of the insulation on the winding leads and CT wiring was so poor that it crumbled when touched. The pictures below show some samples of this condition.





Technical Services

Power Systems

Conclusions & Recommendations:

Removal of the core would subsequently require the replacement of all of the damaged wiring. The CT's also may be impacted by this process and require replacement as they appear brittle as well. If the insulation was in better condition it may have been feasible to further investigate the high resistance readings. However, when taking into account the existing insulation condition we feel that the transformer is not suitable for service & due to cost and timeframe beyond repair. We are not able to be conclusive at this time what the contributing factors might be to cause the severe insulation damage. We intend to further investigate this condition and will advise if any further information is discovered.

I can be reached for further discussion if required on these results. Thank you for the opportunity to be of service.

Regards,

David J. Trask

Manager, Power Systems

Pennecon Energy Technical Services

Direct: 709-778-4167 | Office: 709-726-4554 | Cell: 709-699-5589 | Fax: 709-726-5887

Email: DTrask@pennecon.com | Web: www.pennecon.com

AMBIENT TEMP. 20 °C DATE 3/10/2014

CUSTOMER Nalcor

HUMIDITY 60 % JOB # WTSA004469

LOCATION Bay D'Espoir Hydro

ASSET ID Unit # 6 Excitation Transformer

EQUIPMENT LOCATION Bay D'Espoir Hydro Unit # 6

NAMEPLATE DATA

MANUFACTURER Canadian General Electric SERIAL NO. 679204

SPECIFICATION NO. 817023783 KVA 340 / 369 / TYPE RECTIFIER CLASS

PHASE 3 TEMPERATURE RISE 55 °C IMPEDANCE 8.4 % B.I.L. RATING 110 kV PRI. 45 kV SEC.

COOLANT CAPACITY 160 GALLONS TOTAL WEIGHT 6900

WINDING POLARITY SUBTRACTIVE WINDING MATERIAL CU K FACTOR NA

PRIMARY VOLTAGE 13,800 / 7,967 ☐ DELTA ☒ WYE RATED CURRENT 14 / 15 / AMPERES

SECONDARY VOLTAGE 575 / 153 ☒ DELTA ☐ WYE RATED CURRENT 341 / 371 / AMPERES

TAP VOLTAGES

TAP CONNECTIONS

TAP SETTING VOLTS # FANS TAP CHANGER: ☒ INTERNAL ☐ EXTERNAL DRY TYPE ☐

PRIMARY WINDING:

MEASURED RESISTANCE

H 1 - H 0	4.6	OHMS
H 2 - H 0	24.9	OHMS
H 3 - H 0	4.6	OHMS

PRIMARY WINDING MATERIAL COPPER

SECONDARY WINDING:

MEASURED RESISTANCE

X - X		OHMS
X - X		OHMS
X - X		OHMS

SECONDARY WINDING MATERIAL COPPER

WINDING TEMPERATURE 20 °C

CALCULATED RESISTANCE CORRECTED TO 85°C

PRIMARY R _T	42.809	OHMS
SECONDARY R _T		OHMS

COMMENTS:

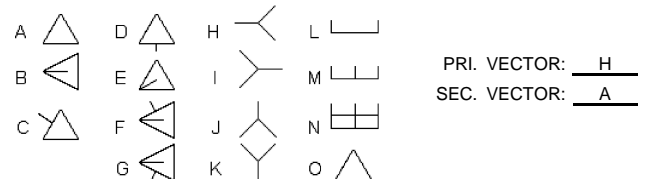
DEFICIENCIES:

Found High Resistance on Phase B. Upon investigation found that severe deterioration of insulation on internal transformer wiring. Signs of Carbon throughout the transformer. Most wire insulation very brittle and falling off wiring.

TEST EQUIPMENT USED: Megger Winding Resistance Tester

TESTED BY: D.J. Wall / Val Greening

VECTOR DIAGRAM


R_T = TOTAL WINDING RESISTANCE AT 85°C

R_M = TOTAL WINDING RESISTANCE AT TEST TEMPERATURE

T_S = TEMPERATURE FOR DESIRED RESISTANCE (85°C)

T_M = WINDING TEMPERATURE

T_K = TEMP. RESISTANCE CONSTANT (°C)

COPPER + 234.5°C

ALUMINUM = 226.0°C (STD. C57.12.91)

DELTA WINDING MULTIPLIER = 3/2X

WYE WINDING MULTIPLIER = 3X

$$R_T = R_M \frac{T_S + T_K}{T_M + T_K}$$

APPENDIX D

Material Safety Data Sheets

MATERIAL SAFETY DATA SHEET

MSDS NUMBER : M20544

MSDS DATE : 10-16-90

PRODUCT NAME : TRANSCLENE

24 HOUR EMERGENCY PHONE: (716) 278-7021

I. PRODUCT IDENTIFICATION

HMIS HAZARD RATINGS

HEALTH HAZARD 2*

FIRE HAZARD 0

REACTIVITY 0

Based on the National Paint & Coatings Association HMIS rating system.

SARA/TITLE III HAZARD CATEGORIES (See Section X)

Immediate (ACUTE) Health: YES
Delayed (Chronic) Health: YES
Fire Hazard: NOReactive Hazard: NO
Sudden Release of Pressure: NOMANUFACTURER'S: Occidental Chemical Corporation
NAME AND ADDRESS: Customer Service, Occidental Tower,
P O Box 809050, Dallas, Texas 75380 Telephone: (1-800-752-5151)

CHEMICAL NAME: Tetrachloroethylene CAS NUMBER: 127-18-4

SYNONYMS/COMMON NAMES: Tetrachloroethylene blend

CHEMICAL FORMULA: C12C=CC12

DOT PROPER SHIPPING NAME: Perchloroethylene

DOT HAZARD CLASS: ORM-A

DOT I.D. NUMBER: NA 1897

DOT HAZARDOUS SUBSTANCE: RQ 100#

II. HEALTH HAZARD INFORMATION

EMERGENCY AND FIRST AID PROCEDURES

EYES:

OBJECT IS TO FLUSH MATERIAL OUT IMMEDIATELY THEN SEEK MEDICAL ATTENTION. IMMEDIATELY flush eyes with large amounts of water for at least 15 minutes, holding lids apart to ensure flushing of the entire surface. SEEK MEDICAL ATTENTION.

SKIN:

Wash contaminated areas with plenty of soap and water. A soothing ointment may be applied to irritated skin after thorough cleansing. Remove contaminated clothing and footwear and wash clothing before reuse. Discard footwear which cannot be decontaminated. SEEK MEDICAL ATTENTION.

CAS = Chemical Abstract Service Number ND = No relevant information found or not available
PEL = OSHA Permissible Exposure Limit CORP = Corporate Exposure Limit
TLV = ACGIH Threshold Limit Value, Current : See Chronic Effects Information NA = Not applicable

IMPORTANT: The information presented herein, while not guaranteed, was prepared by competent technical personnel and is true and accurate to the best of our knowledge. NO WARRANTY OR GUARANTY, EXPRESS OR IMPLIED IS MADE REGARDING PERFORMANCE, STABILITY, OR OTHERWISE. This information is not intended to be all-inclusive as to the manner and conditions of use, handling and storage. Other factors may involve other or additional safety or performance considerations. While our technical personnel will be happy to respond to questions regarding safe handling and use procedures, safe handling and use remains the responsibility of the customer. No suggestions for use are intended as, and nothing herein shall be construed as a recommendation to infringe any existing patents or violate any Federal, State or local laws.

II. HEALTH HAZARD INFORMATION (Continued)

INHALATION:

Remove to fresh air. If breathing is difficult, have trained person administer oxygen. If breathing has stopped, give mouth-to-mouth resuscitation. GET IMMEDIATE MEDICAL ATTENTION.

