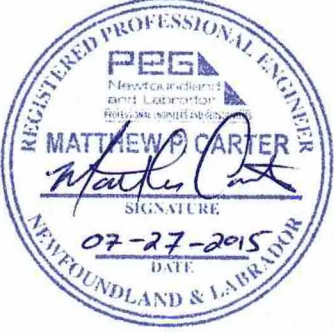


**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

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

**Additions for Load Growth - Isolated
Generating Stations**

L'Anse au Loup and Postville Diesel Plant

July 2015

SUMMARY

This report details a proposal to increase generating capacity at the L’Anse au Loup and Postville diesel plants to support the growing demand on these systems.

The current load forecasts are indicating that the systems load will surpass the firm capacity of both the L’Anse au Loup and Postville diesel plants by the winter of 2015/2016. Previous Operating Load Forecasts indicated that L’Anse au Loup and Postville would violate their firm capacity criterion by 2019 and 2022, respectively. However, the sudden addition of relatively large customers on the both distribution system has advanced the need to install more generation in both communities.

The capacity increase in L’Anse au Loup will be facilitated by replacing Unit 246 (600 kW) with a larger 1,500 kW unit. Due to the limited physical space in the engine hall, this project will also require relocating Unit 2005 to the current position of Unit 246. The current location of Unit 2005 is the only space that can accommodate a larger 1,500 kW unit.

The capacity increase in Postville will be facilitated by replacing Unit 577 (252 kW) with a larger 450 kW unit. Minor upgrades will be required to the plant automation and switchgear.

Based on the most recent Operating Load Forecasts for L’Anse au Loup and Postville, the capacity increases at both plants will support the system load beyond the year 2035.

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1 INTRODUCTION

Hydro currently owns, operates and maintains 21¹ isolated diesel generation systems. These systems are spread across three operating regions, TRO Central, TRO Labrador and TRO Northern, serving approximately 4,600 customers and had a non-coincidental gross-peak of over 18,000 kW in 2014.

Load growth on an isolated distribution system will increase peak demand and overall energy requirements on its generating station. As the load on an isolated system increases, the components of the system can become overloaded. In the case of an isolated diesel system the load could grow to exceed the available generating capacity on the system, unless measures are taken to upgrade the system.

Based on Hydro’s current load forecasts and the established firm generation criterion, the L’Anse au Loup and Postville diesel plants will experience capacity deficits by the winter of 2015/2016. Hydro’s minimum standard is to install at least three generating units, sized according to the firm generation criterion. Under this criterion there would be adequate generation to meet the forecasted peak-demand with the loss of the largest unit.

This report details the justification to increase the plant generating capacity at L’Anse au Loup and Postville, to ensure the firm generation criterion is achieved for the foreseeable future.

¹ In addition to the 21 isolated diesel generation systems owned by Hydro, Hydro also operates and maintains the Natuashish system.

2 PROJECT DESCRIPTION

This is a two year project that will involve increasing the firm capacity of the L’Anse au Loup and Postville diesel plants by replacing existing units with ones of larger prime ratings. A more detailed scope for each location is summarized below:

L’Anse au Loup

The generation expansion at the L’Anse au Loup diesel plant will be achieved by replacing a 600 kW diesel genset (Unit 246) with a new 1,500 kW, 1,800 RPM, 4,160 V diesel genset. Due to the limited physical space in the engine hall, this project will also require relocating Unit 2005 to the current position of Unit 246. The current location of Unit 2005 is the only engine bay that can accommodate a larger 1,500 kW unit. The new 1,500 kW genset will require a new control panel, breaker, power cables, exhaust stack, radiator and aftercooler, and all other necessary equipment to facilitate a new unit. Additional ventilation will be required as the new larger genset will produce more heat than the unit it is replacing (Unit 246).

The installation of a larger genset is also expected to increase station service demand to the point where upgrades will be required. The existing station service transformer must be replaced to accommodate the increase in station service demand. The increase in station service demand is mainly comprised of fans for the radiators and ventilation to support the 1,500kW unit.

Currently there is no available wall space to mount the motor starters associated with the new motor loads and therefore it is recommended that a Motor Control Centre (MCC) be purchased and installed. An MCC is a single compact enclosure that can house each motor starter and therefore provide more space in the engine hall. Existing motor starters are also required to be replaced. During the execution of an Arc Flash Remediation project, it was recommended to install new current-limiting fuses in each motor starter to reduce arc flash levels. Unfortunately the existing motor starters are not designed to support these

current-limiting fuses and therefore they must be replaced to achieve the required arc flash levels.

Postville

The generation expansion at the Postville diesel plant will be achieved by replacing a 252 kW diesel genset with a new 450 kW, 1,900 RPM, 4,160 V diesel genset. The new genset will require a new control panel, breaker, power cables, exhaust stack, radiator and aftercooler, and all other necessary equipment to facilitate a new unit.

3 JUSTIFICATION

This project is justified on the requirement to meet growing electricity needs of Hydro's customers serviced by the L'Anse au Loup and Postville diesel plants. Sufficient generation capacity must be available in an isolated system on a firm basis such that the peak load can be met at all times. Otherwise, when the load exceeds the available generation capacity, a power outage will result which would reduce the overall reliability of the system. In determining what a sufficient amount of generation is, Hydro applies a set of criteria that compares peak demand to the existing system capacity. The criteria as they apply to the isolated generating stations are described below.

3.1 Planning Criteria

Hydro has established criteria related to the appropriate reliability, at the generation level, for the system that determines the timing of generation source additions. These criteria set the minimum level of reserve capacity and energy installed in the system to ensure an adequate supply to meet the load; however, short-term deficiencies can be tolerated if the deficiencies are of minimal incremental risk.

3.1.1 Rural Isolated Generation Planning Criteria

Hydro's Rural Isolated Generation Planning Criterion was established to ensure a reliable supply of power to customers served by isolated diesel plants. This planning criterion is Hydro's first line of contingency planning for loss of generation in isolated communities served by diesel units. As a general rule to guide Hydro's planning activities the following criteria have been adopted:

Energy

- Diesel Systems shall have an adequate fuel supply to meet system energy requirements.
 - For Labrador systems the volume of bulk fuel storage shall be no less than nine months of fuel consumption.

- For Island systems the volume of bulk fuel storage shall be no less than four months of fuel consumption.
- For systems where fuel deliveries can be made on a regular basis and there are economic advantages to maintain less fuel storage; exceptions can be made to the bulk storage planning criteria such that they do not apply.

Capacity

- The Diesel System should have sufficient firm capacity to supply the peak load of the system.
 - The firm generating capacity shall be greater than the peak demand.
 - Firm generation capacity is defined as the total installed prime capacity on the system minus the prime capacity of the largest unit.²
 - Hydro installs a minimum of three units in each system to meet the load requirements of the system.
- The Diesel System electrical equipment shall not be overloaded beyond 100% of the nameplate continuous rating at any time.
- Diesel Plant Substation Transformers shall not be overloaded beyond 110% of the nameplate continuous rating at any time.

By comparing the planning ratings set according to the criteria to the forecast load, Hydro determines the timing of when additional capacity will be required.

3.1.2 Diesel Generator Ratings

For capacity planning purposes, Hydro uses the prime power rating of a diesel generator. The various ratings of diesel generators are based on the ISO8528 Standard, which is defined as follows:

² For L'Anse au Loup, Hydro considers the line capacity of the interconnection from Hydro Quebec as the largest unit on the system. 1,100 kW is also discounted from the installed capacity of the L'Anse au Loup Plant.

Standby Power: Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Prime Power: Output available with varying load for an unlimited time. Average power output is 70% of the prime power rating. Typical peak demand is 100% of prime rated electric power with 10% overload capability for emergency use for a maximum of one hour in 12. Overload operation cannot exceed 25 hours per year.

Continuous Power: Output available with non-varying load for an unlimited time. Average power output is 70-100% of the continuous power rating. Typical peak demand is 100% of continuous rated electric power for 100% of operating hours.

Any single engine is capable of operation at the above ratings. The rating to be used is dependent on the application as defined above.

An isolated generating station is the firm source of power for an isolated system, and is required to operate on a continuous basis. The demand from the system is continuously varying on a seasonal and daily basis, and ranges from a low during night, to a day time peak value. This application requires continuous operation at a varying load, which matches the definition of the prime power rating, and this is the rating used by Hydro in its isolated operations. The continuous rating would also be suitable for this application, but the diesels' engines would be physically larger and higher cost than the prime rated engines when compared on a per kilowatt basis. Due to the higher cost, Hydro does not use the continuous rating.

In addition to the peak load capacity, the prime power diesel engine is designed to operate at a certain load factor or average load. The most common design load factor is 70% of the

nameplate rating (some manufactures list units with 60% load factors). In other words, while the unit is designed to provide a peak demand according to its nameplate rating, it cannot do so continuously, and the load must, on average, when the unit is running, be limited to the design load factor. Exceeding this rating results in the unit operating into its standby operating range, which is meant for no more than 500 hours of operation per year. If the firm capacity of the diesel plant is near to the peak load and the largest unit is out of service, the generating units may be required to operate above their design load factor. Doing this for a prolonged period would subsequently cause the premature failure of the engine.

3.2 Existing System

The L’Anse au Loup diesel plant services the entire Labrador Straits region from L’Anse au Clair to Red Bay providing electrical power to approximately 1,006 customers. The Postville Diesel system services the community of Postville which is approximately 127 customers. Figure 1 is a map of Labrador showing the geographical location of L’Anse au Loup and Postville.



Figure 1: Labrador System

L’Anse au Loup

The L’Anse au Loup diesel plant was constructed in 1972 and designed to accommodate the installation of up to five diesel units, which would yield a plant capacity of 5,000 kW. It currently contains five diesel generators rated at 800 kW, 1,100 kW, 1,000 kW, 600 kW, 600 kW, and a 1,825 kW mobile generator installed outside the plant. Table 1 provides the ages along with other pertinent information for the six installed generating units at L’Anse au Loup. A 600 kW unit will be replaced with a 1,825 kW during the summer of 2015 as part of an approved 2013 Capital Budget Proposal. This new unit will be then given the designation of Unit 2091.

Hydro purchases surplus energy from the Lac Robertson system under a secondary sales contract with Hydro Québec. Since the interconnection came into service in 1996,

approximately 97% of the energy delivered into the L’Anse au Loup system has come from power purchased from Hydro Québec.

Table 1: L’Anse au Loup Installed Generation (December 26, 2014)

Unit #		Engine Model #	Capacity (kW)	Year Built	In-Service Date	Unit Age YTD	Unit Hours	Number of Overhauls
G1	2005	Cat. 3512	800	1988	1988	27	56,452	3
G2	2012	Cat. 3512	1,100	1984	1984	31	85,916	4
G3	2041	Cat. D3512	1,000	1989	2005	10	25,911	4
G4	246	Cat. D398	600	1975	1975	40	78,607	6
G5	247	Cat. D398	600	1975	1975	40	88,249	6
G6	2082	Cat. XQ2000	1,825	2001	2010	5	4,494	0

The firm capacity in L’Anse au Loup is established differently than all other isolated diesel generating plants because of its unique situation with interconnection from Hydro Québec. In determining the plant’s total firm capacity, Hydro considers the line capacity of the interconnection from Hydro Québec, which is stated in the secondary supply contract at 3,000 kW, as the largest unit on the system³. This is a slight exception to the firm capacity criteria in that the interconnection is a secondary source. It was determined in 2010 that another 1,100 kW be discounted from the firm capacity, making L’Anse au Loup follow the more traditional criteria. Consequently, the firm capacity on the L’Anse au Loup system is equal to 4,825 kW. Once Unit 247 is replaced with the 1,825kW, the firm will increase to 6,050 kW.

At the L’Anse au Loup diesel plant, the diesel units are connected to a 1,200 A main bus. Substation protection is provided by a 1,200 A main breaker, which is connected to the diesel plant substation by four runs of 500 kcmil copper RW90 service cables; two runs each go separately to each transformer. There are two fuel storage tanks located onsite with a total capacity of 45,430 L to supply the diesel plant. Table 2 provides a summary of the ratings of equipment found in the L’Anse au Loup diesel plant. A single line diagram for the

³ Hydro Québec has agreed to allow a load in excess of 3,000 kW to flow over the interconnection pending it does not cause problems on their own systems; however they will not change the contracted capacity of the interconnection. This was agreed to during operation committee discussions.

L'Anse au Loup diesel plant can be found in Appendix A.

Table 2: L'Anse au Loup Diesel System⁴

	<u>Equipment Rating</u>	<u>Equipment Rating (kW)</u>
Installed Capacity	8,925 kW	8,925
Firm Capacity	4,825 kW	4,825
Transformation Capacity	9,895 kW	9,895
Main Bus	1,200 A	7,781
Main Breaker	7,781 kW	7,781
Service Conductors	1,264 A/Phase	8,197
Fuel Storage	46,200 L	N/A

Postville

The Postville diesel plant was constructed in 1975 and designed to accommodate the installation of four units⁵. It currently contains three diesel generators rated at 365 kW, 252 kW, and 275 kW. Table 3 provides the ages along with other pertinent information for the three installed generating units at Postville.

Table 3: Postville Installed Generation (December 31, 2014)

Unit #		Engine Model #	Capacity (kW)	Year Built	In-Service Date	Unit Age YTD	Unit Hours	Number of Overhauls
G1	2084	Cat. C15	365	2009	2009	6	21,847	1
G2	577	6063TK35	252	2001	2001	14	66,221	4
G3	573	6063MK35	275	2000	2000	15	78,045	4

The main bus in the Postville diesel plant is an 800 A splitter. The connection between the diesel plant and substation consists of 2 runs per phase of 300 MCM Copper service cables. The fuel storage located onsite has a total capacity of 638,388 L to supply the diesel plant. Table 4 summarizes the ratings of equipment found in the Postville Diesel Plant.

⁴ The 3,000 kW supply from Hydro Quebec is consider in the Installed Capacity. By the end of 2015 the firm capacity will be 6,050kW

⁵ The Postville diesel plant can no longer accommodate four units, as the physically smaller original units have been replaced with larger units.

Table 4: Postville Diesel Plant Equipment

	<u>Equipment Rating</u>	<u>Equipment Rating (kW)</u>
Installed Capacity	892 kW	892
Firm Capacity	527 kW	527
Transformation Capacity	167 kVA/Phase	496
Main Bus	800 A	748
Main Breaker	N/A	N/A
Service Conductors	590 A/Phase	552
Fuel Storage	638,388 L	N/A

3.3 Operating Experience

Additional generation is required at the L’Anse au Loup and Postville diesel plants by the winter of 2015/2016 in order to meet Hydro's firm generation requirements. The forecasted gross peak for the winter of 2015/2016 in L’Anse au Loup and Postville is anticipated to be 6,169 kW and 528 kW, respectively. Consequently, both diesel plants will experience a firm capacity deficit until the winter of 2017/2018, as this project requires two years to complete.

Based on the 2013 Operating Load forecast, the violation in the firm capacity criteria in L’Anse au Loup was originally expected to occur in 2019. However, the sudden addition of three relatively large customers to the distribution system has advanced the need to install more generation capacity. The additions of these three customers have been included in the 2014 Operating Load Forecast (See Section 3.3).

Originally, the 2014 Operating load forecast for Postville indicated that the firm capacity criteria would not be violated until 2022. However, there was also a sudden addition of three relatively large customers to the Postville system, which triggered the need to revise the original forecast. The new revised 2014 Operating Load Forecast for Postville has incorporated these new customers (See Section 3.3).

Unfortunately, both existing capacity deficits were unavoidable due to the sudden and unforeseen increase in both the L’Anse au Loup and Postville load forecasts.

L’Anse au Loup

By replacing a 600 kW unit with a 1,500 kW unit, this project will increase the plant’s firm capacity to 6,950 kW. Based on current load forecasts, this will ensure that there is sufficient generating capacity available in the L’Anse au Loup System to maintain a reliable electrical supply beyond the year 2035.

Table 5 compares the generation capacity in L’Anse au Loup by the end of summer 2015 with the future plant configuration once this proposed project is complete.

Table 5: L’Anse au Loup Diesel Generating Capacity Summary

Generation Source	Unit #	Installed Capacity (kW)*	Proposed Installed Capacity (kW)
G1 (LAL DP)	246	600	1,500
G2 (LAL DP)	247**	1,825	1,825
G3 (LAL DP)	2041	1,000	1,000
G4 (LAL DP)	2005	800	800
G5 (LAL DP)	2012	1,100	1,100
Mobile (LAL DP)	2082	1,825	1,825
HQ Contract		3,000	3,000
Total Generation Capacity		10,150	11,050
Firm Generation(5)		6,050	6,950
*The 1,825kW unit will be installed by the end of Summer 2015			
**The 1,825kW unit will be given the designation Unit 2091			

The short term capacity deficit in L’Anse au Loup presents a potential risk to system reliability, but it is manageable. The fact that there is a secondary supply of power from Hydro Québec reduces the probability of this generation deficit having a negative impact on system reliability. There is a possibility that this secondary source of power may not be available during peak conditions as Hydro Québec is not contractually obligated to supply power. As a contingency plan, Hydro can mitigate any risk by installing a temporary mobile genset. In the event of the loss of multiple units, Hydro will seek available generation from various sources and would relocate units as necessary to the affected system.

The current deficit between firm capacity and forecasted peak demand is growing and will be resolved with the execution of this proposed project. Table 6 illustrates the increasing firm capacity deficit as time progresses. Hydro has executed energy conservation programs in L’Anse au Loup in the past, and continues to do so. Energy and demand savings produced by energy conservation programs has been outpaced by significant load growth in this system. The availability of Island Interconnected rates in this isolated system has led to a trend where customers are converting from fuel-fired heating appliances, to electric heating appliances. It is believed that the conversion from fuel-fired appliances to electric is the main driver of significant load growth in this system. Energy conservation programs will continue to focus on this system; however, given the forecasted load growth, energy conservation alone will not be sufficient to maintain system load within the firm generation capacity criteria. As such, a generation increase will be required for this system.

Table 6: Projected Firm Capacity Deficits – L’Anse au Loup

Year	Gross Peak (kW)	Firm Capacity (kW)	Deficit (kW)
2015	6,169	6,050	119
2016	6,233	6,050	183
2017	6,281	6,050	231
2018	6,324	6,050	274
2019	6,365	6,050	315
2020	6,402	6,050	352

Postville

By replacing a 252 kW unit with a 450 kW unit, this project will increase the plant’s firm capacity to 640 kW. Based on current load forecasts, this will ensure that there is sufficient generating capacity available in the Postville System to maintain a reliable electrical supply beyond the year 2035.

Table 7 compares the existing generation capacity in Postville with the future plant configuration once this proposed project is complete.

Table 7: Postville Diesel Generating Capacity Summary

Diesel Generators	Unit #	Existing Installed Capacity (kW)	Unit #	Proposed Installed Capacity (kW)
G2	2084	365	2084	365
G3	577	252	NEW	450
G4	573	275	573	275
Total Generation Capacity		892		1,090
Firm Generation		527		640

The capacity deficit in Postville presents a potential risk to system reliability, but it is manageable in the short term. The deficit is minimal for the winters of 2015/2016 and 2016/2017 and therefore the probability of a negative impact on system reliability is unlikely. Hydro is pursuing potential conservation and demand management (CDM) programs to reduce the demand in the longer term in its isolated diesel systems. To date, electricity conservation programs throughout the province have been designed with a focus on reducing energy consumption (kWh) and not peak demand (kW). In the case of Postville, Hydro is installing a direct load control pilot to reduce maximum system demand. The exact impact of the CDM program in Postville is not yet quantifiable, therefore, Hydro is planning for the generator replacement in parallel to the CDM pilot program. Hydro expects positive results from the program, and the results of the CDM program will inform future generation expansion timing for other communities.

The current deficit between firm capacity and forecasted peak demand is growing and will be resolved with the execution of this proposed project. Table 8 illustrates the increasing firm capacity deficit as time progresses.

Table 8: Projected Firm Capacity Deficit – Postville

Year	Gross Peak (kW)	Firm Capacity (kW)	Deficit (kW)
2015	528	527	1
2016	531	527	4
2017	534	527	7
2018	537	527	10
2019	540	527	13
2020	543	527	16

3.3.1 Reliability Performance

One of the intents of the isolated generation planning criteria is to avoid outages as a result of the load exceeding the capacity ratings of specific equipment. The planning criteria is intended to maintain at least a minimum level of system reliability by ensuring that equipment is properly rated for the load, and does not specifically target to improve the reliability of the existing equipment within a given system. However, there may be reliability improvements achieved if the replaced equipment is unreliable.

3.3.1.1 Outage Statistics

Similar to distribution systems, the reliability of a diesel plant is tracked using the industry standard service continuity indexes; System Average Interruption Frequency Index (SAIFI), and System Average Interruption Duration Index (SAIDI). Hydro uses the *Loss of Supply* category to track interruptions originating in the diesel plants. The indices are described as follows:

SAIFI - Indicates the average number of power outages a customer has experienced in the respective distribution system per year.

SAIDI - Indicates the average length of time a customer is without power in the respective distribution system per year.

Table 9 provides the 2010 to 2014 average SAIFI and SAIDI data for L’Anse au Loup and Postville for all causes as compared to Loss of Supply outages. The table also lists the 2010 to 2014 regional and corporate indices.

Table 9: Five-Year Average Outage Statistics (2010-2014)

SYSTEM	All Causes		Loss of Supply	
	SAIFI	SAIDI	SAIFI	SAIDI
Labrador Isolated	10.89	14.71	6.60	3.61
L'Anse Au Loup System	8.34	9.83	3.68	2.66
Postville System	8.23	3.47	7.39	2.19
Hydro Corporate	5.25	13.78	2.27	4.02

As presented in Table 9, the L’Anse au Loup system is generally more reliable than other systems in the same region. This would be expected as the L’Anse au Loup distribution system has the advantage of having two sources of power, the diesel plant and the Hydro Québec infeed. This provides the benefit of more operational flexibility when performing maintenance or restoring outages. In comparison to Hydro’s corporate performance, the SAIFI statistics for L’Anse au Loup are slightly higher. This is also expected as the Hydro Corporate statistics include the interconnected systems, which are naturally more reliable systems due to better site accessibility and more available resources.

The Postville system is also generally more reliable than other systems in the Labrador region in that there is a lower frequency and duration of outage occurrence. It is evident from Table 9 that a large portion of outages on Hydro’s diesel systems are due to Loss of Supply. The frequency of outages as a result of Loss of Supply appears to be slightly higher in Postville in comparison to its counterparts in the Labrador region. This shows that Postville is marginally less reliable from a generation standpoint. However, the duration of outages due to Loss of Supply is shorter than other Hydro diesel plants in the same region.

3.3.2 Maintenance

The maintenance of the diesel plant at L’Anse au Loup is performed by internal operations personnel stationed in St. Anthony, while the maintenance of the diesel plant at Postville is performed by personnel stationed in Happy Valley – Goose Bay. Maintenance consists of scheduled preventative maintenance such as changing the oil and oil filters, annual electrical and mechanical preventative maintenance, and required corrective maintenance to repair failed components or correct operational problems. To ensure timely availability of parts, Hydro has established blanket orders for parts for Caterpillar diesel generators with Toromont Cat and for Detroit Diesel units through Diesel Injection Sales Limited. Replacement parts are readily available for the diesel generating sets, and associated auxiliary equipment

The five-year maintenance histories for the L’Anse au Loup and Postville diesel plants are shown in Table 10 and Table 11, respectively.

Table 10: Maintenance History – L’Anse au Loup Diesel Plant

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$ 000)
2014	11.3	129.4	140.7
2013	7.9	69.7	77.6
2012	9.3	36.5	45.8
2011	10.8	13.3	24.1
2010	16.0	98.7	114.7

Table 11: Maintenance History –Postville Diesel Plant

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	9.2	1.1	10.3
2013	25.6	0.6	26.2
2012	25.7	6.5	32.1
2011	30.6	14.4	45.0
2010	14.5	3.8	18.4

Table 12 and Table 13 shows the major works and upgrades over the past 10 years that have occurred in the L’Anse au Loup and Postville diesel plants, respectively.

Table 12: L’Anse au Loup - Major Works or Upgrades

Year	Major Work/Upgrade	Comments
2014	Unit 247 replacement	Will not be fully completed until the summer of 2015
2014	Upgrade load management and control systems	Replaced
2013	Unit 246 bearing replacement	Vibration issues
2010/2011	Mobile Unit and Transformer Installed	Unit 2082
2008	Mufflers and exhaust wrapping replaced	Rusting and leaking
2008	Unit 2041 replaced by Unit 285	Unit 2041 was previously in Nain

Table 13: Postville - Major Works or Upgrades

Year	Major Work/Upgrade	Comments
2011	Two new bulk fuel storage tanks	300,000 L installed, with new dyke
2009	Installation of unit 2084 (G2)	Included new Jacket, water radiator, air to air after cooler, exhaust stack, power cables, control wire, and switch gear.

3.2.3 Historical Information

The L’Anse au Loup and Postville systems are both winter peaking systems and have historically experienced steady growth in peak load and electricity sales. The L’Anse au Loup system currently serves about 1,006 customers, while the Postville system currently serves about 127 customers.

The L’Anse au Loup system has experienced strong sales since its interconnection to Hydro Québec’s Lac Robertson system and the electricity rate reflective of current island interconnected rates. The domestic customers on this system also receive the benefits of the Labrador rebate program. Electric heat has been increasing its market share in both domestic and general service accounts. According to residential customer records, the amount of homes with electric heat in L’Anse au Loup is approaching 50%.

Figure 2 and Figure 3 are graphs that summarize historical annual demand and production

data for the Postville and L’Anse au Loup diesel plant since the year 2004.

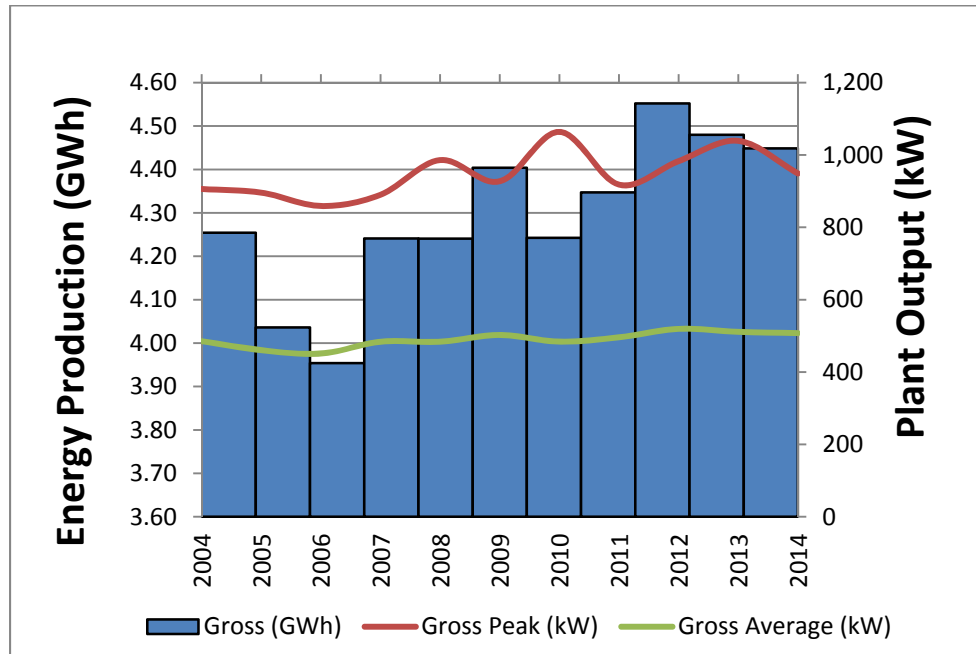


Figure 2: L’Anse au Loup – Historical Consumption Data (2004-2014)

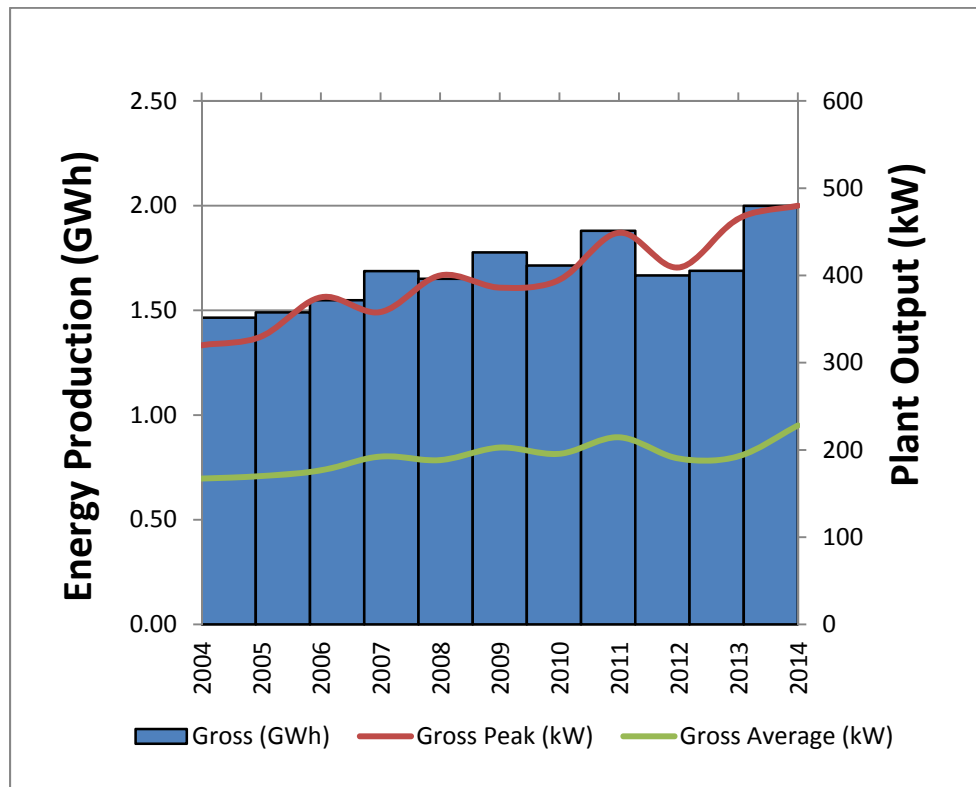


Figure 3: Postville – Historical Consumption Data (2004-2014)

There have been 16 similar projects completed within the last ten years to install new diesel generators. Table 14 is a list of these 16 projects with their respective estimated budget and actual expenditures amounts. Any projects not fully completed were not included in this list, as the final actual expenditures are unknown at this time.

Table 14: Historical Cost Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Capacity (kW)	Cost per unit (\$000/kW)	Comments
2012/2011	2,195.1	1,481.5	1,455	1.0	Unit 2088 and Unit 2087, Charlottetown
2011	467.9	451.6	275	1.6	Unit 586, Little Bay Islands
2011	618.5	496.3	210	2.4	Unit 587, Francois
2011	440.3	380.3	100	3.8	Unit 589, McCallum
2010	1,519.2	1,532.1	1,825	0.8	Unit 2082, L’Anse au Loup
2010	395.8	393.2	50	7.9	Unit 585, Paradise River
2010	484.9	487.3	50	9.7	Unit 581, Norman Bay
2010	1,077.3	1108.9	110	10.1	Units 583, 584, Norman Bay
2010	380.8	390.3	300	1.3	Unit 582, Black Tickle

As expected with any generator installation economies of scale are a key factor in the cost per kilowatt installed. That is, the cost per kilowatt of generation installed increases as the size of the diesel unit decreases. The scope of diesel genset installations may vary depending on physical and technical constraints. Therefore the capital cost of genset installation projects may not always be comparable.

3.3 Forecast Customer Growth

A key input to the planning process is the load forecast. The load forecast allows Hydro to determine timing of criteria violations, so that potential issues can be addressed before they occur. Hydro prepares a forecast of the anticipated loads for all of their distribution systems on an annual basis including L’Anse au Loup and Postville. The forecast projects the peak demands and energy requirements for each system for a seven year period. The peak demand forecast is used to determine the required amount of capacity that a plant or piece

of equipment within the plant must have in order to meet that demand. The energy forecast is used to determine the amount of fuel the system will require in a given year. The forecast includes new customers from both Domestic Service Customers (new homes) and General Service Customers (new businesses, and government facilities). The new residential customers (domestic services) added to the system are assumed to have the same energy consumption as the average of the existing customers in that system. A winter season spreads over two separate calendar years and therefore the winter peak of a system could occur in one of those two years. For a winter peaking system like L’Anse au Loup, the 2016 peak includes the winter of 2016/2017 which ranges between November 2016 and March 2017. Therefore, to meet the 2016 peak, it is necessary that there be adequate firm generation by November 2016.

The 2014 operating load forecast for L’Anse au Loup is presented in Table 15. The revised 2014 operating load forecast for Postville is presented in Table 16.

Table 15: L’Anse au Loup Forecast 2015-2020

Year	Gross Peak (kW)	Net Peak (kW)	Gross Energy (MWh)	Net Energy (MWh)	Total Sales (MWh)	Company Use (MWh)
2015	6,169	6,049	26,416	25,956	24,210	54
2016	6,233	6,113	26,940	26,480	24,701	54
2017	6,281	6,161	27,147	26,687	24,894	54
2018	6,324	6,204	27,336	26,876	25,071	54
2019	6,365	6,245	27,511	27,051	25,234	54
2020	6,402	6,282	27,671	27,211	25,384	54

Table 16: Postville Forecast 2015-2020

Year	Gross Peak (kW)	Net Peak (kW)	Gross Energy (MWh)	Net Energy (MWh)	Total Sales (MWh)	Company Use (MWh)
2015	528	507	2,322	2,207	2,038	5
2016	531	511	2,337	2,221	2,051	5
2017	534	514	2,351	2,234	2,063	5
2018	537	517	2,365	2,248	2,076	5
2019	540	520	2,379	2,261	2,087	5
2020	543	523	2,392	2,274	2,099	5

The sudden forecasted growth in L'Anse au Loup can be attributed to three new large customers, a hotel in Forteau, the Lower Churchill transition compound and Valard construction camp. The new hotel in Forteau is under construction and is expected to be in-service by the end of 2015 and have a peak demand of approximately 200kW. The transition compound for the LCP project in Forteau will be partly in-service by the Fall of 2016 and will eventually have a peak demand of approximately 225 kVA. The construction camp is expected to have a demand of about 290 kW with an expected service life of two years. It should be noted that Valard also has its own 300kW generator for emergency backup power. It has also been confirmed that both the hotel and transition compound will be utilizing electric heat.

The sudden forecasted growth in Postville can be attributed to three new customers, a recreation center, a fire hall and a hydrant heat tracing system. All three of these customers are now in service and are incorporated into the 2015 forecast.

3.4 Development of Alternatives

The follow list includes possible alternatives that were considered for these two projects:

- 1.) Diesel Unit Replacement: This option would involve replacing one or more of the existing diesel units, other than the largest unit, with a new unit of a larger prime power rating. Depending on the physical layout of the plant and the load profile of

the system, various sizes of the replacement unit could be considered as separate alternatives. This alternative is typically the lowest cost alternative when increasing the firm capacity of a diesel plant.

- 2.) Plant extension: This option would involve the extension of the existing power hall to accommodate an additional unit in either L'Anse au Loup or Postville. In L'Anse au Loup a plant extension would also be required if unit 246 was to be replaced by a larger unit in its current bay in the plant. The capital cost associated with this type of work would be significantly higher than the diesel unit replacement option. Based on a plant extension performed in Hopedale in 2014, Hydro expects the civil work to cost in excess of \$1,000,000.
- 3.) Mobile generation: This option would involve the purchase and permanent installation of a mobile genset in L'Anse au Loup or Postville. However, Hydro considers the installation of a mobile genset at a diesel plant as a temporary measure to mitigate any short-term capacity deficits. Mobile gensets tend to be more challenging to operate and maintain as they are not physically located in a sheltered power house. For this reason, Hydro strongly does not recommend the permanent installation of a mobile genset.
- 4.) Diesel Plant Replacement: This would involve the complete replacement of the L'Anse au Loup or Postville diesel plant. The capital cost of this option would be significantly more than the proposed alternative and therefore was deemed uneconomical at this time. Additional generation is required within the next two years, while it would take at least 4-5 years to plan and construct a new diesel plant.
- 5.) Construction of Second Diesel Plant: This option would involve the construction of a second diesel plant on the L'Anse au Loup or Postville system. The capital cost of this option would be significantly more than the proposed alternative and therefore was

deemed uneconomical at this time. Additional generation is required within the next two years, while it would take at least 4-5 years to plan and construct a new diesel plant.

3.5 Evaluation of Alternatives

Economic Analysis

An economic analysis for L’Anse au Loup was not required, as the only feasible option at this time is to replace a diesel unit with a 1,500 kW Unit. A larger unit would not physically fit in the plant and anything smaller would not provide an adequate amount of additional generation capacity.

Four alternatives were considered for the generation expansion at the Postville Diesel Generation Station. All four alternatives involve the replacement of a diesel unit with a larger unit.

Alternative 1: Replace unit 573 at Postville with a larger unit (450 kW).

Alternative 2: Replace unit 573 at Postville with a larger unit (680 kW.)

Alternative 3: Replace unit 577 at Postville with a larger unit (450 kW).

Alternative 4: Replace unit 577 at Postville with a larger unit (680 kW).

Alternative 1 and 3 would involve the replacement of Unit 573 or 577 with a 450 kW diesel generator. This increase in the firm capacity would support the forecasted load of the Postville distribution system for the foreseeable future.

Alternative 2 and 4 would involve the replacement of Unit 573 or 577 with a 680 kW diesel generator. This increase in the firm capacity would also support the forecasted load of the Postville distribution system for the foreseeable future.

The economic analysis for Postville uses a comparison of the cumulative present worth

(CPW) of each alternative to determine the least cost alternative. The CPW analysis considered a study period of 20 years.

The CPW analysis for each plant and their respective alternatives was performed using the following information:

- Estimated Capital and Operating Project Costs;
- Forecasted Fuel Costs;
- Estimated Unit Overhaul Costs and Intervals;
- Estimated Unit Replacement Costs and Years; and
- Remaining Book Values.

Capital and operating project cost estimates were generated by Hydro's multidisciplinary Project Execution and Technical Services Division.

A properly sized unit should minimize overall usage of all diesel units thereby reducing individual annual operating hours per diesel engine. This is because less units would be required to operate in parallel at any given time to serve the load; therefore fewer units will be used at a time and together they accumulate fewer hours per year. Since diesel unit maintenance intervals are based on operating time, the overall maintenance cost of the facility should be reduced accordingly.

Using an internally developed Diesel Plant Simulator, the total operating hours, fuel consumption and production (kWh) per unit for each alternative was determined for every year of the study period. The main inputs to this simulator included load forecasts, load duration curves and diesel unit specifications. By analyzing the annual operating hours for each unit the overhaul and replacement intervals could be projected. Cost estimates for overhauls and unit replacements were provided by Operations and/or the Mechanical Engineering Group.

Using the fuel consumption results from the simulator and the forecasted fuel costs, the cost of fuel each year could be determined for each alternative.

Any book value remaining on a unit at the end of the 20 year study period was calculated and in alternatives where a unit was replaced and not fully depreciated, the remaining book value was considered as a loss.

Postville Evaluation

The results of the economic analysis for Postville are summarized in Table 18.

Table 17: Postville Increased Generation Economic Analysis Summary

Alternative Comparison Cumulative Net Present Value To The Year 2035		
Alternative	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
ALT #1: Replace unit 577 with 450 kW	\$ 10,704,889	\$ 0
ALT #3: Replace unit 573 with 450 kW	\$ 10,804,251	\$ 99,362
ALT #4 Replace unit 573 with 680 kW	\$ 10,883,195	\$ 178,307
ALT #2: Replace unit 577 with 680 kW	\$ 11,080,000	\$ 375,112

Based on the net present value analysis, replacing unit 577 with a 450 kW unit is the least cost alternative to meeting the growing demand in Postville.

4 CONCLUSION

The work proposed in this report is necessary to meet growing electricity needs of Hydro’s customers in L’Anse au Loup and Postville. The forecasted demand in L’Anse au Loup and Postville is expected to exceed the firm capacity of the diesel plant by the winter of 2015/16. Therefore, to maintain a reliable electrical supply, generation capacity must be increased at the diesel plants in L’Anse au Loup and Postville as per this proposal. There will be a capacity deficit for a couple of peak seasons in both locations, but if it becomes an issue, it can be mitigated with the installation of a temporary mobile genset in L’Anse au Loup and Postville.

As described in this proposal, Hydro recommends that Unit 246 in L’Anse au Loup be replaced with a 1,500 kW unit, and that Unit 577 in Postville be replaced with a 450 kW unit. The project in L’Anse au Loup will also require relocating Unit 2005 to the current position of Unit 246. The current location of Unit 2005 is the only space that can accommodate a larger 1,500 kW unit. Both generation expansion projects will increase the firm capacities by 900 kW and 113 kW at the L’Anse au Loup and Postville diesel plants, respectively.

Based on the most recent load forecast and Hydro’s firm capacity criteria, both these unit replacements will support the growing demand in L’Anse au Loup and Postville beyond the year 2035.

4.1 Budget Estimate

The total estimated capital cost for both projects is approximately \$5,629,400. A breakout of the estimated capital costs is shown in Table 19.

Table 18: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	350.0	1,434.0	0.0	1,784.0
Labour	242.0	1,082.0	0.0	1,324.0
Consultant	131.4	247.8	0.0	379.2
Contract Work	45.0	250.0	0.0	295.0
Other Direct Costs	42.8	332.7	0.0	375.6
Interest and Escalation	72.2	567.8	0.0	640.0
Contingency	0.0	831.6	0.0	831.6
TOTAL	883.4	4,746.0	0.0	5,629.4

4.2 Project Schedule

The anticipated project schedules for L’Anse au Loup and Postville are shown in Table 20 and Table 21, respectively. To ensure the system is ready to supply the increased load in the winter of 2017/2018; the work must start in January of 2016 and be completed by December 2017.