INGESTION:

DO NOT INDUCE VOMITING. This material is not soluble. DO NOT GIVE FLUIDS. If spontaneous vomiting is inevitable, PREVENT ASPIRATION by keeping the victims head below the knees. GET IMMEDIATE MEDICAL ATTENTION. A qualified physician can perform gastric lavage only when the airway (trachea) has been secured to prevent aspiration. Further Medical Treatment: Following ingestion, adsorbents such as activated charcoal may be of value. Gastric lavage may be effective when performed by a physician within 4 hours of ingestion.

ROUTES OF EXPOSURE

INHALATION:

Excessive inhalation may produce symptoms of central nervous system depression ranging from light-headedness, nausea and vomiting, to unconsciousness and death.

SKIN:

Mildly irritating. May produce a burning sensation. Prolonged or repeated contact may redden, roughen, and dry due to the removal of natural oils and may result in dermatitis. May be absorbed through the skin, although not expected to produce toxicity through this route.

EYE CONTACT:

Irritating to the eyes pain, tearing, and general inflammation.

INGESTION:

May cause irritation of the gastrointestinal tract with vomiting. If vomiting results in aspiration, chemical pneumonia could follow. Absorption through the gastrointestinal tract may produce symptoms of central nervous system depression ranging from light-headedness to unconsciousness.

EFFECTS OF OVEREXPOSURE

ACUTE:

Excessive inhalation or ingestion may produce symptoms of central nervous system depression ranging from light-headedness, to unconsciousness and death. Can cause headache, mental confusion, depression, fatigue, loss of appetite, nausea, vomiting, cough, loss of sense of balance and visual disturbances. Exposure of the eyes and skin may produce irritation. Animals exposed to high levels have shown cardiac sensitization.

CHRONIC:

Overexposure may result in liver and kidney damage. Prolonged or repeated skin contact may cause dermatitis.

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II. HEALTH HAZARD INFORMATION (Continued)

TOXICOLOGY DATA:

Perchloroethylene:

Acute Oral:	LD50 (rat)	3980 to 4680 mg/kg
Acute Inhalation:	LD50 (rat)	5040 ppm, 34.2 mg/l for 8 hrs

NCI (DHEW-NIH Pub 77-813) stated that laboratory animals exposed to perchloroethylene at 80 to 150 ppm developed liver cancer in one study with no evidence of liver cancer in another study.

IARC - Lists this product as having inadequate evidence in humans, and sufficient evidence in animals to evaluate carcinogenicity. (Group 2B).

The National Toxicology Program (NTP 89-239), reports that PERC when administered via inhalation to rats and mice produced "clear evidence of carcinogenicity" in male rats (mononuclear cell leukemia and kidney tumors) and male and female mice (liver tumors).

The inhibitors in this product are not considered toxic nor carcinogenic by IARC, NTP, OSHA, or other and present no additional hazard.

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III. IMPORTANT COMPONENTS

CAS NUMBER / NAME

111660 1-Octene

EXPOSURE LIMITS

PEL=Not Established
 TLV=Not Established

PERCENTAGE

VOL ND
 WT 5.80-6.20

COMMON NAMES:

Listed On(List Legend Below):

12 23

127184 Ethene, tetrachloro-

EXPOSURE LIMITS

PEL=25 ppm; 170 mg/m3 TWA
 TLV=50 ppm; 339 mg/m3
 STEL=200 ppm; 1368 mg/m3

PERCENTAGE

VOL ND
 WT 93-94

COMMON NAMES:

ETHYLENE TETRACHLORIDE
 PERCHLOROETHYLENE
 TETRACHLOROETHYLENE#
 1,1,2,2,-TETRACHLOROETHYLENE

Listed On(List Legend Below):

02 07 09 11 15 18 21

79016 Ethene, trichloro-

EXPOSURE LIMITS

PEL=50 ppm; 270 mg/m3 TWA
 STEL=200 ppm; 1080 mg/m3
 TLV=50 ppm; 270 mg/m3
 STEL=200 ppm; 1070 mg/m3

PERCENTAGE

VOL ND
 WT 300PPM400PPM

COMMON NAMES:

ETHYLENE TRICHLORIDE
 TRICHLOROETHYLENE#
 TRICHLOROETHYLENE

Listed On(List Legend Below):

02 11 13 18 21

Chemical name used in the SARA Section 313 List of Toxic Chemicals (40 CFR - Section 372.65) if different from CAS name.

NIOSH (DHEW PUB. 78-112) recommends minimal exposure based on NCI study.

See Section II

All components of this product that are required to be on the TSCA Inventory are listed on the inventory.

LIST LEGEND

2 SARA TOXIC CHEM. SECTION 313
 9 IARC GROUP 2A OR 2B CARCINOGEN
 12 PA HAZARDOUS SUBSTANCE
 15 PA SPECIAL & ENV HAZ SUBSTANCE
 21 NJ SPECIAL HEALTH HAZ SUB

7 NTP "ANTPTD HUMAN CARCINOGENS"
 11 CA PROP 65 - CARCINOGEN
 13 PA ENVIROMENTAL HAZ SUBSTANCE
 18 NY HAZARDOUS SUBSTANCES
 23 NJ REQUIREMENT- 1% OR GREATER

IV. FIRE AND EXPLOSION DATA

FLASH POINT: None

AUTOIGNITION TEMPERATURE: ND

FLAMMABLE LIMITS IN AIR, % BY VOLUME- UPPER: Nonflammable
LOWER: Nonflammable

EXTINGUISHING MEDIA:

Fires involving this product are unlikely, but should one occur, it may be controlled by water spray, dry chemical, carbon dioxide or foam.

SPECIAL FIRE FIGHTING PROCEDURES:

Pressure-demand, self-contained breathing apparatus should be provided for fire fighters in buildings or confined areas where this product is stored. Storage containers exposed to fire should be kept cool with a water spray in order to prevent pressure build-up.

UNUSUAL FIRE AND EXPLOSION HAZARD:

Nonflammable and nonexplosive under normal conditions of use. At high temperatures, this product decomposes to give off hydrogen chloride gas and small quantities of other toxic and irritating vapors such as phosgene. If storage containers are exposed to excessive heat, over-pressurization of the containers can result.

V. SPECIAL PROTECTION

VENTILATION REQUIREMENTS:

Work in well ventilated areas. Maintain exposure level below 25 ppm. Where engineering controls are not feasible use adequate local exhaust ventilation where mist, spray, or vapor may be generated. The odor of perchloroethylene may indicate an air concentration in excess of 50 ppm.

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY:

Use a NIOSH/MSHA approved respirator following manufacturer's recommendations where vapor, mist or spray may be generated. Use supplied air respirator in positive pressure mode following ANSI Z117.1-1977 for tank and confined space entry.

EYE:

Wear chemical safety goggles, plus full face shield to protect against splashing when appropriate.

GLOVES:

Solvent resistant gloves should be worn, such as Viton, polyvinyl alcohol, or equivalent. Gloves contaminated with product should be discarded.

OTHER CLOTHING AND EQUIPMENT:

Protective clothing should be worn to minimize skin contact. Use standard work shoes; discard if shoes cannot be decontaminated. Store contaminated clothing in well ventilated cabinets or closed containers. Wash and dry contaminated clothing before reuse. Emergency shower and eyewash facility should be in close proximity.

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VI. PHYSICAL DATA

BOILING POINT @ 760 mm Hg: 120°C

FREEZING POINT: -28°C

VAPOR PRESSURE: 18 mm Hg @ 25°C

SPECIFIC GRAVITY (H₂O=1): 1.5

SOLUBILITY IN H₂O % BY WT: 0.015

APPEARANCE AND ODOR: Clear, colorless liquid with an ether-like odor

pH: NA

% VOLATILES BY VOL.: 100

VAPOR DENSITY (Air=1) 5.83

EVAPORATION RATE (BuAc=1): 2.3 estimate

VII. REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY:

Under normal conditions, the material is stable.