Table 19: L'Anse au Loup - Project Schedule

Activity		Start Date	End Date
Planning	Open project and develop design transmittal, Create scope statement, develop WBS.	February 2016	February 2016
Design	Finalize size and output requirements of new unit. Finalize size of ventilation system Complete mechanical design. Complete electrical design. Complete protection and control design.	February 2016	June 2016
Procurement	With developed tech spec, tender for new unit. Review of received tenders. Award PO for project	May 2016	July 2016
Construction	Disconnect and remove Unit 246. Relocate Unit 2005. Install MCC Install ventilation system Install new genset.	June 2017	September 2017
Commissioning	Commission genset.	September 2017	October 2017
Closeout	Project closet out.	November 2017	December 2017

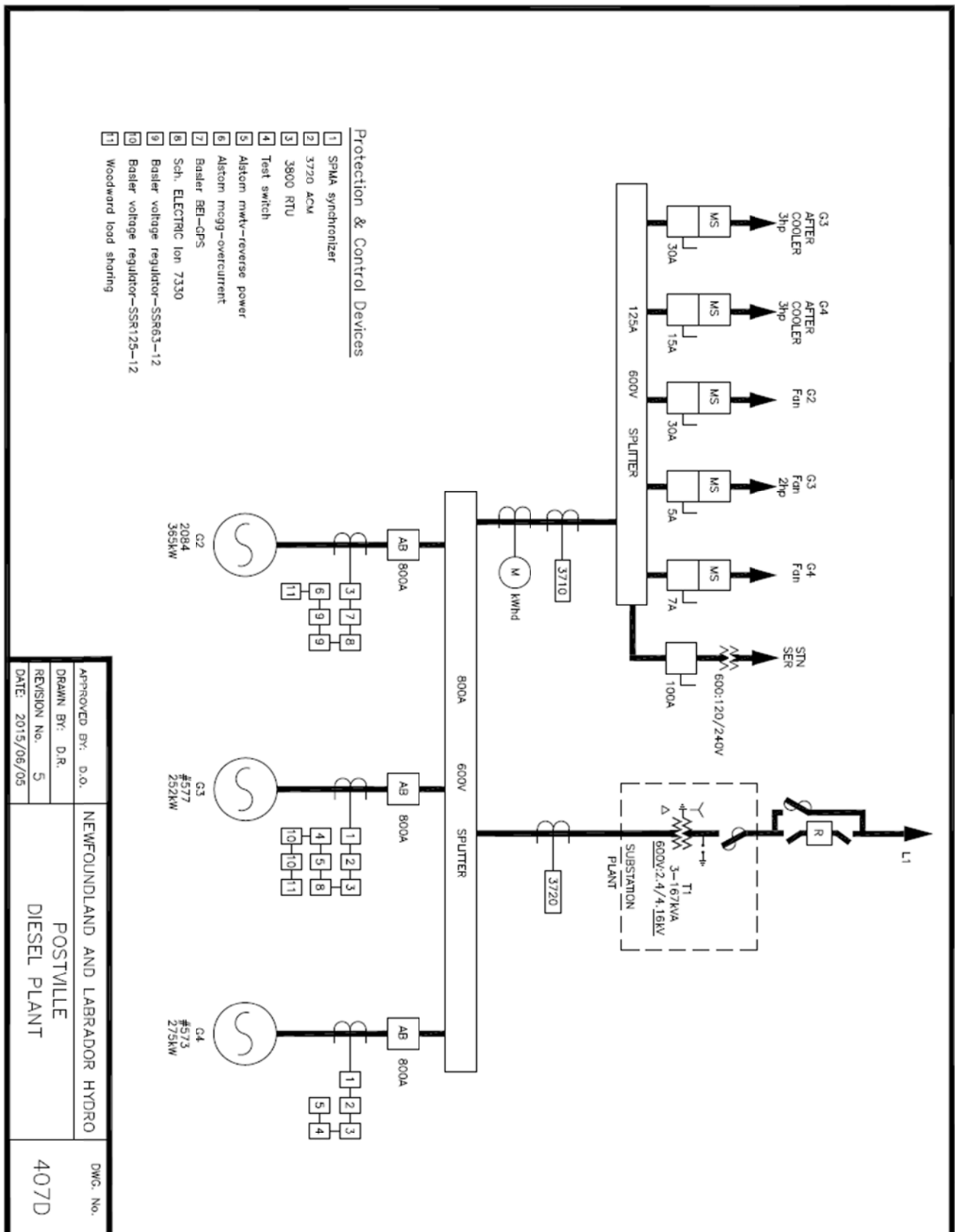
Table 20: Postville - Project Schedule

Activity		Start Date	End Date
Planning	Open project and develop design transmittal.	September 2016	November 2016
Design	Finalize size and output requirements of new unit. Complete mechanical design. Complete electrical design. Complete P&C design.	November 2016	November 2016
Procurement	Order genset. Order switchgear. Order exhaust and cooling systems.	December 2016	June 2017
Construction	Disconnect and remove Unit 577.	July 2017	July 2017
	Install new genset.	July 2017	August 2017
Commissioning	Commission genset.	August 2017	August 2017
Closeout	Project closet out. Lessons Learned	September 2017	October 2017

APPENDIX A

Single Line Diagram





A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

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

Replace Diesel Units
Cartwright and Charlottetown, Labrador

July 2015

SUMMARY

This report details a proposal to replace diesel generator sets (genset) in both Cartwright and Charlottetown, Labrador. In Cartwright, Unit 2052 is due for replacement based on operating hours and therefore, the unit is close to the end of its service life. In Charlottetown, Unit 2079 is due for replacement due to premature failures of the unit in service.

Gensets have an expected average service life of 100,000 operating hours. Hydro's current asset management strategy is to replace gensets when they approach 100,000 operating hours, ensuring reliability for customers served by the generating units. Cartwright's Unit 2052 has been in service since 2002 and has accumulated approximately 89,054 hours of operation as of December 2014. It is expected Unit 2052 to exceed 100,000 hours of operation at some point in 2018. Therefore, in order to maintain a reliable and least cost system in Cartwright, Unit 2052 needs to be replaced.

In Charlottetown, Unit 2079 experienced a pre-mature failure in early 2012. After this failure, a review was conducted of the maintenance history of the unit to determine the root cause for the failure. Temperature readings had been taken during scheduled maintenance on the genset using an infrared thermometer gun and the review identified 25 instances relating to high exhaust temperatures. While it has not been conclusively determined that the high exhaust temperatures were the cause of the premature failure, it is likely a contributing factor. Following the failure there was an overhaul of the engine, however the unit continued to experience high exhaust temperatures and failed for a second time in late 2012 requiring another overhaul in 2013. The unit was returned to service and continued to operate with the high temperatures for another seven months until the most recent failure in November 2013. At the time of the failure, the unit had 39,889 hours of operation since it was installed in 2006 and is presently out of service due to the November 2013 sudden failure.

While another overhaul could be completed to restore the unit to operation, it is Hydro's experience that no reliability will be maintained with an overhaul of the unit given its history to date. Thus, it has been determined the prudent course of action is to replace the failed unit with a new genset of the same output.

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1 INTRODUCTION

Cartwright

Cartwright is located on the southern Labrador coast at the mouth of St. Lewis Inlet as shown in Figure 1. Electricity for the area is supplied by a Hydro owned and operated diesel generating plant (see Figures 2 and 3). Hydro provides electrical service to approximately 350 customers in Cartwright.

The generating plant in Cartwright houses four gensets to provide electrical service to the community with a total generation capacity of the plant at 2,220 kilowatts (kW), resulting in a firm capacity of 1,500 kW.

Charlottetown

Charlottetown is a small community located on the southern Labrador coast as shown in Figure 1. Electricity for the area is supplied by a Hydro owned and operated diesel generating plant (see Figures 4 and 5). Hydro provides electrical service to approximately 200 people in the community. The largest customer on the Charlottetown Distribution System is a shrimp processing plant which has been in service for over 14 years.

The generating plant in Charlottetown houses three gensets inside the. There are also two mobile gensets on the site property that are utilized for peak loading, which occurs when the shrimp plant is in operation during the shrimp processing season in the summer months.

Current winter load on the electrical distribution system for the Charlottetown area peaks at approximately 820 kW. The load drops off during the months of March and April each year but picks up again in May when the shrimp plant prepares for the coming shrimp season. The peak demand is in the summer when the loading requirements can reach approximately 1,700 kW during July and August when the shrimp processing plant is in full operation.

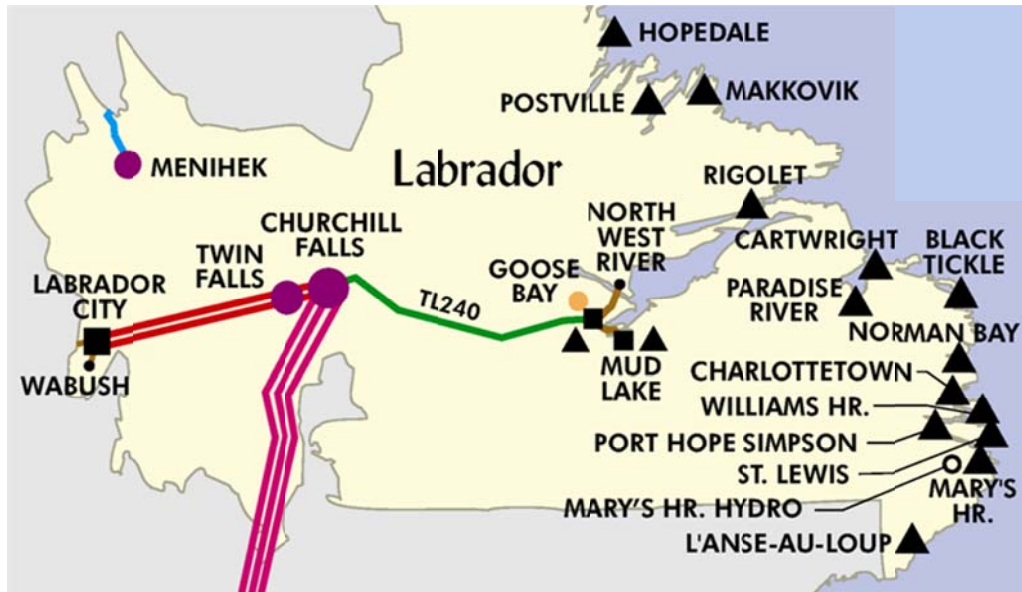


Figure 1: Map of Southern Labrador showing Cartwright and Charlottetown



Figure 2: Cartwright Powerhouse.



Figure 3: Cartwright Diesel Generators in Powerhouse



Figure 4: Charlottetown Generating Plant



Figure 5: Charlottetown Diesel Generators in Powerhouse

2 PROJECT DESCRIPTION

Cartwright

This two year project is for the replacement of one of four gensets at the Cartwright generating plant, Unit 2052.

Piping modifications to the existing cooling system will be required to accommodate the new unit. The existing exhaust system will be reused with minor modifications.

Available new gensets on the market may require a larger footprint than the old gensets. Therefore, re-arrangement of existing gensets inside the powerhouse may be required to allow enough space around the new genset for cooling and maintenance.

The new genset is scheduled to be in service by September 2017, as the genset is a long delivery item estimated to be between six and eight months after contract award. Engineering, construction and project management will be performed by Hydro personnel.

Charlottetown

The scope of work for this project is to replace failed Unit 2079. Unit 2079 failed prematurely in November 2013 and is one of three diesel generating units installed inside the Charlottetown powerhouse. It is proposed that Unit 2079 be replaced with a new genset of the same size. The budget includes all costs associated with procurement and installation of the new 725 kW genset, upgrade of the associated switch gear, and modification of the auxiliary systems to accommodate the new unit.

The switch gear and auxiliary systems were not upgraded during the 2006 installation of unit 2079 and were original to unit 2060 (installed in 2000). The new genset will have an electronically controlled engine whereas the old genset was a mechanical type, therefore the switch gear and the auxiliary systems are required to be upgraded because the existing equipment is not compatible with the new installation. The new genset will be installed in

the Unit 2079 bay. It will be provided with a skid mounted radiator and after cooler system. The existing exhaust system will be reused with minor modifications

Due to the failure of Unit 2079, a 450 kW unit has been temporarily relocated from Hydro's Little Bay Islands¹ diesel generating station to provide additional power during 2015 and 2016 peak load. Also, an additional 600 kW mobile unit will also be positioned at site in case problems should occur with any of the three units in the powerhouse ensuring power to the community while this project is being executed. Peak load occurs during the summer months when the shrimp plant is in operation, expected to be from July to August, however increased loading occurs in Charlottetown from May until November each year.

Completion of the current project proposal includes removal of the 450 kW generator (from Little Bay Islands) to allow installation of the new unit. The two existing generators inside the powerhouse will remain in service throughout the construction period to provide power to the community during execution of the project.

The new genset is scheduled to be in service by February 2017. The genset is a long delivery item estimated to be between six and eight months after contract award. Engineering, construction and project management will be performed by Hydro personnel.

The estimated cost of both genset replacements is \$4,938,900.

¹ The relocated diesel from Little Bay Island was a surplus unit from this site.

3 JUSTIFICATION

Cartwright

This project is justified based on Hydro's asset management strategy to replace gensets when they approach 100,000 operating hours. Unit 2052 at the Cartwright diesel plant is forecasted to incur 100,000 hours in 2018. The new unit will be installed in 2017.

Charlottetown

The history of Unit 2079 includes three premature total engine failures. Since Unit 2079 was installed, the unit has experienced higher than normal exhaust temperatures even after three overhauls. Consultations with the original equipment manufacturer (OEM) have not been able to resolve the high exhaust temperatures and repeated engine failures.

To return existing Unit 2079 to service, another major overhaul would be required, making it the fourth overhaul for the unit. Hydro normally completes overhauls every 20,000 operating hours. The failed unit has just under 40,000 hours on it, and should only have had 2 overhauls for number of running hours. Further, Hydro has no reassurance from the OEM that another overhaul will make the unit any more reliable and prevent unplanned failures.

Considering the experience Hydro has had with this particular model of engine, another overhaul is not considered to be a viable option that would ensure reliability. Replacement of Unit 2079 is the most appropriate course of action to provide reliable electrical service to the community of Charlottetown.

3.1 Existing System

Cartwright

The Cartwright Diesel Generating Station was commissioned in 1987 and currently houses four diesel generating units. The facility is the sole source of power for the community of Cartwright and as such it is required to provide the electrical supply to approximately 350 customers on a continuous basis. The plant is designed to accommodate the installation of

up to four 500 kW class diesel units, which would yield a firm capacity of 1,500 kW. The current plant arrangement consists of four diesel generators rated at 600 kW, 720 kW, and two at 450 kW. The total installed capacity of the facility is currently 2,220 kW giving a firm capacity of 1,500 kW (with the largest unit out of service). Table 1 provides the ages and other pertinent information for the four installed generating units at Cartwright.

Table 1: Cartwright Installed Generation (December 31, 2014)

Unit #		Engine Model #	Capacity (KW)	Year Built	In Service Date	Unit Age	Unit Hours
G1	2036	Cat. D-3412	450	1992	1992	23	37,821
G2	2086	Cat. C-27	600	2009	2009	6	19,474
G3	2045	Cat D-3412	450	1993	1993	22	31,113
G4	2052	Cat. D-3512	720	1998	2002	17	89,054

Charlottetown

Diesel Plant

The Charlottetown Diesel Generating Plant was commissioned in 1987 and consists of three gensets inside the powerhouse and two mobile units located outside. The facility is the sole source of power for the community of Charlottetown and as such, it is required to provide electrical supply to customers on a continuous basis. The genset arrangement in the powerhouse before Unit 2079 failure included one 759 kW genset, one 545 kW genset, and one 300 kW genset, for an installed total of 1,604 kW. The mobile gensets units at the site include one 910 kW unit and one 725 kW unit, for a total of 1635 kW of mobile capacity. This translates into a total installed capacity of 3,239 kW. The firm capacity of Charlottetown, as defined in section 3.2.10.2, prior to the failure of Unit 2079 was 2,329 kW. Table 2 provides the ages and other pertinent information for the three installed generating units and two mobile units at Charlottetown.

Table 2: Charlottetown Installed Generation (December 26, 2014)

Unit #		Engine Model #	Capacity (KW)	Year Built	In Service Date	Unit Age	Unit Hours
G2	2087	Cat D-3412	545	1990	2011	25	20,768
G3	2079	Cat D-3412	579	2006	2006	9	39,889
G4	2034	Cat D-3412	300	1994	1994	21	99,710
G5	2089	Cat C27	725	2012	2012	3	8,240
G6	2088	Cat C32	910	2011	2011	4	8,878

Mobile Gensets

The main purpose of the two mobile units installed at Charlottetown is to provide peaking power during the summer when the shrimp plant is in full operation. The shrimp plant operates on a continuous basis, day and night, starting in May of each year until the end of the shrimp season, typically early November. These mobile units were designed and purchased for the additional loading the shrimp plant adds to the distribution system and were not intended for use during the winter season due to the harsh coastal Labrador climate. Hydro has installed modifications to the mobile units to prevent rain from entering the units in the summertime.

The modification to prevent rain from entering the units is not effective against blowing snow. The winter operation of the mobile gensets is risky due to the potential for operating during high wind, snow conditions, and frigid temperatures. The mobile units will draw in snow, resulting in a shock hazard as electrical equipment is very sensitive to water, or can cause electrical faults. As well, the units require cold air for combustion, and the ambient air in Labrador in the winter is such that when the air gets drawn into a mobile unit, condensation may form, and may be another shock hazard.

3.2 Operating Experience

Cartwright

Unit 2052 has been in service for 13 years. During the 13 years of service life the unit has been overhauled three times. In 2018, the unit is forecast to have incurred over 100,000

hours of operation. To continue operating Unit 2052 beyond 2018 could mean reducing the reliability of the Cartwright Diesel Plant.

Charlottetown

Unit 2079 was installed in April 2006 and was first overhauled in May 2010 according to the typical overhaul schedule which occurs at approximately 20,000 operating hours. This scheduled overhaul took four weeks to complete. The overhaul began with the removal of the radiator and refurbishment of the radiator, completed off site. The idler block and camshaft bearing were inspected and were deemed reusable. It was noted that the main bearings were worn and required replacement, and the communication to the control module was not working and required repair. The unit was overhauled as per the OEM recommendations and returned to service.

In February 2012, the unit experienced an unplanned failure, 10,817 operating hours after the first overhaul. An investigation was conducted and instances of high exhaust temperatures were observed. High exhaust temperatures can cause premature failure of internal components such as gaskets, O-rings, nozzles, injector tubes and turbo chargers. The internal inspection of the unit post-failure found the unit required a major overhaul before it could be returned to service. This overhaul was completed in May 2012. The unit failed again in July 2012, with 822 operating hours after the previous overhaul. The unit was again overhauled in March 2013.

The unit operated for seven months before its most recent failure in November 2013. Internal inspection identified the requirement for the unit to be overhauled to be able to return it to service. This was deemed not practical considering the past failures on the unit. Table 3 below outlines major work performed on Unit 2079 since it was installed and the cost of the overhauls.

Table 3: Major Work or Upgrades

Year	Major Work/Upgrade	Comments	Cost (\$000)
2010 (May)	Overhauled	Planned overhaul of the genset motor based on the running time of the unit of 23,371.	\$75.1
2012 (May)	Overhauled	Unplanned overhaul of the genset motor after 10,817 additional hours on the unit.	\$103.5
2013 ² (March)	Overhauled	Unplanned overhaul of the genset motor after 822 additional hours on the unit.	\$165.7

Hydro asset managers attempted to rectify the high exhaust temperatures being experienced. As well, the Original Equipment Manufacturer (OEM), Caterpillar, was consulted to gain further insight into causes and solutions for the unplanned failures and high exhaust temperatures. Through consultation, it was concluded that an internal issue was creating the high exhaust temperatures although a definitive cause of the high temperatures could not be identified.

3.2.1 Reliability Performance

Cartwright

Hydro's current asset management strategy is to replace diesel gensets when they have incurred approximately 100,000 hours of operation. When a unit has more than 100,000 hours of operation, the reliability of the unit will decrease. SAIDI and SAIFI statistics are not provided as the replacement genset for Cartwright is based on hours of operation, and not a deteriorated reliability rate of the unit.

Charlottetown

Other generators within Hydro's fleet with the same model of diesel engine as that installed on Unit 2079 have experienced higher than normal exhaust temperatures. Unit 2060, which Unit 2079 replaced, had similar issues. However, even though the exhaust temperatures were higher than normal for the two gensets, their cooling water and jacket water

² The unit operated for seven months before failing in November 2013 with only accumulating an additional 4,879 running hours.

temperatures were normal at 180 °F indicating normal internal engine temperatures. Unit 2060 was installed in 2000 and had a planned overhaul in April of 2004, having accumulated 19,730 operating hours. The unit suddenly failed in November of 2005 with a total of only 28,782 hours. The unit failed due to a crankshaft failure, thereby destroying the engine. Unit 2060 was then replaced in 2006 with Unit 2079.

Another similar engine failure occurred with Unit 2061, a mobile unit at Charlottetown. It also had a Cat 3412 engine complete with four turbo chargers and was installed in 2002. Its first planned overhaul took place in 2006 when the unit had 22,854 hours. However, the engine experienced a sudden failure in April of 2012 after only 38,292 total operating hours. Subsequently it was replaced with mobile Unit 2089.

Unit 2079 has not performed on a reliable basis. Unit 2079 has experienced three sudden failures requiring major overhauls before accumulating a total of 40,000 hours of operation. The typical time between overhauls on a properly functioning unit is approximately 20,000 hours and it is Hydro's policy to replace a genset after 100,000 hours of operation (a unit with this many hours would have had four overhauls in its operating life) or 25 years of service.

Similar to distribution systems, the reliability of a diesel plant is tracked using the industry standard service continuity indexes; System Average Interruption Frequency Index (SAIFI), and System Average Interruption Duration Index (SAIDI). Hydro uses the *Loss of Supply* category to track interruptions originating in the diesel plants. The indices are described as follows:

SAIFI - Indicates the average number of power outages a customer has experienced in the respective distribution system per year. (Both planned and unplanned outages)

SAIDI - Indicates the average length of time (in hours) a customer is without power in the

respective distribution system per year.

Loss of Supply: Distribution outages are classified by reason, one of which is *Loss of Supply*, or generating capacity. In the instance of Charlottetown, this is due to the either a full loss or partial loss of generating capacity.

Table 4 provides the 2010 to 2014 average SAIFI and SAIDI data for Charlottetown for all causes as compared to Loss of Supply outages. The table also lists the 2010 to 2014 regional and corporate indices and the latest CEA five-year average (2010 to 2014) for comparison.

Table 4: Five-Year Average Outage Statistics

System	All Causes		Loss of Supply	
	SAIFI	SAIDI	SAIFI	SAIDI
Charlottetown	8.59	8.43	7.03	1.94
Northern Isolated	8.08	9.48	4.86	2.33
Hydro Corporate	5.25	13.78	2.27	4.02

As presented in Table 4, the Charlottetown System is statistically less reliable than other systems in the Northern Isolated region. Comparing outages in the Loss of Supply category to outages from All Causes, it is noted that a large portion of outages on these systems are due to loss of supply, which accounts for both planned and unplanned outages. In comparison to Hydro's corporate performance, customers in the Charlottetown distribution system experience more frequent outages due to loss of supply.

The duration of these outages are also higher than the other diesel plants in the Northern Isolated region due to accessibility. The Charlottetown plant is maintained by staff in St. Anthony. Staff must travel about 450 km, including a ferry ride, taking at least a day to reach site with good weather conditions before any issues can be addressed in the diesel plant and the unit restored to service. Having a more reliable unit in place would improve the frequency and duration of outages experienced by customers.

3.2.2 Legislative or Regulatory Requirements

New or used diesel engines being installed for permanent operation are required to meet current provincial environmental regulations. To meet the requirement of the *Air Pollution Control Regulations, 2004*, an owner or operator of a new or modified emission source shall employ the Best Available Control Technology (BACT). BACT shall be acceptable to government regulators and shall be a) the most effective emission control device or technique, b) the most stringent emission control device or technique, c) proven reliable in comparable processes and d) economically feasible as determined by the minister of environment in light of industry standards.

In order to install the 450 kW unit on a temporary basis at Charlottetown, Hydro has to obtain an amendment to the site operating approval. To obtain this, Hydro is required to submit an air dispersion model which shows compliance with published ground level concentrations of contaminants when the 450 kW unit is installed. It is expected the amendment to approval would result in Hydro receiving approval to install the 24 year old 450 kW unit for one year only. Based on the current timelines for the approval process, the one year approval would expire in fall of 2016.

3.2.3 Safety Performance

Charlottetown

As previously discussed, the mobile gensets were placed in Charlottetown to provide adequate capacity for summer peak. Utilizing the mobile gensets as a permanent replacement for the failed Unit 2079 introduces safety concerns when used in a continuous manner in the winter.

The mobile gensets intake louvres were modified to prevent rain from being drawn into the unit when the units are run through the peak period. The louvres and the intake cannot prevent blowing snow from being drawn into the unit. Blowing snow is drawn into the

louvres and once inside the genset, melts and introduces a hazard to the unit and staff that operate the unit.

To illustrate the hazard of using the mobile units in the winter, consider that in December 2014, the 545 kW unit in the diesel plant tripped. With the 545 kW unit tripped, and the 725 kW unit failed, the only unit remaining was the 300 kW unit. The 300 kW unit is not sufficient for the community load in the winter. Therefore, the 910 kW mobile unit was called upon to be put into service as an emergency measure. The unit ran well on the first day it was required, however, on the second day, blowing snow started. Prior to staff being able to shut the unit down and prevent snow from getting into the unit, the 910 kW unit also tripped due to a generator failure. This unit is currently being assessed but there is preliminary evidence to suggest water had accumulated and pooled, causing the failure. Further, operating the unit in the winter when snow enters the louvres can cause snow to melt and accumulate on the floor of the unit. The water then freezes on the floor, introducing a slip hazard for those operating the unit.

All units, including temporary mobile units, require maintenance. Maintenance on the mobile units that are not meant for long term installation is difficult. The space within the mobile unit is limited, making access around the unit difficult, especially in winter. With the addition of cold, harsh weather creating slip and trip hazards, the risk associated with maintenance activity significantly increases.

Utilizing the existing mobile gensets on a continuous basis in place of a unit installed in the diesel plant is not an appropriate solution for providing power to the community.

3.2.4 Environmental Performance

Both Cartwright's and Charlottetown's diesel replacements are not based on environmental performance; Engine emissions improvements are generally expected when replacing older generating units with newer models. Emissions standards for diesel engines in Canada have been aligned with European Union and United States Environmental Protection Agency

(EPA) standards. These agencies have been phasing in improved emissions standards since 1996. A lack of standards for stationary diesels makes it possible to still sell non-EPA equipment however, in recent years, only EPA compliant equipment has been offered by vendors. Any new generating unit purchased by Hydro is expected to meet US EPA tier 4 interim standards to satisfy the requirements for Best Available Control Technology (BACT) discussed in section 3.2.2.

3.2.5 Maintenance or Support Arrangements

The maintenance of the diesel generating plant at Cartwright is performed by Hydro operations personnel stationed in Happy Valley Goose Bay, and the maintenance at Charlottetown is performed by staff in St. Anthony. Maintenance at diesel plants consists of scheduled preventative maintenance such as changing the oil and oil filters, annual electrical and mechanical preventative maintenance, and required corrective maintenance to repair failed components or correct operational problems. Replacement parts are readily available for the diesel generating sets and associated auxiliary equipment. Hydro maintains a spare substation transformer on site in the event of a failure.

3.2.6 Maintenance History

Cartwright

The five-year maintenance history for the genset 2052 is provided in Table 5.

Table 5: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	2.6	0.0	2.6
2013	2.7	33.3	36.0
2012	0.0	2.7	2.7
2011	1.6	1.5	3.1
2010	0.0	0.2	0.2

Charlottetown

The five-year maintenance history for Unit 2079 is noted in Table 6.

Table 6: Maintenance Costs of Unit 2079

Year	Corrective and Preventative Maintenance (\$000)	Overhaul Maintenance (\$000)	Total Maintenance (\$000)
2014	6.7	0.0	6.7
2013	24.2	165.7	189.9
2012	4.0	103.5	107.5
2011	23.9	-	23.9
2010	17.4	75.1	92.5

There are currently two units in operation in the diesel plant with a 450 kW unit planned for installation as a temporary third unit. The diesel plant building heat is supplied by heat transfer from running the generating units. This obviously means there must be one unit running at all times.

In order to perform maintenance on any unit, another unit must stay in operation to supply the community. The current winter load is between 725 to 850 kW. To perform maintenance on the 545 kW or the 300 kW units, the 759 kW unit was able to be run with no impact on customers. With the 759 kW unit failed, and only two units in service, neither the 545 kW nor the 300 kW units can supply the peak winter load or outages would have to occur while maintenance is being performed, therefore, maintenance has to be performed at off peak hours when the load drops off. This situation will be partially alleviated with the temporary installation of the 450 kW unit, however, on a permanent basis, the new 725 kW unit provides for appropriate flexibility in performing maintenance as this unit can supply the community in the winter, allowing maintenance to be performed with no impact on customers.

3.2.7 Historical Information

Table 7 provides historical capital cost information for similar diesel genset replacement projects across Hydro's system completed over the last four years.

Table 7: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Capacity (kW)	Cost per unit (\$000/kW)	Comments
2012/2011	2,195.1	1,481.5	1,455	1.0	Unit 2088 and Unit 2087, Charlottetown
2011	467.9	451.6	275	1.6	Unit 586, Little Bay Islands
2011	618.5	496.3	210	2.4	Unit 587, Francois
2011	440.3	380.3	100	3.8	Unit 589, McCallum
2010	1,519.2	1,532.1	1,825	0.8	Unit 2082, L'Anse au Loup
2010	395.8	393.2	50	7.9	Unit 585, Paradise River
2010	484.9	487.3	50	9.7	Unit 581, Norman Bay
2010	1,077.3	1108.9	110	10.1	Units 583, 584, Norman Bay
2010	380.8	390.3	300	1.3	Unit 582, Black Tickle

3.2.8 Anticipated Useful Life

Diesel generating units have an expected average service life of 100,000 operating hours. Diesel systems are depreciated over a 25 year period.

3.2.9 Temporary Measures

After the failure of Unit 2079 in November 2013, a non-winterized mobile unit from Port Hope Simpson was relocated to Charlottetown for operation during the 2014 summer shrimp season. This was an emergency temporary solution. The long term viability of leaving this unit in Charlottetown was not feasible as the mobile unit is not available beyond 2016; refer to section 3.4 Development of Alternatives for more details.

To meet the 2015 and 2016 load conditions at Charlottetown, it is planned to temporarily install a 450 kW generator relocated from Hydro's Little Bay Islands generating station. The 450 kW unit is 24 years old and can be approved on an interim basis only due to environmental restrictions. This relocated 450 kW has to be treated as a new installation under provincial definition as it is being installed in a different location than the original

install. This requires Hydro to employ the best available control technology (BACT) under the Air Pollution Control Regulations (2004). The relocated unit could not meet these regulations as a permanent install; however a permit to install on a temporary basis is obtainable from the Department of Environment and Conservation, until a new unit is in place in the fall of 2016. The temporary unit has less capacity than Unit 2079, however, this can be managed for a limited timeframe until the new genset comes on line. Operations will have to change maintenance timing to accommodate the decrease in generation.

3.2.10 Planning Guidelines

Hydro's generation planning guidelines contain three criteria for a remote diesel generating plant, this includes:

The firm generating capacity shall be greater than the peak demand.

Firm generation capacity is defined as the total installed prime capacity on the system minus the prime capacity of the largest unit.

Hydro installs a minimum of three units in each system to provide for redundancy and to meet the load requirements of the system.

3.2.10.1 Diesel Generator Ratings

For capacity planning purposes, Hydro uses the prime power rating of a diesel generator. Prime power rating, and other rating descriptions for diesel generators are based on the ISO8528 Standard. The ratings are defined as follows:

Standby Power: Output available with varying load for the duration of the interruption of the normal source power. Average power output is 70% of the standby power rating. Typical operation is 200 hours per year, with maximum expected usage of 500 hours per year.

Prime Power: Output available with varying load for an unlimited time. Average power output is 70% of the prime power rating. Typical peak demand is 100% of prime rated

electric power with 10% overload capability for emergency use for a maximum of one hour in 12. Overload operation cannot exceed 25 hours per year.

Continuous Power: Output available with non-varying load for an unlimited time. Average power output is 70-100% of the continuous power rating. Typical peak demand is 100% of continuous rated electric power for 100% of operating hours.

Any single engine at Charlottetown is capable of operation at the above ratings. The rating to be used is dependent on the application as defined above.

An isolated generating station is the firm source of power for an isolated system, and is required to operate on a continuous basis. The demand from the system is continuously varying on a seasonal and daily basis, and typically ranges from a low during night, to a day time peak value. The Charlottetown diesels require continuous operation at a varying load, which matches the definition of the prime power rating, and this is the rating used by Hydro in its isolated operations. The continuous rating would also be suitable for this application, but the diesels' engines would be physically larger and cost more than the prime rated engines when compared on a per kilowatt basis. Due to the higher cost, Hydro does not use the continuous rating.

In addition to the peak load capacity, the prime power diesel engine is designed to operate at a certain load factor or average load. The most common design load factor is 70% of the nameplate rating (some manufacturers list units with 60% load factors). In other words, while the unit is designed to provide a peak demand according to its nameplate rating, it cannot do so continuously, and the load must, on average, be limited to the design load factor. Exceeding this rating results in the unit operating into its standby operating range, which is meant for no more than 500 hours of operation per year. If the firm capacity of the diesel plant is near to the peak load and the largest unit is out of service, the generating units may be required to operate above their design load factor. Doing this for a prolonged

period would subsequently cause the premature failure of the engine.

3.2.10.2 Firm Capacity

The firm capacity of Charlottetown, prior to the failure of Unit 2079, is outlined in Table 8. The projected firm capacity with the new proposed unit is also outlined in Table 8. The table below is for the firm capacity in the summer months, when peak demand is experienced, and includes the mobile units, denoted with (m) next to the unit number.

Table 8: Firm Capacity of Charlottetown

Prior to Unit 2079 Failure		Projected after proposed replacement	
Unit Number	Size (kW)	Unit Number	Size (kW)
2034	300	2034	300
2079	759	New Unit	725
2087	545	2087	545
2088 (m) ³	910	2088 (m)	910
2089 (m)	725	2089 (m)	725
Firm Capacity:	2,329	Firm Capacity:	2,295

As seen in Table 8, the firm capacity of Charlottetown is well above the peak demand of 1696 kW that is expected in the months of July and August of 2015, reference Table 11 for the Five Year Monthly Peak Forecast.

3.2.10.3 Minimum Units

With the addition of the Little Bay Islands 450 kW unit on a temporary basis, there will be three units at the Charlottetown location satisfying the final planning guideline until the permanent unit is installed. This guideline is to ensure the assets are able to be maintained without disruption to the community.

³Unit 2088 is the largest unit in Charlottetown, therefore the firm capacity is calculated as: Sum of all Units Capacity – Capacity of Largest Unit (Unit 2088)

3.3 Forecast Customer Growth

A key input to the planning process is the load forecast. The load forecast allows Hydro to determine timing of criteria violations, so that potential issues can be addressed before they occur. Hydro prepares a forecast of the anticipated loads for all of their distribution systems on an annual basis. The forecast projects the peak demands and energy requirements for each system for a seven year period. The peak demand forecast is used to determine the required amount of capacity that a plant or piece of equipment within the plant must have in order to meet that demand. The energy forecast is used to determine the amount of fuel the system will require in a given year. The forecast includes new customers from both Domestic Service Customers (new homes) and General Service Customers (new businesses, and government facilities). The new residential customers (domestic services) added to the system are assumed to have the same energy consumption as the average of the existing customers in that system.

Cartwright

The 2015 operating load forecast for Cartwright is presented in Table 9.

Table 9: Cartwright Load Forecast (2015-2019)

Cartwright	2015	2016	2017	2018	2019
Gross Peak (KW)	1,032	1,040	1,050	1,059	1,069
Net Peak (KW)	997	1,005	1,015	1,024	1,034
Gross Energy (MWh)	4,701	4,739	4,784	4,823	4,869
Net Energy (MWh)	4,500	4,536	4,580	4,617	4,661
Total Sales (MWh)	4,297	4,331	4,372	4,408	4,450
Company Use (MWh)	0	0	0	0	0

There is slight growth forecasted in the small general service class, but the majority of the growth is expected due to residential customers switching to electric heat. Based on the operating load forecast, the peak load served by the Cartwright Diesel Plant will be covered by the existing installed firm capacity.

Charlottetown

Table 10 summarizes the projected load forecast for Charlottetown over the next five years on an annual basis, and Table 11 is the monthly peak forecast for Charlottetown.

Charlottetown's peak loading is different from the typical Island grid as the peak is seen in the summer due to the shrimp processing plant.

Table 10: Charlottetown Forecasted Peak (2015-2019)

Charlottetown	2015	2016	2017	2018	2019
Gross Peak (kW)	1,696	1,705	1,712	1721	1728
Net Peak (kW)	1,648	1,657	1,664	1673	1680
Gross Energy (MWh)	5,719	5,751	5,773	5805	5827
Net Energy (MWh)	5,487	5,518	5,539	5570	5591
Total Sales (MWh)	5,244	5,273	5,293	5323	5343
Company Use (MWh)	0	0	0	0	0

Table 11: Charlottetown Monthly Peak Forecast (kW)

	2015	2016	2017	2018	2019
January	777	781	784	789	792
February	763	767	770	775	777
March	736	740	743	747	749
April	726	730	733	737	740
May	924	929	932	937	941
June	1591	1600	1606	1615	1621
July	1696	1705	1712	1721	1728
August	1696	1705	1712	1721	1728
September	1618	1627	1634	1643	1649
October	1470	1479	1484	1493	1498
November	930	936	939	944	948
December	817	821	824	829	832

The monthly forecasted peak as seen in Table 11 above is the 15 minute average peak. The actual instantaneous peak is unknown because Charlottetown does not have the metering

to capture this reading. It is known that the instantaneous peak is above 1700 kW, therefore when additional loading is activated, such as an electric motor in the shrimp plant, there is a requirement to have additional reserve available to ensure units do not trip due to instantaneous overloading.

3.4 Development of Alternatives

Cartwright

The status quo is not a viable option for the operation of this diesel system. Hydro would be taking a risk in operating a genset that has become obsolete. Not replacing Unit 2052 by 2017 could lead to unplanned outages and corrective maintenance, which will only persist as time progresses.

Possible alternatives that are normally employed to address the obsolescence of a diesel unit are:

Straight Replacement – Replace with a unit of a similar size; and
Replacement – Replace with a unit of a different size.

A properly sized unit should reduce overall usage of all diesel units thereby reducing individual annual operating hours per diesel engine. This is because less units would be required to operate in parallel at any given time to serve the load; therefore, fewer units will be used at a time and together they accumulate fewer hours per year. Since diesel unit maintenance intervals are based on operating time, the overall maintenance cost of the facility should be reduced accordingly.

The two alternatives considered for the replacement of Unit 2052 included:

Alternative 1: Replace Unit 2052 with a 720kW (1,200 rpm) genset.

Alternative 2: Replace Unit 2052 with a 925kW (1,200 rpm) genset.

Alternative 1 represents a straight replacement in which Unit 2052 is to be replaced with a

unit of a similar size (720kW), while Alternative 2 represents the replacement of Unit 2052 with a larger 925 kW Unit. An even larger unit was considered, but it was technically not viable due to it being too large to fit into the space available in the existing plant.

Charlottetown

Seven alternatives were considered to provide replacement generation for failed Unit 2079 at the Charlottetown Diesel Generating Station. The seven alternatives evaluated were as follows:

Alternative No. 1: Replace Unit 2079 with a similar sized Genset.

This alternative is described in the Project Description section of this report.

Alternative No. 2: Lease a Mobile Generating Unit.

Under this alternative, Hydro would lease a mobile generating unit for permanent installation in Charlottetown Diesel Generating Station. The unit would be the same size as Unit 2079 (759 KW). A five-year lease agreement was explored with an option to purchase after the lease expired. This provides for the flexibility in downsizing at the generating plant should any changes occur at the fish plant, as Hydro has experienced in the past with little notice from the customer. The cost estimate for this option included a customized enclosure to allow for winter operation, adequate room for employees to perform maintenance, and improved access of the engine to complete overhauls. The project cost of this option was estimated to be \$918,000, not including the monthly lease rate. The lease rate was based on the supplier's stand-by rate which allowed for 40 hours of operation per month, if usage increased beyond 40 hours, the lease rate increases. This minimum lease rate was used in the cost benefit analysis to reflect the least cost for this option, however if this rate is adhered to this will introduce operational restrictions.

Alternative No. 3: Purchase a Mobile Generating Unit.

Similar to alternative 2 except the mobile unit would be purchased for permanent

installation in Charlottetown Diesel Generating Station. The cost estimate for this option included a customized enclosure to allow for winter operation, more room to perform maintenance, and improved access of the engine to complete overhauls. The project cost of this option was estimated to be \$ 2,055,900.

Alternative No. 4: Transport the mobile unit from Port Hope Simpson yearly for Stand-By Power.

In the summer of 2014, a mobile 600 kW unit from Port Hope Simpson was transferred to Charlottetown to provide stand-by power. Hydro considered moving this mobile unit on a seasonal basis to supplement the demands during the summer period at Charlottetown while the shrimp plant was in operation. However, this was not considered to be viable as it would make that mobile generator unavailable for emergency response in other areas if it was required elsewhere. This unit is intended to supply a number of communities for emergencies.

Alternative No.5: To install the 450 kW diesel from Little Bay Islands permanently.

To assist in supporting the electrical load at Charlottetown during the summer of 2015, until a new diesel generator is installed for the 2016 season, it is planned to temporarily relocate a 450 kW diesel from Hydro's Little Bay Islands plant. This installation is presently going through environmental regulatory approval. It has anticipated that because of the age of the unit, and its environmental performance, it will be approved only on an interim basis until the new genset is installed in April of 2016. The 450 kW genset is 24 years old and is approaching the end of its service life. The unit has poor emission performance and is not acceptable for a permanent installation that would need to meet current regulations. It is therefore not a viable alternative.

Alternative No.6: Modify Unit 2079 by replacing the Cat 3412 diesel engine with a new alternate model of the same size, existing generator remains.