Avoid open flames, welding arcs, or other high temperature sources which induce thermal decomposition to irritating and corrosive HCl from solvent vapor. Strong UV light (eg. welding arc) can cause significant phosgene to be generated.

INCOMPATIBILITY:

Avoid contacting this product with strong alkalies (such as sodium hydroxide), alkali metals, pure oxygen, open flames, and welding arcs. This product should not be used in long term contact with aluminum or zinc or their alloys.

HAZARDOUS DECOMPOSITION PRODUCTS:

Involvement in fire or high temperatures forms hydrogen chloride and very small amounts of phosgene and chlorine. Solvent decomposition occurs when catalyzed by metal chlorides which can be produced by reaction of HCL and metals in the system. In transformer applications where the fluid is used as a dielectric media, oxygen is excluded by use of an N₂ pad which eliminates the potential of phosgene formation if arcing occurs.

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION:

Material is not known to polymerize.

VIII. HANDLING AND STORAGE

HANDLING AND STORAGE PRECAUTIONS:

Do not take internally.
Do not breathe vapors.
Do not get in eyes, on skin, on clothing.
Use with adequate ventilation to maintain exposure level below 25 ppm. Perform personal monitoring to assess the exposure level.
When handling, wear chemical splash goggles, protective clothing, and solvent resistant gloves.
Wash thoroughly after handling or contact. Do not eat, drink or smoke in areas where perchloroethylene is used.
Never enter a pit or tank without following safety procedures—never alone, always with a life line, and always with a positive pressure supply of fresh air. Perchloroethylene vapors are heavier than air and will tend to collect in low areas. Avoid use in confined spaces. Areas of poor ventilation could contain concentration high enough to cause unconsciousness and death.
Use NIOSH/MSHA approved respirators following manufacturer's recommendations where vapors may be generated.
Avoid contact with pure oxygen, flames, pilot lights, hot glowing surfaces, welding arcs, strong alkalis or alkali metals to prevent decomposition resulting in toxic and irritating vapors.
Avoid exposure to strong UV light, can cause generation of phosgene.
Keep containers tightly closed and properly labeled.
Store containers in cool, dry, ventilated place out of direct sunlight.

Under normal conditions this product can be stored satisfactory in mild steel without an interior lining. Aluminum is not recommended for storage and handling. Dike storage tanks separately to contain 110% of tank volume. Vent indoor tanks to an outside location so escaping vapors will not contaminate any work areas.

IX. ENVIRONMENTAL PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

Leaks should be stopped. Spills should be contained and cleaned up immediately. Recovery and reuse of spilled product, rather than disposal, should be the ultimate goal of a clean up operation.

Evacuate unnecessary personnel. Prevent discharge or flushing to streams and sewers systems. Large spills should be removed by vacuum truck. Smaller spills may be soaked up with compatible absorbent material (sand, diatomaceous earth, kitty litter, etc.) which should be placed in closed containers, labeled and stored in a safe place outdoors to await proper disposal. Flush the spill area with water if the rinse water can be collected and placed in appropriate containers for proper disposal. Spills on areas other than pavement, e.g., dirt or sand, may be handled by removing the affected soils and placing in approved containers. People performing the clean up should have full protective equipment including a NIOSH/MSHA approved positive pressure self contained breathing apparatus.

According to 40 CFR 302 Table 302.4 (CERCLA), environmental releases of more than 100 pounds (approximately 7 gallons) of perchloroethylene must be reported to the National Response Center by calling 800-424-8802 (202-426-2675). Releases of over 100 pounds must also be reported to the State Emergency Response Commission and the Local Emergency Planning Committee (40 CFR 355.40). In addition, state and local regulations may have additional reporting requirements. Check with the proper state or local authorities.

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IX. ENVIRONMENTAL PROCEDURES (Continued)

WASTE DISPOSAL METHOD:

Recovery and reuse of solvent, rather than disposal, should be the ultimate goal of handling efforts.

According to RCRA, disposal of perchloroethylene waste will require assignment of an EPA Hazardous Waste Number. Some examples are: perchloroethylene is classed as Hazardous Waste U080 (40 CFR 261.33); spent perchloroethylene from degreasing operations and still bottoms from degreasing solvent stills are assigned Hazardous Waste Number F001 (40 CFR 261.31); spent solvent and still bottoms from solvent recovery operations are assigned Hazardous Waste Number F002 (40 CFR 261.31).

Always package, store, transport, and dispose of all waste and contaminated equipment in accordance with all applicable federal, state and local health and environmental regulations. Shipments of waste materials containing perchloroethylene are subject to manifesting per applicable regulation. Appropriate disposal will depend on the nature of each waste material and should be done by a competent and properly permitted contractor.

X. ADDITIONAL INFORMATION

OSHA Standard 29CFR 1910.1200 requires that information be provided to employees regarding the hazards of chemicals by means of a hazard communication program including labeling, material safety data sheets, training and access to written records. We request that you, and it is your legal duty to, make all information in this Material Safety Data Sheet available to your employees.

To aid our customers in complying with regulatory requirements, SARA Title III hazard categories for this product are indicated in Section I. If the word "YES" appears next to any category, this product may be reportable by you under the requirements of 40 CFR Part 370. Please consult those regulations for details.

This product contains a toxic chemical or chemicals subject to the reporting requirements of SECTION 313 of TITLE III of the SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT OF 1986 and 40 CFR PART 372. (See Section III, List Legend 02)

State of California Safe Drinking Water and Toxic Enforcement Act Of 1986 (Proposition 65) :

Warning: This chemical is known to the State of California to cause cancer. See Section III.

California South Coast Air Quality Management District Rule 443.1:
Maximum Volatile Organic Carbon (VOC) 1500 grams/liter
VOC Vapor Pressure at 20°C 13 mm/Hg

XI. PREPARATION INFORMATION

For additional Non-Emergency health, safety, or environmental information telephone (716) 286-3081, or write to:

Occidental Chemical Corporation
Product Stewardship Department
Suite 400
360 Rainbow Boulevard South
Niagara Falls, NY 14302

For Emergencies: 24 HOUR EMERGENCY PHONE: (716) 278-7021

This MSDS replaces MSDS M20544 dated 7/19/89.

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WARNING LABEL INFORMATION

SIGNAL WORD: CAUTION

STATEMENT OF HAZARDS:

VOLATILE SOLVENT
PROLONGED BREATHING OF VAPOR CAN CAUSE DIZZINESS, LOSS OF CONSCIOUSNESS, LIVER AND KIDNEY DAMAGE AND MAY RESULT IN DEATH. CAUSES IRRITATION OF THE EYES, SKIN, AND RESPIRATORY TRACT. MAY BE FATAL IF SWALLOWED.
POSSIBLE CANCER HAZARD - MAY CAUSE CANCER BASED ON ANIMAL DATA. RISK OF CANCER DEPENDS ON DURATION AND LEVEL OF EXPOSURE.

PRECAUTIONARY STATEMENTS:

Do not take internally.
Do not breathe vapors.
Do not get in eyes, on skin, on clothing.
Use with adequate ventilation to maintain exposure level below 25 ppm. Perform personal monitoring to assess the exposure level.
When handling, wear chemical splash goggles, protective clothing, and solvent resistant gloves.
Wash thoroughly after handling or contact. Do not eat, drink or smoke in areas where perchloroethylene is used.
Never enter a pit or tank without following safety procedures-never alone, always with a life line, and always with a positive pressure supply of fresh air. Perchloroethylene vapors are heavier than air and will tend to collect in low areas. Avoid use in confined spaces. Areas of poor ventilation could contain concentration high enough to cause unconsciousness and death.
Use NIOSH/MSHA approved respirators following manufacturer's recommendations where vapors may be generated.
Avoid contact with pure oxygen, flames, pilot lights, hot glowing surfaces, welding arcs, strong alkalis or alkali metals to prevent decomposition resulting in toxic and irritating vapors.
Avoid exposure to strong UV light, can cause generation of phosgene.
Keep containers tightly closed and properly labeled.
Store containers in cool, dry, ventilated place out of direct sunlight.

FIRST AID:

IN CASE OF CONTACT:

FOR EYES:

OBJECT IS TO FLUSH MATERIAL OUT IMMEDIATELY THEN SEEK MEDICAL ATTENTION. IMMEDIATELY flush eyes with large amounts of water for at least 15 minutes, holding lids apart to ensure flushing of the entire surface. SEEK MEDICAL ATTENTION.

FOR SKIN:

Wash contaminated areas with plenty of soap and water. A soothing ointment may be applied to irritated skin after thorough cleansing. Remove contaminated clothing and footwear and wash clothing before reuse. Discard footwear which cannot be decontaminated. SEEK MEDICAL ATTENTION.

IF INHALED:

Remove to fresh air. If breathing has stopped, give mouth-to-mouth resuscitation. If breathing is difficult, have trained person administer oxygen. GET IMMEDIATE MEDICAL ATTENTION.

WARNING LABEL INFORMATION (Continued)

IF SWALLOWED:

DO NOT INDUCE VOMITING. This material is not soluble. DO NOT GIVE FLUIDS. If spontaneous vomiting is inevitable, PREVENT ASPIRATION by keeping the victims head below the knees. GET IMMEDIATE MEDICAL ATTENTION. A qualified physician can perform gastric lavage only when the airway (trachea) has been secured to prevent aspiration.

IN CASE OF:

SPILL OR LEAK:

Leaks should be stopped. Spills should be contained and cleaned up immediately. Evacuate unnecessary personnel. Prevent discharge or flushing to streams and sewers systems. Large spills should be removed by vacuum truck. Smaller spills may be soaked up with compatible absorbent material (sand, diatomaceous earth, kitty litter, etc.) which should be placed in closed containers, labeled and stored in a safe place outdoors to await proper disposal. People performing the clean up should have full protective equipment including a NIOSH/MSHA approved positive pressure self contained breathing apparatus.

According to 40 CFR 302 Table 302.4 (CERCLA), environmental releases of more than 100 pounds (approximately 7 gallons) of perchloroethylene must be reported to the National Response Center by calling ~~800-424-8802 (202-426-2675)~~. Releases of over 100 pounds must also be reported to the State Emergency Response Commission and the Local Emergency Planning Committee (40 CFR 355.40). In addition, state and local regulations may have additional reporting requirements. Check with the proper state local authorities.

FIRE:

Fires involving this product are unlikely, but should one occur, it may be controlled by water spray, dry chemical, carbon dioxide or foam. Pressure-demand, self-contained breathing apparatus should be provided for fire fighters in buildings or confined areas where this product is stored. Storage containers exposed to fire should be kept cool with a water spray to prevent pressure build up. At high temperatures, product decomposes to give off hydrogen chloride gas and small quantities of other toxic and irritating vapors such as phosgene.

HANDLING AND STORAGE:

Under normal conditions, this product may be stored satisfactorily in mild steel, without an interior lining. Aluminum is not generally recommended for storage or handling. Dike storage tanks separately to contain 110% of tank volume. Vent indoor tanks to an outside location so escaping vapors will not contaminate any work areas.

DISPOSAL:

According to RCRA, disposal of perchloroethylene waste will require assignment of a EPA Hazardous Waste Number. Always package, store, transport, and dispose of all waste and contaminated equipment in accordance with all applicable federal, state and local health and environmental regulations. Shipments of waste materials containing perchloroethylene are subject to manifesting per applicable regulation. Appropriate disposal will depend on the nature of each waste material and should be done by a competent and properly permitted contractor.

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WARNING LABEL INFORMATION (Continued)

INFORMATION REQUIRED BY FEDERAL, STATE OR LOCAL REGULATIONS:

This product contains:

CAS#	NAME
111660	1-Octene
127184	Ethene, tetrachloro-
79016	Ethene, trichloro-

HMIS RATING SYSTEM: HEALTH 2* FLAMMABILITY 0 REACTIVITY 0

FOR INDUSTRIAL USE ONLY

LABEL 100M20544



Material Safety Data Sheet

LA1519 Perchloroethylene

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Id: LA1519

Product Name: Perchloroethylene

Synonyms: Ethylene tetrachloride, PCE, Perc, Perchlor, Perchlorethylene, Perchloroethylene, Perk, Tetrachloroethene, Tetrachlorethylene, 1,1,2,2-Tetrachloroethylene.

Chemical Family: Halogenated aliphatic hydrocarbon.

Application: Chemical intermediate.

Distributed By:

Univar Canada Ltd.
9800 Van Horne Way
Richmond, BC
V6X 1W5

Prepared By: The Environment, Health and Safety Department of Univar Canada Ltd.

Preparation date of MSDS: 19/Jun/2012

Telephone number of preparer: 1-866-686-4827

24-Hour Emergency Telephone Number (CANUTEC): (613) 996-6666

2. COMPOSITION/INFORMATION ON INGREDIENTS

Ingredients	Percentage (W/W)	LD50s and LC50s Route & Species:
Tetrachloroethylene 127-18-4	>99	Oral LD50 Rat = 2629 mg/kg Dermal LD50 Mouse = 2800 mg/kg Inhalation LC50 Rat = 4000 ppm 4 h

Note: No additional remark.

3. HAZARDS IDENTIFICATION

Potential Acute Health Effects:

Eye Contact: May cause pain disproportionate to the level of irritation to eye tissue. May cause slight transient (temporary) eye irritation.

Skin Contact: Brief contact may cause slight irritation with itching and local redness. Prolonged contact can cause skin irritation. Prolonged or repeated contact may result in skin burns. Symptoms may include pain, severe local redness, swelling and tissue damage. May cause drying and flaking of the skin.

3. HAZARDS IDENTIFICATION

Inhalation: Headache, nausea, vomiting, dizziness, drowsiness and loss of consciousness may occur. In confined or poorly ventilated areas vapors can readily accumulate and can cause unconsciousness and death. Dizziness may occur at 200 ppm perchloroethylene; progressively higher levels may also cause nasal irritation, nausea, incoordination, drunkenness, and over 1000 ppm, unconsciousness and death. A single brief (minutes) inhalation exposure to levels above 6000 ppm perchloroethylene may be immediately fatal. Based on structural analogy and/or equivocal data in animals, excessive exposure may potentially increase sensitivity to epinephrine and increase myocardial irritability (irregular heartbeats). Alcohol consumed before or after exposure may increase adverse effects.

Ingestion: Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts. Small amounts swallowed incidental to normal handling operations are not likely to cause injury. Swallowing larger amounts may cause injury.

4. FIRST AID MEASURES

Eye Contact: In case of contact, or suspected contact, immediately flush eyes with plenty of water for at least 15 minutes and get medical attention immediately after flushing.

Skin Contact: In case of contact, immediately flush skin with plenty of water for at least 15 minutes. Get medical attention. Remove contaminated clothing and launder before reuse.

Inhalation: Remove person to fresh air. If not breathing, give artificial respiration. If breathing is difficult, get immediate medical attention.

Ingestion: Do NOT induce vomiting. Never give anything by mouth to an unconscious or convulsing person. Seek immediate medical attention. If vomiting occurs spontaneously, keep head below hips to prevent aspiration of liquid into the lungs.