This was discussed with the manufacturer. It is not a standard offer and significant modifications to the existing generator package would be required. It was considered to be a high risk, unproven solution from a technical perspective and would be without a strong warranty. A high level budget estimate indicated that the cost would be comparable to purchasing a new standard diesel generator package. This alternative was not considered to be viable.

Alternative No. 7: Continue to overhaul Unit 2079 diesel engine as required.

Considering the poor experience Hydro has had with this particular model of diesel engine, another overhaul is not considered to be a viable option to ensure reliability.

3.5 Evaluation of Alternatives

Cartwright

The economic analysis for this proposal uses a comparison of the cumulative present worth (CPW) of each alternative to determine the least cost alternative. The CPW analysis considered a study period of 20 years.

The CPW analysis for each plant and their respective alternatives was performed using the following information:

- Estimated Capital Costs;
- Forecasted Fuel Costs;
- Estimated Unit Overhaul Costs and Intervals;
- Estimated Unit Replacement Costs and Years; and
- Remaining book values.

Capital cost estimates were generated by Hydro's multidisciplinary Project Execution and Technical Services Division. The initial capital cost for each alternative is shown in Table 12.

Table 12: Capital Cost for each Alternative at Cartwright

Alternative	Capital Cost (\$)⁴
Alt. 1: Replace⁵ with 720 kW	\$3,214,400
Alt. 2: Replace⁵ with 925 kW	\$3,507,900

Using an internally developed Diesel Plant Simulator, the total operating hours, fuel consumption and production (kWh) per unit for each alternative was determined for every year of the study period. The main inputs to this simulator included load forecasts, load duration curves and diesel unit specifications. By analyzing the annual operating hours for each unit, the overhaul and replacement intervals could be projected. Cost estimates for overhauls and unit replacements were provided by Operations and/or the Mechanical Engineering Group.

Any book value remaining on a project at the end of the 20 year study period was calculated using straight line depreciation. In alternatives where a unit was replaced and not fully depreciated, the remaining book value was considered as a loss.

The results of economic analysis are summarized in Table 13. Although Alternative 2 has the higher capital cost, Table 13 confirms it has the lower total life cycle cost and therefore is the least cost alternative. The additional capital cost associated with Alternative 2 would be offset in the savings of fuel, unit replacement, and operation and maintenance (O&M) costs. Over the 20 year period of the Cost Benefit Analysis, Alternative 2 consumed less fuel to support the same load and less unit overhauls and unit replacements were triggered for the diesel plant.

⁴ Capital costs include contingency, escalation and IDC

⁵ Replacement cost in Cartwright are higher compared to Charlottetown due to the larger sized unit that is a 1,200 RPM unit, and the additional Protection and Control work necessary for this location.

Table 13: Cost Benefit Analysis Cartwright

CTW Engine Replacement		
Alternative Comparison <i>Cumulative Net Present Value</i> <i>To The Year</i> 2015		
Alternatives	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
925 kW	19,499,380	0
725 kW	20,315,444	816,064

Charlottetown

A cost benefit analysis (CBA) was performed on all viable options (alternatives 1, 2, and 3) with the results in Table 14 below.

Table 14: Cost Benefit Analysis Charlottetown

CHT Diesel Replacement Options		
Alternative Comparison <i>Cumulative Net Present Value</i> <i>To The Year</i> 2015		
Alternatives	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
Alt.No.1-Replace the Genset	1,610,884	0
Alt.No.2- Lease a Mobile Unit	1,950,426	339,543
Alt.No.3 - Purchase a Mobile Unit	2,148,387	537,503

Based on the economic analysis Alternative No.1, Replace Unit 2079 with a new similar sized unit, is the least cost alternative.

3.5.1 Energy Efficiency Benefits

Fuel efficiency improvements may be expected when replacing older units with more modern equipment, but any such improvement cannot be accurately quantified at this time.

4 CONCLUSION

Cartwright

The project will replace Unit 2052 (720 KW) with a larger unit (925 KW). The results of economic analysis confirmed that the replacement of Unit 2052 with a larger unit has a lower total life cycle cost than the replacement with a similarly rated unit.

Unit 2052 was commissioned in 2002 in Cartwright. Since commissioning the unit has been available for operation and in 2018 it is projected to have accumulated approximately 100,000 hours of service. In accordance with Hydro's current asset management philosophy this unit will have reached the end of its useful life and will need to be replaced to maintain acceptable reliability for power generation.

Charlottetown

Diesel generating Unit 2079 was installed at Charlottetown in 2006. It received its first scheduled engine overhaul four years later in 2010 after accumulating the standard amount of operating hours before completing a planned overhaul. Since that time, the engine has incurred three sudden failures, each time after accumulating limited operating hours. The most recent failure was in November of 2013. All failures required the engine to undergo a major overhaul before it could be placed back in service.

The engine had a history of exhibiting high exhaust gas temperatures. However after consultation with the manufacture, this was not conclusively determined to be the cause of the failures and a definitive cause could not be determined. Overhauls took place for the first two sudden failures but a third overhaul has not taken place to bring the unit back in service after the most recent failure.

Considering the history of premature engine failures over its last 42 months of operation, the unit is not considered to be reliable. Analysis of several alternatives for serving the community according to Hydro generation planning criteria concluded the more

appropriate solution is to replace Unit 2079 with a new genset of similar size and configuration fitted with a more reliable model of diesel engine.

4.1 Budget Estimate

The estimate for both genset replacements for Cartwright and Charlottetown is in Table 15.

Table 15: Project Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	798.9	892.0	0.0	1690.9
Labour	460.2	891.4	0.0	1351.4
Consultant	198.0	283.0	0.0	481.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	88.6	218.4	0.0	306.9
Interest and Escalation	72.3	270.4	0.0	342.7
Contingency	222.7	543.3	0.0	766.0
TOTAL	1,840.5	3,098.4	0.0	4,938.9

4.2 Project Schedule

The anticipated project schedules are provided in Table 16 and 17.

Cartwright

Table 16: Project Schedule

	Activity	Start Date	End Date
Planning	Open project and develop scope statement.	January 2016	February 2016
Design	Prepare general layout showing new genset and re-arrangement of old gensets.	March 2016	April 2016
	Complete mechanical design.	April 2016	May 2016
	Complete electrical design.	July 2017	August 2017
	Complete protection and control design.	April 2017	May 2017
Procurement	Order genset.	June 2016	July 2016
	Supply and deliver genset.	August 2016	March 2017
	Order electrical, and protection and control materials.	May 2017	June 2017
Construction	Install new genset.	August 2017	September 2017
Commissioning	Commission genset.	September 2017	September 2017
Closeout	Project close out.	November 2017	November 2017

Charlottetown

Table 17: Project Schedule

	Activity	Start Date	End Date
Planning	Open project and develop design transmittal.	January 2016	February 2016
Design	Complete design and output requirements of new unit. Complete mechanical. Complete electrical design. Complete protection and control design.	February 2016	March 2016
Procurement	Order genset. Order switchgear.	March 2016	March 2016
Construction	Disconnect and remove 450 kW unit. Install new genset.	October 2016	December 2016
Commissioning	Commission genset.	December 2016	January 2017
Closeout	Project close out.	January 2017	February 2017

**A REPORT TO
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Install Fire Protection in Diesel Plants
Nain and Cartwright, Labrador

July 2015

SUMMARY

Hydro owns and operates 25 diesel powered generation plants. Most are located in remote coastal areas of Newfoundland and Labrador and are not staffed 24 hours per day. An automatic fire protection system is being installed at Hopedale diesel plant in 2015. The other plants are not currently equipped with automatic fire protection systems. In the past, there have been at least six serious fires resulting in the loss of equipment and facilities.

In 2011, Hydro contracted Hatch Ltd. (Hatch), an engineering consulting firm, to complete a study and recommend suitable fire protection systems for each of its diesel plants. The study included development of a decision matrix to determine the risk ranking for each plant. From this study Nain and Cartwright were identified as having high risk.

This project proposal for Nain and Cartwright will be a continuation of a multi-year program for Hydro's diesel plants to be equipped with automatic fire protection systems. Hydro will evaluate if fire protection systems are the best alternative, as compared to fire walls for example, to maintaining reliable service in remote diesel plants when it considers future plans. Following a systematic review of each location, it is anticipated that Hydro will submit other proposals to the Board of Commissioners of Public Utilities (Board) in subsequent years to have fire protection projects completed at other remote diesel plants.

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1 INTRODUCTION

In 25 communities in Newfoundland and Labrador, Hydro owns and operates diesel generating stations consisting of diesel powered electric generators. In 21 of these communities, the diesel plants are the only source of electric power as the communities are isolated. Continuous operation of the generating units, or their availability in the case of standby plants, is critical to each community.

There are multiple generating units installed at each of Hydro's isolated diesel generating stations. Each station has the ability to generate enough power to meet community load with the loss of the largest generating unit. However, the plants are vulnerable to fire. Although they are equipped with fire detection systems, they are not staffed 24 hours per day, seven days per week, and they do not have automatic fire protection systems. Catastrophic consequences could result if a fire broke out and was not extinguished immediately, which has been experienced in the past. A community could be left without a sufficient supply of electricity for an extended period of time, possibly weeks, resulting in disruption in services and health and safety concerns.

In November 2011, Hydro engaged an engineering firm, Hatch, to review all of its diesel plants. Their engineering report (see Appendix A) includes a risk assessment matrix (Table 1) to determine the risk ranking to establish the criticality of each plant. A cost estimate was also provided to install recommended automatic fire protection systems for each of three typical plant sizes; small, medium and large. From the risk assessment matrix, the diesel generating plants in Nain and Cartwright (Figures 1 and 2) were determined to be at high risk.

Table 1: Hatch's Risk Assessment Matrix.

Site	Accessibility	Population Served <250=1, 250-500=2, 500-750=3, 750-1k=4, >1k=5	Weather/Climate vs Accessibility Weather Greatly Affects Accessibility = 5	Number of Units >5 = 5	Total Generating Capacity	Average Age of Unite	Continuous Operation vs Standby Operation Continuous = 5; Standby = 1	Community Fire Protection Capability No Capability = 5	Relative Replacement Cost of Plant i.e. Relative cost of new plant	Material of construction/Plant Layout	Industrial/Large Commercial Costumers Yes = 5, No = 1	Maintenance Record	Total
St. Brendans	2	1	2	3	1	3	5	5	1	1	1	1	194
McCallum	2	2	2	3	1	3	5	5	1	1	1	1	202
Mud Lake	5	1	1	1	1	3	1	5	1	1	1	5	204
Grey River	2	1	3	3	1	3	5	5	1	2	1	1	212
Norman Bay	3	1	3	3	1	1	5	5	1	1	1	2	214
Francois	2	1	4	3	1	4	5	5	1	2	1	1	227
Little Bay Islands	2	1	3	4	2	4	5	5	2	2	1	1	240
St. Lewis	3	2	3	3	2	1	5	4	2	1	5	2	255
Ramea	2	3	2	3	3	3	5	5	3	1	1	2	256
Port Hope Simpson	2	3	3	3	2	3	5	4	2	2	5	1	261
Kawkes Bay	1	5	1	2	5	5	1	5	5	1	1	3	263
Williams Harbour	5	1	5	3	1	2	5	5	1	2	1	2	267
Mary's Harbour	3	2	3	3	2	4	5	2	2	2	5	2	268
St Anthony	1	5	1	5	5	5	1	1	5	1	5	3	278
Charlottetown	3	2	3	2	3	4	5	2	3	2	5	2	281
Black Tickle	4	1	4	3	2	1	5	5	2	2	5	3	290
Paradise River	3	1	3	3	1	4	5	5	1	5	1	5	291
Postville	4	1	4	3	2	2	5	3	2	2	5	4	295
Goose Bay	1	5	1	5	5	5	1	1	5	1	5	5	298
Makkovik	4	2	4	3	2	4	5	3	2	1	5	4	305
Rigolet	4	2	4	4	3	3	5	3	3	2	1	4	311
Cartwright	3	3	3	4	3	3	5	2	3	2	5	4	314
Natuishish	4	3	4	4	4	2	5	2	4	1	1	5	329
L'Anse-au-Loup	3	5	3	5	4	5	5	2	4	1	5	2	335
Hopedale	4	3	4	3	3	2	5	3	3	4	5	4	345
Nain	4	5	4	3	4	2	5	3	4	1	5	4	355

Weight	10	8	10	5	8	5	10	5	10	8	5	10
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Figure 1: Nain – Diesel Generating Plant.



Figure 2: Cartwright – Diesel Generating Plant.

2 PROJECT DESCRIPTION

This proposed project is a continuation of a multi-year program to equip diesel plants with automatic fire protection systems. A water mist fire protection system will be installed where a spray of water and nitrogen produces a blanket of atomized water particles that absorb heat and smother the fire. This system will be used in the diesel generator main hall area (Figures 3 and 4) and other interior spaces requiring fire protection including the supervisory control room, battery room and the lube and coolant storage room.



Figure 3: Nain – Diesel Generators in Powerhouse.



Figure 4: Cartwright - Diesel Generators in Powerhouse.

The scope of work includes design, procurement, installation and commissioning of the new equipment. A new storage container for nitrogen cylinders will be supplied and installed outside the powerhouse including required foundations, electrical work and ventilation.

The majority of the work including detailed design will be completed by the external contractor supplying the systems with support from Hydro's internal engineering and labor forces. The design and procurement work will be completed in 2016 for both Nain and Cartwright. The installation, testing and commissioning work will be completed in 2016 for Nain and in 2017 for Cartwright.

The design, procurement, installation, testing and commissioning will be in accordance with the National Fire Protection Association (NFPA) requirements and will be approved by FM Global

3 JUSTIFICATION

This project is justified by the requirement to protect critical assets at the diesel plants in Nain and Cartwright from potential catastrophic consequences in the event of a fire. As both diesel plants are not staffed 24 hours per day seven days a week, the potential for a fire to be left unchecked for a period of time is a risk. The result could be the community being left without power for an extended period of time which would have both operational and health and safety concerns for the community.

In 2011/2012 Hydro engaged Hatch to complete a study and recommend measures that could be taken to reduce the risk of fire and minimize fire damages to diesel generating stations. In addition, Hydro's insurer, Factory Mutual Global, has recommended that diesel plants be equipped with automatic fire protection systems.

A list of reported incidents involving fire within Hydro diesel plants is provided in the engineering report prepared by Hatch (see Appendix A, Section 3). For example, Nain diesel plant experienced a major fire in 1993 and another in September 2008.

3.1 Existing System

The diesel plants at Nain and Cartwright presently do not have a fire protection system. The plants are only equipped with a fire detection system that consists of heat detectors, manual pull stations, fire alarm annunciation control panels, audible alarms, and auto dialers. When a fire is detected, the fire alarm system will alarm and the auto dialer will attempt to contact the shift operator or Energy Control Center (ECC) in St. John's. In addition, the control panel which interfaces with the plant's operating equipment is activated to shut down all ventilation systems and on-line generators.

The plants are also equipped with a number of portable fire extinguishers. If there is a fire, extinguishing the fire is either done by plant personnel when they are in attendance or by the local volunteer fire department.

3.2 Operating Experience

Cartwright diesel plant experienced a fire to engine components and wiring in 2002 due to an oil leakage over hot exhaust manifold. The fire was extinguished by an employee using a fire extinguisher.

In 1973, Nain diesel plant was destroyed by fire when it was under the ownership of Labrador Services Division. The plant was rebuilt and in 1993 there was another major fire caused by a catastrophic engine failure. In 2006, a new plant was constructed at a different site near the community and it experienced a major fire in 2008. That fire destroyed one generating unit, damaged the other two, and caused significant damage to the auxiliary equipment and building finishes. At that time, one of the three generating units was replaced and the other two units were repaired. In addition, a large amount of mechanical and electrical auxiliary equipment was replaced along with interior building architectural finishes. The total refurbishment cost was \$5,000,000.

There have been other fires at Hydro's diesel plants which have resulted in extensive damage or total loss of plants (see Appendix A, pages 4 and 5).

Although Hydro's diesel plants are equipped with fire detection systems, they are not staffed 24 hours per day, seven days per week, and they do not have automatic fire protection systems. During the fire on September 7, 2008 at Nain, the existing fire alarm system performed as designed and alerted Energy Control Center (ECC) in St. John's and the plant operator. The fire was extinguished by the Nain Volunteer Fire Department but not before extensive damage was experienced.

3.2.1 Reliability Performance

Whenever there is a fire in a diesel plant the reliability of generation can be affected especially if it is a major fire as was the case in Nain in September 2008 when all three diesel generators were damaged.

3.2.1.1 Outage Statistics

Major outages that were the result of fires in diesel plants include:

- A fire in Rencontre East, on September 2, 2002, when the plant was destroyed and resulted in a power outage of 42.5 hours.
- A fire in the Nain diesel plant that occurred on September 7, 2008 resulted in a power outage of 35.5 Hours. In addition, a second major outage occurred at Nain diesel plant on November 19, 2008 due to a fault in the temporary bus work used to interconnect the temporary mobile diesels to the main diesel plant. This outage lasted 29.5 hours for 50 percent of the customers and 52 hours for the remaining customers.
- A fire in Black Tickle, on March 14, 2012 when the engine hall was damaged resulting in a power outage of 40 hours.

3.2.2 Legislative or Regulatory Requirements

Presently there are no legislative or regulatory requirements that mandate the requirement for fire protection systems in diesel plants.

3.2.3 Safety Performance

Major loss of equipment or the loss of a diesel plant due to fire has major potential for affecting the safety and health of plant personnel and the community especially during the winter months. Many of the communities are isolated and the diesel plant is the only source of electricity for the residents.

3.2.4 Environmental Performance

Environmental performance is not affected by this project.

3.2.5 Industry Experience

It is electric utility practice to install fire protection systems to minimize the destruction caused by fire. Some of Canada's major utilities such as Manitoba Hydro and Ontario's

Hydro One employ fire protection systems in their diesel plants. The majority of Hydro's hydroelectric generating stations (e.g., Bay d'Espoir) have emergency diesel rooms which are equipped with fire protection systems. The exception is Paradise River where the diesel is located in a container outside of the plant.

3.2.6 Vendor Recommendations

Although there are no specific diesel generating unit vendor recommendations, Hydro's risk and insurance agent, Factory Mutual Global, recommends the installation of a fire protection system in diesel plants. The diesel plants at Nain and Cartwright do not have a water supply to support a conventional sprinkler system; therefore, a high pressure water mist system is recommended to provide fire protection. A high pressure water mist system is an approved system by Factory Mutual Global for this application.

3.2.7 Maintenance or Support Arrangements

A new fire protection system including the existing fire detection system would be maintained by an external qualified contractor. Routine checks of the system would be completed by plant personnel.

3.2.8 Maintenance History

Nain and Cartwright have not had automatic fire protection systems installed in the past; therefore, there is no maintenance history available.

3.2.9 Historical Information

In 2014, the Board approved a two-year capital project to install an automatic fire protection system at L'Anse au Loup diesel plant under the same multi-year program to equip diesel plants with automatic fire protection systems. The budget estimate for this project was \$1,346,800.

The Board also approved a capital project called Additions to Accommodate Load Growth -

Isolated Generating Stations – Various Sites that included installation of a fire protection system at the Hopedale diesel plant. The installation of the fire protection system at Hopedale will be completed this year.

In 2013, the Board approved a two-year capital project to install an automatic fire protection system at Nain diesel plant. The conceptual design for this project was completed in 2014. An evaluation of space requirements for the nitrogen cylinders used for the water mist fire protection system at Nain revealed that the scope of work must be expanded to include a new nitrogen storage building or container as the powerhouse has no enough space for the estimated number of nitrogen cylinders. Also, based on the supply and installation costs for Hopedale fire protection system, Hydro is expecting that the supply and installation costs for Nain fire protection system will be much higher than originally estimated. The original budget proposal in 2013 for Nain included \$459, 000 (equivalent to \$215 per cubic meter of the plant volume to be protected) for the fire protection system supply and installation contract. By contrast, for the project being completed at Hopedale in 2015, the costs for that project are closer to \$540 per cubic meter of the plant volume to be protected. Additional analysis suggests that the costs may be higher per cubic meter for locations such as Nain. Therefore, Hydro decided to revise the budget estimate for Nain and submit to the Board this proposal to install fire protection systems at Nain and Cartwright. The previous proposal for Nain did not include several required aspects of project scope. The change in scope of work includes the installation of a new container for the nitrogen cylinders storage, and the budget reflects this additional scope plus the expected higher supply and installation costs based on the actual costs in Hopedale fire protection project. The learnings for the scope and budget from Hopedale have been applied to Cartwright as well as Nain.

3.2.10 Anticipated Useful Life

The anticipated useful life of automatic fire protection systems is 45 years.

3.3 Forecast Customer Growth

Forecast customer growth does not impact this project.

3.4 Development of Alternatives

Available systems of fire protection were reviewed by Hatch based on their general advantages, disadvantages and limitations. Hatch recommended two applicable systems for Hydro's diesel plants. These systems are water mist and Novec gas/chemical fire systems. Two bids were received for the automatic fire protection system at Hopedale and both bids were for water mist systems.

3.5 Evaluation of Alternatives

There are no viable alternatives to this project. The powerhouse does not have adequate space to install fire walls between the diesel generators. The status quo is not acceptable because of the operation and safety concerns. Therefore, an evaluation of alternatives is not required.

4 CONCLUSION

Hydro's diesel plant in the isolated communities of Nain and Cartwright on the coast of Labrador is the only supply of electricity for each community. A major fire and resulting damages to the diesel plants would be catastrophic for the community especially if it were to occur during the winter months when access by boat is not possible. The two plants at the present time have no automatic fire protection systems to permit early intervention in the event of a fire. This project will address the risk of damage resulting from a fire by installing automatic fire protection systems in the diesel generator main hall area and other interior spaces requiring fire protection including the supervisory control room, battery room and the lube and coolant storage room.

4.1 Budget Estimate

Hydro's diesel plants were classified by size (powerhouse volume) as small, medium and large in the Hatch engineering report (see Appendix A, page 29). Cartwright was classified as small size and Nain was classified as medium size. The plant size is a major factor affects the cost to install automatic fire protection systems. The budget estimate to install an automatic fire protection system for Cartwright is approximately half as that of Nain.

The total budget estimate for this project (Nain and Cartwright) is provided in Table 2.

Table 2: Project Budget Estimate.

Project Cost: (\$ x1,000)	2016	2017	Beyond	Total
Material Supply	45	0.0	0.0	45.0
Labour	338.3	50.5	0.0	388.8
Consultant	118.4	0.0	0.0	118.4
Contract Work	1855	988	0.0	2843
Other Direct Costs	56.2	2.6	0.0	58.8
Interest and Escalation	149.8	112.6	0.0	262.4
Contingency	468.1	222.7	0.0	690.8
TOTAL	3,030.7	1,376.4	0.0	4,407.1

4.2 Project Schedule

The anticipated schedule for this project is provided in Table 3.

Table 3: Project Schedule.

Activity		Start Date	End Date
Planning	Open Project; and Prepare scope statement.	January 2016	January 2016
Design	Prepare technical conditions for supply and installation of fire protection systems.	March 2016	May 2016
	Prepare detailed design and shop drawings.	July 2016	September 2016
Procurement	Issue request for proposal (RFP) for technical conditions preparation; and Award contract.	February 2016	March 2016
	Prepare two tender packages for a) Detailed design, supply and installation of fire protection system and b) Supply and installation of nitrogen storage container including foundations, ventilation, associated electrical work and vehicular access extension; and Award contracts.	May 2016	July 2016
	Order AC power cable to the new fire protection control panel.	June 2016	June 2016
	Supply fire protection equipment and two nitrogen storage containers.	August 2016	December 2016
Construction	Install fire protection equipment and nitrogen container (Nain).	March 2017	May 2017
	Install fire protection equipment and nitrogen container (Cartwright).	June 2017	August 2017
Commissioning	Perform testing and commissioning of fire protection systems (Nain).	June 2016	June 2016
	Perform testing and commissioning of fire protection systems (Cartwright).	September 2017	September 2017
Closeout	Prepare closeout package.	November 2017	November 2017

APPENDIX A
Diesel Plant Fire Protection Study – Final report (HATCH)



Newfoundland and Labrador Hydro

Diesel Plant Fire Protection Study
Final Report

H340127-0000-50-124-0001
Rev. 0
March 29, 2012

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Newfoundland and Labrador Hydro - Diesel Plant Fire Protection Study
Final Report - March 29, 2012

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Executive Summary

Newfoundland and Labrador Hydro (NL Hydro) own and operate twenty six (26) diesel powered electrical generation plants that are not manned twenty four hours per day and are located in rural and remote areas of the island and the Labrador coast. None of these plants are equipped with automatic fire suppression systems and in the past several of these plants have had fires resulting in the loss of equipment and facilities.

Based on Hatch's firsthand knowledge of many of these plants, in November 2011, NL Hydro contracted Hatch to prepare a study into the fire protection of all their diesel plants. This included the development of a decision matrix to determine the risk ranking of the plants and the recommendation of three plants for detailed study. The matrix was sorted into three main groups; small size plants, medium size plants and large size plants. Based on the outcome of the matrix and discussions with NL Hydro the three plants chosen were as follows:

1. Williams Harbour (Small)
2. Nain (Medium)
3. Natuashish (Large)

Many fire protection systems were reviewed and evaluated based on their general advantages and disadvantages as applicable for existing diesel electrical generation facilities in remote locations. From this evaluation it was determined the best alternative was a water mist system for the generator area and a Novec gas/chemical system for all other interior areas.

Conceptual drawings showing the general arrangement of the recommended fire protection systems were prepared and issued to vendors to obtain preliminary sizing and costing information.

As this was a high level study order of magnitude (+/- 50%) cost estimates were prepared for the design, supply and installation of the recommended fire detection and suppression systems for each of the three sites as presented in the following table.

Table 1: Summary of Budgetary Cost Estimates

Site	Engineering Cost (A)	Equipment Cost (B)	Equipment Supply and Install Cost (C = Bx2.5)	Accessibility and Logistical Factor* (D)	Total (A + CxD)
Williams Harbour	\$30,000	\$42,000	\$105,000	2.5	\$293,000
Nain	\$50,000	\$123,000	\$307,500	2.0	\$665,000
Natuashish	\$75,000	\$213,000	\$532,500	2.0	\$1,140,000

* This factor applies to the equipment supply and installation cost only and is not applied to the engineering cost.

In conclusion we have determined there are very few practical options for an automated fire protection system for these plants. The solution chosen is the same for each site and would only vary in the scale which is proportional to the volume of the building or area to be protected.

As a recommendation we feel there needs to be further engineering performed to optimize the design. Further engineering, in general or at specific sites, would be needed to simplify the design and consequentially lower equipment and installation costs.





1. Introduction

In the following communities in Newfoundland and Labrador (NL), Newfoundland and Labrador Hydro (NL Hydro) own and operate diesel plants, consisting of diesel powered, electrical generators. In most of these communities, these diesel plants are the only source of electrical power.

Transmission and Rural Operations (TRO) Labrador Region

- Black Tickle (BKT)
- Cartwright (CWT)
- Mud Lake (MDL)*
- Hopedale (HPD)
- Makkovik (MAK)
- Happy Valley Goose Bay (North Plant) (HVY)*
- Nain (NAN)
- Natuashish (NAT)
- Paradise River (PDR)
- Postville (POV)
- Rigolet (RIG)

TRO Northern Region

- Charlottetown (CHT)
- Norman Bay (NOB)
- Hawke's Bay (HBY)*
- L'Anse-au-Loup (LAL)
- Mary's Harbour (MSH)
- Port Hope-Simpson (PHS)
- St. Anthony (STA)*
- St. Lewis (SLE)
- Williams Harbour (WHR)

TRO Central Region

- Francois (FRS)
- Grey River (GYR)
- Little Bay Islands (LBI)
- McCallum (MCC)
- Ramea (RAM)
- St. Brendan's (SBN)

* *standby plants*

As such, the continuous operation (or availability in the case of the standby plants) of these generators is critical to the operation of these communities. Any disruption of the operation of these diesel plants is not acceptable.

Multiple generating units are installed at each of NL Hydro's diesel generating stations. Each station also has the ability to generate enough power to meet full community load upon loss of one generating unit.

There is however, one area where these plants are extremely vulnerable: Fire.





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Since these plants are not manned twenty four hours per day, seven days per week and most (if not all) have either no or inadequate fire suppression systems, catastrophic consequences would result if a fire broke out and was left unchecked. The community could be left without electricity for an extended period resulting in operational, health and safety concerns for communities.

NL Hydro has recognized the vulnerability of these communities, having experienced fires in the past.

As a result in November 2011, NL Hydro engaged Hatch to review all diesel plants and develop a decision matrix to determine the risk ranking and to establish a list of three of the most critical plants for more detailed study. A high level recommendation with cost estimate was also to be provided for the recommended fire protection system for each of the plants.



2. Study Goals and Methodology

Hatch was selected by NL Hydro to perform this “desk top study” due to past project experience with many of the plants. On a previous project in 2009, Hatch visited fourteen of the existing plants.

This study is based solely on information gathered by Hatch on previous projects, from information supplied to Hatch by NL Hydro and from consultation with suppliers and contractors. No site visit was conducted specifically for this study. Based on this information, this report will:

- Review each of the diesel plant locations.
- Develop a decision matrix with risk ranking.
- Identify three diesel plants for further study.
- Identify and discuss the available fire suppression options.
- Recommend the best fire suppression option(s) for each of the three locations selected for further study.
- Provide a preliminary layout drawing that shows the recommended fire protection system layout for the three locations selected for further study.
- Provide a budgetary cost estimate for the design, supply and installation of the proposed system types for each location selected for further study.

Note: The final pricing and equipment selection can only be provided after a detailed design has been completed (not in the scope of this study).



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3. Loss and Near Miss History

According to information provided to Hatch by NL Hydro, the primary driver for this study came from the root cause analysis conducted for the Nain Diesel Plant fire in 2008.

In addition to the fire at the Nain Diesel Plant, there have been several other fire losses and near misses at diesel plants. Below is the list of reported incidents provided to Hatch by NL Hydro involving fire within NL Hydro Diesel Plants. In addition to these, there may have been other fires that were not reported.

NL HYDRO DIESEL PLANT FIRE HISTORY

Cartwright

- 2002 - Engine fire caused by leak in oil supply line to the oil pressure gauge, fire was extinguished by mechanic.
- 1995 - Exhaust blanket caught fire.

Hopedale

- 1991 - Extensive damage to plant, injection line failed resulting in fuel spraying on manifold of adjacent engine.
- 1999 - Engine [Mitsubishi] caught fire. Fuel plunger handle backed off resulting in fuel spraying on manifold.

L'Anse au Loup

- 2007 - Electrical short, wiring fire. Fire was extinguished by an employee with a fire extinguisher.

Little Bay Islands

- October 28, 2004 - Fire on Unit 2031 due to pressure base regulator failure on Unit 565 that resulted in discharge of oil through oil filter on adjacent host engine (Unit 2031). Operator extinguished the fire.

Makkovik

- 1997 - Engine caught fire in base, catastrophic failure.

Mary's Harbour

- 2002 - Lube oil spill, oil ignited.
- 2008 - Injector line broke spraying fuel, near miss.
- 2008 - Injector line broke spraying fuel, near miss.
- 2009 - Injector line broke spraying fuel, near miss.
- Fire was extinguished by an employee with a fire extinguisher.



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Nain

- 1973 - Plant destroyed in spring under ownership of Labrador Services Division, actual cause unknown.
- 1993 - Extensive damage to plant, catastrophic engine failure, crankcase explosion.

Natuashish

- 2003 - Unit fire. Fire was extinguished with a fire extinguisher.

North Plant

- 2001 - welding debris caused fire in ceiling, contractor cutting and welding.

Port Hope Simpson

- 2006 - Rags ignited near work area.
- 2006 - Chafed fuel line, fuel ignited.
- 2007 - Bearing/housing failed, caused fire.
- 2007 - Exhaust wrap caught fire.
- 2009 - Oil sprayed on hot turbo after oil line broke on turbo.

In each case above, fire was extinguished by an employee with a fire extinguisher.

Rigolet

- 1993 - Engine fire caused by broken oil filter housing, oil sprayed on exhaust manifolds.

Roncontre East

- 2002 - Plant fire, suspected engine failure. Fire was beyond extinguishing, caused a complete loss of plant, cost estimate of approximately \$1,700,000.



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4. Industry Practice

Below is a table provided to Hatch by NL Hydro outlining current industry practices. This table is presented to provide a comparison of the fire suppression systems recommended in this report to current industry practice.

It is worthy to note that the sites that do not have fire suppression systems have taken other measures to prevent fires or reduce the effects of a fire such as:

- Separation of their mobile units such that, in the event that a unit is lost to a fire the other mobile units should remain operational.
- Production units are separated by fire retardant barriers to confine fire.
- Back up generation and switchgear are located in separate building to minimize the impact of a fire.

Table 2: Summary of Industry Practice

Company	Fire Suppression System	Fire Detection System	Description
BC Hydro	None	Present	• They utilize alarms, fire stop valves, anti-siphon valves and fire retardant materials. • Separation of their mobile units is their best defense. In the event that a unit is lost to a fire the other mobile units should still be operational.
Hydro-Quebec	None	Present	• They utilize fire stop valves on fuel lines, fire stop flap in ventilation duct and fire retardant materials. • Production units are separated to confine fire and fire retardant materials.
Manitoba Hydro	Present	Present	• They also utilize fuel shut-off valves. • The suppression system was installed because of plant layouts which house all generators in a common powerhouse without fire breaks or isolation between units. • Extinguishing agents used are Argon, FM200 and Integrated Compressed Air Foam (ICAF) systems.
Atco Electric	Present (Only at Fort Chipewyan)	Present	• They utilize the "Hi-Fog" system; a series of water bottles charged and discharged by Nitrogen. It produces a 12-15 minute fog that cools the fire and creates a steam environment which chokes out oxygen. • The "Hi-Fog" system is used with heat and flame detection and shut-off valves to all fluids. • In plants where suppression systems are not in place back up generation and switchgear are present in a separate building to minimize the impact of a fire.
Hydro One	Present	Present	• Utilize Inergen or FM200 (site dependent). • A concern with installing a fire suppression system in older buildings is the air tightness of the building. (The rooms had to be sealed but equipped with a relief vent) to contain the gas in the system. Space is also a concern. • They have experienced unexpected agent releases, but have pre-action alarms and abort switches to reduce the effect of these incidences. The false releases are believed to be an issue with the seals; they have a 10 year life span. • Inspections are performed bi-annually; they should be inspected annually to keep the systems certified, but the fire suppression systems are optional and as such it is not necessary to keep them certified.



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5. Review of Fire Suppression Systems

5.1 General

Starting and sustaining a fire requires three things to be present at the same time:

- Oxygen
- Spark or an ignition source
- Fuel

If any of these are missing, there can be no fire. Fire suppression systems disrupt one or more of these items to extinguish the fire.

There are several fire suppressing methods on the market (from a number of reputable suppliers). The following is a summary of the most commonly used methods along with the advantages and disadvantages of each. While in some cases this report will refer to trade names, each method may be readily available from a number of suppliers.

The selection of a fire suppression method is on a location specific basis and takes into consideration such things as:

- Type of fire
- Potential harm to occupants as a result of system activation
- Potential damage to equipment as a result of system activation

5.2 Halon

Until banned in the mid 90's (for environmental reasons), this type of system was widely use in areas where damage to building contents was not acceptable (such as computer rooms).

The system saturates the affective area with Halon gas and works by absorbing heat, reducing oxygen levels and interfering with the combustion process.

While very effective, there were some drawbacks:

- It was not advisable to activate the system with people in the area. Once a fire was detected, there would be a time delay prior to activation to allow evacuation of personnel.
- It was proven that the Halon gas was damaging to the earth's ozone layer. As a result, Halon systems were banned.

Since this system is no longer available, it was not considered as an option and was given only for historical background information.

5.3 CO₂

Carbon dioxides systems work by flooding the area with CO₂ to rob the fire of oxygen. While very effective (and not causing damage to contents), it can, however, be lethal to anyone in the area.



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For this reason, CO₂ systems were not considered for use in this report.

5.4 Water Sprinklers

5.4.1 General

The most common fire suppression system is the sprinkler system (seen in most buildings). When actuated, the affect area is sprayed (soaked) with water.

Sprinkler systems come in four main types.

5.4.2 Wet Systems

Wet systems are the most common and are used where there is no risk of freezing. The sprinkler headers are always filled with water and the system will start as soon as one of the sprinkler nozzles opens (either by fire actuation or by physical damage). Flow through subsequent nozzles will only happen as they open (either by fire actuation or by physical damage).

5.4.3 Dry Systems

Dry systems are used when there is a risk that freezing will occur in the spray headers.

In this system, water is prevented from entering the freeze zone by a flapper valve that is held shut by compressed air in the spray header.

The sprinkler headers are always filled with pressurized air and water flow will start once the air pressure is released when one of the sprinkler nozzles opens (either by fire actuation or by physical damage). Flow through subsequent nozzles will only happen as they open (either by fire actuation or by physical damage).

5.4.4 Pre-Action

Pre-action systems are similar to dry systems except that external, electronic interlocks are used to start the flow of water and prevent accidental flow (i.e., in the event that a sprinkler nozzle is damaged).

5.4.4.1 Pre-Action (Single Interlock)

In this system, the flapper valve (dry system) is replaced by a solenoid actuated valve that will only open on automatic fire detection (smoke, heat detection). Once open, the system will behave like a wet system.

5.4.4.2 Pre-Action (Double Interlock)

This is similar to the single interlock system with the exception that the air pressure inside the spray header is also electronically monitored. The solenoid actuated valve will only open when there is a lowering of air pressure AND there is fire detection. In this way, there will not be any water flow if a sprinkler nozzle is accidently damaged.

5.4.5 Sprinkler Systems Conclusion

Although sprinkler systems are effective and widely used, they are generally used in areas where water damage is not an overriding concern. Sprinkler systems require flooding with water which is not the most appropriate method for extinguishing a fuel or liquid fire.



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In addition, sprinkler systems require a reliable water source with sufficient flow capacity and residual pressure. Based on our knowledge of sites visited in the past, it is our opinion that the existing municipal infrastructure, where it exists, would not have sufficient residual pressure or flow capacity to meet the requirements of a sprinkler fire suppression system and could require significant upgrades and a dedicated water supply would be expensive.

On review, it was determined that this option would cause significant collateral damage with an associated high cost in the event of a discharge. As a result, water sprinklers were not considered as a viable option in this study.

5.5 Aqueous Film Forming Foam (AFFF) Suppression

Foam systems are common for the suppression of fuel spill fires (i.e., airport hangers). On actuation, foam is delivered by sprinkler type system to cover the fuel spill. The fire is suppressed by:

- Cooling the spill by providing a water film between the foam and the fuel. This water film also prevents the formation of flammable vapours, preventing re-ignition.
- The foam provides a barrier between the fuel spill and the oxygen in the air.

The foam used in this application is Aqueous Film Forming Foam which is a mixture of water and foaming agent.

While being effective, there are a few disadvantages.

- A reliable, high volume water source is required (typically 0.16 gpm/ft² for 10 minutes of operation).
- After deployment, the foam will slowly degrade to water contaminated with the foaming agents. This liquid must be contained, collected and sent to a treatment plant for proper disposal.

Considering the remoteness of the sites being studied, the above concerns are important enough to disqualify foam systems from consideration.

5.6 Novec Systems (i.e., Ansul SAPHIRE)

5.6.1 General

With the banning of Halon systems, Novec 1230 has been developed to become a clean and environmentally friendly fire suppression agent. Novec 1230 works by absorbing heat.

Generally used in areas where harm to people or equipment is unacceptable.

5.6.2 Typical Systems

Typical Novec systems are comprised of:

- Fire detection system
- Multiple canisters of the Novec liquid that are pressurized by nitrogen to 360 psig



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- Piping and spray nozzles
- Nitrogen cylinders

Once activated, the Novec fluid is supplied to the spray nozzles and, once airborne, the liquid vaporizes to blanket the affected area.

5.6.3 *Pros*

- Environmentally friendly
- Safe for occupied spaces (per NFPA 2001)
- FM certified for occupied spaces (NL Hydro to request confirmation from FM)
- Non-conductive and will not harm electrical equipment
- Will not harm building contents
- Not harmful to occupants due to the low concentration level required
- The Novec liquid can be easily re-charge on site with a sufficient quantity of nitrogen for multiple discharges. Novec liquid can be shipped to site and the liquid can be easily transferred to the storage cylinder. Once transferred, the cylinder can be re-pressurized with Nitrogen.

5.6.4 *Cons*

- Ceiling height limitation of 14 ft (4.3 m), above which a second layer of nozzles is required
- Cannot work multiple areas independently from one system. Separate rooms require individual systems
- Requires a closed area that is fairly well sealed
- NL Hydro has no experience with this type of system
- Shipping nitrogen to isolated sites, if required, outside of seasonal shipping window may prove to be costly. Identification of a sufficient quantity of nitrogen to be maintained at various sites to manage this risk should be determined during detailed design and risk assessments.

5.7 *Inergen (Ansul Product)*

5.7.1 *General*

INERGEN is an Ansul product that reduces the oxygen content of the space sufficiently to extinguish the fire but not to a level that would be harmful to occupants.

Generally used in areas where harm to people or equipment is unacceptable.

5.7.2 *Typical Systems*

Typical INERGEN systems include:

- Fire detection system



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- Multiple canisters of high pressure INERGEN gas
- System pressure in the distribution piping is reduced by an orifice plate during activation
- Piping and spray nozzles

Once activated, the Inergen gas is supplied to the spray nozzles and, once airborne, blankets the affected area.

5.7.3 *Pros*

- Environmentally friendly
- Safe for occupied spaces (per NFPA 2001)
- FM certified for occupied spaces (NL Hydro to request confirmation from FM)
- Non-conductive and will not harm electrical equipment
- Will not harm building contents
- Not harmful to occupants
- One system can handle multiple independent areas (i.e., If there is a fire in one of multiple rooms connected to the system, the system can deploy Inergen only in the affected area)
- NL Hydro has experience with this type of system

5.7.4 *Cons*

- Requires a closed area that is fairly well sealed
- Since Inergen is a gas and is pressurized to approximately 3000 psi, the empty cylinders must be removed from site and re-charged at the Inergen supplier

5.8 High Pressure Water Mist

5.8.1 *General*

These systems use a spray of water and nitrogen to produce a blanket of atomized water particles that absorb heat and smother the fire.

Water mist systems are readily available from various suppliers such as:

- Ansul (AQUASONIC)
- Victaulic (VORTEX)

These types of system are typically used in open areas where there are flammable and combustible liquid hazards.

5.8.2 *Typical System*

A typical water mist system will include:

- Fire detection system





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- Multiple cylinders of nitrogen (pressurized to approximately 3000 psi)
 - Cylinders are equipped with regulators to lower the system pressure to approximately 115 psi
- Multiple water cylinders (pressurized by the nitrogen cylinders to approximately 115 psi)
- Piping and spray nozzles

5.8.3

Pros

- Environmentally friendly
- Safe for occupied spaces
- Victaulic VORTEX brochure claims that the system can be used in areas containing computer and other sensitive electrical equipment
- No requirement for a sealed spray area
- FM certified for occupied spaces (NL Hydro to request confirmation from FM)
- Not harmful to occupants
- With a sufficient quantity of nitrogen for multiple discharges, the system can be easily re-charge on site
- No special chemicals required

5.8.4

Cons

- May cause minimal harm to building contents
- Ansul does not recommend its use in areas containing critical electrical equipment (i.e., computers)
- NL Hydro has no experience with this type of system
- Shipping nitrogen to isolated sites, if required, outside of a seasonal shipping window may prove to be costly. Identification of a sufficient quantity of nitrogen to be maintained at various sites to manage this risk should be determined during detailed design and risk assessments.

5.9

Selection Matrix

As a summary, the following is a matrix of the pros and cons of each of the system under consideration.



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Table 3: Fire Suppression Type Selection Matrix

System	Pros										Cons			
	Safe for occupied spaces	Will not harm computer equipment	Does not require sealed areas	Environmentally friendly	Will not harm building contents	Can handle multiple areas	Can be easily re-charged on site	Banned	Not environmentally friendly	May harm building contents	Require Reliable Water source	Cannot be recharged on site	Requires sealed areas	Requires containment and special disposal
Halon														
CO2		x		x										x
Water Sprinkler	x		x	x	x				x	x				
Foam Suppression									x	x			x	
Novec (Ansule Sapphire)	x	x		x	x	x					x	x		
Inergen (Ansul)	x	x		x	x	x					x			
Water Mist (Ansul/Victaulic)	x		x	x	x	x			x					

Designates an overriding concern



6. Decision Matrix

6.1 General

In close consultation with NL Hydro, Hatch developed a decision matrix to determine the risk ranking for the 26 diesel plants. This matrix includes a list of criteria which has been assigned a rating and weighting factor. NL Hydro provided input for identification of criteria and the assigning of an appropriate rating and weighting factors.

6.2 Rating Methodology

Each plant is assessed based on a predetermined set of criteria. Each criteria item is rated from 1 to 5 based on the level of risk, probability of a fire and/or effects of a fire.

- 1 - Represents a "Low risk of the criteria causing a fire or relatively few consequences as a result of a fire"
- 5 - Represents a "High risk of the criteria causing a fire or relatively significant consequences as a result of a fire"

6.3 Weighting Methodology

The relative level of importance for each individual criteria item is identified by a weighting system, with 1 representing "Least Important" and 10 representing "Most Important".

6.4 Matrix Criteria

6.4.1 Accessibility

- 5 No ferry/road. Limited access by air
- 4 Access only by air with seasonal ferry
- 3 Access by seasonal ferry/road
- 2 Direct access by year round ferry
- 1 Complete access (located in major center)

6.4.2 Population Served

- 5 > 1000
- 4 750-1000
- 3 500-750
- 2 250-500
- 1 < 250

6.4.3 Weather/Climate vs. Accessibility

- 5 Air access only
- 4 Air access, seasonal ferry, no road access
- 3 Air access, seasonal ferry and road only





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2 Year round ferry only

1 Very little to no effect

6.4.4 *Number of Units*

This criterion excludes Mobile Units.

5 Five or more units

4 Four units

3 Three units

2 Two units

1 One unit

6.4.5 *Total Generating Capacity*

5 > 5000 KW

4 3001-5000 KW

3 1501-3000 KW

2 751-1500 KW

1 < 750 KW

6.4.6 *Average Age of Units*

5 Average Installed date of 1990 or before

4 Average Installed date of 1991- 1995 to present

3 Average Installed date of 1996- 2000 to present

2 Average Installed date of 2001- 2005 to present

1 Average Installed date of 2006 to present

6.4.7 *Continuous Operation vs. Standby Operation*

5 Continuous operation

1 Standby operation

6.4.8 *Community Fire Protection Capability*

5 No fire department

4 Volunteer fire department with no fire truck. Fire Hydrants present.

3 Volunteer fire department with fire truck. Fire Hydrants present. No winter roads.

2 Volunteer fire department with fire truck. Fire hydrants present. Winter roads.

1 Fully functional fire department. Major center.



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6.4.9 *Replacement Cost of Plant, i.e., Cost of new plant*

This criterion assumes replacement cost to be a direct function of total generating capacity.

- 5 > 5000 KW
- 4 3001-5000 KW
- 3 1501-3000 KW
- 2 751-1500 KW
- 1 < 750 KW

6.4.10 *Material of Construction/Plant Layout*

- 5 Exposed wooden construction and congested
- 4 Exposed wooden construction and spacious
- 3 Combination of wood and steel
- 2 Steel construction and congested
- 1 Steel construction and spacious

6.4.11 *Industrial/ Large Commercial Customers*

- 5 Yes
- 1 No

6.4.12 *Maintenance Record*

- 5 0-20% Complete (from 2006 to 2011)
- 4 20-40% Complete (from 2006 to 2011)
- 3 40-60% Complete (from 2006 to 2011)
- 2 60-80% Complete (from 2006 to 2011)
- 1 80-100% Complete (from 2006 to 2011)

6.5 *Ranking*

Table 4 gives a summary of the results, ranking each plant in terms of risk and/or consequences of a fire. The plants in Hopedale, L'Anse-au-Loup and Nain received the highest ranking, whereas St. Brendan's received the lowest ranking.

The Risk Assessment Matrix indicates the need for improvement in maintenance practices related to a number of plants, most notably those in the northern region of the Labrador coast. It appears however that, from the maintenance records provided, NL Hydro has recognized this need and is improving its compliance. In 2011, approximately 70 percent of scheduled preventive maintenance tasks were completed for those plants in the northern region of the Labrador coast. During the review process of this report, NL Hydro advised Hatch that a corporate target of 90% has been set across all plants.





The Risk Assessment Matrix provides a good guide for comparing risk between plants; however other issues may need to be considered if plans are made to reduce risk at specific sites. Projected load growth, customer growth, and the possibilities for emergency alternate power supply may also need to be considered at that time.

The table does not relate to the dollar amount required to implement a fire suppression system. As a result, Hatch does not necessarily recommend that fire suppression systems be implemented in the order as presented in this matrix. NL Hydro may, at its discretion, determine that it is more desirable to implement fire suppression systems in a different order than presented in this matrix.



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Table 4: Risk Assessment Matrix

Site	Accessibility	Population Served <200 = 1, 250-200 = 2, 500-750 = 3, 100-1k = 4, >1k = 5	Weather Conditions in Accessibility Average Quality Where Accessibility = 4 to = 5	Number of Units	Total Generating Capacity	Average Age of Units	Continuous Operation vs. Standby Operation Continuous = 5, Standby = 1	Emergency Fire Protection Capability No Capability = 5	Public Relationship vs. Relationship of new plant	Means of Construction Plant Layout	Industrial Logic Commercial Consensus Yes = 5 No = 1	Maintenance Review	Total
St. Brendan's	2	1	2	3	1	3	5	5	1	1	1	1	194
Mccallum	2	2	2	3	1	3	5	5	1	1	1	1	202
Mud Lake	5	1	1	1	1	3	1	5	1	1	1	5	204
Grey River	2	1	3	3	1	3	5	5	1	2	1	1	212
Norman Bay	3	1	3	3	1	1	5	5	1	1	1	2	214
Francois	2	1	4	3	1	4	5	5	1	2	1	1	227
Little Bay Islands	2	1	3	4	2	4	5	5	2	2	1	1	240
St. Louis	3	2	3	3	2	1	5	4	2	1	5	2	255
Ramea	2	3	2	3	3	3	5	5	3	1	1	2	256
Port Hope Simpson	2	3	3	3	2	3	5	4	2	2	5	1	261
Murdoch Bay	1	5	1	2	5	5	1	5	5	1	1	3	263
Williams Harbour	5	1	5	3	1	2	5	5	1	2	1	2	267
Marys Harbour	3	2	3	3	2	4	5	2	2	2	5	2	268
St. Anthony	1	5	1	5	5	5	1	1	5	1	5	3	278
Charlottetown	3	2	3	2	3	4	5	2	3	2	5	2	281
Black Tickle	4	1	4	3	2	1	5	5	2	2	5	3	290
Paradise River	3	1	3	3	1	4	5	5	1	5	1	5	291
Postville	4	1	4	3	2	2	5	3	2	2	5	4	295
Goose Bay	1	5	1	5	5	5	1	1	5	1	5	5	298
Makkovik	4	2	4	3	2	4	5	3	2	1	5	4	305
Rigolet	4	2	4	4	3	3	5	3	3	2	1	4	311
Cartwright	3	3	3	4	3	3	5	2	3	2	5	4	314
Natashish	4	3	4	4	4	2	5	2	4	1	1	5	329
L'Anse-au-Loup	3	5	3	5	4	5	5	2	4	1	5	2	335
Hopedale	4	3	4	3	3	2	5	3	3	4	5	4	345
Nain	4	5	4	3	4	2	5	3	4	1	5	4	355
Weight	10	8	10	5	8	5	10	5	10	8	5	10	



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7. Selection of Plants for Further Study

7.1 Grouping by Size

To choose three plants for further study that best represent the range of plants, the plants were sorted by size (volume) and separated into three main groups:

- Small Size Plants
- Medium Size Plants
- Large Size Plants

Table 5: List of Diesel Plants by Size and Volume

Site	Region	Ranking	Powerhouse Size				
			Length (ft)	Width (ft)	Height (ft)	Floor Area (ft ²)	Volume (ft ³)
Francois	TRO Central	21	27	19	12	513	6156
Paradise River	TRO Labrador	10	30	18	12	540	6480
St. Brendan's	TRO Central	26	31	21	12	651	7487
Cartwright	TRO Labrador	5	40	20	11	800	8800
Norman Bay	TRO Northern Region	22	30	30	12	828	9936
Postville	TRO Labrador	9	50	20	11	1000	11000
Rigolet	TRO Labrador	6	50	20	11	1000	11000
Little Bay Islands	TRO Central	20	52	20	11.5	1040	11960
Williams Harbour	TRO Northern Region	15	40	25	12	1000	12000
Macallum	TRO Central	25	38	34	16	1076	17216
Black Tickle	TRO Labrador	11	81	20	11	1670	18370
Grey River	TRO Central	23	38	26	17	1084	18432
Makkovik	TRO Labrador	7	60	30	14	1800	25200
Nain	TRO Labrador	1	65	30	14	1950	27300
Mary's Harbour	TRO Northern Region	14	66	33	14	2178	30492
Hopedale	TRO Labrador	2	41	40	19	1640	31160
Port Hope Simpson	TRO Northern Region	17	66	35	15	2310	34650
Charlottetown	TRO Northern Region	12	60	31	19	1860	35340
Ramea	TRO Central	18	54	40	17	2160	36720
St. Lewis	TRO Northern Region	19	72	36	22	2592	57024
Natuashish	TRO Labrador	4	86	55	19	5138	97622
L'Anse-au-Loup	TRO Northern Region	3	92	40	27	3680	99360
St. Anthony	TRO Northern Region	13	160	50	15/20	8000	149500
Goose Bay	TRO Labrador	8	135	67		9045	

Units without a powerhouse

Hawkes Bay TRO Northern Region 16

Mud Lake TRO Labrador 24

7.2 Sites Chosen for Further Study

7.2.1 Williams Harbour

Williams Harbour was chosen since it is the largest of the plants in the small group and best represents that group in terms of size and volume.



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7.2.2 Nain

Nain was chosen since it ranked the highest of all the plants in the medium group and was a good representative of that group in terms of size and volume.

7.2.3 Natuashish

Natuashish was chosen since it ranked the second highest of all the plants in the large group and unlike the top ranked plant (L'Anse-au-Loup), the community is not directly connected to the grid.



8. Proposed Fire Protection Systems

8.1 General

The purpose of automatic fire suppression is twofold:

1. Automatically detect and extinguish fires
2. Provides valuable time for fire-fighters or first responders to reach the sites

On review of the available systems, Hatch believes the best solution is to have a combination of:

- High pressure water mist for the generator areas
- Novec system for the balance of the plant areas
- Hand held extinguishers in all areas

During the course of this study, manufacturer's information on suitability and application of the water mist systems were found to vary.

- Victaulic indicated that the VORTEX system is suitable for areas where there is sensitive electronics (i.e., computers)
- Ansul does not recommend the AQUASONIC system for areas with sensitive electronic equipment.

For the purposes of this study, we recommend that the water mist systems only be used in the generator rooms.

The selection of the Novec system over the INERGEN system was due to the fact that, with sufficient nitrogen, the Novec liquid can be re-charged on site. While there are operational advantages of using INERGEN, we believe the re-charging issue is an overriding concern. This issue can be examined in detail in the design phase of the project.

In the selection of equipment, a number of items should be noted:

- Volume of equipment inside the building was not taken into consideration in the sizing of the system
- Building dimensions were taken from drawings supplied by NL Hydro
- Some building dimensions were estimated due to insufficient information
- The sizing of some of the Novec systems was performed by pro-rating known supplier information (i.e., from specific quotes given from suppliers) based on room volume.

8.2 Williams Harbour (Reference Drawing H340127-A1-M-001)

8.2.1 Generator Room

A water mist system is recommended in this area. Due to the small area to be covered, a pre-package AQUASONIC 260 system is recommended (for 10 minute operation) and is comprised of the following components:





- Six (6) Nitrogen cylinders
- One (1) 50 gal water tank assemblies
- Two (2) Atomizers (spray nozzles)
- One (1) smoke detector
- Four (4) thermal detectors

8.2.2 Other Areas

All areas apart from the Generator room will be serviced by a Novec system (similar to the Ansul Sapphire system). The following is a summary of the sizing of the main components based on information from Ansul (Appendix B).

Table 6: Williams Harbour Diesel Plant - Areas outside of the Generator Room

Room	Nitrogen Cylinders	Novec Qty (lbs)	Qty Nozzles	Thermal Detectors	Smoke Detectors
Office/Washroom	1 - 90 lbs	65 lbs	2	2	2

8.2.3 Fire System Control

For the purposes of this study, we are assuming a single controller will be used to control all the fire suppression systems (such as the Ansul Auto Pulse IQ 318C).

8.2.4 Challenges

The fire suppression system takes up a significant amount of floor space (i.e., 6 tanks and cylinder assemblies). To alleviate this, it may be necessary to add an extension to the building to house the fire suppression equipment or to install the equipment in a self contained unit. This can be investigated during the detail design phase of the project.

8.3 Nain (Reference Drawing H340127-A1-M-002)

8.3.1 Generator Room

A water mist system is recommended in this area. Based on information received from Ansul, an AQUASONIC system (for 10 minute operation) and is comprised of the following components:

- Sixteen (16) Nitrogen cylinders
- Four (4) 50 gal water tank assemblies
- Six (6) Atomizers (spray nozzles)
- One (1) smoke detectors
- Five (5) thermal detectors



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8.3.2 Other Areas

All areas apart from the Generator room will be serviced by a Novec system (similar to the Ansul Sapphire system). The following is a summary of the sizing of the main components based on information received from Ansul (Appendix B).

Table 7: Nain Diesel Plant - Areas outside of the Generator Room

Room	Nitrogen Cylinders	Novec Qty (lbs)	Qty Nozzles	Thermal Detectors	Smoke Detectors
Washroom	1 x 90 lbs	16 lbs	1	1	1
Furnace Room	1 x 90 lbs	19 lbs	1	1	1
Office	1 x 90 lbs	60 lbs	1	1	1
Supply Room/Line Storage	1 x 280 lbs	95 lbs	1	1	1
Workshop	1 x 280 lbs	151 lbs	1	1	1

8.3.3 Fire System Control

For the purposes of this study, we are assuming a single controller will be used to control all the fire suppression systems (such as the Ansul Auto Pulse IQ 318C).

8.3.4 Challenges

The fire suppression system takes up a significant amount of floor space (i.e., 21 tanks and cylinder assemblies). To alleviate this, it may be necessary to add an extension to the building to house the fire suppression equipment or to install the equipment in a self contained unit. This can be investigated during the detail design phase of the project.

8.4 Natuashish (Reference Drawing H340127-A1-M-003)

Natuashish is the largest and most complex of the three systems with large areas and multiple rooms. The following is a brief summary of the systems recommended.

8.4.1 Generator Room

A water mist system is recommended in this area. Based on information received from Ansul, an AQUASONIC system (for 10 minute operation) and is comprised of the following components:

- Thirty (30) Nitrogen cylinders
- Six (6) 50 gal water tank assemblies
- Ten (10) Atomizers (spray nozzles)
- One (1) smoke detectors
- Nine (9) thermal detectors

8.4.2 Other Areas

All areas apart from the Generator room will be serviced by a Novec system (similar to the Ansul Sapphire system). The following is a summary of the sizing of the main component based on information from Ansul (Appendix B).



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Table 8: Natuashish Diesel Plant - Areas outside of the Generator Room

Room	Nitrogen Cylinders	Novec Qty (lbs)	Qty Nozzles	Thermal Detectors	Smoke Detectors
Electrical Control Room	1 x 390 lbs	286 lbs	2	3	1
Computer Room	1 x 90 lbs	54 lbs	1	1	1
Battery Room	1 x 90 lbs	42 lbs	1	1	1
Storage Room	1 x 280 lbs	98 lbs	1	1	1
Lunch Room	1 x 90 lbs	73 lbs	1	1	1
Maintenance/Workshop	1 x 280 lbs	138 lbs	1	2	1
Consumable Storage	1 x 280 lbs	131 lbs	1	2	1
Heat Exchanger Room	1 x 280 lbs	147 lbs	1	2	1
Corridor	1 x 90 lbs	52 lbs	1	1	1
Washroom	1 x 90 lbs	28 lbs	1	1	1

8.4.3 Fire System Control

In many cases, each fire suppression zone will have its own dedicated controller (i.e., Ansul Autopulse Z-10). However, with a building consisting of multiple zones it should be more efficient to have the entire building controlled by a single control unit (such as the Ansul Auto Pulse IQ 318C).

For the purposes of this study, we are assuming a single controller will be used to control all the fire suppression systems.

8.4.4 Challenges

The fire suppression system takes up a significant amount of floor space (i.e., 46 tanks and cylinder assemblies). To alleviate this, it may be necessary to add an extension to the building to house the fire suppression equipment or to install the equipment in a self contained unit. This can be investigated during the detail design phase of the project.



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9. Costing

9.1 Fire Suppression System

Budgetary (+/- 50%) cost estimates were prepared for the design, supply and installation of the recommended fire detection and suppression systems for each of the three sites as presented in Table 9.

Table 9: Summary of Budgetary Cost Estimates

Site	Engineering Cost (A)	Equipment Cost (B)	Equipment Supply and Install Cost (C = Bx2.5)	Accessibility and Logistical Factor* (D)	Total (A + CxD)
Williams Harbour	\$30,000	\$42,000	\$105,000	2.5	\$293,000
Nain	\$50,000	\$123,000	\$307,500	2.0	\$665,000
Natuashish	\$75,000	\$213,000	\$532,500	2.0	\$1,140,000

* This factor applies to the equipment supply and installation cost only and is not applied to the engineering cost.

The estimates assume:

- all new equipment fits within the existing building envelope
- construction during the summer season

The estimates exclude:

- telecommunication cost associated with fire detection
- owners costs, a contingency or any applicable taxes

Engineering costs are estimated as follows:

- Small size plants - \$30k
- Medium size plants - \$50k
- Large size plants - \$75k

Equipment cost has been provided by vendors. See Appendix B. For this exercise the costing was based on one specific manufacturer's product. Final system selection will be made during the detailed design phase of the project.

Installation cost has been estimated based on consultation with vendors. At the recommendation of the equipment supplier, a factor of 2.5 has been applied to the total equipment cost to include the installation cost in a very accessible metro location.

In addition, based on past project experience and consultation with local contractors, Hatch has applied the following historical cost factors to adjust for site accessibility and logistical issues. Hatch recommends that NL Hydro review these factors and revise if necessary, based on their past project experience for each site.





- A 1.5 factor is applied to the total cost to for sites accessible by road, i.e., sites on the southern Labrador Coast.
- A 2.0 factor is applied to the total cost for sites only accessible by seasonal ferry and freight service, i.e., sites on the Northern Labrador Coast.
- A 2.5 factor is applied to the total cost for sites with no access by road or seasonal ferry, i.e., Williams Harbour.

9.2 Relative Replacement Costs of Each Plant

It is our understanding that NL Hydro's design standard, for any new or replacement diesel generation plants, is the St. Lewis facility. As provided by NL Hydro, this plant commissioned in 2006 cost in the order of \$2.8 million dollars. Based on current construction market conditions and pricing of recent tenders, it is highly likely the escalation factor for construction of a similar plant could be as high as 1.5, indicating a cost in 2012 dollars of over \$4million.

The previous plant in St. Lewis was approximately 800ft² in floor area and 8000ft³ in volume with three generating units. Comparing to the other plants in Table 5, all of which have at least three generating units, the previous plant in St. Lewis would have ranked as one of the smallest plants.

The new plant in St. Lewis is now larger than all but four other plants, two of which are standby plants. Based on this it is assumed that the majority of the diesel plants, if replaced with a plant built to NL Hydro's new standard, would be as large as the St. Lewis plant or larger. Therefore the replacement cost of the majority of these diesel plants would be as high or higher than the escalated replacement cost of the St. Lewis plant.



10. Conclusions

The decision matrix was completed and from it we were able to rank the plants in order of risk.

The codes and standards below are a compilation of those most applicable to general fire protection of diesel powered electrical generation plants and those specifically applicable to the fire suppression options proposed:

- National Building Code of Canada
- National Electrical Code of Canada
- National Fire Code of Canada
 - ♦ NFPA 10 – Standard for Portable Fire Extinguishers
 - ♦ NFPA 37 – Standard for the Installation and use of Stationary Combustion Engines and Gas Turbines
 - ♦ NFPA 72 – National Fire Alarm and Signalling Code
 - ♦ NFPA 80 – Standard for Fire Doors and other Opening Protective's.
 - ♦ NFPA 101 – Life Safety Code
 - ♦ NFPA 750 – Standard on Water Mist Fire Protection Systems
 - ♦ NFPA 2001 – Standard on Clean Agent Fire Extinguishing Systems

The study was successful in determining which fire suppression systems are most applicable for remote diesel electrical generation plants. The systems that we believe would work the best are:

- Water mist
- Novec

These systems were chosen because they can be retrofitted into existing facilities and are effective in suppressing both fuel and electrical fires. In addition, they have the lowest possibility of causing collateral damage to the mechanical and electrical equipment and are the least likely to cause a clean-up problem.

These systems were investigated in detail for Williams Harbour, Nain and Natuashish and cost estimates for these plants were prepared.

- Williams Harbour – \$293,000
- Nain - \$665,000
- Natuashish - \$1,140,000



11. Recommendations

11.1 Areas for Further Study

As the current designs are only conceptual, we feel there are areas available for optimization which will lower or simplify the design, lower equipment costs and lower installation costs. This optimization can be dealt with in the detailed engineering phase of the project.

1. Existing Fire Detection Systems

In this study, it has been assumed that a new fire detection system will be required for each plant. During the detailed design phase of the project, further investigations can be conducted to determine if the existing fire detection systems are compatible with the proposed fire suppression systems.

2. Optimization of the Novec System

In this study, it has been assumed that each room will have its own, stand alone Novec system. This is due to the fact that a single system cannot handle multiple, independently controlled areas. During the detail design phase of the project, further investigations can be conducted to determine if there are cost savings possible by having multiple rooms serviced by one system. For example: Is it practical or desirable to have the Natuashish Lunchroom and Maintenance shop be serviced by one Novec system?

3. Modularization

Given the remoteness of the site locations, ease of construction will be of paramount importance. Consideration should be given to the use of self contained equipment modules that can be manufactured off site and shipped to site complete, thus minimizing the site work.

4. Maintaining a "Sealed" Environment

NL Hydro operations staff indicated that sometimes doors are propped open to maintain airflow and cooling in the summer months. As stated in this report, Novec systems require a relatively air tight environment, to work properly. In order to mitigate this situation, a concept that is used in many hospitals can be considered.

Each door can be equipped with an electro magnet to hold the door open. In the event of a fire alarm, the magnets would de-energize, allowing the doors to close automatically.

11.2 Interim Measures

As the implementation of the proposed fire suppression systems would take a considerable amount of time, the following measures could be taken now to reduce the plants risk of damage by fire:

- A quick review of Section 3 – Loss and Near Miss History shows that most of the fires are related to combustible liquids. We recommend a thorough inspection of the fuel and lubrication delivery systems paying particular attention to the fuel and lubrication piping and



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completion of all maintenance required to repair or replace faulty equipment, piping and pipe supports.

- Similarly, complete a thorough inspection of the electrical equipment. Complete all maintenance required to repair or replace any faulty electrical equipment and wiring.
- Design and install fire barriers between units in plants where there may be sufficient space.

In addition, we recommend the following:

1. Initiate good housekeeping practices
2. Ensure all operators are fully trained in the area of safety and fire prevention
3. Installation of fire alarms and fire stop valves at each location where none currently exist or aren't operational
4. Implement proper control/safety procedures for contractors working on site
5. Perform annual fire/safety drills at each location
6. Provide training to diesel plant operators to enhance their capability to perform inspections of equipment/components that have a high risk of causing fire upon failure.



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

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

Wood Pole Line Management Program

Various Sites

July 2015

SUMMARY

The Wood Pole Line Management (WPLM) program is a condition-based program, which uses Reliability Centered Maintenance (RCM) principles and strategies. Under the program, transmission line inspection data in each year is analyzed and appropriate recommendations made for necessary refurbishment and/or replacement of line components such as poles/structures, hardware and conductor in the subsequent year. The inspection data and any refurbishment and/or replacement of assets are recorded in a centralized database for future access and tracking.

The program is aimed at early detection and treatment of deteriorating wood poles and line components before the integrity of a structure is jeopardized. If the deterioration of the structure or components is not detected early enough then the reduced integrity of the structure will affect the reliability of the line and the system as a whole and could lead to increased failure costs and potentially, customer interruptions. It may also create safety issues and hazards for Hydro personnel and for the general public.

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1 INTRODUCTION

Hydro maintains approximately 2,500 kilometers (km) of wood pole transmission lines operating at voltages of 69 kV, 138 kV and 230 kV. These lines consist of approximately 26,000 poles of varying ages, with the maximum age being 50 years. In 2015, over 90% of the transmission pole assets are more than 20 years old with about 50% of these at or above 40 years old. The remaining assets are less than 20 years old.

As wood poles age, their preservative retention levels decrease and the poles become increasingly subjected to deterioration by different agents including fungi and insects. Wood poles must be regularly inspected and treated in-situ to proactively identify and assess any deterioration. Prior to 2003, Hydro's pole inspection and maintenance practices followed the traditional utility approach of sounding inspections only. In 1998, Hydro began to collect core samples on selected poles to test for preservative retention levels and pole decay. The results of early tests raised concerns regarding the general preservative retention levels in the poles. This testing confirmed that there were poles in Hydro's system that had a preservative level below that required to maintain the required design criteria. During this period, certain poles were replaced because the preservative level had lowered to the point that decay had advanced and the pole was no longer structurally sound. These inspections and the analysis of the data confirmed that a more rigorous wood pole line management program was required. Figure 1 illustrates typical wood pole inspection techniques. Figure 2 shows typical wood pole inspection results.



Figure 1: WPLM Inspection Techniques, Clockwise From Bottom Left: 1) Typical Field Data Collector 2) Cavity Measuring 3) Climbing Inspection 4) Destructive Testing at MUN



Figure 2: Typical Wood Pole Inspection Results

Hydro first initiated the Wood Pole Line Management WPLM program as a pilot study in 2003. It was determined that the program should continue as a long-term asset management and life extension program. The program was presented to the Board of

Commissioners of Public Utilities (the Board) in October 2004 as part of Hydro's 2005 Capital Budget Application and was entitled "Replace Wood Poles – Transmission". The proposal was supported in the application by the Hydro internal report titled "Wood Pole Line Management Using RCM Principles" by Asim Haldar, PhD, P. Eng.

The Board found that "This approach (by Hydro) is a more strategic method of managing wood poles and conductors and associated equipment and is persuaded that the new WPLM Program, based on RCM principles, will lead to an extension of the life of the assets, as well as a more reliable method of determining the residual life of each asset. One of the obvious benefits of RCM will be to defer the replacement of these assets thereby resulting in a direct benefit to the ratepayers".

The Board approved the project submitted in the 2005 Capital Budget in Order No. P.U. 53(2004). As part of its annual Capital Budget Application process, Hydro committed to provide the Board with an update of the program work that includes both a progress summary of the work completed as well as a forecast of the future program objectives.

2 PROJECT DESCRIPTION

The WPLM program is a condition-based program, which uses the basic principles and strategies of reliability centered maintenance. Under the program, line inspection data is analyzed each year and appropriate recommendations are made for necessary refurbishment or replacement of deteriorated line components (poles, structures, hardware, conductor, etc.) in the subsequent year. The inspection data and any refurbishment or replacement of assets is recorded in a centralized database for easy access and future tracking. Infrequently, Hydro may inspect and find an item that should be replaced in the current year, as opposed to waiting and scheduling it for the subsequent year. This will be managed within the existing budget and will only be implemented if the component is deemed not able to last another year.

The program is aimed at early detection and rehabilitation or replacement of the wood poles and components before the integrity of the structures is jeopardized. If the deterioration of the structures is not detected early enough, then the reliability of the structures will affect the reliability of the line and the system as a whole. It may also create safety issues and hazards for Hydro personnel and for the general public.

The WPLM program is based on a ten year inspection cycle. To provide the quantitative benefits on the improvement of transmission line reliability, sufficient long term data derived from two full inspection cycles will be required to provide adequate statistical evidence. The second WPLM inspection cycle is scheduled to be completed by 2023. In the absence of this long term data, an analysis of recent ice storms, such as in March 2008 and March 2010, can provide an indication of how the transmission lines are performing. On March 18-19, 2008 there was a severe ice storm on the Avalon Peninsula. Hydro's test site at Hawke Hill recorded more than 25 mm of radial glaze ice which exceeds the design load of the wood poles on the Avalon Peninsula. There were no reported failures because the poles which were not structurally sound had already been replaced during the first WPLM inspection cycle between 2003 and 2007. This was again supported during the ice storm of March 2010, in which there were no failures of Hydro's wood pole assets on the Avalon

Peninsula. This supports Hydro's request to pursue the continued proactive condition-based management program.

3 JUSTIFICATION

The WPLM program detects “danger poles” and other deteriorated line components early to avoid safety hazards and to identify poles that are at early stages of decay to ensure that corrective measures can be taken to extend the average life of these poles. This is a least cost strategy in the long term through the deferring of rebuilding lines and avoiding forced outages.

3.1 Existing System

As stated previously, Hydro maintains approximately 2,500km of wood pole transmission lines operating at voltages of 69 kV, 138 kV and 230 kV. These lines consist of approximately 26,000 transmission size poles of varying ages.

3.2 Operating Experience

The WPLM inspection schedule is generally built on the strategy of focusing on older lines first and working toward newer lines. The exact lines and the number of poles are reviewed on an annual basis and may be modified based on the following criteria:

- Age;
- Priority (radial or redundant); and
- Known problems.

3.2.1 Maintenance History

The five-year historical cost information for the WPLM program as well as the budget for 2015 is provided in Table 1 below. No units or cost per unit is available, since the work is not easily defined into individual units such as a line or structure number. The actual work completed is variable and is dependent on the actual condition of the asset. For example, in most cases the work completed on any one structure is not related to the work on the next structure (i.e., one structure may require a pole replacement and the next structure may need a cross arm or an insulator replacement). The same is true for a breakdown by individual transmission line, where the cost will be affected by the configuration and

voltage of the line, its age and geographical location.

Table 1: Historical WPLM Program Expenditures

Year	Budget (\$000)	Actuals (\$000)
2015B	2,830.6	-
2014	2,564.2	2,496.8
2013	2,466.7	2,380.1
2012	2,519.3	2,562.8
2011	2,019.4	2,218.8
2010	2,308.2	2,501.2

3.2.2 Historical Information

Table 2 provides the annual statistics for pole and pole component replacement for the five years prior to implementation of the WPLM program and for the years since implementation of the program.

Table 2: Annual Statistics of Pole and Pole Component Replacement

Year	Poles	Cross Arm	Knee Brace	Cross Brace	Comments
2014	57	11	10	6	
2013	34	8	88	8	
2012	32	14	4	4	
2011	53	19	80	22	
2010	60	20	45	58	
2009	81	12	14	25	
2008	93	27	27	25	
2007	97	31	11	19	
2006	142	30	18	21	
2005	98	47	43	58	
2004	51	13	12	22	Start of WPLM
2003	31	29	13	55	
2002	126	53	6	61	
2001	21	16	2	2	
2000	44	30	21	30	
1999	135	7	20	2	
TOTAL	1,103	356	404	412	

1999 to 2003	357	135	62	150	Five Years Before WPLM
2004 to 2013	746	221	342	262	Ten Years Since WPLM

3.2.3 Anticipated Useful Life

The anticipated useful life of a wood pole transmission line not subject to inspection or maintenance is approximately 40 years. Hydro has implemented a WPLM program, with the mandate to thoroughly inspect, treat and refurbish the transmission structures prior to any serious failure on the line. Through this type of proper inspection and maintenance the life of a transmission line could be extended by ten years or more.

3.2.4 Review of 2014 WPLM Program

The first objective of the 2014 program was to inspect, test and treat at least 1,888 poles and associated line components.

Table 3 summarizes the inspection accomplishments for 2014.

Table 3: 2014 Inspections Completed

Regions	Line Name	Year In Service	Voltage Level	Target Number of Poles to Inspect	Actual Number of Poles Inspected	Percent Complete
Eastern	TL218	1966	230	210	183	87%
Central	TL210	1969	138	153	153	100%
	TL222	1967	138	120	120	100%
	TL224	1968	138	396	396	100%
Western	TL225	1970	69	15	15	100%
	TL250	1987	138	217	217	100%
Northern	TL221	1970	69	250	250	100%
	TL226	1970	69	200	200	100%
	TL227	1970	69	50	50	100%
Labrador	TL240	1976	138	277	370	134%
Total				1,888	1,954	103%

Another objective of the 2014 program was the replacement of defective components identified in previous inspections. A summary of the work completed in 2014 is given in Table 4.

Table 4: Summary of 2014 Refurbishment

Component	TL201	TL203	TL210	TL220	TL222	TL226	TOTAL
Poles	11	6	17	7	13	3	57
Cross arms	2	2	3		4		11
Cross bracing		2	3		1		6
Knee braces	1	9					10
Insulators	6	3			4		13
Foundations	4						4
Miscellaneous	55	17	45	1	13		131

In addition to the above work completed, the following work was deferred until future years because of outage constraints and/or increased budget costs. This deferred work typically comprised components that are generally rated 4, which should be replaced within one to three years.

- TL234 – Due to the limited availability of outages on an annual basis, the work on TL234 was deferred until 2015; and
- TL203 – Due to schedule constraints, work on TL203 was deferred until 2015.

3.2.5 Update of 2015 WPLM Program

The proposed inspection and treatment work for 2015 is summarized in Table 5.

Table 5: 2015 Inspection Plan

Region	Line No.	Year Built	Age of Line	Target Number of Poles to Inspect
Eastern	TL201	1966	49	386
	TL218	1966	49	222
Central	TL224	1968	47	222
	TL232	1981	34	359
	TL235	1966	49	3
Western	TL225	1970	45	19
	TL250	1987	28	333
Northern	TL227	1970	45	180
	TL239	1982	33	279
	TL241	1983	32	280
Labrador	TL240	1976	39	300
TOTALS				2,583

As a result of the 2014 inspection program and deferred work from previous years, a refurbishment program will begin during the spring and summer months of 2015 and continue into the fall. This will include the replacement of approximately 47 poles, 20 cross arms, two sets of cross bracing, 13 sets of knee bracing and other smaller components. A list of the refurbishment work to be completed in 2015 is provided in Table 6. This work is planned to be completed within the previously approved budget guidelines.

Table 6: 2015 Refurbishment Plan

Component	Region				TOTAL
	Eastern	Central	Western	Northern	
Poles	29	14		4	47
Cross arms	5	14		1	20
Cross bracing	1	1			2
Knee bracing	9	4			13
Insulators	3	9			12
Foundations		1		1	2
Miscellaneous	63	46	33	33	175

3.3 Development of Alternatives

No alternatives have been explored. In 2005, the Board found that this approach was justified and prudent and approved the expenditures as submitted in the 2005 Capital Budget in Board Order No. P.U. 53(2004).

This current submission to the Board provides an update of the program work, which includes both a progress report of the work completed as well as a forecast of the future program objectives.

4 CONCLUSION

In conclusion, the major objectives for the 2014 program were achieved. The total expenditure of \$2.5 million was approximately \$67,000 or 2.6% under the budget estimate of \$2.56 million.

The framework for systematically analyzing a large volume of wood pole transmission line inspection data, developed using the condition based analysis technique, is still under expansion to include additional components.

4.1 Budget Estimate

The WPLM budget shown in Table 7 includes the complete inspection of the stated lines, including the visual inspection supported by inspecting each pole using non-destructive evaluation tools, limited full-scale testing and full treatment of the pole as required. The budget for 2017 and beyond will be established based on the annual inspection results.

It is assumed that a percentage of those poles inspected will also be rejected according to the IOWA curves (shown in Appendix A) depending on their age and group. Poles rejected in the field will be analyzed with respect to reliability issues, and if rejected after structural analysis, a recommendation to refurbish or replace will be made.

Using the average age of the poles being inspected along with the 2012 IOWA curve, the anticipated pole replacement rate is calculated and this is used to develop the future refurbishment program. A schedule of the pole inspections from 2015 to 2020 is provided in Appendix A. The table also provides the average age and anticipated pole rejection rate for each year.

Table 7: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	472.0	0.0	0.0	472.0
Labour	1,695.0	0.0	0.0	1,695.0
Consultant	100.0	0.0	0.0	100.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	84.8	0.0	0.0	84.8
Interest and Escalation	96.8	0.0	0.0	96.8
Contingency	470.4	0.0	0.0	470.4
TOTAL	2,919.0	0.0	0.0	2,919.0

4.2 Project Schedule

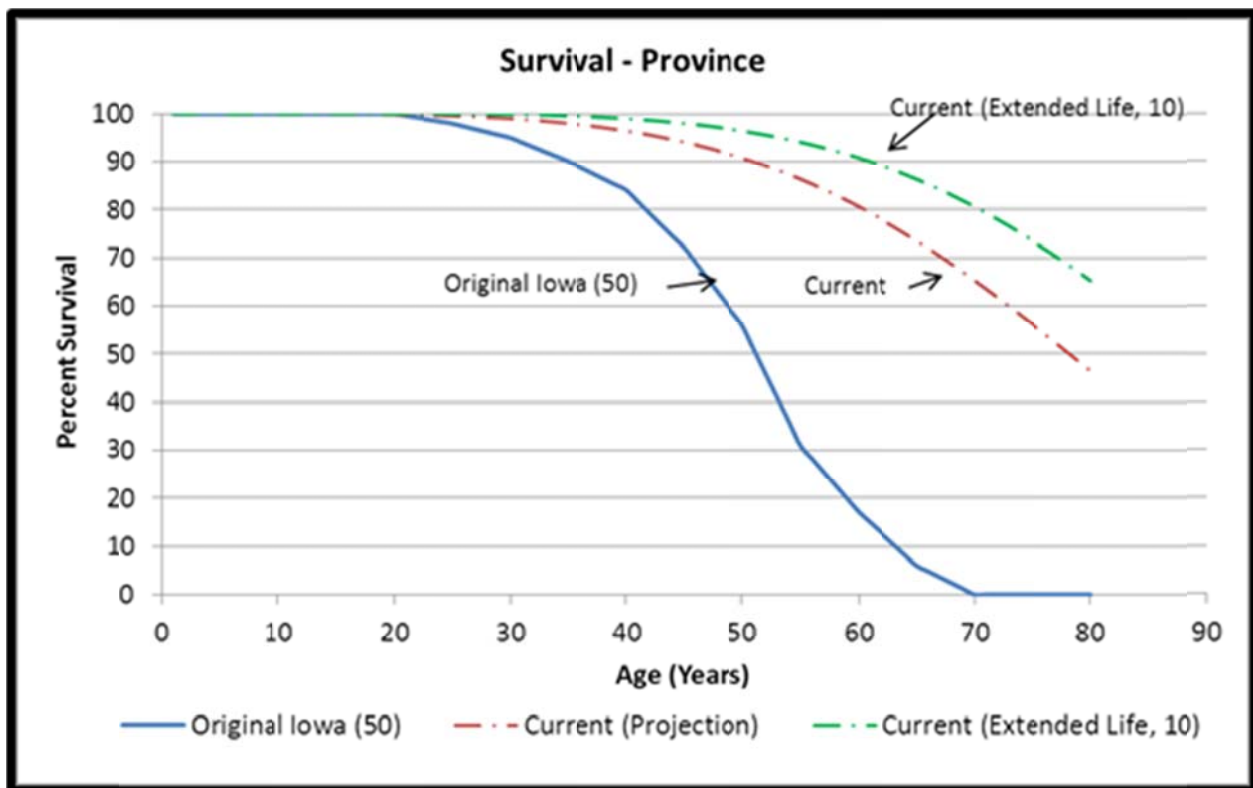
The annual project schedule is highly dependent on the annual work load and availability of outages and is therefore determined during the spring of each year. Therefore, a schedule has not been provided at this time.