Notes to Physician: Because rapid absorption may occur through lungs if aspirated and cause systemic effects, the decision of whether to induce vomiting or not should be made by a physician. If lavage is performed, suggest endotracheal and/or esophageal control. Danger from lung aspiration must be weighed against toxicity when considering emptying the stomach.

5. FIRE FIGHTING MEASURES

Flash Point: None.

Flash Point Method: Tag Closed Cup ASTM D56

Autoignition Temperature: Not available.

Flammable Limits in Air (%): Not Available.

Extinguishing Media: Does not burn. Use extinguishing media appropriate for surrounding fire.

Special Exposure Hazards: Containers exposed to intense heat from fires should be cooled with water to prevent vapor pressure build-up which could result in container rupture. Vapors are heavier than air and may travel a long distance and accumulate in low lying areas. Violent steam generation or eruption may occur upon application of direct water stream. Isolate and restrict area access. Contain fire control water for later disposal.

Hazardous Decomposition/Combustion Materials (under fire conditions): Decomposition products can include and are not limited to: Hydrogen chloride. Phosgene. Chlorine.

Special Protective Equipment: Fire fighters should wear full protective clothing, including self-contained breathing equipment.

NFPA RATINGS FOR THIS PRODUCT ARE: HEALTH 2, FLAMMABILITY 0, INSTABILITY 0

HMIS RATINGS FOR THIS PRODUCT ARE: HEALTH 2, FLAMMABILITY 0, REACTIVITY 0

6. ACCIDENTAL RELEASE MEASURES

Personal Precautionary Measures: Wear appropriate protective equipment.

Environmental Precautionary Measures: Prevent entry into sewers or streams, dike if needed.

Procedure for Clean Up: Isolate hazard area and restrict access. Absorb with an inert dry material and place in an appropriate waste disposal container. Avoid direct contact with material.

7. HANDLING AND STORAGE

Handling: Avoid contact with eyes, skin and clothing. Wash thoroughly after handling. Do not ingest. Avoid breathing vapor. Use with adequate ventilation. Keep the containers closed when not in use. Do not enter confined spaces unless adequately ventilated. DO NOT handle or store near an open flame, heat, or other sources of ignition.

Storage: Store in a cool, dry, well ventilated area. Keep away from direct sunlight. Keep containers tightly closed. Do not store in aluminum containers. Store in accordance with good industrial practices.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Engineering Controls:

Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Lethal concentrations may exist in areas with poor ventilation.

Respiratory Protection: If exposure exceeds occupational exposure limits, use an appropriate NIOSH-approved respirator. Positive pressure self-contained breathing apparatus. In case of spill or leak resulting in unknown concentration, use NIOSH approved supplied air respirator.

Gloves:

Use gloves chemically resistant to this material, examples of preferred glove barrier materials include: Ethyl Vinyl Alcohol Laminate (EVAL). Polyvinyl alcohol gloves. Viton gloves. Examples of acceptable glove barrier materials include: Butyl rubber gloves. NOTICE: The selection of a specific glove for a particular application and duration of use in a workplace should also take into account all relevant workplace factors such as, but not limited to: Other chemicals which may be handled, physical requirements (cut/puncture protection, dexterity, thermal protection), potential body reactions to glove materials as well as the instructions/specifications provided by the glove supplier.

Skin Protection: Impervious clothing. The selection of personal protective equipment varies depending upon conditions of use.

Eyes: Safety glasses. If exposure causes eye discomfort, use a full-face respirator.

Other Personal Protection Data: Ensure that eyewash stations and safety showers are proximal to the work-station location.

Ingredients	Exposure Limit - ACGIH	Exposure Limit - OSHA	Immediately Dangerous to Life or Health - IDLH
Tetrachloroethylene	100 ppm STEL 25 ppm TLV-TWA	25 ppm TWA 170 mg/m ³ TWA	150 ppm

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State: Liquid.

Color: Colorless

Odor: Characteristic.

pH Not Available.

Specific Gravity: 1.619 @ 25°C

Boiling Point: 121.1°C /250°F

Freezing/Melting Point: -22°C / -8°F

Vapor Pressure: 13 mmHg @ 20°C

Vapor Density: 5.76

% Volatile by Volume: Not Available.

Evaporation Rate: Not Available.

Solubility: Water: 0.015% @ 25°C

VOCs: Not Available.

Viscosity: 0.52 mm²/s @ 25°C

Molecular Weight: Not Available.

Other: Not Available.

10. STABILITY AND REACTIVITY

Chemical Stability: Stable.

Hazardous Polymerization: Will not occur.

Conditions to Avoid: UV light exposure. Direct sunlight. Avoid open flames, welding arcs, or other high temperature sources which induce thermal decomposition. High energy sources such as welding arcs can cause degradation generating chlorine, hydrogen chloride and possible phosgene, and should be avoided.

Materials to Avoid: Aluminum powders, magnesium powders, potassium, sodium and zinc powder. Aluminum and alloys. Amines. Strong oxidizing agents. Strong bases.

Hazardous Decomposition Products: Hydrogen chloride. Trace amounts of chlorine and phosgene.

Additional Information:

No additional remark.

11. TOXICOLOGICAL INFORMATION

Principle Routes of Exposure

Ingestion: Very low toxicity if swallowed. Harmful effects not anticipated from swallowing small amounts. Small amounts swallowed incidental to normal handling operations are not likely to cause injury. Swallowing larger amounts may cause injury.

Skin Contact: Brief contact may cause slight irritation with itching and local redness. Prolonged contact can cause skin irritation. Prolonged or repeated contact may result in skin burns. Symptoms may include pain, severe local redness, swelling and tissue damage. May cause drying and flaking of the skin.

Inhalation: Headache, nausea, vomiting, dizziness, drowsiness and loss of consciousness may occur. In confined or poorly ventilated areas vapors can readily accumulate and can cause unconsciousness and death. Dizziness may occur at 200 ppm perchloroethylene; progressively higher levels may also cause nasal irritation, nausea, incoordination, drunkenness, and over 1000 ppm, unconsciousness and death. A single brief (minutes) inhalation exposure to levels above 6000 ppm perchloroethylene may be immediately fatal. Based on structural analogy and/or equivocal data in animals, excessive exposure may potentially increase sensitivity to epinephrine and increase myocardial irritability (irregular heartbeats). Alcohol consumed before or after exposure may increase adverse effects.

Eye Contact: May cause pain disproportionate to the level of irritation to eye tissue. May cause slight transient (temporary) eye irritation.

Additional Information: Signs and symptoms of excessive exposure may be anesthetic or narcotic effects. Signs and symptoms of excessive exposure may include central nervous system effects. Observations in animals include liver and kidney effects.

Acute Test of Product:

Acute Oral LD50: Not Available.

Acute Dermal LD50: Not Available.

Acute Inhalation LC50: Not Available.

Carcinogenicity:

Ingredients	IARC - Carcinogens	ACGIH - Carcinogens
Tetrachloroethylene	Group 2	A3

Carcinogenicity Comment: Perchloroethylene has been shown to increase the incidence of tumors in certain strains of mice and rats. Other long-term inhalation studies in rats failed to show tumorigenic response. Human data are limited and have not established an association between perchloroethylene exposure and cancer. Perchloroethylene is not believed to pose a measurable carcinogenic risk to man when handled as recommended.

Reproductive Toxicity/ Teratogenicity/ Embryotoxicity/ Mutagenicity: Studies have not shown harmful effects in the offspring of rats, rabbits or mice in the absence of toxicity in the mothers. The available studies have not shown harmful effects on fertility. Birth defects are unlikely.