APPENDIX A
WPLM Inspection Schedule 2015-2020
(With Average Age of Transmission Lines and Estimated Pole Rejection Rates)

WPLM Inspection Schedule and Expected Pole Rejection Rates (Summary)

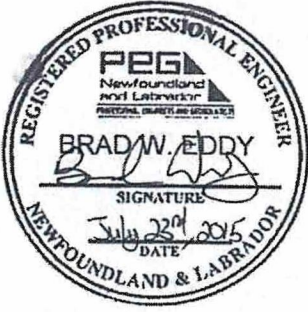
Year	Age of Lines	No. of Poles Inspected	Estimated Approximate Pole Rejection Rate	No. of Poles Rejected
2015	36.23	2,583	3%	67
2016	35.92	2,702	3%	78
2017	36.76	2,731	4%	95
2018	35.23	2,447	2%	37
2019	34.85	2,634	1%	14
2020	38.11	2,591	1%	18

IOWA CURVE (Extended Life, Ten Years used for Prediction)



For detailed IOWA curves please refer the “Review of the Current WPLM Program, Interim Report, prepared in response to Board questions raised in Order No. P.U. 2(2012)”.

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

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

Overhaul Diesel Engines

Various Sites

July 2015

SUMMARY

This report presents the capital budget proposal for diesel engine overhauls performed on a usage-based schedule at an interval of 20,000 operating hours. Overhauls are required to ensure the engine is able to meet its expected life of 100,000 hours. This project proposal is for the overhaul of eleven diesel engines in 2016 at an estimated cost of \$2.1 million. The projection of future overhauls forecasts 44 overhauls over the 2016 to 2020 period.

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1 INTRODUCTION

Hydro's diesel engine overhaul plan has been developed to ensure the reliability of diesel engines at diesel generating stations. Hydro has 25 diesel generating stations, 21 of which are prime power stations serving a total of approximately 4,400 customers. Prime power means the primary (or, in some cases, sole) power source. These generating stations are the primary source of electricity for their community which means that if the station cannot meet the load then customer outages will occur. The reliability of the prime power diesel generating stations is such that the station can withstand a single contingency, meaning that the plant is designed to be able to provide maximum load in the event of the unavailability of any single diesel unit (due to failure). This means that while the failure of a single unit will not result in customer outages, the failure of an additional unit before the initially failed unit is returned to service may result in customer outages. This highlights the importance of the reliability of these diesel engines. In short, the prime power diesel generating stations are normally the only power source for their community and require major overhauls to achieve their expected service lives while providing reliable power.

The four generating stations that are not prime power stations are Hawke's Bay, St. Anthony, Mud Lake and Happy Valley. These stations provide emergency backup generation. Both Hawke's Bay and St. Anthony provide emergency backup to the Island Interconnected system and Happy Valley and Mud Lake provides emergency backup to the customers served by the Happy Valley distribution system.

Figure 1 below is a photo of Ramea Unit 2077 prior to its installation in the Ramea Diesel Plant.



Figure 1: Ramea Unit 2077

2 PROJECT DESCRIPTION

This project is required to overhaul the diesel engines at various diesel generating stations. The project consists of overhauling 11 engines in 2016. The five year plan for overhauls, which can be found in Appendix A, consists of the overhaul of 44 engines during the 2016 - 2020 five-year period. Diesel engine overhauls are planned based on the engines being overhauled every 20,000 hours of operation. This is the criteria being used for diesel engine overhauls and was the criteria recommended in 2003 following a comprehensive internal maintenance review (subsequently referred to in this report as the Asset Maintenance Strategy review). Prior to this maintenance review, overhauls were performed at an interval of 15,000 operating hours.

The planned overhaul schedule is based on an estimate of when each engine will reach 20,000 operating hours since either it was newly placed in service or since its last overhaul. On average and for a typical unit, 20,000 operating hours accumulate in 7.2 years, but depends on individual plant utilization factors and the subsequent usage of the engines in that plant. As such, this schedule is subject to change and the year for which an engine is projected to become due for an overhaul can vary depending on plant conditions and the actual hours accumulated. While the specific engines projected to be due for overhaul in a given year can vary from year to year, the number of engines projected to be due for overhaul in a given year tends to be relatively consistent.

An overhaul consists of replacement of specific critical parts such as the pistons, liners, main bearings, connecting rod bearings, fuel injectors, oil cooler, turbo charger, water pump, oil pump, cylinder heads, fuel lines, and all necessary gaskets. Also included in an overhaul is a bench top overhaul of the fuel pump. An overhaul of the alternator and replacement of the fuel lines are typically completed on every other overhaul or when identified through maintenance checks. The fuel pump and alternator overhauls were added to the overhaul scope in recent years as a result of a formal Asset Maintenance Strategy review which considered Hydro's experience, other utility experience, other utility practice, and manufacturer recommendations. With the exception of the fuel lines, the replacement parts are remanufactured parts.

The unit overhauls included in this project are those that are projected to become due during 2016. The eleven units to be overhauled are Hopedale 2054, Little Bay Islands 2058, Mary's Harbour 2037, Mary's Harbour 2083, Nain 2085, Postville 577, Ramea 2077, Rigolet 2051, St. Brendan's 578, St. Anthony 544, and St. Lewis 2039. In addition, Mary's Harbour 2037 will also have its alternator overhauled, St. Lewis 2039, Hopedale 2054, Postville 577, and Rigolet 2051 will have their fuel lines replaced, and Ramea 2077 and St. Brendan's 578 will have both their alternators overhauled and their fuel lines replaced. From time to time, a unit in one of the diesel plants across Hydro's operating area experiences issues that necessitate an unplanned overhaul. Where appropriate, Hydro may complete such an overhaul under this project and if possible, defer one of the units slated for completion as noted above.

3 JUSTIFICATION

3.1 Existing System

The existing system of diesel generating stations consists of 25 diesel generating stations, 21 of which are prime power generating stations and four of which are emergency backup generating stations. The number of diesel generating units at a generating station ranges from three to six and the rated output of the units range from 30kW to 2,600kW. The diesel engines across the system range in age from less than one year to 57 years and currently range in operating hours from less than 2,000 hours to over 127,000 hours (as of the end of 2014). The oldest engine in a prime power station is 35 years old. Table 1 below lists, for each engine in this proposal, the number of operating hours left before the engine becomes due for an overhaul as well as the forecasted time when that overhaul becomes due.

Table 1: 2016 Overhaul Forecast

Engine	Remaining Operating Hours Before Due for Overhaul (as of Dec. 31 st , 2014)	Forecasted Overdue Due Date
Hopedale 2054	8,407	Q2 2016
Little Bay Islands 2058	2,803	Q1 2016
Mary's Harbour 2037	6,633	Q2 2016
Mary's Harbour 2083	5,044	Q4 2016
Nain 2085	10,272	Q3 2016
Postville 577	5,422	Q2 2016
Ramea 2077	6,005	Q3 2016
Rigolet 2051	5,560	Q2 2016
St. Brendan's 578	5,103	Q3 2016
St. Lewis 2039	8,869	Q4 2016
St. Anthony 544 ¹	overdue	overdue

¹ Unit 544 at St. Anthony is a 720 RPM unit, which is lower than most of Hydro's fleet of diesel units. This unit is also a standby unit as St. Anthony is on the Island Interconnected System. By contrast, most diesel units used for remote electricity supply are prime power and higher RPM. Hydro's criteria for hours in service before overhaul, currently 20,000, is based on the higher RPM prime power units. The current criterion for overhaul was set for all units, regardless of RPM. This is why St. Anthony was included in the schedule for overhaul in 2016. However, Hydro is currently reviewing its experience and vendor recommendations that lower RPM units can safely and reliably operate longer between overhauls, up to 30,000 hours. The final recommendation on time between overhauls for lower RPM units is expected in the coming months. If the current criteria changes to a longer duration between overhauls for lower RPM units, St. Anthony will be re-scheduled for a future year accordingly.

3.2 Operating Experience

Isolated diesel generation plants operate continuously since it provides the primary source of electricity to communities isolated from the province's electrical grid. A given unit is not in service continually since the number of units in service varies based on the customer demand. Emergency backup diesel generation plants operate only in emergency situations which are rare but critical. In automated plants the engine mix is automatically controlled by a control system to maximize fuel efficiency, while in a manual plant this is controlled by the operator.

In all plants the operator has the flexibility to shut down engines for planned maintenance provided there is another engine available to supply the load for that time. As a result, planned outages to engines can occur without customer outages.

Please refer to Table 1 below for details concerning the overhaul work completed during the previous five years and the work planned for the current year.

Table 2: Overhauls Completed In Last Five Years

Year	Unit
2015 ¹	Cartwright Unit 2052
2015 ¹	Francois 587
2015 ¹	Gray River Unit 2062
2015 ¹	Hopedale Unit 2074
2015 ¹	Makkovik Unit 2059
2015 ¹	Makkovik Unit 3033
2015 ¹	Norman Bay Unit 581
2015 ¹	Port Hope Simpson Unit 2042
2015 ¹	Ramea 2045
2014	Charlottetown 2087
2014	Francois 570
2014	L'Anse-au-Loup 2041
2014	McCallum 2064
2014	Paradise Unit 324
2014	Port Hope Simpson 2043
2014	Port Hope Simpson 2073
2014	Postville Unit 2084
2014	Postville 573
2014	William's Harbour Unit 580
2013	Charlottetown Unit 2034
2013	Charlottetown Unit 2079
2013	Grey River Unit 2067
2013	Nain Unit 2085
2013	Nain Unit 576
2013	St. Lewis Unit 2039
2012	Black Tickle Unit 579
2012	Cartwright Unit 2052
2012	Charlottetown Unit 2079
2012	Hopedale Unit 2054
2012	Hopedale Unit 2074
2012	Little Bay Islands Unit 2058
2012	Makkovik Unit 2059
2012	Mary's Harbour 2037
2012	Mobile Unit 2071
2012	Ramea Unit 2047
2012	Rigolet 2081
2012	St. Brendan's Unit 578 (alternator only)
2012	St. Lewis Unit 2080
2011	Grey River Unit 2062
2011	McCallum Unit 2063
2011	Ramea Unit 2077
2011	St. Brendan's Unit 2056
2011	St. Lewis Unit 2039
2011	William's Harbour Unit 2057

Year	Unit
2011	Port Hope Simpson Unit 2042
2011	Port Hope Simpson Unit 2043
2011	Rigolet Unit 2081
2011	Rigolet Unit 2051
2011	Postville Unit 577
2011	Hopedale Unit 2053
2010	St. Brendan's Unit 578
2010	Ramea Unit 2045
2010	Spare Unit 2072
2010	Charlottetown Unit 2079
2010	Mary's Harbour Unit 2038
2010	Cartwright Unit 2045
2010	Nain Unit 574
2010	Cartwright Unit 2036

¹ Refers to planned work for the stated year.

3.2.1 Reliability Performance

A consequence of not completing this project is an increase in the frequency and duration of customer outages as a result of an increase in diesel unit failures.

3.2.1.1 Outage Statistics

Hydro tracks all distribution system outages using industry standard indexes, SAIDI and SAIFI which are explained as follows:

SAIDI- indicates the System Average Interruption Duration Index for customers served per year, or the average length of time a customer is without power in the respective distribution system per year.

SAIFI - is the System Average Interruption Frequency Index per year which indicates the average of sustained interruptions per customer served per year or the average number of power outages a customer has experienced in the respective distribution system per year.

Loss of Supply is defined by the CEA as:

Customer interruptions due to problems in the bulk electricity supply system such as underfrequency load shedding, transmission system transients, or system frequency excursions. During a rotating load shedding cycle, the duration is the total outage time until normal operating conditions resume, while the number of customers affected is the average number of customers interrupted per rotating cycle.

In this case it applies to the loss of the diesel generation.

Table 3 lists the SAIDI Loss of Supply outage statistics for the prime power diesel generating stations for the previous five years. Table 4 below lists the SAIFI Loss of Supply outage statistics for the same diesel generating stations for the previous five years.

Table 3: 2010 to 2014 Outage Statistics (SAIDI Loss of Supply)

System	SAIDI (Loss of Supply)				
	2010	2011	2012	2013	2014
Central					
Francois	0.833	0.249	0.083	0.000	0.083
Grey River	0.165	0.000	0.000	0.167	0.083
Little Bay Islands	0.083	3.561	0.000	0.250	0.250
McCallum	0.167	0.167	0.000	0.000	0.000
Ramea	0.283	1.221	0.000	0.123	0.083
St. Brendan's	0.017	0.000	16.633	6.044	0.367
Northern					
Charlottetown	1.545	0.133	4.949	0.846	1.367
L'Anse-au-Loup	1.561	1.167	0.300	2.033	3.567
Mary's Harbour	4.408	0.661	1.643	2.517	1.767
Norman Bay	0.167	2.834	0.116	0.167	0.167
Port Hope Simpson	1.228	0.550	4.697	0.450	4.367
St. Lewis	0.500	1.531	0.349	0.167	0.283
William's Harbour	0.333	12.167	0.633	0.083	0.867
Labrador					
Black Tickle	11.892	2.867	45.520	1.250	0.667
Cartwright	3.850	0.699	0.350	0.499	0.583
Hopedale	6.913	2.406	1.908	9.309	10.383
Makkovik	0.238	2.087	4.783	4.027	1.883
Nain	3.767	1.407	0.583	1.334	1.067
Paradise River	5.050	2.924	0.030	0.583	0.667
Postville	0.901	1.866	0.913	4.748	2.250
Rigolet	3.503	0.616	2.738	0.100	0.283

Table 4: 2010 to 2014 Outage Statistics (SAIFI Loss of Supply)

System	SAIFI (Loss of Supply)				
	2010	2011	2012	2013	2014
Central					
Francois	3.0	2.0	1.0	0.0	1.0
Grey River	2.0	0.0	0.0	2.0	1.0
Little Bay Islands	1.0	6.0	0.0	2.0	2.0
McCallum	1.0	1.0	0.0	0.0	0.0
Ramea	3.0	10.0	0.0	1.6	1.0
St. Brendan's	1.0	0.0	5.0	8.0	3.0
Northern					
Charlottetown	12.0	2.0	9.0	1.1	6.0
L'Anse-au-Loup	4.0	2.0	1.7	2.0	5.0
Mary's Harbour	9.0	6.0	23.0	0.8	4.0
Norman Bay	1.0	18.0	1.0	2.0	1.0
Port Hope Simpson	5.0	3.0	12.0	3.0	5.0
St. Lewis	3.0	8.0	3.0	1.0	2.0
William's Harbour	4.0	2.0	7.0	1.0	5.0
Labrador					
Black Tickle	5.0	4.0	13.0	9.0	3.0
Cartwright	11.0	4.0	1.0	3.0	5.0
Hopedale	12.0	6.0	6.0	10.0	18.0
Makkovik	2.0	10.0	14.0	12.0	4.0
Nain	7.0	6.0	2.0	4.0	3.0
Paradise River	7.0	6.0	1.0	5.0	10.0
Postville	3.0	9.0	6.0	10.0	9.0
Rigolet	3.0	2.0	8.0	2.0	2.0

3.2.2 Safety Performance

This is a reliability-based project. If this project is not executed, there is a higher risk of diesel engine failure and diesel engine failure can result in extended customer outages which can negatively impact public safety. As well, diesel engines can fail catastrophically with possible hazards for the employees in the vicinity. The risk of this occurring increases if overhauls are not completed.

3.2.3 Environmental Performance

This project is being justified from a reliability perspective but if overhauls are not completed, failures could result in oil and glycol being released into the environment.

3.2.4 Industry Experience

Manufacturers of diesel engines will provide recommended overhaul intervals which typically are in the 15,000 hour range. Hydro adopted this philosophy for many years but completed a comprehensive review of its maintenance practices in 2003 and extended the overhaul period to 20,000 hours.

3.2.5 Vendor Recommendations

The diesel engine manufacturers generally recommend an overhaul interval of 15,000 hours but as a result of a review of maintenance practices and failure history it was decided to extend Hydro's overhauls to 20,000 hours.

3.2.6 Maintenance or Support Arrangements

Generally, a routine annual inspection is performed by internal resources. The annual inspection checks the fuel, coolant, and exhaust systems as well as the engine structure. Problems identified during the inspection are typically corrected during the inspection. If an engine fails prematurely, the manufacturer is typically consulted to help with a failure analysis.

Also, to help manage the service of the parts for diesel engine, blanket orders are created with the engine original equipment manufacturers (OEMs) or their authorized distributor. Compared to purchase orders, blanket orders allow for quicker procurement of diesel engine parts by virtue of the fact that, with a blanket order, approval is given up front and therefore isn't required for each of the multiple parts orders which are placed. Such arrangements are necessary to ensure lead times on parts are acceptable and Hydro does not have to incur the cost of stocking diesel parts in inventory.

3.2.7 Maintenance History

The five-year maintenance cost history for the prime power diesel engines is shown in Table 5.

Table 5: Five-Year Maintenance Cost History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	85.1	805.2	890.3
2013	49.8	458.6	508.5
2012	62.0	545.5	607.6
2011	69.0	782.7	851.7
2010	80.7	1,309.8	1,390.5

3.2.8 Historical Information

Prior to 2012, diesel engine overhauls were being performed as operating projects. The historical cost information for the overhaul of diesels engines since 2012 is shown in Table 6.

Table 6: Overhaul Diesel Engines Historical Cost

Year	2012	2013	2014	2015B
Total	\$1,515,600	\$1,134,319	\$968,450	\$1,199,000
Number of Engines	17	7	10	9
Per Engine Average (Actual)	\$89,200	\$162,000	\$96,845	\$133,222

3.2.9 Anticipated Useful Life

The average life of a major overhaul is 7.2 years. Actual life depends primarily on the operating hours of the unit.

3.3 Development of Alternatives

One alternative was considered for this overhaul project and it is to overhaul the engines at the manufacturer-recommended interval which is typically 15,000 operating hours. A review completed in 2003 recommended changing the interval to 20,000 operating hours to improve the balance between least-cost and reliability. Hydro adopted this recommendation. Changing the overhaul interval to 20,000 operating hours from 15,000 operating hours reduces the lifetime overhaul cost for an engine by one-third (as a result of reducing the number of overhauls required from 6 to 4) without increasing the cost of an overhaul.

3.4 Evaluation of Alternatives

The alternative identified above was analyzed as part of the review completed by Hydro in 2003. The review considered Hydro's experience, other utility experience, other utility practice, and manufacturer recommendations. The recommendation on diesel engine overhauls made as part of this review states that *"parts being removed from the units have sustained very little wear and the overhaul can very easily be extended to 20,000 hours."*

3.4.1 Economic Analysis

No quantitative economic analysis of the two alternatives has been completed. Qualitative economic analysis shows that the selected alternative of completing overhauls at an interval of 20,000 operating hours reduces lifetime overhaul costs by one-third compared to the 15,000 operating hour interval alternative. This is a result of the selected alternative having one-third less overhauls but the same cost for an overhaul.

4 CONCLUSION

This project is necessary in order to provide least cost, reliable electrical service to the customers served by diesel generation. Overhauling diesel engines is a necessity in operating this type of equipment.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 7.

Table 7: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	1,141.2	0.0	0.0	1,141.2
Labour	362.2	0.0	0.0	362.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	87.0	0.0	0.0	87.0
Other Direct Costs	79.2	0.0	0.0	79.2
Interest and Escalation	74.9	0.0	0.0	74.9
Contingency	333.9	0.0	0.0	333.9
TOTAL	2,078.4	0.0	0.0	2,078.4

4.2 Project Schedule

The anticipated project schedule is shown in Table 8.

Table 8: Project Schedule

Activity		Start Date	End Date
Planning	Schedule annual overhauls	February 2016	September 2016
Procurement	Purchase overhaul components	March 2016	October 2016
Installation	Complete overhaul	April 2016	November 2016
Commissioning	Testing after overhaul	April 2016	November 2016
Closeout	Release For service and Asset Assignment	December 2016	December 2016

APPENDIX A
Diesel Engine Overhaul Five Year Plan

Unit	Planned Year of Overhaul
2016	
Hopedale 2054	2016
Little Bay Islands 2058	2016
Mary's Harbour 2037	2016
Mary's Harbour 2083	2016
Nain 2085	2016
Postville 577	2016
Ramea 2077	2016
Rigolet 2051	2016
St. Anthony 544	2016
St. Brendan's 578	2016
St. Lewis 2039	2016
2017	
Black Tickle 582	2017
Grey River 2067	2017
Hopedale 2053	2017
Nain 574	2017
Paradise River 585	2017
Rigolet 2065	2017
2018	
Charlottetown 2087	2018
Charlottetown 2089	2018
Hopedale 2074	2018
Norman's Bay #584 (G1)	2018
Rigolet 2081	2018
St. Brendan's 2056	2018
St. Lewis 2080	2018
2019	
Black Tickle 579	2019
McCallum 589	2019
McCallum 2063	2019
Nain 2085	2019
Nain 576	2019
Norman Bay 583	2019
Paradise River 324	2019
Postville 2084	2019
Ramea 2047	2019
William's Harbour 2075	2019
William's Harbour 580	2019
2020	
Cartwright 2086	2020
Charlottetown 2088	2020
Francois 587	2020
Grey River 2062	2020

Unit	Planned Year of Overhaul
Little Bay Islands 2058	2020
Mary's Harbour 2038's replacement	2020
Norman Bay 581	2020
Port Hope Simpson 2073	2020
William's Harbour 2057	2020

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

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

Install Spare Transformer

Happy Valley Terminal Station

July 2015

SUMMARY

This report provides details regarding a capital budget proposal to install infrastructure to allow the timely connection of a spare transformer, should it be required, within the Happy Valley Terminal Station. The 15/20/25 MVA transformer is currently situated in the station but not able to be placed into service in a timely fashion. The project includes the installation of bus work, a 138 kV disconnect, a 25 kV breaker, a 25 kV disconnect, and a transformer protection panel. These additions are required to place the transformer into service and to ensure that it is monitored and protected.

This proposal is requesting the approval of a one year plan to with an estimated cost of \$2,040,900.

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1 INTRODUCTION

The Happy Valley Terminal Station is located within the community of Happy Valley – Goose Bay. Supply of electricity to this region is from a 138 kV transmission line (TL240¹) supplied from the Churchill Falls hydroelectric Generating Station. The station supplies the communities of Happy Valley – Goose Bay, Sheshatshui, and North West River, as illustrated in Figure 1. Further description of the existing transmission system in eastern Labrador is provided in Section 3.1.

A review of the contingency plan to place the spare transformer into service (in the event of a failure of one of the existing transformers in this station) was conducted. This review indicates that system modifications are required in order to be compliant with Hydro's Business Continuity Plan, which states that any equipment failure resulting in a loss of service to customers must be remedied within two days.

This proposal is requesting the approval of a one year project to complete these modifications to the Happy Valley Terminal Station for an estimated cost of \$2,040,900.

¹ Operations personnel from Hydro refer to the 138 kV transmission line as TL240. Operations personnel from Churchill Falls refer to the 138 kV transmission line as L1301



Figure 1: Labrador Generation and Transmission Grid

2 PROJECT DESCRIPTION

The scope of work within this project includes the procurement, installation and commissioning of equipment required to place the spare 15/20/25 MVA transformer located within the Happy Valley Terminal Station into service.

The equipment required for this installation includes the following:

- additions and modifications to the 138 kV rigid bus to provide a high voltage connection to the transformer;
- the installation of a 138 kV disconnect switch to provide electrical isolation of the transformer;
- the installation of a 25 kV breaker on the low voltage side of the transformer;
- the installation of a 25 kV disconnect switch to provide electrical isolation of the transformer; and
- the installation of a transformer protection panel which includes protective relays to monitor and protect the transformer.

Figure 2 provides a photograph of the spare transformer located within the Happy Valley Terminal Station.



Figure 2: Spare 15/20/25 MVA Transformer (Happy Valley)

3 JUSTIFICATION

This section includes a discussion of the existing transmission system in eastern Labrador, including a review of operating experience and customer growth. A review of alternatives is also performed.

3.1 Existing System

Existing Transmission System in Eastern Labrador

The existing transmission system in eastern Labrador is designed to deliver power and energy to commercial and domestic customers in the Happy Valley - Goose Bay area and consists of a single, radial 296 km, 138 kV transmission line connecting Churchill Falls (CHF) to the 138/25 kV terminal station at Happy Valley – Goose Bay (HVY). A single line diagram of the transmission system in eastern Labrador is provided in Figure 3.

The transmission line, L1301, is connected to the CHF 230 kV bus B21 through T31, a 230/138 kV, 125 MVA autotransformer which is supplied by generator A1 and 230/735 kV autotransformer T71 under normal operation. L1301 connects CHF and Muskrat Falls (MFA) and L1302 connects MFA and HVY.

The 138/25 kV HVY contains two 138/25 kV power transformers T1 and T2. T1 is rated 25/30/50 MVA and T2 is rated 15/20/25/28 MVA. A 27 MW combustion turbine is connected to the 25 kV bus via T3 and operates as a synchronous condenser under normal operation. An 11.4 MVAR, 25 kV four stage switched capacitor bank provides additional voltage support. A 2 MVA, 138/25 kV station supplies a water pumping system and a 138/25 kV, 30/40/50 MVA station supplies construction power at the Muskrat Falls site. In addition, a 21.6 MVAR, 25 kV, six stage capacitor bank has been installed to provide voltage support for the additional construction loads.

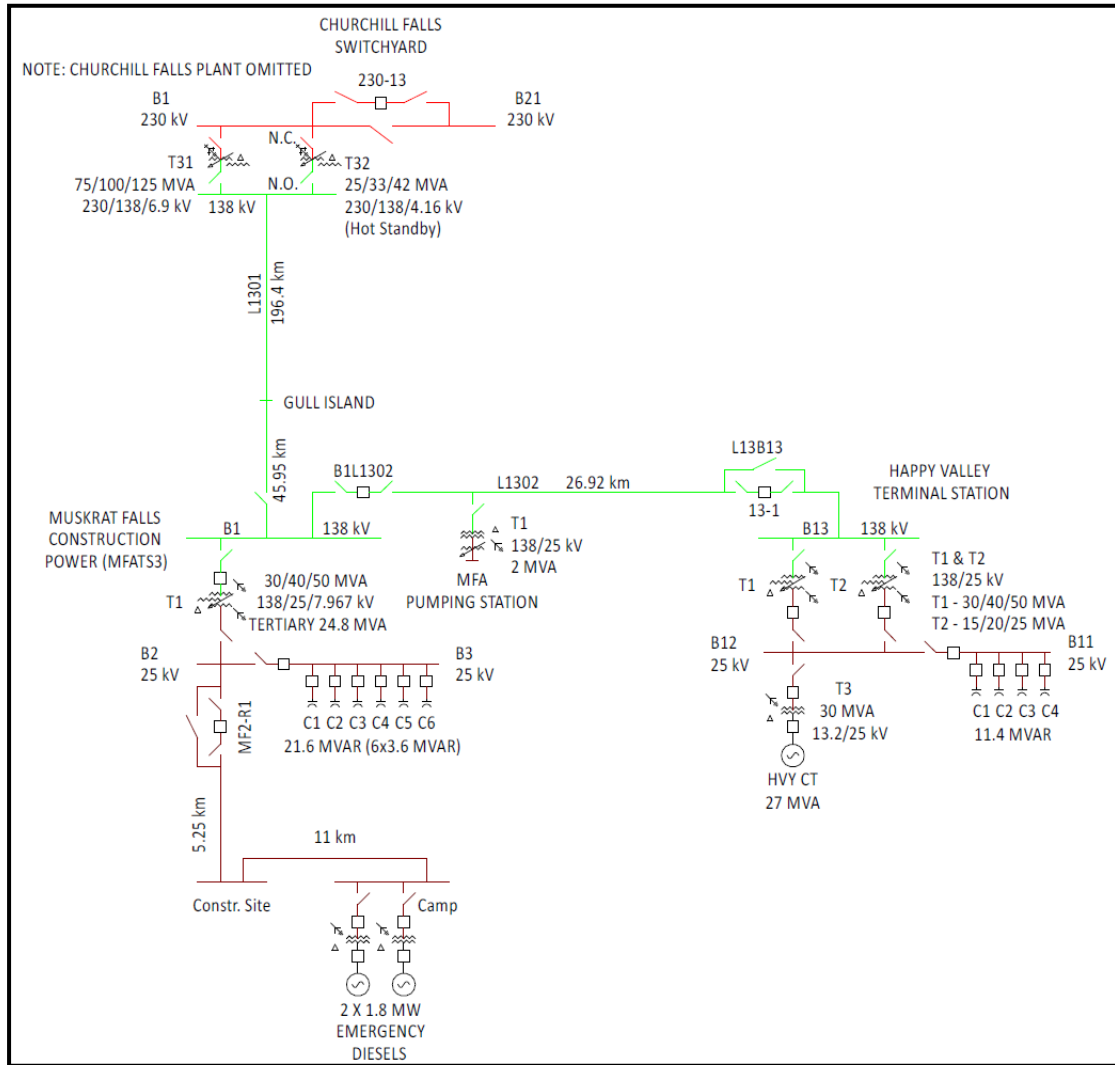


Figure 3: Transmission System in Eastern Labrador - Single Line Diagram

Assessment of System Planning Criteria at Happy Valley Terminal Station

Hydro's System Planning Criteria relating to power transformers are specified as follows:

- Transformer additions at all major terminal stations (i.e. two or more transformers per voltage class) are planned on the basis of being able to withstand the loss of the largest unit.
- For single transformer stations, there is a back-up plan in place which utilizes Hydro's and/or Newfoundland Power's mobile equipment to restore service.

Compliance with these criteria at HVY has been on the basis that the spare transformer

(tagged as T4) could be placed in service in the event of the failure of transformer T1 or T2.

This is illustrated in the load flow plot provided in Figure 4. In this case, it is shown that the 2019 peak load of 73 MW can be met at HVY when transformer T4 is placed in service and the HVY Gas Turbine is in operation as a generator.

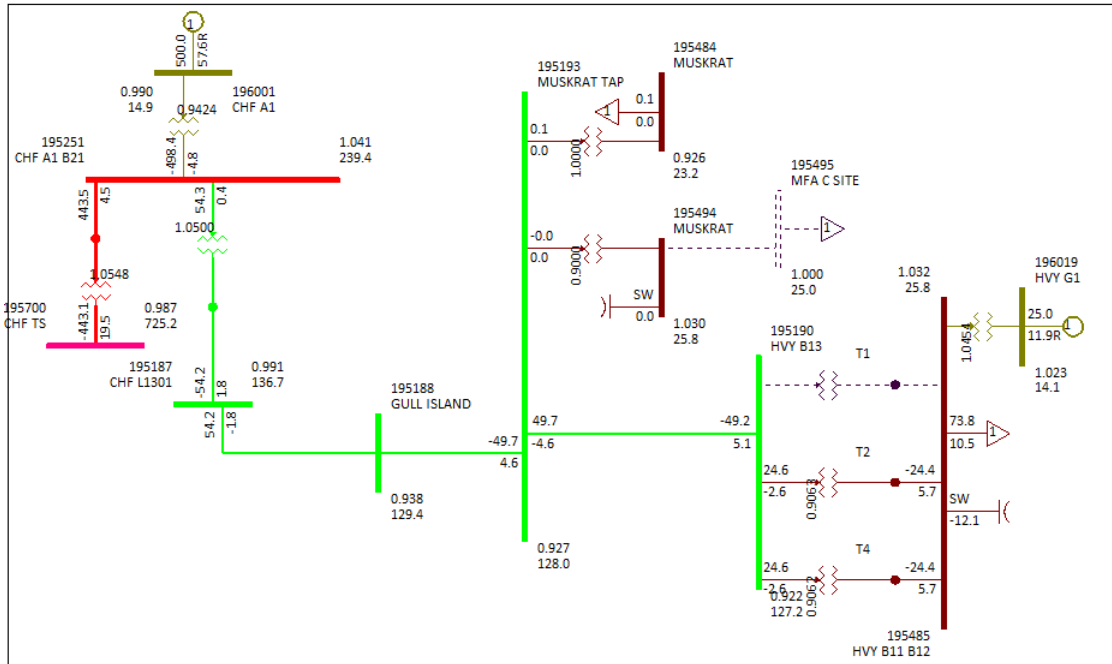


Figure 4: Load Flow Plot – HVY Terminal Station Capacity with T1 Out of Service and T4 In Service

Without the spare transformer, a maximum load of 53 MW can be supported before transformer T2 is overloaded. In 2016 the peak demand for HVY is forecasted to be approximately 72.1 MW, indicating that approximately 74% of peak load can be supported in the event of the failure of transformer T1. As per the load duration curve presented in Section 3.3, the exposure for unserved energy as a result of this contingency represents approximately 20% of the year, or 73 days.

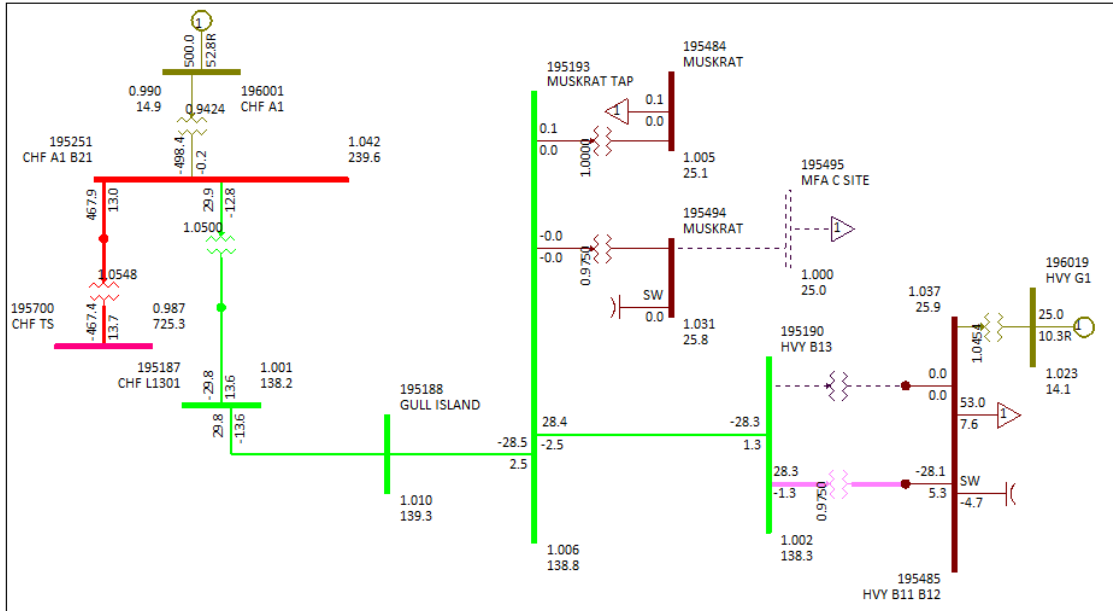


Figure 5: Load Flow Plot – HVY Terminal Station Capacity with T1 Out of Service

Hydro has performed a review of the contingency plan at HVY involving the physical removal of transformer T1 and replacement with the spare unit. The review was performed in the context of Hydro's Business Continuity Plan which states that the maximum acceptable down time for a local area is approximately two days.

It is noted that the procedure for the physical replacement of the transformer involves a complex procedure requiring several steps. Durations associated with these tasks will vary and are heavily dependent on environment conditions and crew and equipment availability.

A listing of tasks required for the transformer replacement is provided in Table 1. This table includes durations that have been specified for a 2014/2015 capital project involving the replacement of a 230/66 kV transformer at Hardwoods Terminal Station.

Table 1: Emergency Transformer Replacement Task Durations

Task	Duration
Mobilization	2 days
Removal of oil from transformer T1	1 day
Disassembly of transformer T1, as required	2 days
Physical removal of transformer T1	1 day
Installation of spare transformer	3 days
Assembly of spare transformer radiators, conservator tanks, bushings, and fans, as required	3 days
Commission spare transformer	5 days
TOTAL	17 days

Exact durations required for the execution of an emergency transformer replacement may vary significantly from the detail noted above depending on numerous factors include environmental conditions. It is clear, however, that such a replacement would require well in excess of the specified maximum of two days that are listed in the existing contingency plan for Happy Valley in Hydro's Business Continuity plan. On this basis, a system modification is required to provide appropriate reliable power to customers served by this terminal station.

3.2 Operating Experience

There have been no significant issues with the performance of this terminal station. Hydro considers business continuity in the event of a transformer loss, such as those noted below. Hydro has had five transformer failures since 2000, as outlined in Table 2.

Table 2: Major Transformer Defects 2000 - Present

Transformer	Year	Problem	Cause
Corner Brook Frequency Converter T2	2002	Shorted Winding	Weak solid insulation
Wiltondale T1	2008	Shorted Winding	Unknown
Sunnyside T1	2014	Bushing Failure*	Not determined (investigation by OEM was inconclusive)
Western Avalon T5	2014	Shorted tap changer*	Suspected to be transient overvoltage resulting from a mis-operating breaker
Corner Brook Frequency Converter T2	2014	Winding failure	Failure of winding bracing

*Speculated by post-failure third-party investigation conducted by equipment manufacturer

3.2.1 Maintenance or Support Arrangements

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

3.2.2 Maintenance History

The five-year maintenance history for the spare transformer is shown in the following table:

Table 2: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	1.8	0.0	1.8
2013	0.0	14.8	14.8
2012	0.0	5.5	5.5
2011	0.3	0.0	0.3
2010	0.0	0.2	0.2

3.2.3 Anticipated Useful Life

For the various components proposed to be installed in this project, the following are anticipated useful lives. Disconnect switches have an anticipated service life of 45 years. Hydro depreciates circuit breakers over a 55 year period. The protection and control panel has an anticipated service life of 30 years. Power transformers are depreciated over a 40 year period. The actual useful life of a transformer depends greatly on environmental factors, electrical faults, and loading levels, but is generally accepted to be between 40 and 60 years.

3.3 Forecast Customer Growth

A load forecast for the transmission system in eastern Labrador is provided in Table 3. Load profile and load duration curves are provided in Figure 6 and Figure 7, respectively.

Table 3: Load Forecast

Labrador Interconnected Load Forecast - Spring 2015						
	2014A	2015	2016	2017	2018	2019
Happy Valley - Goose Bay³						
Gross Peak (kW)	70,963	71,217	72,103	72,908	73,387	73,814
Gross Energy (MWh)	280,003	285,783	289,339	292,566	294,490	296,205
Total Sales (MWh)	271,904	271,682	275,079	278,162	280,001	281,639
Company Use (MWh)	1,411	1,396	1,396	1,396	1,396	1,396
Muskrat Falls						
Customer Peak ⁴ (kW)	4,740	8,000	8,000	8,000	8,000	0
System Peak ⁵ (kW)	0	7,680	7,680	7,680	0	0
Total Sales (MWh)	14,522	31,986	36,100	35,800	19,000	0
Gross Energy (MWh)	16,198	33,482	37,788	37,474	19,889	0
Notes: 1. Gross peak and energy equates to bulk deliveries on interconnected systems. 2. Gross peak and system peaks reported on winter peak basis. 3. Forecast excludes Muskrat Falls construction power and energy requirements. 4. Customer peak reported on a annual peak basis. 5. Muskrat Falls system peak and HV-GB gross peak are coincident.						
Source: Market Analysis Section, System Planning Department Spring 2015						

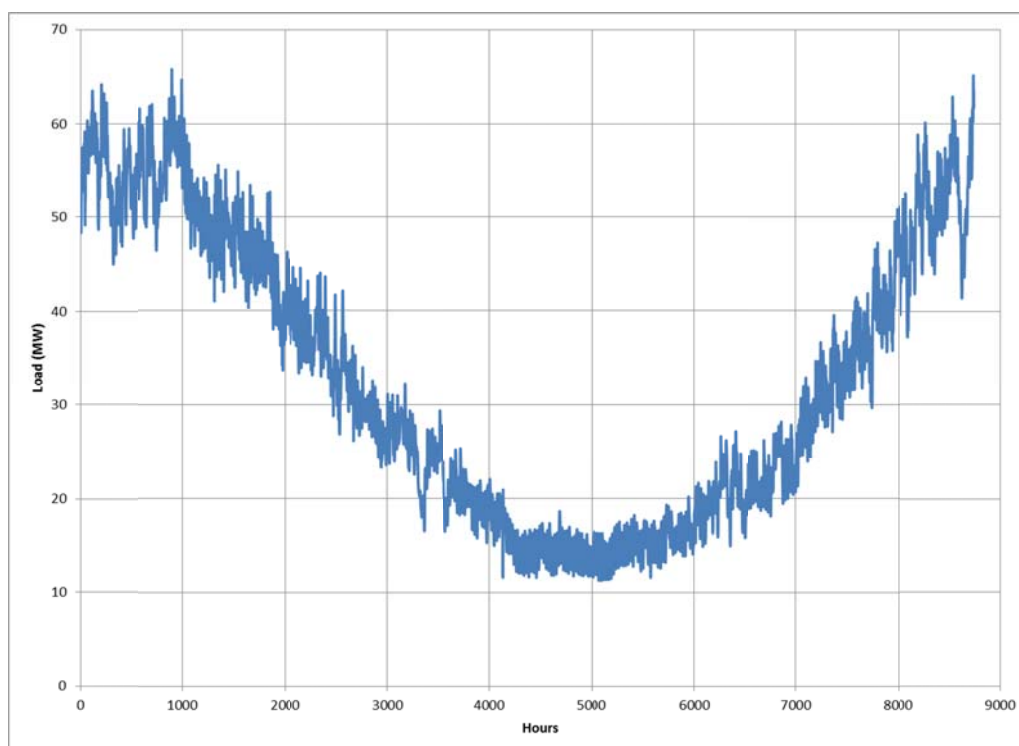


Figure 6: Happy Valley Load Profile

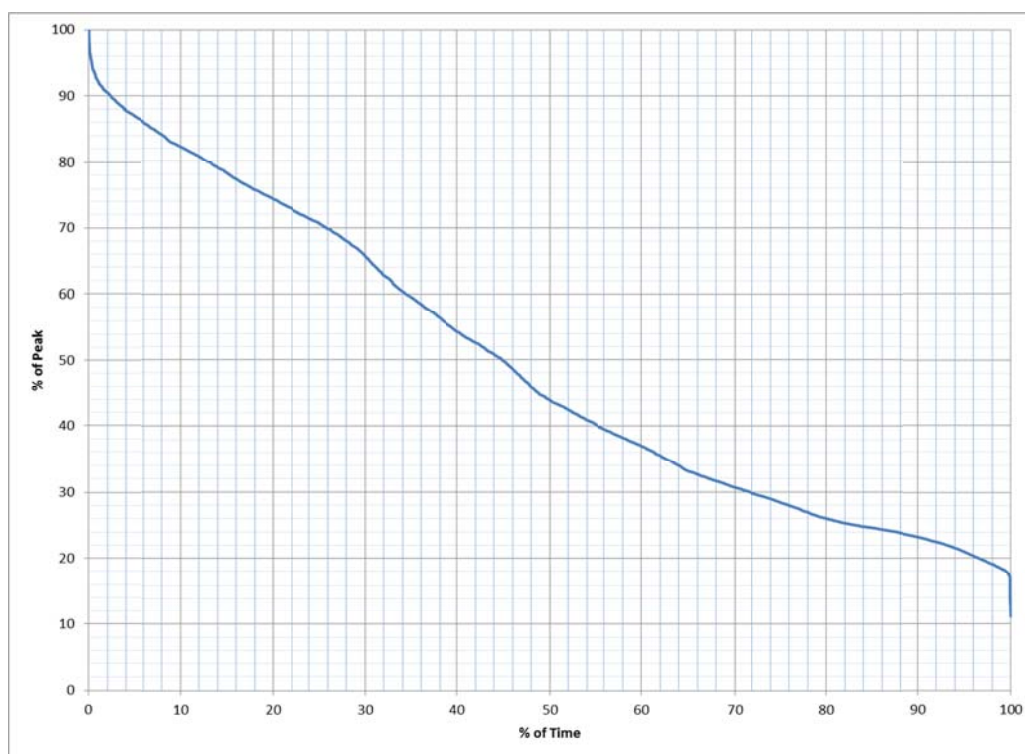


Figure 7: Happy Valley Load Duration Curve

3.4 Development of Alternatives

As discussed in Section 3.1, the existing contingency plan for Happy Valley is in violation of Hydro's Business Continuity plan. It would take several days to replace HVY transformer T1 by moving the spare, currently on site, into the place of the failed transformer, where it would connect into the system with existing infrastructure. Due to the extended length of time to connect the spare into the existing infrastructure, a system modification is required.

Alternatives considered as part of this include the following:

- Terminal station modifications for the emergency interconnection of T4;
- Installation of a mobile substation; and
- Permanent installation of T4 at HVY.

These alternatives are further discussed in the following section.

3.5 Evaluation of Alternatives

The section includes a technical review of alternatives.

Terminal Station Modifications for the Emergency Interconnection of T4

A proposed alternative to reduce customer impacts in the event of a transformer failure at HVY would involve a terminal station modification to facilitate the emergency interconnection of the spare transformer in its current location. The spare transformer would be tagged as T4 in this alternative.

This proposal would involve a modification of 138 kV bus work and the installation of a 138 kV disconnect at HVY to allow for the interconnection of transformer T4. The project would also involve the purchase of 25 kV cables that would be used to jumper connections from the low-voltage side of transformer T4 to circuit breaker T1B12.

A review of this alternative indicates that the time required for the emergency

interconnection of transformer T4 would be between 14 and 28 days, depending on environmental conditions at the time, exceeding the two day maximum outage duration as specified in Hydro's Business Continuity Plan. This is due to complexities associated with the emergency modification to power system equipment as well control and protection schemes.

In summary, the proposed alternative involving terminal station modification to facilitate the emergency interconnection of the spare transformer is technically viable, but would not allow for power restoration within the maximum duration of two days, as specified in Hydro's Business Continuity Plan.

The Installation of a Mobile Substation

Hydro currently has one mobile substation that includes a 132/66/25/12.5 kV, 15 MVA power transformer.

In the event of a power transformer failure, the time required for the mobilization of a portable transformer for installation of HVY would far exceed acceptable durations. Environmental considerations including icing conditions in the Strait of Belle Isle must also be considered. These factors also pertain to mobile substations owned by Newfoundland Power.

Consideration may also be given to the procurement of an additional portable substation. However, based on recent quotes it is noted that the direct costs associated such a purchase are in the range of \$2.3 to \$2.5 million. Costs associated with such a solution would therefore exceed those involving terminal station modifications that would allow for the use of the existing spare transformer onsite at HVY.

Based on the above, the installation of a mobile substation at HVY is not a viable alternative due to the mobilization times that would be required for existing portable transformers and

the high capital cost that would be required for the acquisition of a dedicated portable substation for use in HVY.

The Permanent Interconnection of T4 at HVY

The permanent interconnection of spare transformer (T4) at HVY would provide a long term solution for the terminal station. This alternative would support load growth at HVY and, as indicated in Section 3.1, this installation would ensure compliance with System Planning Criteria; ensuring adequate capacity in the event of the loss of the largest transformer beyond 2019.

Additional benefits of this alternative include the elimination of a requirement to execute emergency procedures in the event of a transformer failure. This alternative therefore minimizes customer impact and eliminates safety risks for Hydro workers.

The interconnection would be as discussed in Section 2 and as illustrated in Figure 8.



Based on the review of alternatives presented in this section, the permanent interconnection of spare transformer at HVY is a viable alternative that is consistent with Hydro's System Planning Criteria and Business Continuity Plan. This alternative supports long term load growth at the terminal station while minimizing customer impacts and health and safety risks to Hydro workers in the event of a transformer failure.

4 CONCLUSION

Upgrades to the Happy Valley Terminal Station are required to ensure consistency with Hydro's System Planning Criteria and Business Continuity Plan. This budget proposal supports the best alternative which is the permanent connection of the spare transformer located within the Happy Valley Terminal Station.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 4.

Table 4: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	550.5	0.0	0.0	550.5
Labour	554.0	0.0	0.0	554.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	432.0	0.0	0.0	432.0
Other Direct Costs	69.6	0.0	0.0	69.6
Interest and Escalation	113.6	0.0	0.0	113.6
Contingency	321.2	0.0	0.0	321.2
TOTAL	2,040.9	0.0	0.0	2,040.9

4.2 Project Schedule

The anticipated project schedule is shown in Table 5.

Table 5: Project Schedule

Activity		Start Date	End Date
Planning	Scope, schedule, cost, risk, quality and communications planning.	January 2016	February 2016
Design	Site visit, engineering design, outage scheduling	February 2016	March 2016
Procurement	Specify and order materials, tender and awarding of contract	April 2016	June 2016
Construction	Installation of new equipment	July 2016	September 2016
Commissioning	Commissioning of new equipment	September 2016	November 2016
Closeout	As built drawing review, project financial closeout, post implementation review	November 2016	December 2016

**A REPORT TO
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	Electrical
	Mechanical
	Civil
	Protection & Control
	Transmission & Distribution
	Telecontrol
	System Planning

Insulator Replacement

TL203

July 2015

SUMMARY

During the 2013-2014 winter season, numerous insulator pin failures have occurred on both Transmission Line TL201 and Transmission Line TL203. As a result of the insulator pin failures, an entire insulator inspection was completed on both lines between January 20 and April 3, 2014. Although the lines are inspected regularly, the previous inspection method did not detect the specific corrosion issue that caused the pin failure. The previous inspection technique was modified prior to the January inspection to incorporate the use of high resolution cameras for improved analysis.

The new inspection determined that many of the insulator pins were significantly corroded and required replacement. Given the widespread extent of the corrosion found on TL201 and the frequency of failures, it was recommended that all the insulators be replaced as soon as possible. This work was completed from September to December, 2014. On TL203, the extensive corrosion was identified to a specific area and it was recommended that insulators on the 30 structures identified be replaced immediately. This work was also a part of the project scope and was completed during the same timeframe as the TL201 replacement.

It is recognized that the remaining TL203 insulator pins are showing the start of corrosion and will experience additional corrosion over time. Therefore, the remaining insulators should be replaced as part of the 2016 Capital Budget Application.

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1 INTRODUCTION

Transmission line TL203 is a 230 kV line located on the Avalon Peninsula of Hydro's Island Interconnected System. TL203 crosses a section of the Avalon characterized by a maritime regional climate and is affected by many low pressure system that cross North America, as well as the maritime systems passing along the eastern seaboard. Many sections of line are subject to high winds and icing from this frequent low pressure. Figure 1 shows the location of TL203.



Figure 1: Route Photo of TL203

TL203 was commissioned in 1965 and consists of 2-pole tangent structures with 3-pole dead end and angle structures. It runs from Sunnyside Terminal Station to Western Avalon Terminal Station, a distance of approximately 45 km. The main conductor is a special aluminum alloy 562.5 Kcmil AACSR 30/19 with a rated strength of 53,000 lb. Another smaller section of line contains a 636 Kcmil ACSR 26/7 conductor with a rated strength of 25,000 lb.

Although inspections were performed over the years, they did not detect that the insulator pins have corroded, specifically the originally installed glass Pilkington insulators. This defect became evident when the frequency of insulator pin failures increased for both TL201 and TL203 during the winter of 2014. This prompted a change to the previously used inspection technique for insulators. Prior to January, 2014, the insulators were visually inspected to identify any possible defects or damage in the insulator string and / or insulator hardware from the pole, during the regular climbing inspection of the overall structure. The nature and location of this specific insulator corrosion made the damage difficult to identify from this vantage point. Therefore, the inspection technique was modified to include the use of high resolution cameras to photograph the damage from the ground. Using this inspection technique, it was determined that TL201 had significant corrosion on the insulator pins along the entire line while the inspection of TL203 found isolated sections with significant corrosion and others showing the start of corrosion.

Through the findings of the inspections, TL201 underwent a complete insulator replacement in 2014 and TL203 underwent insulator replacement on selectively identified structures. The remaining insulators on TL203 are at risk of failure in the future. Therefore, these insulators should be replaced.

2 PROJECT DESCRIPTION

A concern with the Pilkington insulators was first evident in August 27, 2009 on TL203. An insulator pin failure occurred on the center phase of Structure 167 causing an insulator string separation. Inspections were carried out in the general area and no other corrosion issues were identified so it was thought to be an isolated event.

Throughout the 2013-2014 winter season, high winds and adverse weather conditions were experienced on many transmission lines in Hydro's system. These weather conditions escalated the insulator pin failures on both TL201 and TL203. The first failure of the winter season occurred on Structure 163 (TL203) on January 12, 2014. See Figure 2 below.



Figure 2: TL203 – Structure 163 Pilkington Insulator Pin Corrosion

Inspections of both lines began immediately after this failure and continued until April 3, 2014. Since the first reported incident, TL201 and TL203 have experienced four separate line trips due to Pilkington insulator pin failures. See Section 3.2 for complete details regarding these failures.

Through the inspection of TL201, a total of 153 structures were identified with corrosion issues, while 30 structures were identified on TL203.

As previously mentioned, given the widespread extent of the corrosion and frequency of previous line failures on TL201, all insulators were replaced and TL203 underwent insulator replacement on selectively identified structures from September to December, 2014. This proposal is for the remaining insulators on TL203 to be replaced.

The project scope of work is as follows:

- Replace insulators on 155 structures of TL203.

All work will be carried out under Hydro's outage management program.

3 JUSTIFICATION

An insulator replacement is justified on the requirement to replace failing or deteriorated infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service.

The reliability of the insulators affects the reliability of the line and the system as a whole and could lead to increased failure costs. Insulator string separation can also create safety issues and hazards for Hydro personnel and for the general public.

3.1 Existing System

TL203 was constructed in 1965, making the line currently 50 years old. This transmission line has a total of 185 H-frame wooden structures. Table 4 below gives a summary of the structure types on TL203.

Table 1: TL203 Structure Type Summary

Structure Type	Quantity	Percent Total
A	45	24.3%
GA	4	2.16%
B	1	0.54%
D	2	1.08%
GD	2	1.08%
F	5	2.70%
GG	1	0.54%
HA	83	44.86%
HAX	1	0.54%
HD	34	18.38%
HE	2	1.08%
HF	2	1.08%
HHD	3	1.62%

TL203 was designed for two loading zones: “Ice Zone” and “Normal Zone”. In the Ice Zone section, the conductor is aluminum alloy 562.5 Kcmil AACSR 30/19 while in the Normal Zone section, the conductor is a 636 Kcmil ACSR 26/7. A short summary of the major work and upgrades to TL203 can be found in Table 2 below.

Table 2: Major Work or Upgrades TL203

Year	Major Work/Upgrade	Comments
1970	Repaired 28 structures, 8 conductor miles	50 day duration of repairs
2014	Replace insulators, 30 structures	September to December

3.2 Operating Experience

TL203 is one of the oldest transmission lines in Hydro's system. It is a critical line, supplying electrical service to the most densely populated areas of the province. Much of the line traverses very rough terrain which is subject to high winds and icing conditions.

The frequency of recent insulator failures makes the reliability of the line of concern and additional failures are likely. Insulator replacement is necessary to ensure the reliability of the system.

3.2.1 Reliability Performance

The following section will outline in detail the recent reliability of TL203, explaining the recent insulator pin failures and the overall performance of the transmission line.

3.2.1.1 Outage Statistics

TL203 first experienced line separation in August 2009 due to insulator pin failure and also experienced a failure on January 12, 2014. An outage of the line is of particular concern from a reliability standpoint as it results in the unavailability of one of the two parallel 230 KV transmission paths supplying the major load centers on the Avalon. This leads to the potential requirement for customer curtailment to prevent an overload on the remaining in-service line. A significant and widespread customer outage can also result if the remaining line trips unexpectedly.

3.2.2 Legislative or Regulatory Requirements

Legislative or regulatory requirements are not applicable for this project.

3.2.3 Safety Performance

Even though precautionary measures (like the Wood Pole Line Management Program, WPLM) were taken to determine structural and mechanical failures before they occur, the extent of corrosion to the insulators on TL203 was not identified through the visual Wood Pole Line Management inspection method.

There is numerous safety issues associated with inadequate structural strength of insulator pins. The reduced integrity of the insulators affects the reliability of the line and the system as a whole and creates safety issues and hazards for Hydro personnel and for the general public. The condition of the insulators results in a high probability of failure, therefore expedited insulator replacement is necessary.

3.2.4 Maintenance History

In accordance with the WPLM program, TL203 has been regularly inspected. Under the regular inspection method the extent of corroded insulators on the line was not identified. Most recent WPLM inspections for TL203 commenced in June 2011 and the entire line was inspected by the end of 2012.

As previously indicated, the inspection technique has been modified to include high resolution cameras specifically focused towards corrosive insulators. The images taken allow for much better analysis versus visual inspection alone. This technique was used immediately after the failures on TL201 and TL203 to inspect the insulators on both lines. (See Section 3.3)

TL203 will also undergo structural refurbishment under the Wood Pole Line Management Program in the current calendar year of 2015. The estimated cost is approximately \$200,000. The total five-year maintenance history for the line is shown below in Table 3.

Table 3: TL203 Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	-	93.4	93.4
2013	-	15.5	15.5
2012	195.3	142.7	338.0
2011	118.8	2.2	121.0
2010	-	2.8	2.8

3.2.5 Anticipated Useful Life

Without any treatment or refurbishment, the typical life-span of a wood pole structure and its hardware is approximately 40 years. Through proper inspection, maintenance and refurbishment the life of a transmission structure can be extended to over 60 years.

3.3 Insulator Inspection Results

The inspection of TL203 identified 30 structures with significantly corroded insulator pins. The rest of the insulators on the line also show the start of corrosion. Detailed inspection results can also be found in Appendix A.

3.4 Development of Alternatives

There is no viable alternative to replacing the insulators on TL203.

4 CONCLUSION

Given the widespread extent of the corrosion on the insulator pins, it is recommended that all remaining insulators on 155 structures of TL203 undergo insulator replacement. This will reduce the risk of potential failures and associated reliability concerns as well as safety concerns for Hydro personnel and the general public.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 4.

Table 4: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	582.8	0.0	0.0	582.8
Labour	182.2	0.0	0.0	182.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	627.9	0.0	0.0	627.9
Other Direct Costs	180.0	0.0	0.0	180.0
Interest and Escalation	98.1	0.0	0.0	98.1
Contingency	314.6	0.0	0.0	314.6
TOTAL	1,985.6	0.0	0.0	1,985.6

4.2 Project Schedule

The anticipated project schedule is shown in Table 5. The entire project is scheduled to be completed within the 2016 calendar year. In general, the engineering and material procurement will take place from May to August with the construction scheduled from September to November.

Table 5: Project Schedule

Activity		Start Date	End Date
Planning	Engineering Design and Planning	May 2016	August 2016
Procurement	Procurement of Insulators and Hardware	May 2016	August 2016
Construction	Insulator Replacement	September 2016	November 2016
Closeout	Project Closeout	December 2016	December 2016

APPENDIX A
Detailed Insulator Inspection Results

TL203 Detailed Inspection Results

Str. Number	Type	Pole Height	Phases with Extensive Corrosive Insulator Pins
15	A	65	R-Phase
16	A	65	L-Phase
19	A	70	C-Phase
38	HA	60	R-Phase
39	HA	65	R-Phase
48	HA	75	C-Phase
50	HA	50	L-Phase
62	HA	75	C-Phase
68	HA	60	C-Phase
85	HA	75	L-Phase
91	HE	75	C-Phase
113	HA	70	L-Phase
114	HA	65	L-Phase, C-Phase
122	HA	50	C-Phase
128	HA	60	C-Phase
145	A	50	C-Phase, R-Phase
146	A	55	L-Phase, C-Phase
148	A	55	L-Phase, C-Phase
149	A	55	L-Phase, C-Phase
153	A	55	L-Phase, C-Phase
156	A	60	L-Phase, C-Phase
159	A	60	L-Phase, C-Phase
160	A	50	L-Phase
169	A	50	L-Phase
172	A	60	C-Phase
175	A	65	C-Phase
177	A	65	C-Phase, R-Phase
178	A	60	C-Phase
179	A	55	R-Phase
180	A	65	C-Phase

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

Replace Disconnect Switches

Various Sites

July 2015

SUMMARY

This report outlines the basis of the capital budget proposal for the disconnect switch replacement project. This project is part of an ongoing program to replace aging and inoperative 69 kV, 138 kV, and 230 kV disconnect switches within Hydro's terminal stations on the Island Interconnected System. This proposal is requesting the approval of a two-year project plan for disconnect switch replacements. Future capital budget proposals for disconnect replacement will also be planned using the multi-year approach.

This proposal requests approval of a two-year plan for the purchase and replacement of disconnect switches for a total estimated cost of \$1,967,800.

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1 INTRODUCTION

Disconnect switches are used to isolate or bypass equipment and provide a visual air gap to ensure the circuit is open when performing work on adjacent equipment. The disconnect switch replacement program targets 69 kV, 138 kV and 230 kV disconnect switches which operate within Hydro's terminal stations. Disconnect switches are included in the replacement program as condition assessments dictate or as failures occur. The criteria used within the maintenance assessments identify the type, age and condition of the disconnect switches.

Disconnect switches included in the replacement program are prioritized and scheduled for replacement based on their condition as well as their location and outage requirements. Hydro's five-year plan for disconnect switch replacements is provided in Appendix A.

2 PROJECT DESCRIPTION

This project is part of an ongoing program to replace aging 69 kV, 138 kV and 230 kV disconnect switches in Hydro's terminal stations on the Island Interconnected System. The condition of a disconnect switch is defined in terms of age, history of failures, availability of spare parts, and condition (e.g. corrosion, misaligned and broken parts). The priority for disconnect switch replacement is based on the condition, operating location in the system, availability of outage time for repairs, and availability of spare parts. These criteria are considered collectively to determine the priority of repairs or replacements.

The disconnect switch replacement project is scheduled over a two year period to manage risks associated with long lead times for material supply, resource demands, and schedule constraints when planning construction in a short outage period. The multi-year approach will involve engineering and material procurement in the first year and construction and commissioning in both the first and second year.

All disconnect switch replacements are direct replacements using existing support structures.

3 JUSTIFICATION

Disconnect switches are used to isolate equipment either for maintenance activities or system operation and control. Proper operation of disconnect switches is essential for a safe work environment and for reliable and secure system operation. Disconnect switches that do not operate properly prevent reliable and secure system operation and create a safety hazard. Condition inspections have identified the switches scheduled for replacement in this project as having problems such as inoperable mechanical linkages, misalignment of switch blades, broken insulators, and seizing of moving parts. The switches have reached the end of their useful lives and replacement parts are no longer available.

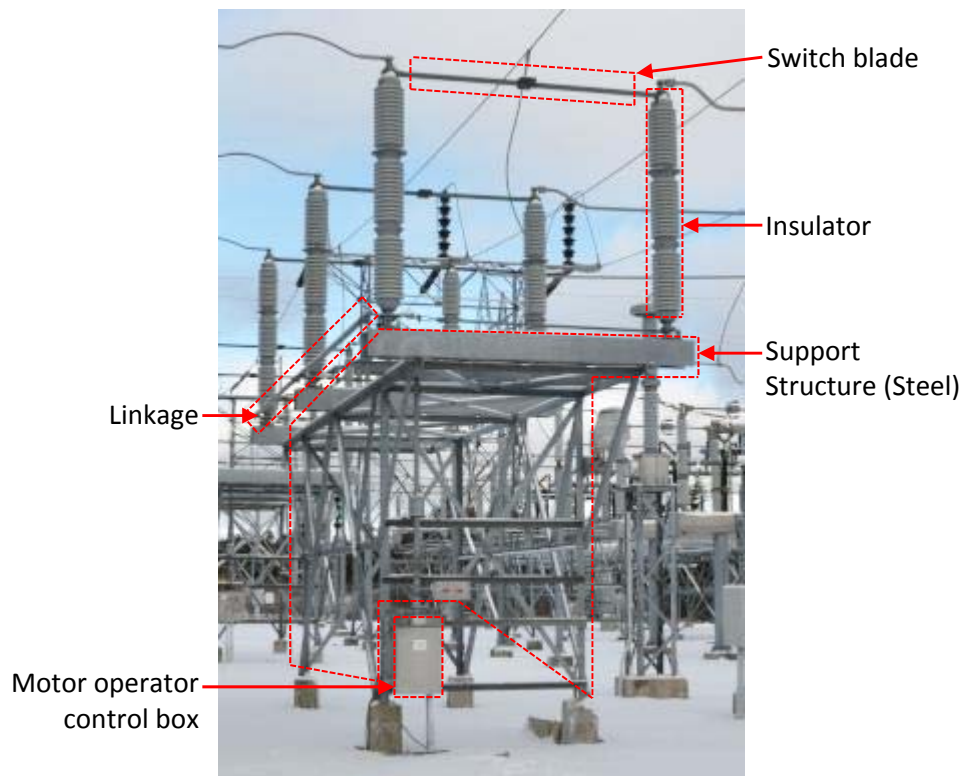


Figure1: Typical 230 kV Disconnect Switch

The condition of the disconnect switches has deteriorated such that continued repair is not an effective solution for eliminating safety hazards and ensuring reliable operation.

Complete replacement of the disconnect switches is required and is best executed within a planned and prioritized replacement program. Hydro has developed a Long Term Asset Management Plan (LTAMP) to support the disconnect switch replacement program. This

project proposes replacement of disconnect switches targeted for 2016. Appendix A contains a copy of the LTAMP, showing the next five years of planned disconnect replacements (2016 to 2020). The figures below show damaged or malfunctioning disconnect switches, which forms the basis for the need for replacement.



Figure 2: Broken Gear Drive from 230 kV disconnect switch in Holyrood



Figure 3: Broken insulator on 69 kV disconnect switch in Barchoix



Figure 4: Misaligned blade terminal on 69 kV disconnect switch in Holyrood

3.1 Existing System

Disconnect switches are an integral part of the power system. These switches are used to isolate a piece of equipment, such as a breaker, transformer or transmission line, in support of maintenance and repair activities. Disconnect switches are also used to bypass equipment to prevent customer outages while work is being performed on adjacent equipment. Disconnect switches are an important part of the Work Protection Code as they provide a visible air gap, i.e., visible isolation, for utility workers. Work Protection is defined as “a guarantee that an ISOLATED, or ISOLATED and DE-ENERGIZED, condition has been established for worker protection and will continue to exist, except for authorized tests.”¹

The basic components of a disconnect switch are the blade, insulators, switch base and operating mechanism. The blade is the main current carrying component in the switch and it moves to open and close the switch. The insulators are made of porcelain and insulate the switch base from the current carrying parts. The switch base supports the insulators and is mounted to a metal frame for wood pole structures or on a steel tower structure. The switches are operated either manually, using a handle at ground level to open and close the blade, or automatically, by a motor operated device.

3.1.1 Operating Regime

Disconnect switches operating in the system are in either an open or closed position. They are operated on an as needed basis to isolate or bypass a piece of equipment.

3.1.2 Age of Equipment or System

The age of disconnect switches on the Island Interconnected System ranges from one to 48 years.

3.1.3 Major Work and/or Upgrades

Aside from the current disconnect switch replacement program, there have been no major

¹ Nalcor Energy Safety and Health Handbook, November 2014, pg. 94.

replacements of terminal station disconnect switches since they were installed. Repairs have been made to replace broken or damaged switch components. The maintenance history of these disconnect switches includes repair or replacement of insulators, control systems, drive motors, gearboxes, auxiliary contact cams, brakes, heaters, motor contactors, control arms, jaws, springs, blades, couplings, and hinges. This work history is summarized in Table 1. The hot spot data shown in the table refers to events where operations staff had to respond to overheating conditions resulting from the failure of mechanical and current carrying parts.

Table 1: Work History Summary

Disconnect Switch Work History Summary(2000 to 2013)				
kV Class	Replace Insulators	Repair Controls	Hardware and Mechanical Issues	Hot Spots and Emergencies
230	29	119	158	30
138	11	29	60	7
69	21	10	103	24
Total	61	158	321	61

3.2 Operating Experience

The existing disconnect switches targeted for replacement in 2016/17 have reached the end of their service lives and, in some cases, no longer perform their intended function. Faulty or damaged switches may be tagged inoperative, which means the switch cannot be opened or closed. As a result, equipment cannot be isolated by the inoperative disconnect switch and adjacent disconnect switches must be operated in order to isolate the equipment. This decreases system reliability and performance since additional equipment and customers will be included in the outage/isolation for a longer duration of time. This scenario also increases the safety risk to personnel who have to execute a more complicated switching order, which may involve a remote disconnect not typically included in the isolation of the equipment.

Bay d’Espoir disconnect switch B3B4-1 has experienced a motor operator and contactor failure.

Massey Drive disconnect switches B4T1-1, B4L1-1, B4L16-1, B4L17-1 and B2B4-1 have experienced insulator and linkage failures.

Bottom Brook disconnect switches B2T1 and B2T2 have experienced gear box and linkage failures.

Holyrood disconnect switch B11T5 has experienced insulator and linkage issues.

Bay d'Espoir disconnect switch B1B2-1 has experienced issues with couplings and linkages.

Holyrood disconnect switch B2L42-2/L42G and B1L17-2/L17G have experienced insulator and linkage issues.

Springdale disconnect switch B1L22-2/L22G has experienced linkage and alignment issues.

Sunnyside disconnect switch B1L02-2/L02G has experienced linkage and alignment issues.

The status quo is not an acceptable alternative. These disconnect switches present safety and reliability issues.

3.2.1 Reliability Performance

Hydro does not monitor the reliability performance of disconnect switches, as the disconnect switches are a sub-component within terminal stations. Instead, Hydro tracks the performance of terminal stations, which includes disconnect switches, circuit breakers, insulators, surge arresters, transformers and station power buses.

3.2.1.1 Outage Statistics

Outage statistics for terminal station equipment includes outages as a result of disconnect failures, but the performance of the disconnect switches is not directly measured. Properly functioning disconnect switches have a positive impact on both frequency and duration of

outages originating in terminal stations. Following Canadian utility practice of tracking system performance, Hydro measures the forced outage performance of terminal stations. Table 2 lists the 2010 to 2014 average T-SAIFI and T-SAIDI data by region, and compares Hydro's system averages to Canadian Electricity Association (CEA) system averages.

Table 2: Forced Outage Performance Statistics

Five-year Averages of Forced Outages (2010 to 2014)		
Delivery Point Affected	T-SAIFI	T-SAIDI
Hydro, Central Region	0.55	52.62
Hydro, Northern Region	7.15	365.55
Hydro, Labrador Region	3.47	125.12
Hydro	2.07	120.98
CEA (2009-2013)	0.78	74.16

T-SAIFI is a measure of the average frequency of transmission interruptions that a delivery point experiences during a given period.

T-SAIDI is a measure of average total interruption duration, in hours, that a delivery point experiences during a given period.

3.2.2 Safety Performance

Faulty or malfunctioning disconnect switches create safety hazards. A disconnect switch having a damaged insulator can result in parts breaking off, which could potentially fall on personnel working on or around the disconnect structure. Insulator failures on disconnect switches have occurred at the Bay d'Espoir, Barachois, Conne River, Hawke's Bay, Wiltondale, Glenburnie, and Parsons Pond Terminal Stations. Hydro has revised its terminal station standards for disconnect switches to include insulators with higher cantilever strength in an effort to reduce the risk of parts breaking and falling.

3.2.3 Industry Experience

Hydro's approach to the disconnect replacement program is consistent with utility industry practice, in which replacements are based on the condition (age and functionality), safety,

criticality and reliability of the disconnect switch.

3.2.4 Vendor Recommendations

Vendors typically recommend the replacement of a disconnect switch after 1,000 operations. However, Hydro does not track the operating history of its disconnect switches. Disconnect switches are operated to isolate equipment for operation or maintenance purposes. Many of the disconnect switches that operate frequently may only operate six to ten times per year. Others, in a radial application operate twice a year or less. As a result, the majority of disconnect switches will take decades to experience 1,000 operations. With the environmental conditions in Newfoundland and Labrador, it is more prudent to consider replacement based upon condition such as component failures (seizure or misalignment for example), which are typically due to corrosion. Essentially, due to the fact that the majority of switches within Hydro will take decades to experience 1,000 operations, effort is better spent on understanding the condition of the asset, to plan its replacement and ensure it is operating reliably.

3.2.5 Maintenance or Support Arrangements

Maintenance on disconnect switches is performed by Hydro personnel.

3.2.6 Maintenance History

The five-year maintenance history for disconnect switches is shown in Table 3.

Table 3: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	159.1	117.8	276.9
2013	30.4	88.5	118.9
2012	50.7	39.6	90.3
2011	46.9	24.0	70.9
2010	24.3	28.9	53.2

3.2.7 Historical Information

Table 4 provides a recent history of disconnect switch replacements.

Table 4: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)	Comments
2014	815.9	148.4	1	148.4	Installed one disconnect in Deer Lake and placed order for seven disconnects. Delivery of disconnects in 2015 due to longer than expected lead time for manufacturing. This is a multiyear project ending in 2015.
2013	492.6	374.5	3	124.8	Purchased six disconnects. Installed three of the six units due to schedule constraints on delivery and outages.
2012	351.8	319.2	4	79.8	Replaced four disconnects at Western Avalon and Happy Valley. Purchase for eight disconnects.
2011	295.0	408.2	9	45.4	Purchased and replaced four disconnects at Conne River and English Harbour West. Purchased five disconnects.
2010	199.0	301.0	5	60.2	Replacements of switches at English Harbour West, Conne River, and Corner Brook Converter stations.
2009	0.0	0.0	0	0.0	No disconnect replacement project in 2009.
2008	367.6	568.4	16	35.5	Replacement of switches at Cow Head and Daniel's Harbour.

It is anticipated that all disconnects procured and scheduled for replacement up to and including 2015, will be installed by the end of 2015.

3.2.8 Anticipated Useful Life

Disconnect switches have an anticipated service life of 45 years.

3.3 Forecast Customer Growth

Customer load growth does not affect this project.

3.4 Development of Alternatives

There are no viable alternatives for the replacement of disconnect switches.

4 CONCLUSION

Proper operation of disconnect switches is essential to a safe work environment and for reliable and secure system operation. Many of the disconnect switches within the Island Interconnected System have exceeded their useful life and have faulty or damaged parts, which compromise the safety and reliability in their performance. This capital budget proposal supports a feasible, orderly and prioritized program to replace the most problematic disconnect switches.

This capital budget proposal is for the replacement disconnects switches as listed in the disconnect replacement plan (Appendix A).

4.1 Budget Estimate

The budget estimate for this project is shown in Table 5.

Table 5: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	69.0	30.0	0.0	99.0
Labour	532.0	795.5	0.0	1,327.5
Consultant	0.0	7.4	0.0	7.4
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	7.4	52.5	0.0	59.9
Interest and Escalation	38.5	136.8	0.0	175.3
Contingency	0.0	298.7	0.0	298.7
TOTAL	646.9	1,320.9	0.0	1,967.8

4.2 Project Schedule

The anticipated project schedule is shown in Table 6.

Table 6: Project Schedule

	Activity	Start Date	End Date
Planning	Scope, schedule, cost, risk, quality and communication planning. Also involves monitoring and controlling project activities.	January 2016	March 2016
Design	Site visits, engineering and design of disconnect replacement drawings, commissioning procedures and checklists, issue for construction work package.	March 2016	May 2016
Procurement	Disconnect technical specification and purchase order for 2016. Tender evaluation and selection. (<i>Delivery lead time four to six months</i>).	May 2016	September 2016
Construction 1	Replacement of disconnect switches.	September 2016	November 2016
Commissioning 1	Energization and testing of new disconnects.	September 2016	November 2016
Construction 2	Replacement of disconnect switches.	April 2017	November 2017
Closeout	As built drawing review. Procurement contract close out, project financial close out and post implementation review.	November 2017	December 2017

APPENDIX A
Five-Year Plan For Disconnect Replacements

Target Year (Year 2 of Project)	Terminal Station	Asset Description	Voltage Rating (kV)	Condition Assessment Results
2017	Bay d'Espoir	B3B4-1	230	Motor operator and contactor failure. Parts unavailable.
2017	Massey Drive	B4T1-1	69	Insulators and linkages. Procurement 2016, install 2017.
2017	Massey Drive	B4L17-1	69	Insulators and linkages. Procurement 2016, install 2017.
2017	Massey Drive	B4L16-1	69	Insulators and linkages. Procurement 2016, install 2017.
2017	Massey Drive	B4L1-1	69	Insulators and linkages. Procurement 2016, install 2017.
2017	Massey Drive	B2B4-1	69	Insulators and linkages. Procurement 2016, install 2017.
2017	Bottom Brook	B2T1	138	Gear Box and Linkage
2017	Bottom Brook	B2T2	138	Gear Box and Linkage
2017	Holyrood	B11T5	230	Gear Box and Linkage
2017	Bay d'Espoir	B1B2-1	230	Couplings and Linkage
2017	Holyrood	B2L42-2 / L42G	230	Insulators and linkages
2017	Holyrood	B1L17-2 / L17G	230	Insulators and linkages
2017	Springdale	B1L22-2 / L22G	138	Linkage and Alignment
2017	Sunnyside	B1L02-2 / L02G	230	Linkage and Alignment
2018	Bottom Brook	B1L11-2/L11G	230	Gear Box and Linkage
2018	Bottom Brook	B2L14-2/L14G	138	Couplings and Linkage. Unable to operate L14G
2018	Bottom Brook	B2L14-1	138	Couplings and Linkage
2018	Massey Drive	B3L357-1	69	Insulators and linkages
2018	Massey Drive	B3L351-1	69	Insulators and linkages
2018	Massey Drive	B2T2-1	69	Insulators and linkages
2018	Massey Drive	B2L356-1	69	Insulators and linkages
2018	Massey Drive	B2L352-1	69	Insulators and linkages
2018	Massey Drive	B2GT-1	69	Insulators and linkages

Target Year (Year 2 of Project)	Terminal Station	Asset Description	Voltage Rating (kV)	Condition Assessment Results
2018	Massey Drive	B2B3-1	69	Insulators and linkages
2018	Western Avalon	B1L37-1	230	Insulators and linkages
2018	Western Avalon	B1L37-2 / L37G	230	Insulators and linkages
2018	Sunnyside	B2L12-2 / L12G	138	Couplings and linkage
2018	Sunnyside	B2L12-1	138	Gear Box
2018	Sunnyside	B2T1-1	138	Rusty linkage on one phase.
2019	Deer Lake	B1L45-1	138	Gear Box
2019	Deer Lake	B1L15-2	69	Bearings, Gear Box and Linkage
2019	Rattle Brook Tap	L53-1 / L53G-2	69	Insulators and linkages
2019	Stony Brook	L04L32-1	230	Insulators and linkages
2019	Stony Brook	B1L35-2	230	Insulators and linkages
2019	Barchoix	L20T1/L20G	69	Insulator failures causing safety hazard.
2019	Barchoix	T1AG	69	Insulator failures causing safety hazard.
2019	Bottom Brook	L09L33-2/L33G	230	Couplings and Linkage
2019	Bottom Brook	L11L33-2	230	Gear Box
2019	Deer Lake	B1L39-2/L39G	138	Gear Box
2019	Deer Lake	B1L45-2/L45G	138	Gear Box
2019	Deer Lake	B1L39-1	138	Gear Box
2019	Holyrood	B8L39-1	138	Insulators and linkages
2019	Holyrood	B8L39-2 / L39G	138	Insulators and linkages
2019	Sunnyside	L100L109-1	138	Insulators and linkages
2020	Cone River	L20T1	69	Insulator failures.
2020	Hampden Tap	L51-1/L51G	69	Linkage and Alignment
2020	Hampden Tap	L52-1/L52G	69	Linkage and Alignment

Target Year (Year 2 of Project)	Terminal Station	Asset Description	Voltage Rating (kV)	Condition Assessment Results
2020	Buchans	L28L32-1	230	Insulators and linkages
2020	Buchans	L28L32-2 / L32G	230	Insulators and linkages
2020	Holyrood	B12L42-1	230	Insulators and linkages
2020	Holyrood	B12L42-2	230	Insulators and linkages
2020	Holyrood	B12L18-1	230	Insulators and linkages
2020	Holyrood	B12L18-2	230	Insulators and linkages
2020	Sunnyside	L02L07-1	230	Insulators and linkages
2020	Sunnyside	L02L07-2	230	Insulators and linkages
2020	Sunnyside	L06L07-1 / L06G	230	Insulators and linkages
2020	Sunnyside	L03L06-2	230	Insulators and linkages
2020	Sunnyside	B1L03-2 / L03G	230	Insulators and linkages
2020	Sunnyside	B1L03-1	230	Insulators and linkages
2020	Sunnyside	B1L02-1	230	Insulators and linkages
2021	Holyrood	B12L17-1	230	Insulators and linkages
2021	Bay d'Espoir	B12L17-2	230	Insulators and linkages
2021	Bay d'Espoir	B6L31 / L31G	230	Insulators and linkages
2021	Bay d'Espoir	B5B6-2	230	Insulators and linkages
2021	Bay d'Espoir	B5B6-1	230	Insulators and linkages
2021	Bay d'Espoir	B6B10-1	230	Insulators and linkages
2021	Bay d'Espoir	B6B10-2	230	Insulators and linkages
2021	Bay d'Espoir	B1B10-2	230	Insulators and linkages
2021	Bay d'Espoir	B1B10-1	230	Insulators and linkages
2021	Bay d'Espoir	B1T1-1	230	Insulators and linkages
2021	Bay d'Espoir	B1B2-2	230	Insulators and linkages
2021	Bay d'Espoir	B1T2-1	230	Insulators and linkages

Target Year (Year 2 of Project)	Terminal Station	Asset Description	Voltage Rating (kV)	Condition Assessment Results
2021	Bay d'Espoir	B2T3-1	230	Insulators and linkages
2021	Bay d'Espoir	B2T4-1	230	Insulators and linkages
2021	Bay d'Espoir	B2B3-1	230	Insulators and linkages
2021	Bay d'Espoir	B2B3-2	230	Insulators and linkages
2021	Bay d'Espoir	B3T5-1	230	Insulators and linkages

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

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

**Replace Protective Relays
Various Sites**

July 2015

SUMMARY

The report addresses the need to replace existing protective relays on the following equipment:

Bay d’Espoir Generating Station: Transformers T1, T2, T3 (Note 1), T4, T5, T6 and T7;

Cat Arm Generating Station: Transformer T1;

Holyrood Terminal Station: Transformer T5; Transmission Lines 38L and 39L;

Bay d’Espoir Terminal Station: Transmission Line TL202 (Note 2);

Sunnyside Terminal Station: Transmission Line TL202 (Note 2); and

Western Avalon Terminal Station: Transmission Line 64L.

Notes:

- 1) For Bay d’Espoir Generating Station Transformer T3, there is an existing digital multifunction relay and only a second will be added.
- 2) For TL202 at both Bay d’Espoir and Sunnyside Terminal Stations, only the Protection A relay will be replaced as the existing Protection B relay is a digital multifunction type.

The existing relays are the electromechanical and older solid state types and they need to be replaced due to age and performance limitations. Modern digital multifunction relays will be installed. These relays have increased setting flexibility, fault disturbance monitoring, communications capability and metering functionality and they offer greater dependability and security.

In 2014 Hydro prepared a plan to replace the relays on the 230 kV transformers, buses and transmission lines over eleven years starting in 2015. The plan for 2016 was to replace the relays on Bay d’Espoir transformers T1, T2, T4, T5, T6 and T7; Holyrood transformer T5 and transmission line TL202 at both Bay d’Espoir and Sunnyside. Bay d’Espoir transformer T3 was not in the original plan as it had been upgraded in 2014 with a single transformer multifunction relay. A draft transformer protection standard prepared by Hydro in 2014 recommended two multifunction relays for transformers over 10 MVA and therefore a

second multifunction relay will be added to T3. The relays on Cat Arm T1 were planned for 2019 but since the transformer T1 will be replaced in 2016 it was decided to replace the relays during the same outage.

Hydro's plan to replace electromechanical relays on 230 kV rated equipment did not include those on 38L, 39L and 64L as they operate at 66kV or 138 kV. The relays on these lines are electromechanical and older solid state types and need to be replaced due to age and performance limitations. These lines form sections of transmission loops between Holyrood and Hardwoods and Western Avalon Terminal Stations operated by Newfoundland Power who have replaced the relays at their substations in these loops.

The project will begin in January, 2016 and be completed by November, 2017.

The total project estimate is \$1,857,000.

The scope may change if it is necessary to replace relays that have failed on equipment other than that specified in this proposal.