12. ECOLOGICAL INFORMATION

Ecotoxicological Information:

Ingredients	Ecotoxicity - Fish Species Data	Acute Crustaceans Toxicity:	Ecotoxicity - Freshwater Algae Data
Tetrachloroethylene	11.0 - 15.0 mg/L LC50 (Lepomis macrochirus) 96 h static 12.4 - 14.4 mg/L LC50 (Pimephales promelas) 96 h flow-through 4.73 - 5.27 mg/L LC50 (Oncorhynchus mykiss) 96 h flow-through 8.6 - 13.5 mg/L LC50 (Pimephales promelas) 96 h static	Not Available.	500 mg/L EC50 Pseudokirchneriella subcapitata 96 h

Other Information: Moderately toxic to aquatic organisms.

13. DISPOSAL CONSIDERATIONS

Disposal of Waste Method: Disposal of all wastes must be done in accordance with municipal, provincial and federal regulations.

Contaminated Packaging: Empty containers should be recycled or disposed of through an approved waste management facility.

14. TRANSPORT INFORMATION

DOT (U.S.):

DOT Shipping Name: TETRACHLOROETHYLENE

DOT Hazardous Class 6.1

DOT UN Number: UN1897

DOT Packing Group: III

DOT Reportable Quantity (lbs): Not Available.

Note: No additional remark.

Marine Pollutant: Yes.

TDG (Canada):

TDG Shipping Name: TETRACHLOROETHYLENE

Hazard Class: 6.1

UN Number: UN1897

Packing Group: III

Note: No additional remark.

Marine Pollutant: Yes.

15. REGULATORY INFORMATION

U.S. TSCA Inventory Status: All components of this product are either on the Toxic Substances Control Act (TSCA) Inventory List or exempt.

Canadian DSL Inventory Status: All components of this product are either on the Domestic Substances List (DSL), the Non-Domestic Substances List (NDSL) or exempt.

Note: Not available.

U.S. Regulatory Rules

Ingredients	CERCLA/SARA - Section 302:	SARA (311, 312) Hazard Class:	CERCLA/SARA - Section 313:
Tetrachloroethylene	Not Listed.	Listed	Listed

California Proposition 65: Listed.

MA Right to Know List: Listed.

New Jersey Right-to-Know List: Listed.

Pennsylvania Right to Know List: Listed.

WHMIS Hazardous Class:

D1B TOXIC MATERIALS

D2A VERY TOXIC MATERIALS

D2B TOXIC MATERIALS



16. OTHER INFORMATION**Additional Information:**

This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

Disclaimer:**NOTICE TO READER:**

Univar, expressly disclaims all express or implied warranties of merchantability and fitness for a particular purpose, with respect to the product or information provided herein, and shall under no circumstances be liable for incidental or consequential damages.

Do not use ingredient information and/or ingredient percentages in this MSDS as a product specification. For product specification information refer to a Product Specification Sheet and/or a Certificate of Analysis. These can be obtained from your local Univar Sales Office.

All information appearing herein is based upon data obtained from the manufacturer and/or recognized technical sources. While the information is believed to be accurate, Univar makes no representations as to its accuracy or sufficiency. Conditions of use are beyond Univar's control and therefore users are responsible to verify this data under their own operating conditions to determine whether the product is suitable for their particular purposes and they assume all risks of their use, handling, and disposal of the product, or from the publication or use of, or reliance upon, information contained herein. This information relates only to the product designated herein, and does not relate to its use in combination with any other material or in any other process.

*****END OF MSDS*****



TCI AMERICA

SAFETY DATA SHEET

Revision number: 1
Revision date: 11/12/2013

1. IDENTIFICATION

Product name: Allyl Glycidyl Ether
Product code: A0221

Product use: For laboratory research purposes.
Restrictions on use: Not for drug or household use.

Company:
TCI America
9211 N. Harborage Street
Portland, OR 97203 U.S.A.
Telephone:
+1-800-423-8616 / +1-503-283-1681
Fax:
+1-888-520-1075 / +1-503-283-1987
e-mail:
sales@tciamerica.com
www.TCIchemicals.com

Emergency telephone number:
Chemical Emergencies:
TCI America (8:00am - 5:00pm) PST
+1-503-286-7624
Transportation Emergencies:
Chemtrec 24-Hour
+1-800-424-9300 (U.S.A.)
+1-703-527-3887 (International)
Responsible department:
TCI America
Environmental Health Safety and Security
+1- 503-286-7624

2. HAZARD(S) IDENTIFICATION

OSHA Haz Com: CFR 1910.1200:

Acute Toxicity - Oral [Category 4]
Acute Toxicity - Inhalation [Category 3]
Skin Corrosion/Irritation [Category 2]
Eye Damage/Irritation [Category 2A]
Sensitization - Skin [Category 1]
Germ Cell Mutagenicity [Category 2]
Toxic to Reproduction [Category 2]
Specific Target Organ Toxicity (Single Exposure) [Category 1]
Specific Target Organ Toxicity (Single Exposure) [Category 3]
Specific Target Organ Toxicity (Repeated Exposure) [Category 1]
Flammable Liquids [Category 3]
Aquatic Hazard (Acute) [Category 3]
Aquatic Hazard (Long-Term) [Category 3]

Signal word: Danger!

Hazard Statement(s):
Causes serious eye irritation
Causes skin irritation
Flammable liquid and vapor
Harmful if swallowed
May cause an allergic skin reaction
Suspected of causing genetic defects
Suspected of damaging fertility or the unborn child
Toxic if inhaled
Harmful to aquatic life
Harmful to aquatic life with long lasting effects
Causes damage to: Liver Respiratory System Kidney Central Nervous System
May cause drowsiness or dizziness.
Causes damage to organs: Respiratory System through prolonged or repeated exposure.

Pictogram(s) or Symbol(s):



Precautionary Statement(s):

2. HAZARD(S) IDENTIFICATION

[Prevention]

Do not eat, drink or smoke when using this product. Wash hands and face thoroughly after handling. Do not breathe fume, mist, vapors or spray. Use only outdoors or in a well-ventilated area. Wear protective gloves. Wear eye and face protection. Avoid breathing dusts or mists. Contaminated work clothing must not be allowed out of the workplace. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Wear protective gloves, protective clothing, eye protection and face protection. Avoid breathing fume, mist, vapors or spray. Keep away from heat, sparks, open flames or other hot surfaces. - No smoking. Keep container tightly closed. Ground or bond container and receiving equipment. Use explosion-proof electrical, ventilating, lighting, and equipment. Use only non-sparking tools. Take precautionary measures against static discharge. Wear protective gloves, eye protection and face protection.

[Response]

If swallowed: Immediately call a poison center or doctor. Rinse mouth. If inhaled: Remove person to fresh air and keep comfortable for breathing. Call a poison center or doctor. If on skin: Wash with plenty of water. If skin irritation or rash occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse. If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. If eye irritation persists: Get medical advice or attention. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse. If exposed: Call a poison center or doctor. Call a poison center or doctor if you feel unwell. Get medical advice or attention if you feel unwell. If on skin (or hair): Take off immediately all contaminated clothing. Rinse skin with water or shower. In case of fire: Use dry chemical, CO₂, water spray or alcohol-resistant foam to extinguish.

[Storage]

Store in a well-ventilated place. Keep container tightly closed. Store locked up. Store in a well-ventilated place. Keep cool.

[Disposal]

Dispose of contents and container in accordance with US EPA guidelines for the classification and determination of hazardous waste listed in 40 CFR 261.3. (See Section 13)

Hazards not otherwise classified: [HNOC] May cause polymerization. May form explosive peroxides. May be harmful if in contact with skin.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Substance/Mixture:	Substance
Components:	Allyl Glycidyl Ether
Percent:	>99.0%(GC)
CAS Number:	106-92-3
Molecular Weight:	114.14
Chemical Formula:	C ₆ H ₁₀ O ₂
Synonyms:	1-Allyl-2,3-epoxypropane

4. FIRST-AID MEASURES

Inhalation:

May cause coughing, difficult breathing and nausea. Immediately call a poison center or doctor. Effects of exposure (inhalation) to substance may be delayed. Inhalation of vapors or contact with substance will result in contamination and potential harmful effects. Move victim to fresh air. Give artificial respiration if victim is not breathing. Administer oxygen if breathing is difficult. Keep victim warm and quiet. Treat symptomatically and supportively. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Skin contact:

Immediately call a poison center or doctor. Effects of exposure (skin contact) to substance may be delayed. Remove and wash contaminated clothing before re-use. Remove and isolate contaminated clothing and shoes. In case of contact with substance, immediately flush skin with running water for at least 20 minutes. Treat symptomatically and supportively. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Eye contact:

IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. Contact with material may irritate or burn eyes. Call emergency medical service. Move victim to fresh air. Check for and remove any contact lenses. Keep victim warm and quiet. Treat symptomatically and supportively. Effects of exposure to substance may be delayed. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Ingestion:

Harmful if swallowed. Do not induce vomiting without medical advice. Effects of exposure (ingestion) to substance may be delayed. Call a physician or Poison Control Center immediately. Do not use mouth-to-mouth method if victim ingested the substance; give artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Loosen tight clothing such as a collar, tie, belt or waistband. If a person vomits place them in the recovery position so that vomit will not reenter the mouth and throat. Rinse mouth. Keep victim warm and quiet. Treat symptomatically and supportively. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

Symptoms/effects:

Acute:

Dizziness. Redness. Drowsiness.

Delayed:

May cause heritable genetic damage in humans. May cause skin sensitization.

4. FIRST-AID MEASURES

Immediate medical attention:

WARNING: It might be dangerous to the person providing aid to give mouth-to-mouth respiration, because the inhaled material is toxic. CAUTION: Victim may be a source of contamination. If breathing has stopped, perform artificial respiration. Use first aid treatment according to the nature of the injury. Ensure that medical personnel are aware of the material(s) involved and take precautions to protect themselves.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:

Dry chemical, CO₂ or water spray. Consult with local fire authorities before attempting large scale fire fighting operations.

Specific hazards arising from the chemical

Hazardous combustion products:

These products include: Carbon oxides

Other specific hazards:

Closed containers may explode from heat of a fire.

Special precautions for fire-fighters:

Use water spray or fog; do not use straight streams. Dike fire-control water for later disposal; do not scatter the material. CAUTION: All these products have a very low flash point: Use of water spray when fighting fire may be inefficient. Do not use straight streams. Runoff to sewer may create fire or explosion hazard. Containers may explode when heated. Move containers from fire area if you can do it without risk.

Special protective equipment for fire-fighters:

Wear positive pressure self-contained breathing apparatus (SCBA). Structural fire fighters' protective clothing provides limited protection in fire situations ONLY; it may not be effective in spill situations. Wear chemical protective clothing which is specifically recommended by the manufacturer. It may provide little or no thermal protection.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:

Avoid contact with skin, eyes, and clothing. Keep people away from and upwind of spill/leak. Use spark-proof tools and explosion-proof equipment. Remove all sources of ignition. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing (Section 8). Warn unnecessary personnel to move away. Stop leak if you can do it without risk. Ensure adequate ventilation. Isolate the hazard area and deny entry to unnecessary and unprotected personnel.

Personal protective equipment:

Wear eye protection (splash goggles) and face protection (full length face shield). Wear protective clothing (chemical resistant suit and chemical resistant boots). Vapor respirator. Be sure to use a MSHA/NIOSH approved respirator or equivalent. Wear protective gloves (nitrile).

Emergency procedures:

Isolate area until gas has dispersed. Do not clean-up or dispose except under supervision of a specialist. In case of a spill and/or a leak, always shut off any sources of ignition, ventilate the area, and exercise caution. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Warn personnel to move away. Prevent entry into sewers, basements or confined areas; dike if needed.

Methods and materials for containment and cleaning up:

ELIMINATE all ignition sources (no smoking, flares, sparks, or flames in immediate area). All equipment used when handling the product must be grounded. Stop leak if without risk. Ventilate the area. Absorb with an inert material and put the spilled material in an appropriate waste disposal container. Use clean non-sparking tools to collect absorbed material. Dike far ahead of spill; use dry sand to contain the flow of material.

Environmental precautions:

Keep away from living quarters. Environmental hazard. Do not let product enter drains. Prevent further leakage or spillage if safe to do so. Water runoff can cause environmental damage. Prevent entry into sewers, basements or confined areas; dike if needed.

7. HANDLING AND STORAGE

Precautions for safe handling:

Do NOT breath gas, fumes, vapor, or spray. Manipulate under an adequate fume hood. Do not ingest. Avoid contact with skin and eyes. Avoid contact - obtain special instructions before use. Avoid prolonged or repeated exposure. Normal measures for preventive fire protection. Keep away from heat and sources of ignition. Use explosion-proof equipment. Use only non-sparking hand tool when handling this product. Ground all equipment containing material. Take measures to prevent build up of electrostatic charge. Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. Keep container dry. Handle and open container with care. Wear suitable protective clothing, gloves and eye/face protection. When using do not eat, drink, or smoke. Keep away from sources of ignition.

Conditions for safe storage:

Store locked up. Keep containers tightly closed in a cool, well-ventilated place. Keep away from sources of ignition. Store and use away from heat, sparks, open flame, or any other ignition source. Keep away from incompatibles. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Avoid prolonged storage periods.

Storage incompatibilities:

Combustible substances, Store away from oxidizing agents

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Exposure limits:

ACGIH TLV (TWA):

1 ppm

OSHA PEL (CEIL):

10 ppm

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Appropriate engineering controls:

Handle only in a fully enclosed system and equipment. Use process enclosures, local exhaust ventilation, or other engineering controls to keep airborne levels below recommended exposure limits. Ventilation is normally required when handling or using this product. Eyewash fountains should be provided in areas where there is any possibility that workers could be exposed to the substance. Follow safe industrial engineering/laboratory practices when handling any chemical.

Personal protective equipment

Respiratory protection:	Vapor respirator. Be sure to use a MSHA/NIOSH approved respirator or equivalent.
Hand protection:	Wear protective gloves.
Eye protection:	Splash goggles.
Skin and body protection:	Wear protective clothing (chemical resistant suit and chemical resistant boots).

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical state (20°C):	Liquid
Form:	Clear
Color:	Colorless
Odor:	Characteristic
Odor threshold:	No data available

Melting point/freezing point:	-100°C (-148°F)	pH:	No data available
Boiling point/range:	154°C (309°F)	Vapor pressure:	0.63kPa/25°C
Decomposition temperature:	No data available	Vapor density:	No data available
Relative density:	0.97	Dynamic Viscosity:	No data available
Kinematic viscosity:	No data available		
Partition coefficient:	0.34	Evaporation rate:	No data available
n-octanol/water (log P_{ow})		(Butyl Acetate = 1)	

Flash point:	49°C (120°F)	Autoignition temperature:	227°C (441°F)
Flammability (solid, gas):	No data available	Flammability or explosive limits:	
		Lower:	No data available
		Upper:	No data available

Solubility(ies):

Water: Slightly soluble

Soluble: Alcohols, Benzene, Acetone, Toluene

10. STABILITY AND REACTIVITY

Reactivity:	Not Available.
Chemical Stability:	Stable under recommended storage conditions. (See Section 7)
Possibility of Hazardous Reactions:	In use, may form flammable/explosive vapor-air mixture.
Conditions to avoid:	Avoid excessive heat and light.
Incompatible materials:	Oxidizing agents
Hazardous Decomposition Products:	No data available

11. TOXICOLOGICAL INFORMATION

RTECS Number: RR0875000

Acute Toxicity:

ihl-rat LC50:670 ppm/8H

orl-mus LD50:390 mg/kg

orl-rat LD50:1600 mg/kg

skn-rbt LD50:2550 mg/kg

Skin corrosion/irritation:

skn-rbt 485 mg/3D MOD

skn-rbt 2 mg/24H SEV

Serious eye damage/irritation:

eye-rbt 750 ug/24H SEV

eye-rbt 97 mg SEV

Respiratory or skin sensitization:

No data available

Germ cell mutagenicity:

mno-sat 1 mg/plate (-S9)

mno-sat 100 ug/plate (+S9)

sln-dmg-orl 5500 ppm

Carcinogenicity:

No data available

IARC: No data available

NTP: No data available

OSHA: No data available

Reproductive toxicity:

No data available

Routes of Exposure:

Inhalation, Eye contact, Ingestion, Skin contact.