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1 INTRODUCTION

The Bay d’Espoir Hydroelectric Generating Station (Bay d’Espoir) consists of seven generating units producing a total capacity of 604 MW which is approximately 39% of the Island Interconnected System’s installed capacity. Units 1, 2 and 3 were put into service in 1967; Unit 4 in 1968; Units 5 and 6 in 1970 and Unit 7 in 1977.

Each of the seven generating units has a generator step up transformer which raises the voltage from 13.8 kV to 230 kV. These transformers are designated by the generating unit number preceded by the letter T. Therefore, the transformer designations are T1, T2, T3, T4, T5, T6 and T7.

The Cat Arm Hydroelectric Generating Station (Cat Arm) is located on the Great Northern Peninsula between Cat Arm Reservoir and White Bay. The plant was put into service in February, 1985 and has two identical generating units, each with a net rating of 63.5 MW for a total capacity of 127 MW. Cat Arm has an annual energy production of approximately 675 GWH. Each of the generating units has a generator step up transformer which raises the voltage from 13.8 kV to 230 kV. The transformer designations are T1 and T2.

Transformer T5 in the Holyrood Terminal Station steps the voltage from 230 kV to 69 kV to provide station service supply to the Holyrood Generating Station and for line 38L which forms a section of a transmission loop operated by Newfoundland Power between Holyrood Terminal Station and Hardwoods Terminal Station.

Transmission line TL202 is a 230 kV line between Bay d’Espoir Terminal Station and Sunnyside Terminal Station. It is one of two 230 kV transmission lines linking Bay d’Espoir with the eastern portion of the Island. The existing Protection A is based on an older solid state design and it will be replaced. The existing Protection B relay is a microprocessor based model and it will not be replaced.

Line 38L is a 69 kV transmission line between Holyrood Terminal Station and Newfoundland Power's Seal Cove Substation. It is part of a transmission loop between Holyrood Terminal Station and Hardwoods Terminal Station. Line 38L is used as an alternate station service supply from Hardwoods Gas Turbine to the Holyrood Generating Station.

Hydro maintains the breaker and protective relays at Holyrood Terminal Station and the lines are maintained by Newfoundland Power.

Line 39L is a 138 kV transmission line between Holyrood Terminal Station and Newfoundland Power's Holyrood Substation. It is part of a transmission loop between Holyrood Terminal Station and Western Avalon Terminal Station. Hydro maintains the breaker and protective relays at Holyrood Terminal Station and the lines are maintained by Newfoundland Power.

Line 64L is the Western Avalon termination for the 138 kV transmission loop from Holyrood Terminal Station that begins with line 39L. The breaker for 64L is owned by Newfoundland Power but the protective relays are owned and maintained by Hydro.

The existing protective relays on transformers T1, T2, T4, T5, T6 and T7 at Bay d'Espoir, transformer T1 at Cat Arm and transformer T5 at Holyrood are electromechanical and older solid state types and will need to be replaced with redundant digital multifunction relays. T3 at Bay d'Espoir has an existing digital multifunction relay and only a second multifunction relay will need to be installed.

Transmission line TL202 has a digital multifunction relay as Protection B but the Protection A relays are electromechanical and an older solid state type and will need to be replaced. Transmission lines 39L and 64L have electromechanical relays and line 38L has an older solid state relay and electromechanical relays.

2 PROJECT DESCRIPTION

This project involves the replacement of electromechanical and solid state relays on the following equipment and transmission lines:

- Bay d’Espoir Generating Station: Transformers T1,T2,T3 (Note 1),T4,T5,T6 and T7
- Cat Arm Generating Station: Transformer T1
- Holyrood Terminal Station: Transformer T5; Transmission lines 38L and 39L
- Bay d’Espoir Terminal Station: Transmission line TL202 (Note 2)
- Sunnyside Terminal Station: Transmission line TL202 (Note 2)
- Western Avalon Terminal Station: Transmission line 64L

Note:

- 1) For Bay d’Espoir Generating Station Transformer T3, there is an existing multifunction relay and only a second will be added.
- 2) For TL202 at both Bay d’Espoir and Sunnyside Terminal Stations, only the Protection A relay will be replaced as the existing Protection B relay is a multifunction type.

Each transformer will have redundant digital multifunction relays from different suppliers. Lines 38L, 39L and 64L will have one line protection multifunction relay and one digital overcurrent relay. The reclosing relay on 38L will also be replaced. TL202 at Bay d’Espoir and Sunnyside will have one multifunction relay added as Protection A.

Control cables will be replaced on Bay d’Espoir T1, T2, T4, T5, T6, T7; Cat Arm T1 and Holyrood T5. The cables were replaced on Bay d’Espoir T3 in 2014. They will not be replaced at the Terminal Stations for TL202, 38L, 39L and 64L. They will be replaced at those stations if the line breakers are replaced.

In 2016 relays will be replaced on the following:

- o Bay d’Espoir Generating Station Transformers T1, T2, T4, T5 and T7, and
- o Cat Arm Generating Station Transformer T1.

In 2017 relays will be replaced on the following:

- o Bay d’Espoir Generating Station Transformer T6 and a second multifunction relay will be added to Transformer T3,
- o Holyrood Terminal Station Transformer T5 ,
- o Holyrood Terminal Station transmission lines 38L and 39L,
- o Western Avalon Terminal Station transmission line 64L, and
- o Bay d’Espoir and Sunnyside Terminal Stations Protection A on TL202.

The relays that are replaced in each year may change depending on availability of outages and resources. All relay replacements will be completed by November, 2017.

The Project Management and Engineering design work will be done by the Project Execution and Technical Services Division.

3 JUSTIFICATION

In 2014, Hydro completed the following:

- A review of all transformer, bus, and line relays on 230 kV, 138 kV, and 69 kV systems.
- A plan to replace all existing 230 kV electromechanical transformer, bus, and line protection relays with modern digital relays. The 230 kV relays are the priority for the first phase of the plan.
- A review of data storage and fault recording capabilities on modern digital relays.

The review recommended replacement of relays on the following equipment in 2016 and 2017:

- A) Bay d’Espoir Generating Station: Transformers T1,T2,T4,T5,T6,T7,
- B) Holyrood Terminal Station: Transformer T5, and
- C) Bay d’Espoir and Sunnyside Terminal Stations: Transmission line TL202.

It was also recommended in the review to upgrade the relays on Transmission line TL242 between Holyrood and Hardwoods Terminal Stations but this work will be done under a separate project related to the Lower Churchill Project and the construction of Soldier’s Pond Terminal Station.

In addition, Bay d’Espoir T3 was not in the original plan as it had been upgraded in 2014 with a single transformer multifunction relay. A draft transformer standard prepared by Hydro in 2014 recommends two multifunction relays for transformers over 10 MVA and therefore a second multifunction relay will be added to T3.

The relays on Cat Arm T1 were planned for 2019 but since the transformer T1 will be replaced in 2016 it was decided to replace the relays during the same outage.

Electromechanical relays needing replacement on 138 and 66 kV equipment were identified

in the review prepared by Hydro. However, since the relays on 230 kV equipment were the priority, a plan to replace those on the lower voltage equipment was not prepared. The relays on 38L, 39L and 64L need to be replaced as Newfoundland Power have replaced the relays on all other sections of the transmission loops between Holyrood and Hardwoods and Western Avalon Terminal Stations.

Line 39L is a 138 kV transmission line between Holyrood Terminal Station and Newfoundland Power's Holyrood Substation. It is part of a transmission loop between Holyrood Terminal Station and Western Avalon Terminal Station. Hydro maintains the breaker and protective relays at Holyrood Terminal Station and the lines are maintained by Newfoundland Power. Originally 39L ran from Holyrood Terminal Station to Newfoundland Power's Bay Roberts Substation. In 2014 Newfoundland Power installed a breaker at their Holyrood Substation and renamed the section from the Holyrood Substation to the Bay Roberts Substation as 42L. This shortened 39L to the line section between Holyrood Terminal Station and Newfoundland Power's Holyrood Substation. Due to this change the settings on the protective relays (Westinghouse types KD-4 and KD-41) at Holyrood Terminal Station had to be reduced for the shortened section of line. The available setting range on the existing relays would not permit the new settings and they were replaced with other electromechanical relays KD-10 and KD-11.

On September 11, 2012, there were events on the interconnected electrical system caused by Hurricane Leslie that resulted in all customers east of the Western Avalon Terminal Station experiencing an outage. Analysis of the events concluded that protective relays operated only at the Bay Roberts end of 39L and this resulted in slow clearing of faults which impacted the 230 kV system. It was recommended in the analysis report that the electromechanical relays on 39L be replaced. Newfoundland Power has replaced the relays on all of their lines in the Holyrood to Western Avalon transmission loop. The only relays remaining to be replaced are those at Holyrood Terminal Station on 39L and Western Avalon Terminal Station on 64L.

Line 64L is the Western Avalon termination for the 138 kV transmission loop from Holyrood Terminal Station that begins with line 39L. The breaker for 64L is owned by Newfoundland Power but the protection is owned and maintained by Hydro. The existing relays are an electromechanical type.

Line 38L is a 69 kV transmission line between Holyrood Terminal Station and Newfoundland Power's Seal Cove Substation. It is part of a transmission loop between Holyrood Terminal Station and Hardwoods Terminal Station. Line 38L is used as an alternate station service supply from Hardwoods Gas Turbine to the Holyrood Generating Station.

Hydro maintains the breaker and protective relays at Holyrood Terminal Station and the line is maintained by Newfoundland Power.

The existing primary protection relay on 38L is an earlier solid state model and the secondary protection is an electromechanical type. Newfoundland Power has replaced the relays on all of their lines in the Holyrood to Hardwoods transmission loop. The only relays remaining to be replaced are those at Holyrood Terminal Station on 38L.

The report on the disturbances during Hurricane Leslie on September 11, 2012 also recommended the replacement of electromechanical and solid state relays on lines 64L, 39L and 38L.

Replacement relays for all equipment in this proposal will be modern microprocessor type. These relays will have increased setting flexibility, fault disturbance monitoring, communications capability and metering functionality and will offer greater dependability and security. All functions to protect the equipment are contained in one relay and are configured using software.

3.1 Existing System

The existing relays on the transformers and transmission lines are electromechanical and solid state types. The relays for each transformer and transmission line are shown in Table 1.

Table 1: Relay Types

Transformer/Line	Relay Type	Notes
Bay d’Espoir T1	Differential, Westinghouse type HU Overcurrent, GE type IAC	Electromechanical Electromechanical
Bay d’Espoir T2	Differential, Alstom type MBCH Overcurrent, GE type IAC	Solid state relay Electromechanical
Bay d’Espoir T3	Existing multifunction relay installed in 2014	Second relay to be installed under this proposal
Bay d’Espoir T4	Differential, Alstom type MBCH Overcurrent, GE type IAC	Solid state relay Electromechanical
Bay d’Espoir T5	Differential, Alstom type MBCH Overcurrent, GE type IAC	Solid state relay Electromechanical
Bay d’Espoir T6	Differential, Alstom type MBCH Overcurrent, GE type IAC	Solid state relay Electromechanical
Bay d’Espoir T7	Differential, GE type BDD Overcurrent, GE type IAC	Electromechanical Electromechanical
Cat Arm T1	Differential, Westinghouse type HU Overcurrent, GE type IAC	Electromechanical Electromechanical
Holyrood T5	Differential, Westinghouse type HU Overcurrent, GE type IAC	Electromechanical Electromechanical
Bay d’Espoir TL202	Line distance, Alstom Optimho (Primary Protection A) Overcurrent, GE types IAV & PJC	Solid state relay Electromechanical
Sunnyside TL202	Line distance, Alstom Optimho (Primary Protection A) Overcurrent, GE types IAV & PJC	Solid state relay Electromechanical
Holyrood 38L	Line distance, ABB RAZOA Overcurrent, GE type IAC Reclosing relay, Agastat timers	Solid state relay Electromechanical Electromechanical
Holyrood 39L	Line distance, Westinghouse type KD-10 (replaced existing KD-4 in January, 2015) Line distance, Westinghouse type KD-11 (replaced existing KD-41 in Jan. 2015) Overcurrent, GE type IAC	Electromechanical Electromechanical Electromechanical
Western Avalon 64L	Line distance, Westinghouse KD-4 Line distance, Westinghouse KD-41 Overcurrent, GE type IAC	Electromechanical Electromechanical Electromechanical

There has not been any major work or upgrades on the equipment relays specified in this proposal.

3.2 Operating Experience

The existing electromechanical and solid state relays on the transformers and transmission line have performed well. The electromechanical relays in Table 1 have been used in the Hydro system for over 40 years.

The Alstom Optimho relays are solid state type approximately 20 years old and their replacement, due to age and performance imitations, was recommended in an earlier protection review. Based on this recommendation, the Optimho relays on TL203 between Sunnyside and Western Avalon Terminal Stations are being replaced in 2015.

The Alstom MBCH relays are a solid state type used in the Hydro system for the last 20 years.

The ABB RAZOA line distance relay was installed on 38L in 1989.

3.2.1 Reliability Performance

The relays have been reliable but need to be replaced due to age and performance limitations.

Newfoundland Power has replaced the relays at the other end of 38L, 39L and 64L.

3.2.1.1 Outage Statistics

There have been no events resulting from equipment or protection issues on Bay d’Espoir Generating Station Transformers T1, T2, T3, T4, T5, T6 or T7; Cat Arm Generating Station Transformer T1 or Holyrood Terminal Station Transformer T5 since 2000.

The outage statistics for transmission line TL202 from 2009 to 2013 are:

Table 2: TL202 Outage Statistics (2009 to 2013)

Description	Frequency (per a)	Unavailability (%)
TL202	0.90	0.041
NLH 230 kV	0.07	0.004
CEA 230 kV	0.150	0.520

- a) Frequency (per terminal year): the number of line outages per line terminal
- b) Unavailability: the amount of time the line is not available for the line /terminal related

The T-SAIFI and T-SAIDI for Holyrood 38L, Holyrood 39L and Western Avalon 64L delivery points are given in Table 3. The outages listed are for forced outages only.

Interruptions to these delivery points (DP) are an unlikely occurrence as these DP are supplied by two transmission sources. All of the interruptions listed in the table were the result of major events which affected most, if not all, customers on the Avalon Peninsula.

Table 3: Performance Data from 2004 to 2014 for 38L, 39L and 64L

Delivery Point	Number of Interruptions	Duration of Interruptions	T-SAIFI	T-SAIDI
Holyrood 38L	6	416	0.6	41.6
Holyrood 39L	3	989	0.3	98.6
Western Avalon 64L	9	600	0.9	60

T-SAIFI(S) is the System Average Interruption Frequency Index for Sustained. Delivery Point Interruptions. This provides a measure of the average number of sustained interruptions that a delivery point experiences during a specified period.

$$T - SAIFI(S) = \frac{\text{Total No. of Sustained Interruptions}}{\text{Total No. of Delivery Points Monitored}}$$

T-SAIDI is the System Average Interruption Duration Index. This index provides a measure of the average duration of sustained interruptions that a delivery point experiences during a specified period.

$$T - SAIDI = \frac{\text{Total Duration of All Interruptions}}{\text{Total No. of Delivery Points Monitored}}$$

3.2.2 Legislative or Regulatory Requirements

There are no legislative requirements to replace the relays.

3.2.3 Safety Performance

There are no safety issues involved.

3.2.4 Environmental Performance

There are no environmental issues involved.

3.2.5 Industry Experience

Electromechanical and older solid state relays are being phased out by utilities including Hydro as the modern microprocessor relays have enhanced setting, monitoring and disturbance recording capabilities.

3.2.6 Vendor Recommendations

Protective relay vendors recommend replacing the electromechanical and older solid state relays with modern microprocessor models.

3.2.7 Maintenance or Support Arrangements

Routine maintenance is done by Hydro personnel and is scheduled every six years.

3.2.8 Maintenance History

The five-year maintenance history for the relays to be replaced is not available.

3.2.9 Historical Information

Protective relays were replaced on transformers T1 and T3 at Oxen Pond Terminal Station in 2013 and 2014 as part of the project to replace the existing transformers. The cost for the protective relay replacement work was included in the major project and not broken out separately.

Protective relays for transformer T1 at Sunnyside Terminal Station and replacements for the Optimho relays on TL202 are being installed in 2015.

Table 4 shows similar work to that proposed for 38L, 39L and 64L.

Table 4: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)	Comments
2010	240.5	263.4	5	52.7	Line protection upgrade on Great Northern Peninsula (138 kV & 66 kV)

3.2.10 Anticipated Useful Life

The anticipated life of a protective relay is 30 years.

3.3 Forecast Customer Growth

This is not applicable.

3.4 Development of Alternatives

There are no viable alternatives. Electromechanical and older solid state relays are being replaced by modern microprocessor relays with greater setting and monitoring capabilities.

3.5 Evaluation of Alternatives

There are no alternatives identified.

3.5.1 Energy Efficiency Benefits

This is not applicable.

3.5.2 Economic Analysis

This is not applicable.

4 CONCLUSION

Protective relay upgrades are recommended for Bay d’Espoir Transformers T1, T2, T3 (one multifunction relay to be added), T4,T5,T6,T7; Cat Arm Transformer T1; Holyrood Transformer T5,Holyrood transmission lines 38L and 39L; Western Avalon transmission line 64L and both the Bay d’Espoir and Sunnyside terminals of TL202 (Protection A only) due to their age and limitations.

The relay replacements for Bay d’Espoir T1, T2, T4, T5, T6, T7; Cat Arm T1, Holyrood T5 and TL202 at Bay d’Espoir and Sunnyside were recommended in a review of older relays completed by Hydro.

Protective relay upgrades were recommended for 38L, 39L and 64L in the analysis report prepared by Hydro for the east coast outage caused by Hurricane Leslie on September 11, 2012. Slow clearing on 39L was a factor in the outage. These three lines form sections of important transmission loops that link Holyrood Terminal Station with Hardwoods Terminal Station and Western Avalon Terminal Station. Newfoundland Power has replaced the relays on the lines they maintain within these two transmission loops.

The existing electromechanical and older solid state relays have limited capabilities to make setting changes. They also do not provide fault disturbance recording or self monitoring to detect internal problems whereas modern microprocessor relays will provide these functions.

4.1 Budget Estimate

Table 5: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	264.0	227.6	0.0	491.6
Labour	338.0	463.0	0.0	801.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	47.7	47.4	0.0	95.1
Interest and Escalation	50.9	140.9	0.0	191.8
Contingency	0.0	277.5	0.0	277.5
TOTAL	700.6	1,156.4	0.0	1,857.0

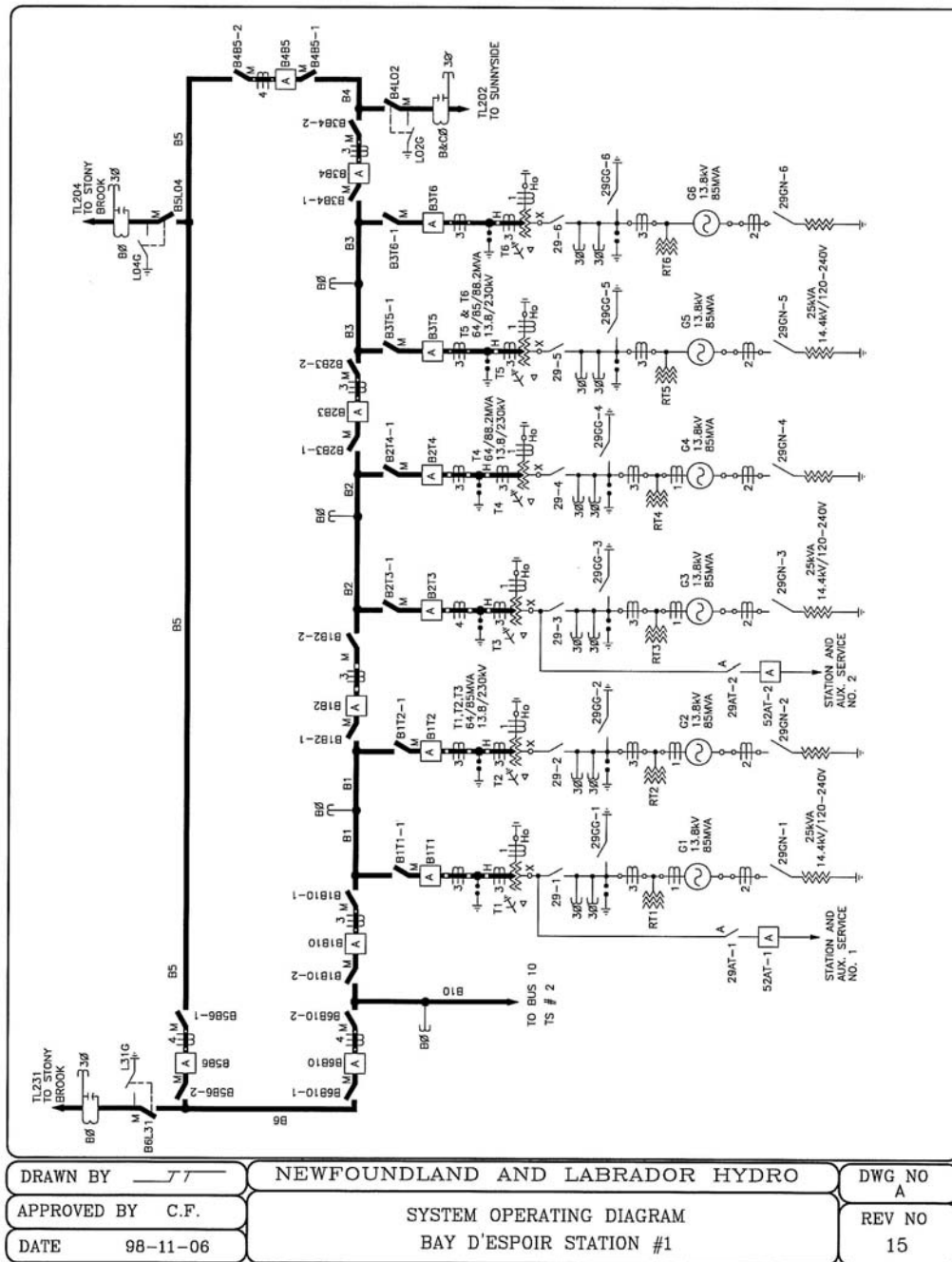
4.2 Project Schedule

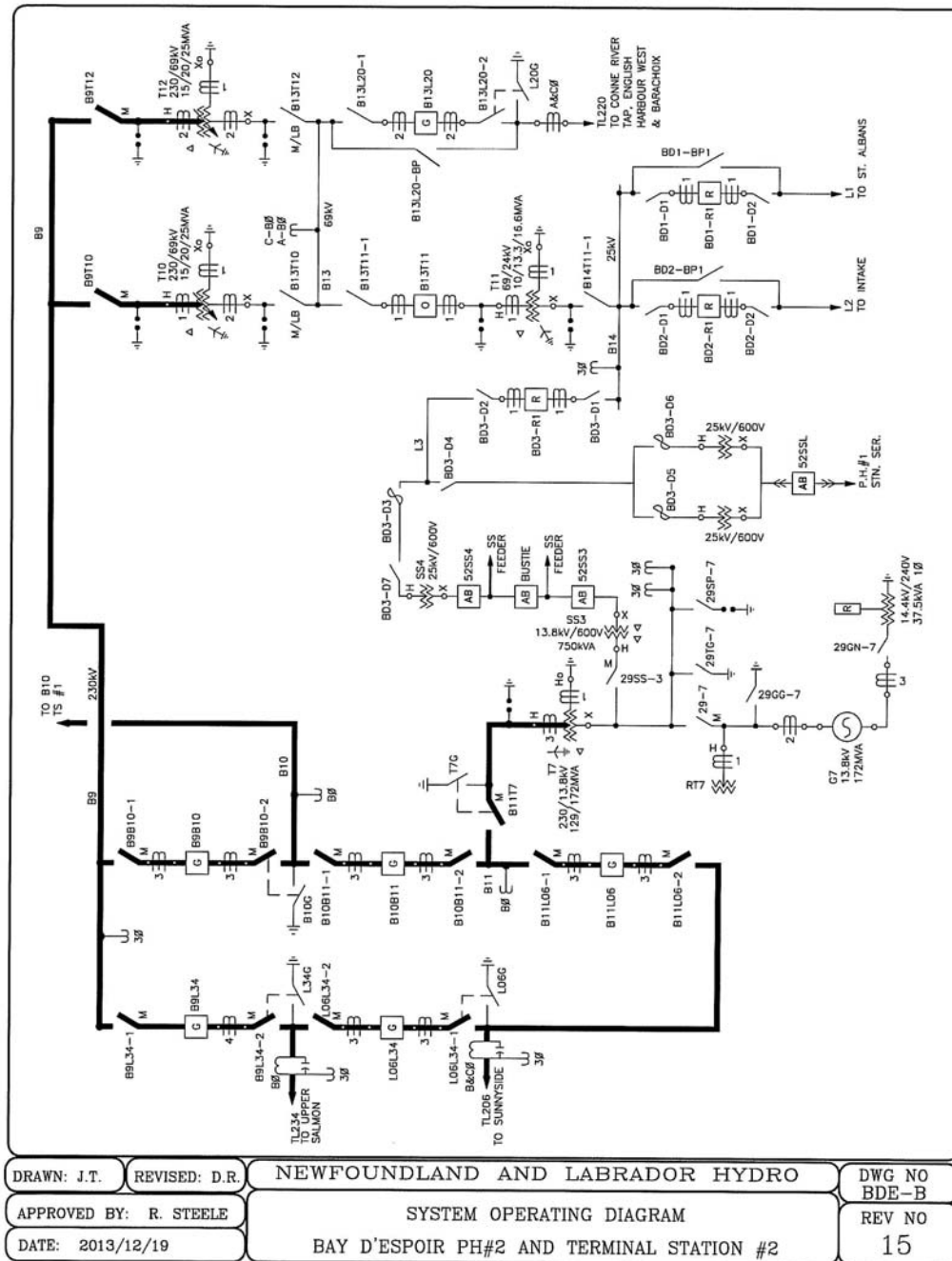
Table 6: Project Schedule

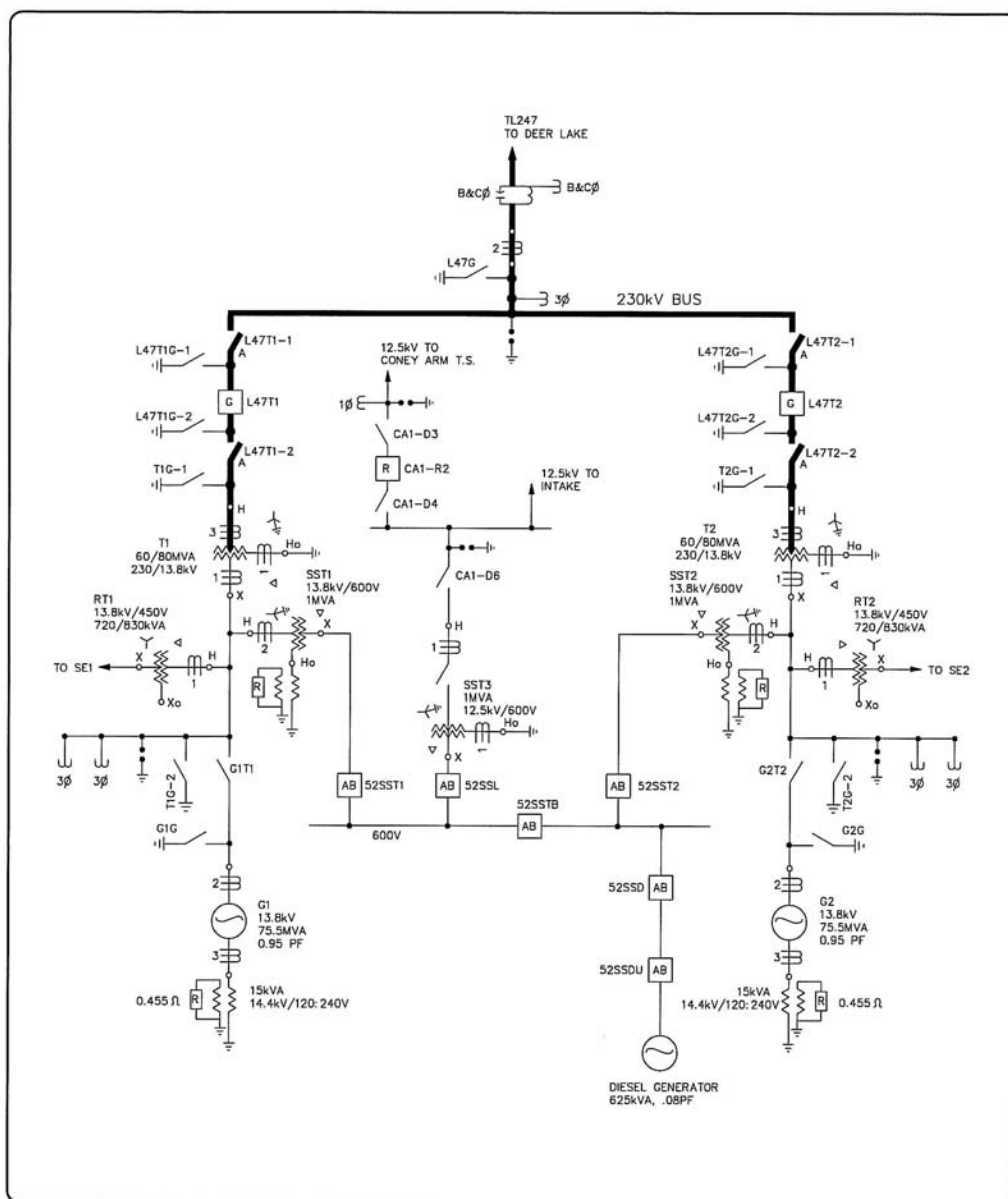
Activity		Start Date	End Date
Planning	Prepare scope statement	January 2016	January 2016
Design	Site visit	February 2016	February 2016
	Prepare drawings (2016 work)	February 2016	May 2016
	Prepare drawings (2017 work)	January 2017	April 2017
Procurement	Purchase relays & cables (2016 work)	January 2016	January 2016
	Receive relays & cables (2016 work)	April 2016	April 2016
	Purchase relays & cables (2017 work)	January 2017	January 2017
	Receive relays & cables (2017 work)	April 2017	April 2017
Construction	Install relays & cables (2016 work)	April 2016	Sept. 2016
	Install relays & cables (2017 work)	April 2017	Sept. 2017
Commissioning	Commission relays (2016 work)	April 2016	Sept 2016
	Commission relays (2017 work)	April 2017	Sept. 2017
Closeout	As built drawings (2016 work)	October 2016	Nov. 2016
	As built drawings (2017 work)	October 2017	Nov.2017
	Project closeout information	Nov. 2017	Nov. 2017

APPENDIX A

**Single Line Diagrams for Bay d’Espoir Stations #1 and 2
Cat Arm Generating Station, Holyrood Terminal Station (B)
Sunnyside Terminal Station and Western Avalon Terminal Station**







APPROVED BY J.W.

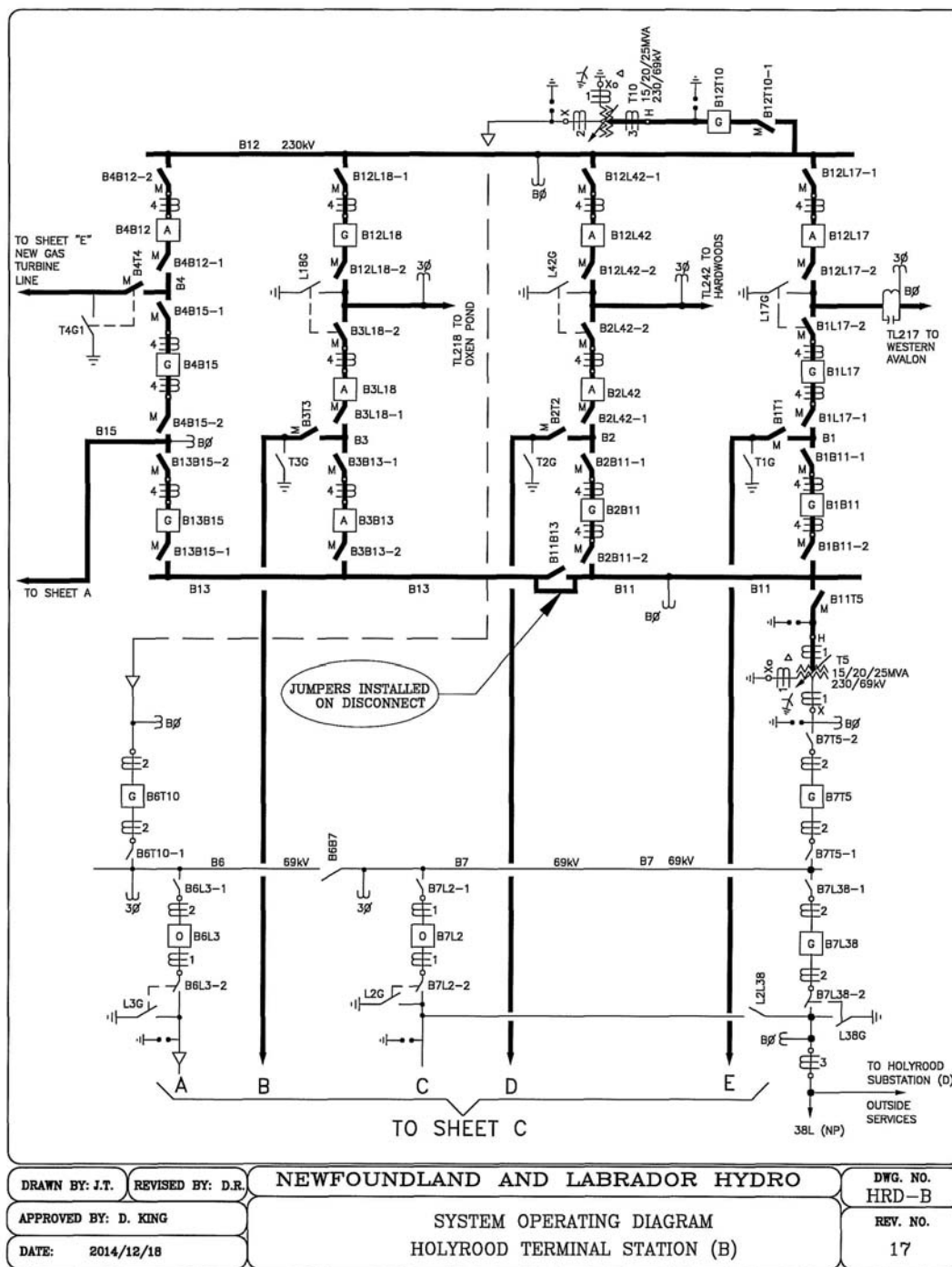
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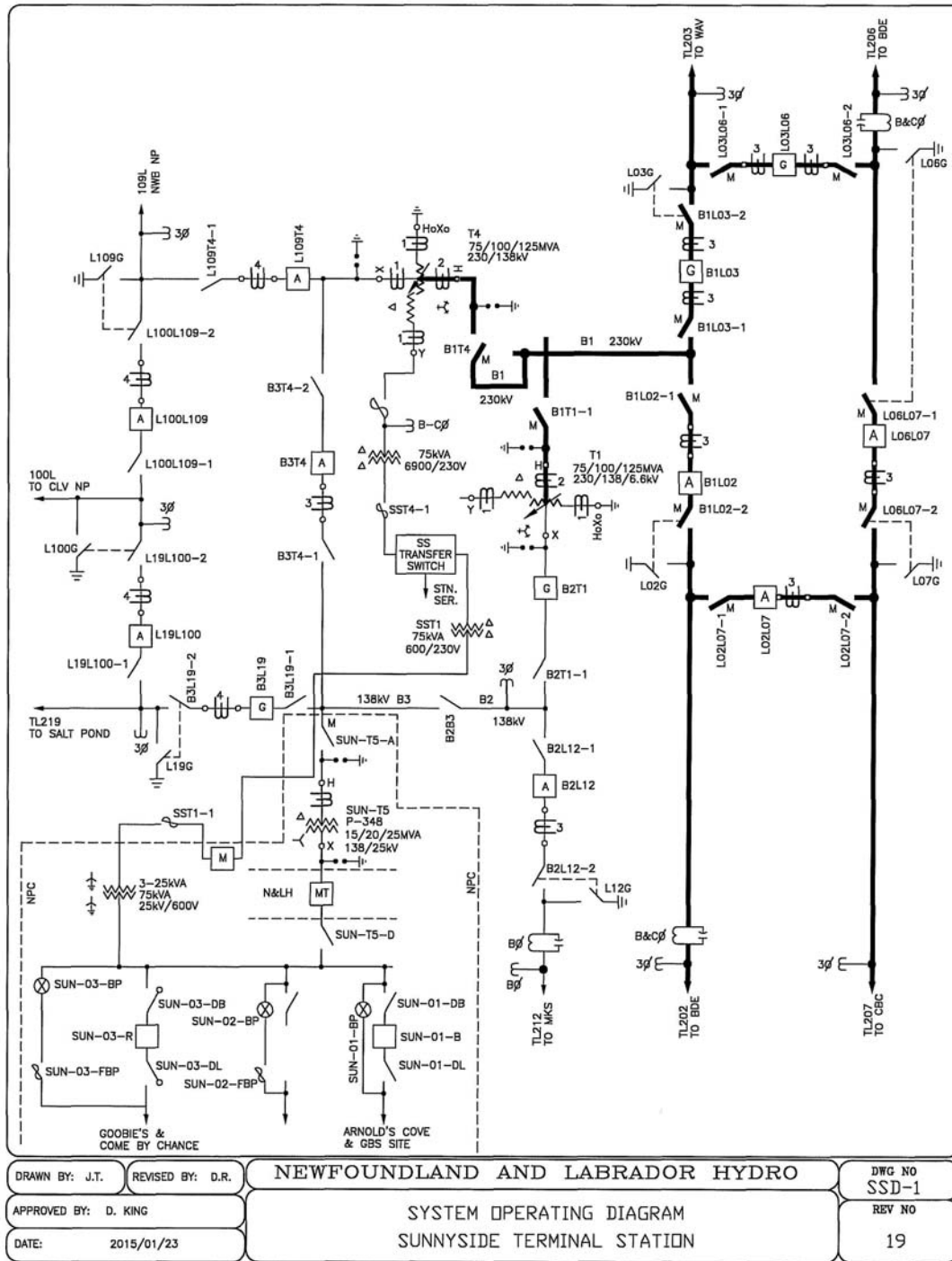
SYSTEM OPERATING DIAGRAM
CAT ARM GENERATING STATION

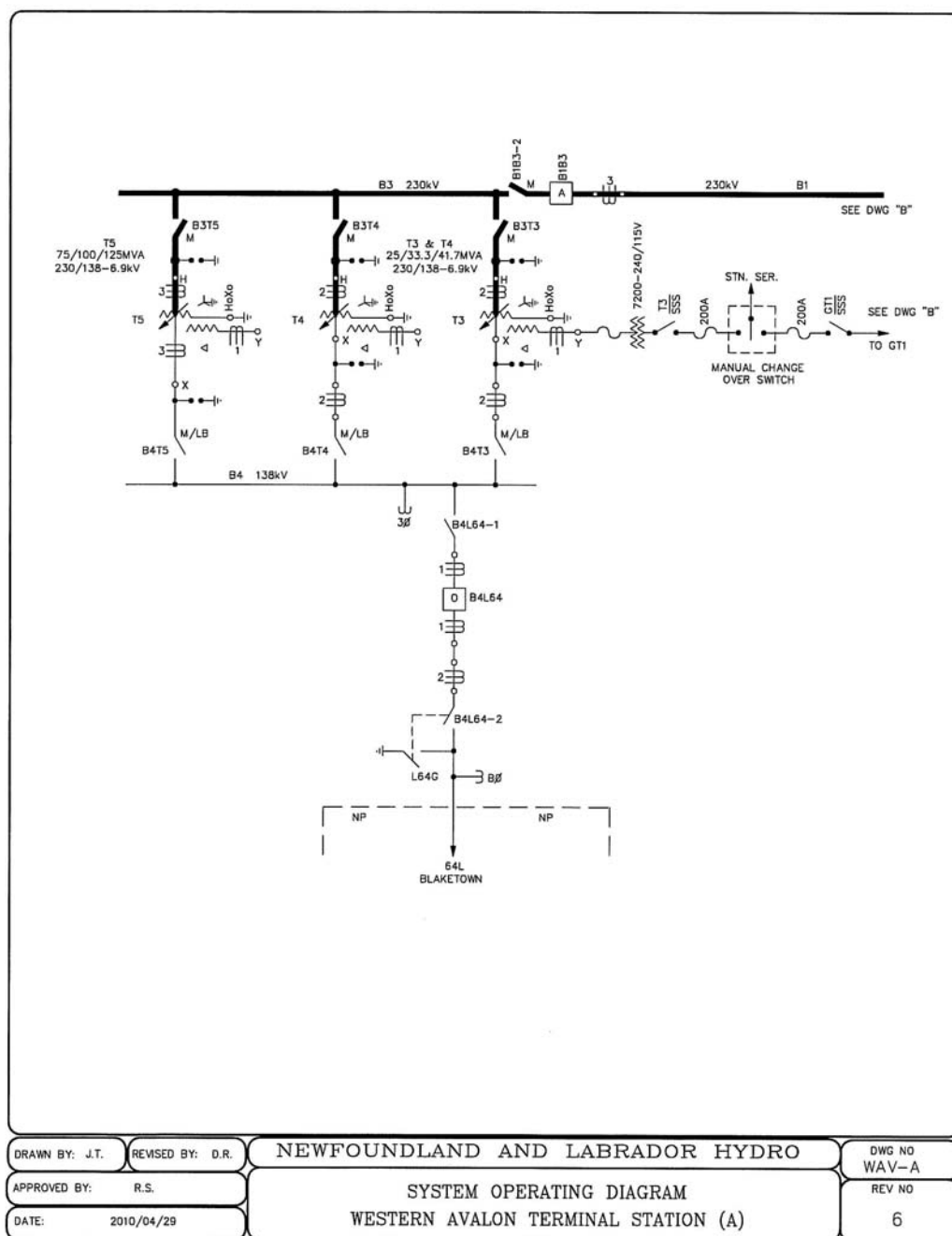
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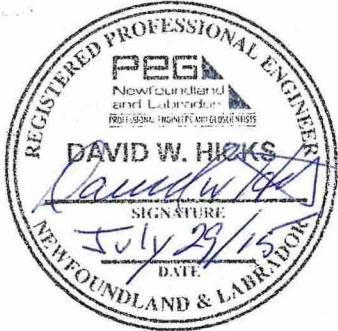
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**A REPORT TO
THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES**

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

**Replace Aircraft Obstruction Lighting
TL228**

July 2015

SUMMARY

This proposal is for the replacement of marker systems that are located on four 230 kV transmission crossing tower structures that span over a section of Grand Lake at Glover's Island. Each marker system will replace the following: an aircraft beacon, control equipment, photovoltaic (PV) panels complete with frame structures, sealed batteries and tower identification painting.