Symptoms related to exposure:

Overexposure may result in serious illness or death. Skin contact may result in inflammation; characterized by itching, scaling, reddening, or occasionally blistering. Skin contact may result in redness, pain or dry skin. Eye contact may result in redness or pain. Skin contact may result in sensitization. Readily absorbed through skin. Inhalation causes irritation of the lungs and respiratory system.

Potential Health Effects:

Skin and eye contact may result in irritation. Inhalation causes irritation of the lungs and respiratory system. May be harmful if inhaled or ingested. Overexposure may result in serious illness or death.

Target organ(s):

Causes damage to: Liver Respiratory System Kidney Central Nervous System

May cause drowsiness or dizziness.

Causes damage to organs: Respiratory System through prolonged or repeated exposure.

12. ECOLOGICAL INFORMATION

Ecotoxicity

Fish: No data available

Crustacea: No data available

Algae: No data available

Persistence and degradability:

No data available

Bioaccumulative potential (BCF):

No data available

Mobility in soil:

No data available

Partition coefficient:

0.34

n-octanol/water (log P_{ow})

Soil adsorption (K_{oc}):

No data available

Henry's Law:

No data available

constant (PaM³/mol)

13. DISPOSAL CONSIDERATIONS

Disposal of product:

Recycle to process if possible. It is the generator's responsibility to comply with Federal, State and Local rules and regulations. You may be able to dissolve or mix material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber system. This section is intended to provide assistance but does not replace these laws, nor does compliance in accordance with this section ensure regulatory compliance according to the law. US EPA guidelines for Identification and Listing of Hazardous Waste are listed in 40 CFR Parts 261. The product should not be allowed to enter the environment, drains, water ways, or the soil.

Disposal of container:

Dispose of as unused product. Do not re-use empty containers.

13. DISPOSAL CONSIDERATIONS

Other considerations: Observe all federal, state and local regulations when disposing of the substance.

14. TRANSPORT INFORMATION

DOT (US)

UN number:	Proper Shipping Name:	Class or Division:	Packing Group:
UN2219	Allyl glycidyl ether	3 Flammable liquid	III

IATA

UN number:	Proper Shipping Name:	Class or Division:	Packing Group:
UN2219	Allyl glycidyl ether	3 Flammable liquid	III

IMDG

UN number:	Proper Shipping Name:	Class or Division:	Packing Group:
UN2219	Allyl glycidyl ether	3 Flammable liquid	III

EmS number: F-E, S-D

15. REGULATORY INFORMATION

Toxic Substance Control Act (TSCA 8b.):

This product is ON the EPA Toxic Substances Control Act (TSCA) inventory.

US Federal Regulations

CERCLA Hazardous substance and Reportable Quantity:

SARA 313:	Not Listed
SARA 302:	Not Listed

State Regulations

State Right-to-Know

Massachusetts	Not Listed
New Jersey	Listed
Pennsylvania	Not Listed
California Proposition 65:	Not Listed

Other Information

NFPA Rating:

Health:	2
Flammability:	2
Instability:	0

HMIS Classification:

Health:	2
Flammability:	2
Physical:	0

International Inventories

WHMIS hazard class: B2: Flammable Liquid.
D1B: Materials causing immediate and serious toxic effects. (Toxic)
D2A: Materials causing other toxic effects. (Very Toxic)
D2B: Materials causing other toxic effects. (Toxic)
EC-No: 203-442-4
Notice Through Official Gazettes Reference Number: (Japan)
ENCS: (2)-393

16. OTHER INFORMATION

Revision date: 11/12/2013

Revision number: 1

16. OTHER INFORMATION

TCI chemicals are for research purposes only and are NOT intended for use as drugs, food additives, households, or pesticides. The information herein is believed to be correct, but does not claim to be all inclusive and should be used only as a guide. Neither the above named supplier nor any of its affiliates or subsidiaries assumes any liability whatsoever for the accuracy or completeness of the information contained herein. Final determination of suitability of any material is the sole responsibility of the user. All chemical reagents must be handled with the recognition that their chemical, physiological, toxicological, and hazardous properties have not been fully investigated or determined. All chemical reagents should be handled only by individuals who are familiar with their potential hazards and who have been fully trained in proper safety, laboratory, and chemical handling procedures. Although certain hazards are described herein, we can not guarantee that these are the only hazards which exist. Our SDS are based only on data available at the time of shipping and are subject to change without notice as new information is obtained. Avoid long storage periods since the product is subject to degradation with age and may become more dangerous or hazardous. It is the responsibility of the user to request updated SDS for products that are stored for extended periods. Disposal of unused product must be undertaken by qualified personnel who are knowledgeable in all applicable regulations and follow all pertinent safety precautions including the use of appropriate protective equipment (e.g. protective goggles, protective clothing, breathing equipment, face mask, fume hood). For proper handling and disposal, always comply with federal, state and local regulations.

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

AN ORDER OF THE BOARD

NO. P.U. __ (2014)

1 **IN THE MATTER OF** the *Electrical Power*
2 *Control Act*, R.S.N.L. 1994, Chapter E-5.1 (the
3 “EPCA”) and the *Public Utilities Act*, R.S.N.L. 1990,
4 Chapter P-47 (the “Act”), and regulations thereunder;

5
6 **AND**

7
8 **IN THE MATTER OF** an Application
9 by Newfoundland and Labrador Hydro
10 pursuant to Subsection 41(3) of the *Act*, for
11 the approval of the replacement of the
12 excitation transformers at Bay d’Espoir.

13
14
15 **WHEREAS** Newfoundland and Labrador Hydro (“Hydro”) is a corporation continued
16 and existing under the *Hydro Corporation Act, 2007*, is a public utility within the
17 meaning of the Act, and is subject to the provisions of the *EPCA*; and

18
19 **WHEREAS** Subsection 41(3) of the Act requires that a public utility not proceed with
20 the construction, purchase or lease of improvements or additions to its property where:

- 21
22 a) the cost of construction or purchase is in excess of \$50,000; or
23 b) the cost of the lease is in excess of \$5,000 in a year of the lease,

24
25 without prior approval of the Board; and

26
27 **WHEREAS** in Order No. P.U. 42(2013) the Board approved Hydro's 2014 Capital
28 Budget; and

29
30 **WHEREAS** on June 19, 2014 Hydro applied to the Board for approval to replace the
31 excitation transformers at the Bay d’Espoir generating station (the "Application"); and

32
33 **WHEREAS** the Board is satisfied that the 2014 supplemental capital expenditure for the
34 replacement of the excitation transformers at the Bay d’Espoir generating station is
35 necessary to allow Hydro to provide service and facilities which are reasonably safe and
36 adequate and just and reasonable.

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IT IS THEREFORE ORDERED THAT:

- 1. The proposed capital expenditure of \$996,700 for the replacement of the excitation transformers at the Bay d’Espoir generating 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 , .