The existing solar aircraft obstruction lighting system has reached 22 years of service, and has reached its end of life. The existing system is obsolete, and Hydro is no longer able to source required parts to keep the aircraft obstruction system in operation in accordance with Transport Canada requirements.

The transmission line that spans Grand Lake is TL228. Government regulations require the use of operational warning equipment to alert aviation of the transmission line obstacle. These requirements are paint placed on structures for day use and obstruction markers (or lighted beacons) for day and night use.

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1 INTRODUCTION

Obstruction markers for aviation are required for the identification of impending hazards or obstacles based on height and location. Transmission Line TL228 goes from Buchans Terminal Station to the Massey Drive Terminal Station and spans a section of Grand Lake at Glover Island along this route.

TL228 was constructed in 1967 with the construction of the Bay d’Espoir Development. TL228 provides electricity to the western portion of Newfoundland, along with TL233. The crossing at Grand Lake includes twelve 230 kV structures, of which four are crossing structures, meaning the support a transmission line at high tension across a large body of water or crevice. Each of the four crossing structures contains an aviation warning system that includes a lighted obstruction marker and painted checkerboards in accordance with Transport Canada requirements in colour and pattern. The length of each transmission line span for the crossing structures is as follows:

1. Site #1 and #2 between eastern portion (Buchans Side) and Glover Island with a span of 1,335 metres; and
2. Site #3 and #4 between the Pasadena side and Glover Island with a span of 2,640 metres.

Figure 1 shows the site map of the four sites and spans a section of Grand Lake.



Figure 1: Site Map – Grand Lake

Originally, the four transmission line spans had numerous coloured balls that were suspended from the transmission line along with the four crossing structures being painted with a checkerboard pattern with international orange and white for daytime identification, and painted shore markers to identify the presence of a catenary¹ obstruction. These criteria were required to meet Transport Canada Standard 621.19 “Standard Obstruction Markings”. In the 1980’s, the suspended balls were becoming problematic as they required regular replacement due to the high vibration levels the balls created on the transmission line spans. In 1993, the coloured balls were completely removed and an aircraft obstruction lighting system was installed on each of the four crossing structures to maintain compliance with Transport Canada regulations. Figure 2 shows site #1 crossing structure and Figure 3 shows the flash head on the painted structure.

¹ Catenary: A curve formed by a wire, rope, or chain hanging freely from two points and forming a U shape.



Figure 2: Site #1 crossing structure



Figure 3: Flash Head on the 230kV structure

The aircraft warning light system has been in service for over 20 years and has reached its end of service life. The components of the system are failing and require replacement.

2 PROJECT DESCRIPTION

This project includes the replacement and commissioning of four aircraft warning systems located on four 230 kV crossing tower structures that span Grand Lake.

Each system has the following major components:

- Aircraft warning beacon CL865 / CL864;
- VRLA batteries complete with ventilated enclosure;
- Photovoltaic Panels complete with mounting frame, for installation on existing foundation;
- Control panel for complete system including battery charger, light controller, alarms and system protection equipment;
- New wiring and conduit from PV panels to Control enclosure and control panel to obstruction markers; and
- New paint system on existing structures.

Any items deemed acceptable for re-use (i.e. foundations), will be re-used. The installation will involve the procurement of new material with installation through tendered contractor.

3 JUSTIFICATION

The replacement of the aircraft warning system is justified based on Transport Canada regulation for the marking of aviation obstructions due to catenary crossings over water bodies.

Since 1967, with the construction of TL-228, Hydro has maintained the span of Grand Lake under Transport Canada Regulations. Aircraft markers are required to identify the presence of the transmission infrastructure at the Grand Lake crossing.

3.1 Existing System

The existing marker systems were installed in 1993. Since installation, semi-annual inspections have been carried out and preventative and corrective maintenance has been performed as required.

TL228 Crosses Grand Lake at two separate locations and aircraft markers are installed on structures on each side of the two Grand Lake crossings. Each of these four sites has an aircraft marker system comprised of a solar array (26 panels at three of the sites and 36 panels at the other site), 24V battery bank (four modules with three cells per module at each site), system controller, strobe light and strobe light controller. The solar panels are currently SIEMANS module #M55 (rated at 53 Watts) and the batteries are currently GNB Absolyte II.

There have been no major upgrades since the installation of the aircraft obstruction marking system.

3.2 Operating Experience

Component failure and corrective maintenance have become commonplace in recent years. The current system is deteriorated and experiences downtime which is a safety concern for aircraft. Due to the remote location of each site, the system is not monitored in real time, and may experience downtime before the failure is recognized and corrected.

Many replacement components cannot be sourced due to obsolescence. An upgraded system will provide improved assurance of appropriate operation.

Table 1 lists the failed components found at the four sites (based on the 2015 preventative maintenance (PM) and assessment by Original Equipment Manufacturer.



Figure 4: Failed VRLA Battery at Site #2

Table 1: Failure Components for all Four Sites

Site number	Failure components
Site #1	• Battery bank failed and bypassed • Diminished solar output • Light functions only in night mode (failed light controller)
Site #2	• Partial battery bank failure • Damaged solar array
Site #3	• Missing and damaged solar panels • Battery bank degradation • Light functions only in day mode (failed light controller)
Site #4	• Several damaged solar panels • Battery bank degradation

3.2.1 Reliability Performance

The reliability of each site cannot be quantified due to the lack of daily monitoring at the site. Two of four sites do not transition between day and night mode. Degraded solar arrays

and battery banks diminish the ability of the system to function during overnight periods or extended periods of reduced sun exposure.

3.2.2 Legislative or Regulatory Requirements

The aircraft obstruction marking system is required as per Transport Canada regulations. In 1992, Hydro was granted an authorization for the 'deviation from standards' by Transport Canada. The deviation stipulated that the Grand Lake Crossing system must be marked by the following:

- Medium intensity white flashing strobe lights to be installed on top of each structure;
- Shore Markers as per TP382; and
- Structures to be painted in accordance with TP382.

This 'deviation from standards' is applicable as long as the obstruction itself, in this case the transmission line and associated towers, is not relocated or modified. Therefore, the 'deviation from standards' remains the regulatory standard that must be met by the Grand Lake Crossing aircraft obstruction marking system. The existing system is no longer functioning as required, and the components required to return the system to normal operation are no longer available.

3.2.3 Safety Performance

The existing system presents a risk to aviators in the area of Grand Lake, particularly float plane operators, if the system does not operate reliably. After an assessment on the existing crossing towers, it has been determined that each crossing tower's checkerboard painting has to be re-painted to meet standards. The existing paint has faded and chipped, and no longer bares the colour arrangement required.

3.2.4 Environmental Performance

Existing batteries have been known to leak during failure, which presents an environmental risk.

3.2.5 Industry Experience

As presented in section 3.1 and 3.2 of this report, the existing marker systems were installed in 1993 and are outdated. Common Failure and replacement components are difficult to source.

3.2.6 Vendor Recommendations

The existing obstruction lighting control system was supplied by Northern Reliability in 1993. Based on 2015 assessment by the manufacturer, it is recommended that the existing system be replaced, with the exception of existing foundations, which are suitable for reuse.

3.2.7 Maintenance or Support Arrangements

There is no maintenance philosophy change or update required for the new marker system. Annual PM inspection would be required as before.

3.2.8 Maintenance History

The past five-year maintenance history for the marker system is shown in the table 2:

Table 2: Past Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	3.2	0.0	3.2
2013	1	0.0	1.0
2012	1.7	1.0	2.6
2011	3.7	0.0	3.7
2010	1.4	1.0	1.4

Note: the helicopter travel is required for accessing three of the four sites and is a significant portion of the cost of the maintenance. However, cost associated with helicopter travel is not including in the cost as the cost for the helicopter travel is charged to a general standing work order which covers all work for TRO.

3.2.9 Anticipated Useful Life

The new marker system SOLS 100 Solar-powered Obstruction Lighting System has an

estimated service life of 15 years. There are two main components of the SOLS 100 system; the battery bank, and the solar array and associated controllers. The Solar system, controllers and flash head has a maximum performance degradation of 0.7% per annum in the course of 25 years and Absolyte GP battery bank has a 20 years design life in float application at 25°C (77°F). In a non-temperature control environment such as the existing configuration, the battery bank has an expected life of 10-12 years.

3.4 Development of Alternatives

The purpose of this project is to return the aircraft obstruction marking system at Grand Lake Crossing to normal operations per Transport Canada regulations. There were three alternatives considered:

1. Replace entire aircraft marking system. This alternative involves the assembly and testing of control cabinets in the manufacturer's facility, and installation at site.
2. Replace aircraft marking system, re-using existing cabinet. This alternative involves the assembly of all system components within the existing cabinet.
3. Status quo, keeping the existing system in its current state.

3.5 Evaluation of Alternatives

Alternative #3, or status quo, is not an acceptable solution. The existing system is no longer compliant with Transport Canada regulations, and the necessary components to remediate the system deficiencies are no longer available.

While alternative #2 offers a modest reduction in material costs, the extra labour required on site offsets these cost savings. The estimated project costs for each alternative are listed in Table 3:

Table 3: Estimated Costs of Alternatives

Alternative	Estimated Cost (\$000)
1	1567.9
2	1629.1

The difference in life cycle costs is negligible and therefore alternative #1 is the least cost alternative. However, the greater difference between the alternatives comes from the qualitative differences. Installing, testing and commissioning a system in a remote wilderness location as opposed to a controlled manufacturing environment lends itself to greater risks. There are also no guarantees that a new system, complete with the heating and ventilation recommended by the manufacturer, would fit in the existing cabinet as the existing cabinet was designed specifically for the existing system. The installation of alternative #2 would also require a longer duration of system downtime, creating additional hazards for aircrafts in the area during the installation.

Therefore, given that alternative #1 is the least-cost and most-preferred option it is recommended that we proceed with alternative #1.

4 CONCLUSION

This project includes the purchase and installation of a new obstruction lighting control system (SOLS 100) on four 230 kV transmission structures at Grand Lake. The existing marker system is deteriorated and experiences downtime which presents a safety concern for aircraft. Failure of the various equipment components is increasing in frequency and some replacement components can no longer be sourced. Therefore, a more modern and reliable marker system is required at these sites. The replacement will cover all system components including solar panels, battery banks, strobe lights, controllers and other miscellaneous components at the four crossing sites. Existing foundations and frames will be re-used.

Engineering design and procurement of all equipment and associated materials is planned for 2016, with delivery and installation in 2017.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 3.

Table 3: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	308.5	0.0	0.0	308.5
Labour	112.0	198.7	0.0	310.7
Consultant	7.4	0.0	0.0	7.4
Contract Work	100.0	245.5	0.0	345.5
Other Direct Costs	26.9	186.0	0.0	212.9
Interest and Escalation	34.8	111.2	0.0	146.0
Contingency	0.0	237.0	0.0	237.0
TOTAL	589.6	978.3	0.0	1,567.9

4.2 Project Schedule

The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Project Planning for Aircraft Marker system replacement	January 2016	February 2016
Design	Engineering Design, include outage plan	Mar 2016	May 2016
Procurement	Tendering, equipment ordering and delivery for 2015	June 2016	October 2016
Construction	-Removal the existing PV panel, battery bank, control system for the Obstruction Lighting system. -Install the new marker system -Paint the four 230 kV steel transmission structures.	May 2017	June 2017
Commissioning	Commissioning	June 2017	June 2017
Closeout	Project Closeout	November 2017	December 2017

APPENDIX A
Condition Assessment



SITE ACCESS INSTRUCTIONS

Helicopter access

SCOPE OF SERVICES PERFORMED

Check all that apply:

☐ Installation Support	☐ Commissioning Services
☐ Scheduled Maintenance	☐ Un-Scheduled Maintenance
☒ Billable Services	☐ Non Billable services (i.e. TSB work, Warranty, other)

SAFETY POLICY OBSERVED

Northern Reliability Inc., Safety Plan, Revision _____

Or List Alternate Safety Plan:

List Competent Individual #1 : Murray Stone, Northern Reliability Field Service Technician

List Competent Individual #2 :

TECHNICAL DETAILS

Provide additional detail in this location regarding the scope of service performed.

Work Performed Dates:	02 June 2015
Work Order Issued by:	Northern Reliability Operations
NRI engineers on site:	Murray Stone



PURPOSE OF TRIP

Field Engineering Services for Grand Lake Crossing Obstruction Lighting
Systems:

1. Visual inspection of PV panels, controller boards, wiring and cabinets.
2. Visual inspection of obstruction lighting systems:
3. Inspection and testing of battery banks:
 - a. Measure each cell voltage individually to confirm condition of battery bank
 - b. Inspect cells for leaking acid or acid residue
4. If PV output appears to not be operating properly,
PV string output will be tested
5. Test obstruction lights to confirm operating condition
6. Field report with summary of findings, test results, photos of
damaged/ worn equipment and recommended course of action.

Client:

Newfound Labrador Hydro
Hydro Place 500 Columbus Drive
P.O. Box 12400
St. Johns, NL A1B 4K7

Purchase Order Number : 22269-000 OB

Purchase Order Date: 7 May 2015



SITE NOTES

Monday: 1 June 2015 - travelled from VT to Deer Lake, Newfoundland, CA.

Tuesday: 2 June 2015 – met with Matt Halloran and flew to the 4 sites.

Wednesday: 3 June 2015 – travelled from Deer Lake, Newfoundland, CA to VT

General conditions:

Solar Panels – most panels were in reasonable shape considering their age, there were a few panels with holes burned through, some missing, and some vandalized. The functional panels showed an expected decrease in output for their age.

Solar Panel Frame and Foundations - all were in good shape and could be reused.

Batteries – the batteries at all the sites were in various states of decay and should be replaced. One site appeared to have the original equipment from ~1993 (no longer used) and the others appeared to have been replaced around 2004-2006. Batteries of this type typically last approximately 10 years.

System Controllers – all of the power system controllers appeared to be functioning normally.

Tower Lights & Light Controllers – all of the tower lights were functional, however in some cases the light controllers were not functioning properly and would not change the light into/out of day or night mode.

Site specifics – We visited all sites starting with the most easterly site, and progressed west, back towards Deer Lake. For this report I will be referring to the sites by number according to the following table:

Site Number	Location
1	Short Span East
2	Short Span West
3	Long Span East
4	Long Span West





Site 1

Foundation – wood piles with wood cross beams. The overall condition of the foundation is acceptable to reuse.



Figure 1 - Site 1 Foundation



PV Array

String Number	Open Circuit Voltage	Short Circuit Current
1	41.28	8.1
2	41.41	8.2
3	41.57	4.2
4	41.63	4.1

The measurements were taken in clear conditions without direct sunlight. The panels should be outputting an estimated 10-12 amps (for string 1 and 2) under these conditions. The reduced output is expected for a 22 year old panel. 3 or 4 panels were damaged.

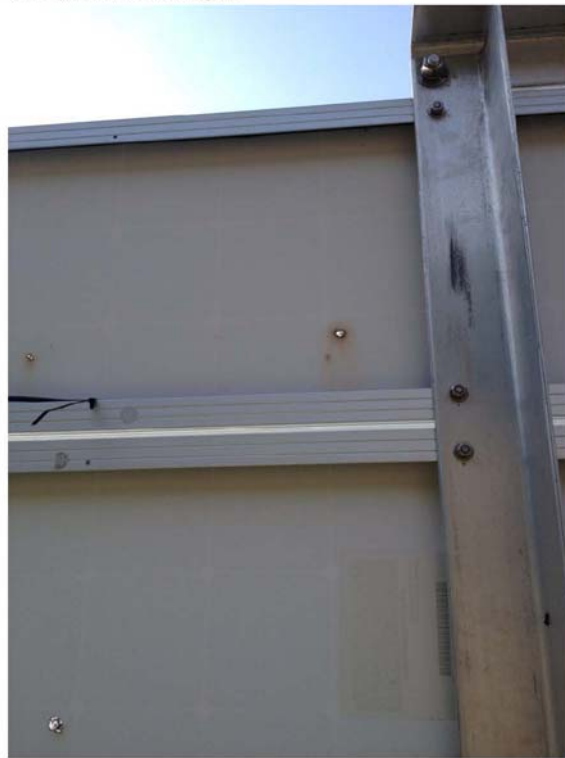


Figure 2 - Site 1 Panel Holes



Batteries

Cell #	VDC	Cell #	VDC
1	2.12	7	2.28
2	2.29	8	2.27
3	2.27	9	2.27
4	2.30	10	2.26
5	2.28	11	2.27
6	2.28	12	2.27

These batteries were replaced around 2006 making them about 10 years old. Cell #1 shows a much lower voltage than the rest of the cells, indicating a possible degradation of this cell.



Figure 3 - Site 1 Batteries



Tower Light

The light was working in both day and night modes.



Figure 4 - Light Controller



Figure 5 - System Controller



Site 2

Foundation – wood piles with wood cross beams. The overall condition of the foundation is acceptable to reuse.



Figure 6 - Site 2 Foundation

PV Array

Array Number	Open Circuit Voltage	Short Circuit Current
1	40.6	9.5
2	40.6	9.5
3	0	0
4	40.6	2.4

At Site 2 some panels missing and at least 2 more were not connected, string 3 was not contributing to the system.



Batteries

Cell #	VDC	Cell #	VDC
1	2.28	7	2.26
2	2.27	8	2.26
3	2.27	9	2.24
4	2.27	10	2.05
5	1.84	11	2.07
6	2.25	12	2.24

3 cells here show a significantly lower charge than the rest.

Tower Light

The light was stuck in Day mode and would not work in Night mode.

Site 3

Foundation – steel frame on concrete pillars. PV array mounted on 4" aluminum I beam bolted to steel.



Figure 7 - Site 3 Aerial



Figure 8 - Site 3 Foundation

PV Array

Array Number	Open Circuit Voltage	Short Circuit Current
1	41.5	6.12
2	41.5	6.12
3	41.8	4.6
4	41.6	3.04



One panel was damaged by impact.

Batteries

Cell #	VDC	Cell #	VDC
1	2.27	7	2.29
2	2.26	8	2.29
3	2.29	9	2.32
4	2.28	10	0
5	2.29	11	2.25
6	2.27	12	2.31

One cell's terminals had corroded away and was completely bypassed. This raises the other cell's voltage up to a level higher than recommended since the controller attempts to maintain a total system voltage.



Figure 9 - Site 3 Batteries



Tower Light
Functioned normally

Site 4

Foundation – steel frame consisting of railroad rails. PV array mounted on 4" aluminum I beam bolted to steel, which is welded to the railroad rails.



Figure 10 - Site 4 Foundation



PV Array

Array Number	Open Circuit Voltage	Short Circuit Current
1	40.3	8.9
2	40.2	9.0
3	40.3	8.9
4	40.1	9.1
5	40.3	4.5

Panels are situated in a low spot, with a large amount of shading from the tower and overgrown trees. At a minimum the trees and brush needs to be cut back, the array could also be moved to a more suitable location.

Batteries

The originally installed GNB batteries here were not in use, they had been replaced with 2- 12 volt 100 AH deep cycle marine batteries.



Figure 11 - Site 4 Batteries



Figure 12 - Site 4 Replacement Batteries

Tower Light

The light appeared to be stuck in night mode.



CONCLUSIONS

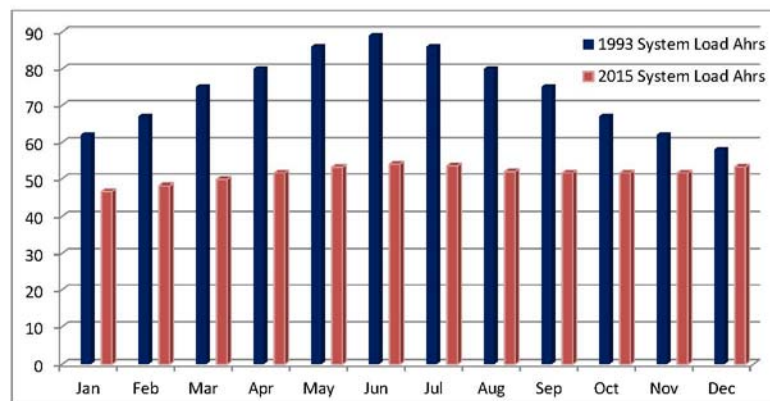
We recommend that the beacon and light controller be replaced with a lower wattage, longer lasting LED light.

The battery banks at all of the sites are in need of replacement.

Although the power system controllers and enclosures are still functional for the most part (although ventilation systems are no longer in operation), they are ~22 years old and have surpassed their intended life expectancy. Life expectancy for these systems is 15-20 years. In addition, integrating new equipment with the old controllers & enclosures onsite can be tricky and time consuming. The existing enclosures are not heated or actively vented, leaving the batteries exposed to extreme temperatures.

The solar panels are showing their ~22 year age and are no longer capable of generating their rated power. The PV cells should be expected to decrease in output linearly, in 5 years the output will be approximately 5% less than now, 10 years, 10%, etc. The foundations appear structurally sound and can be reused with minor modifications to fit the new panel dimensions.

The following chart shows the average daily Amp hour usage for the beacon as installed, and a new SPX Flash beacon. The 1993 data was taken from the original system manual. 2015 data is based on the number of daylight hours for this location and a usage of 80w for day, 40w for night modes.





There are 2 options for restoring the 4 sites to reliable operation:

Option 1 –

Replace entire system – quickest and most optimum solution for longer battery life and overall system reliability. New solar power systems would cost approximately \$35,000 each and require 2 technicians for 1 day to install per site. Light controller parts for the existing lights are no longer available.

Option 2 –

Replace Batteries, PV Array, System Controller, Beacon and Beacon controller. Keep existing cabinet and integrate new system into existing cabinet. This would reduce the cost of the system but would most likely be the more expensive and less reliable option. The time necessary for in-field services to integrate batteries and all other components into an existing cabinet and testing would be at least double that of Option 1. Additionally, there is the consideration that a system built in the field with old, existing equipment may not function as well as a completely new system that is factory designed, built and tested.

Communications – if monitoring is desired, it is possible.

No cell coverage at sites 1, 2, 4. Site 3 had a very weak signal. Line of site communications are possible between sites 1 and 2 and 3 and 4, but not between 2 and 3. Satellite internet is likely available from Xplornet or Galaxy Broadband or another company.

A system using the Iridium satellite network could be used to provide basic status and alarm updates.

See pricing options in the attached NLH0313 Proposal.

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

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

**Inspect Fuel Storage Tanks
Various Sites**

July 2015

SUMMARY

To facilitate its operations, Hydro owns and operates 99 above ground storage tanks comprising 76 horizontal tanks and 23 vertical tanks. Approximately 75% of the tanks store diesel fuel, 12% store waste oil, 10% store transformer oil and the remaining 3% store either Jet A1 fuel, lube oil or glycol.

In the interest of maximizing the service life of its assets and adhering to its Environmental Policy and Guiding Principles, Hydro has completed inspections of its above ground fuel storage tanks in the past. These inspections were completed on an individual, tank by tank, basis and lacked the guidance of a systematic approach. As part of its ongoing asset management strategy, Hydro has since formalized these inspections into a coordinated program. The program uses the tank inspection procedures, outlined by The American Petroleum Institute (API), as the basis for this standardized approach.

The scope of work for this project involves the completion of the ten-year internal tank inspection, as outlined in the American Petroleum Institute (API) Standard 653, and the completion of routine upgrades identified during the inspection. The inspections will serve to identify corrective and preventive maintenance items. Identifying and completing the necessary maintenance will maximize the service life, ensuring that these assets are in reliable operating condition.

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1 INTRODUCTION

To facilitate its operations, Hydro owns and operates 99 above ground fuel storage tanks comprising 76 horizontal tanks and 23 vertical tanks. Approximately 75% of the tanks store diesel fuel, 12% store waste oil, 10% store transformer oil and the remaining 3% store Jet A1 fuel, lube oil or glycol.

Hydro must ensure that its fuel storage tanks are maintained in a safe, reliable operating condition. Tank inspections serve to identify maintenance and repair items, enabling the work to be completed in a timely fashion. Work under this proposal consists of the completion of tank inspections at Hydro's diesel generation sites located in Hawkes Bay and Nain, however, Hydro may inspect a higher priority tank should conditions change and defer the inspection of a lower priority tank. These inspections are necessary to ensure that the tanks continue to perform as designed, ensuring that they are structurally sound, suitable for operation, and not at risk of releasing fuel into the environment.

2 PROJECT DESCRIPTION

The purpose of this project is to complete detailed inspections of the above ground fuel storage tanks and associated fuel supply systems owned and operated by Hydro. The inspections will serve to identify corrective and preventive maintenance items. Identifying and completing the necessary maintenance will maximize the service life, ensuring that these assets are in reliable operating condition. Results from these inspections will be used to determine the necessary work that needs to be completed to ensure the tank is at operational standards.

The scope of work for this project involves the completion of the ten-year internal tank inspection, as outlined in the American Petroleum Institute (API) Standard 653, and the completion of routine upgrades, identified during the inspection, while the tank is empty. The tanks to be inspected under this proposal in 2016 include those listed below, however, Hydro may inspect a higher priority tank should conditions change and defer a lower priority tank.

- Two 45,400 Liter, horizontal fuel storage tanks, located at the Hawkes Bay diesel plant; and
- One 600,000 Liter, vertical fuel storage tank; three 144,140 Liter, vertical fuel storage tanks; and one 45,400 Liter, horizontal fuel storage tank, located at the Nain diesel plant.

The project scope includes:

- Draining and cleaning of the tank in preparation for the inspection;
- Comprehensive inspection of all accessible tank components;
- Ultrasonic thickness surveys of the floor, shell, roof, and nozzles;
- Implementation of temporary site storage, where required; and
- Completion of the routine upgrades identified during the inspection.

Routine upgrade costs have been included based on expected condition from similar tank inspections in the past. Hydro will complete the work necessary to enable the tanks to

continue to perform as designed, ensuring that they are structurally sound, suitable for operation, and not at risk of releasing fuel into the environment.

3 JUSTIFICATION

To maximize the service life of its assets and adhering to its Environmental Policy and Guiding Principles, Hydro has formalized its tank inspections into a coordinated program. The program uses the tank inspection procedures, outlined by API, as the basis for this standardized approach. While it is recognized that the API Standard applies to vertical storage tanks, in the absence of a suitable horizontal storage tank inspection standard, Hydro has adopted the API guidelines pertaining to inspection frequency for its horizontal storage tanks. The application of the recommended API inspection frequency to its horizontal storage tanks is considered to be an interim measure as Hydro works to develop its own horizontal tank inspection guidelines.

API recommends that above ground fuel storage tanks undergo an internal inspection every ten years after its initial service date. The required inspection procedures are outlined in *API Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction, section 6* (see Appendix A). This project will ensure that the tanks are inspected in accordance with the requirements identified in the API 653 standard.

An inspection plan has been developed and is outlined in Appendix B. The inspection plan consists of a listing of the diesel fuel storage tanks, owned and operated by Hydro, along with the corresponding dates of the proposed inspections. The tank inspection plan places priority for the completion of inspections on those tanks which have not received an initial ten year inspection. Fuel volume, availability of temporary storage, existing work plans, and equipment outages have also been considered. As data is made available on tank corrosion rates, through the completion of these inspections, the frequency and timing of future inspections may change.

Hydro must ensure that its fuel storage tanks are maintained in a safe, reliable operating condition. Tank inspections serve to identify maintenance items, enabling the work to be completed in a timely fashion. This proactive maintenance approach will enable the tanks to continue to perform as designed, ensuring that they are structurally sound, suitable for

operation, and not at risk of releasing fuel into the environment.

3.1 Existing System

Hydro owns and operates 99 above ground fuel storage tanks comprising 75 horizontal tanks and 23 vertical tanks.

Approximately 75% of the tanks store diesel fuel, 12% store waste oil, 10% store transformer oil and the remaining 3% store either Jet A1 fuel, lube oil or glycol.

3.2 Operating Experience

75% of Hydro's aboveground fuel storage tanks serve as a fuel supply for its isolated diesel generation units and standby generation facilities. These tanks are critical to ensuring the continued supply of reliable power to the communities in which they are located. Fuel storage tanks containing diesel fuel are located in isolated communities across the province.

3.2.1 Reliability Performance

Hydro's fuel storage tanks have performed well throughout their service life. The completion of the proposed inspection will ensure that they continue to do so for many years to come.

3.2.2 Environmental Performance

Undetected deterioration of fuel storage tanks could potentially result in a loss of fuel oil into the environment. The completion of the proposed inspections will identify potential areas of concern, thus, enabling the completion of refurbishments before any loss of fuel oil can occur.

3.2.3 Industry Experience

Industry experience with above ground fuel oil storage tanks indicates the floors and ceilings of the tanks are affected the most by oxidation. Trapped water at the bottom of tank and air voids above the fuel oil result in corrosion of the tank floor and the tank ceiling.

Generally, the walls of the steel storage tanks do not experience corrosion from the inside because they are continuously coated with fuel oil through refilling. The main protection against oxidation for the exterior surfaces has been epoxy coating systems.

API Standard 653, Tank Inspection, Repair, Alteration, and Reconstruction, Section 6 is widely accepted as the benchmark for the implementation of tank inspection programs required for the early detection of tank deterioration.

3.2.4 Maintenance or Support Arrangements

Routine inspection and maintenance of the fuel storage tanks is performed by Hydro personnel with standardized external and internal inspections performed by a certified inspection agency. All major maintenance such as the application of epoxy coatings and steel fabrication is completed by external contractors.

3.2.5 Maintenance History

Hydro performs routine inspections at its diesel plants and gas turbine sites to help identify any equipment deficiency or leak to the environment. These routine inspections are completed on a daily basis by operations personnel and are limited to visual checks of the checks of tanks and associated fuel supply system.

Standardized internal inspections have been completed on various tanks, as indicated in Table 1.

3.2.6 Historical Information

Table 1 details the costs associated with tank cleaning and inspection projects within the past five years.

As can be seen in the table, the costs associated with tank cleaning and inspection vary significantly on a per unit basis. This fluctuation is most greatly affected by the size of the tanks, the geographic location of the work area and the number of tanks located at the site.

The cleaning and inspection effort associated with the larger vertical tanks is greater than that of the smaller horizontal tanks and consequently more costly. Remote sites containing a single tank, such as Little Bay Islands, are subject to an increase in cost, resulting from the requirement to arrange for temporary site fuel storage to facilitate the draining of the existing tank for cleaning and inspection purposes.

Table 1: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)	Comments
2015B	1,761.1	-	One 600,000 L, vertical tank; Three 144,140 L, vertical tanks; Six 45,400 L, horizontal tanks; One 22,700 L horizontal tank; and One 10,000 L, horizontal tank		Clean and Inspect Tanks (Hawkes Bay, Charlottetown, Paradise River, Happy Valley-Goose Bay, Hopedale and Nain)
2014	495.0	271.6	Three 501,000 L, vertical tanks and Three 22,700 L horizontal tanks	45.3	Clean and Inspect Tanks (Stephenville and St. Anthony)
2012	80.0	108.5	Two 314,000 L, vertical tanks	54.3	Clean and Inspect Tanks (Mary's Harbour)
2010	37.0	48.5	One 22,000 L, horizontal tank	48.5	Clean and Inspect Tank (Little Bay Islands)
	45.8	48.6	Two 45,000 L, horizontal tanks	24.3	Clean and Inspect Tanks (Happy Valley-Goose Bay)

4 CONCLUSION

Hydro has implemented a systematic approach for its fuel storage system inspections and the API 653 standard has been adopted as the guide. Inspection of the tanks is imperative to ensuring that the tanks are performing as intended, which will prevent the release of fuel into the environment.

The completion of the upgrades identified during the inspections will extend the useful service life of the tanks, thus ensuring the continuation of reliable operation for years to come.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 2.

Table 2: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	202.1	0.0	0.0	202.1
Consultant	0.0	0.0	0.0	0.0
Contract Work	799.7	0.0	0.0	799.7
Other Direct Costs	37.3	0.0	0.0	37.3
Interest and Escalation	80.0	0.0	0.0	80.0
Contingency	207.8	0.0	0.0	207.8
TOTAL	1,326.9	0.0	0.0	1,326.9

4.2 Project Schedule

The anticipated project schedule is shown in Table 3.

Table 3: Project Schedule

Activity		Start Date	End Date
Planning	Scope Statement, Schedule, WBS	January 2016	February 2016
Design	Prepare Tender Package	February 2016	March 2016
Procurement	Tender and Award Tank Cleaning and Inspection Contract	March 2016	April 2016
Construction	Clean and Inspect Tanks Nain	July 2016	September 2016
	Clean and Inspect Tanks Hawke's Bay	October 2016	October 2016
Commissioning	Tank Recertification Nain	-	September 2016
	Tank Recertification Hawke's Bay	-	October 2016
Closeout	Project Completion Certificate, Interest Cut-Off, PIR	-	November 2016

APPENDIX A
API Standard 653 - Section 6 Inspection

Section 6—Inspection

6.1 General

Periodic in-service inspection of tanks shall be performed as defined herein. The purpose of this inspection is to assure continued tank integrity. Inspections, other than those defined in 6.3 shall be directed by an authorized inspector.

6.2 Inspection Frequency Considerations

6.2.1 Several factors must be considered to determine inspection intervals for storage tanks. These include, but are not limited to, the following:

- a) the nature of the product stored;
- b) the results of visual maintenance checks;
- c) corrosion allowances and corrosion rates;
- d) corrosion prevention systems;
- e) conditions at previous inspections;
- f) the methods and materials of construction and repair;
- g) the location of tanks, such as those in isolated or high risk areas;
- h) the potential risk of air or water pollution;
- i) leak detection systems;
- j) change in operating mode (e.g. frequency of fill cycling, frequent grounding of floating roof support legs);
- k) jurisdictional requirements;
- l) changes in service (including changes in water bottoms);
- m) the existence of a double bottom or a release prevention barrier.

6.2.2 The interval between inspections of a tank (both internal and external) should be determined by its service history unless special reasons indicate that an earlier inspection must be made. A history of the service of a given tank or a tank in similar service (preferably at the same site) should be available so that complete inspections can be scheduled with a frequency commensurate with the corrosion rate of the tank. On-stream, non-destructive methods of inspection shall be considered when establishing inspection frequencies.

6.2.3 Jurisdictional regulations, in some cases, control the frequency and interval of the inspections. These regulations may include vapor loss requirements, seal condition, leakage, proper diking, and repair procedures. Knowledge of such regulations is necessary to ensure compliance with scheduling and inspection requirements.

6.3 Inspections from the Outside of the Tank

6.3.1 Routine In-service Inspections

6.3.1.1 The external condition of the tank shall be monitored by close visual inspection from the ground on a routine basis. This inspection may be done by owner/operator personnel, and can be done by other than authorized inspectors as defined in 3.4. Personnel performing this inspection should be knowledgeable of the storage facility operations, the tank, and the characteristics of the product stored.

6.3.1.2 The interval of such inspections shall be consistent with conditions at the particular site, but shall not exceed one month.

6.3.1.3 This routine in-service inspection shall include a visual inspection of the tank's exterior surfaces. Evidence of leaks; shell distortions; signs of settlement; corrosion; and condition of

the foundation, paint coatings, insulation systems, and appurtenances should be documented for follow-up action by an authorized inspector.

6.3.2 External Inspection

6.3.2.1 All tanks shall be given a visual external inspection by an authorized inspector. This inspection shall be called the external inspection and must be conducted at least every five years or $RCA/4N$ years (where RCA is the difference between the measured shell thickness and the minimum required thickness in mils, and N is the shell corrosion rate in mils per year) whichever is less. Tanks may be in operation during this inspection.

6.3.2.2 Insulated tanks need to have insulation removed only to the extent necessary to determine the condition of the exterior wall of the tank or the roof.

6.3.2.3 Tank grounding system components such as shunts or mechanical connections of cables shall be visually checked. Recommended practices dealing with the prevention of hydrocarbon ignition are covered by API 2003.

6.3.3 Ultrasonic Thickness Inspection

6.3.3.1 External, ultrasonic thickness measurements of the shell can be a means of determining a rate of uniform general corrosion while the tank is in service, and can provide an indication of the integrity of the shell. The extent of such measurements shall be determined by the owner/operator.

6.3.3.2 When used, the ultrasonic thickness measurements shall be made at intervals not to exceed the following.

- a) When the corrosion rate is not known, the maximum interval shall be five years. Corrosion rates may be estimated from tanks in similar service based on thickness measurements taken at an interval not exceeding five years.
- b) When the corrosion rate is known, the maximum interval shall be the smaller of $RCA/2N$ years (where RCA is the difference between the measured shell thickness and the minimum required thickness in mils, and N is the shell corrosion rate in mils per year) or 15 years.

6.3.3.3 Internal inspection of the tank shell, when the tank is out of service, can be substituted for a program of external ultrasonic thickness measurement if the internal inspection interval is equal to or less than the interval required in 6.3.3.2 b).

6.3.4 Cathodic Protection Surveys

6.3.4.1 Where exterior tank bottom corrosion is controlled by a cathodic protection system, periodic surveys of the system shall be conducted in accordance with API 651. The owner/operator shall review the survey results.

6.3.4.2 The owner/operator shall assure competency of personnel performing surveys.

6.4 Internal Inspection

6.4.1 General

6.4.1.1 Internal inspection is primarily required to do as follows.

- a) Ensure that the bottom is not severely corroded and leaking.
- b) Gather the data necessary for the minimum bottom and shell thickness assessments detailed in

Section 6. As applicable, these data shall also take into account external ultrasonic thickness measurements made during in-service inspections (see 6.3.3).

c) Identify and evaluate any tank bottom settlement.

6.4.1.2 All tanks shall have a formal internal inspection conducted at the intervals defined by 6.4.2. The authorized inspector who is responsible for evaluation of a tank must conduct a visual inspection and assure the quality and completeness of the non-destructive examination (NDE) results. If the internal inspection is required solely for the purpose of determining the condition and integrity of the tank bottom, the internal inspection may be accomplished with the tank in-service utilizing various ultrasonic robotic thickness measurement and other on-stream inspection methods capable of assessing the thickness of the tank bottom, in combination with methods capable of assessing tank bottom integrity as described in 4.4.1. Electromagnetic methods may be used to supplement the on-stream ultrasonic inspection. If an in-service inspection is selected, the data and information collected shall be sufficient to evaluate the thickness, corrosion rate, and integrity of the tank bottom and establish the internal inspection interval, based on tank bottom thickness, corrosion rate, and integrity, utilizing the methods included in this standard. An individual, knowledgeable and experienced in relevant inspection methodologies, and the authorized inspector who is responsible for evaluation of a tank must assure the quality and completeness of the in-service NDE results.

6.4.2 Inspection Intervals

6.4.2.1 The interval from initial service until the initial internal inspection shall not exceed 10 years. Alternatively, when either a risk-based inspection (RBI) assessment per 6.4.2.4, or a similar service assessment per Annex H is performed, and the tank has one of the following leak prevention, detection, or containment safeguards, the initial internal inspection interval shall not exceed the applicable maximum interval as shown below.

Tank Safeguard	Max. Initial Interval
i) Original nominal bottom thickness 5/16 in. or greater	12 Years
ii) Cathodic protection of the soil-side of the primary tank bottom per Note 1	12 Years
iii) Thin-film lining of the product-side of the tank bottom per Note 2	12 Years
iv) Fiberglass-reinforced lining of the product-side of the tank bottom per Note 2	13 Years
v) Cathodic protection plus thin-film lining	14 Years
vi) Cathodic protection plus fiberglass-reinforced lining	15 Years
vii) Release prevention barrier per Note 3 (when similar service assessment performed)	20 Years
viii) Release prevention barrier per Note 3 (when RBI assessment performed)	25 Years
NOTE 1 For purposes of 6.4.2.1, effective cathodic protection of the soil-side of the primary tank bottom means a system installed and maintained in accordance with API 651.	
NOTE 2 For purposes of 6.4.2.1, lining of the product-side of the tank bottom means a lining installed, maintained and inspected in accordance with API 652.	
NOTE 3 For purposes of 6.4.2.1, a release prevention barrier means an under-bottom leak detection and containment system designed in accordance with API 650, Appendix I.	

6.4.2.2 The interval between subsequent internal inspections shall be determined in accordance with either the corrosion rate procedures of 6.4.2.3 or the RBI procedures as outlined in 6.4.2.4. and shall not exceed the applicable maximum intervals as shown below.

Procedure Used	Max. Interval
i) Corrosion rate procedures in 6.4.2.3	20 Years
ii) RBI assessment per 6.4.2.4	25 Years
iii) RBI assessment per 6.4.2.4 and a release prevention barrier per Note	30 Years
NOTE: For purposes of 6.4.2.2, a release prevention barrier means an under-bottom leak detection and containment system designed in accordance with API 650, Appendix I.	

6.4.2.3 An owner/operator who has obtained data on the thickness and condition of the tank bottom during an internal inspection may calculate the interval until the subsequent internal inspection using the measured tank bottom corrosion rate and the minimum remaining thickness in accordance with 4.4.7.

6.4.2.4 As an alternative to the procedures in 6.4.2.3, an owner/operator may establish the internal inspection interval using RBI procedures in accordance with this section.

RBI assessment shall be performed by an individual or team of individuals knowledgeable in the proper application of API 580 principles to aboveground storage tanks, and experienced in tank design, construction details, and reasons for tank deterioration, and shall be reviewed and approved by an authorized inspector and a storage tank engineer. The initial RBI assessment shall be re-assessed at intervals not to exceed 10 years, at the time of a premature failure, and at the time of proposed changes in service or other significant changes in conditions.

RBI assessment shall consist of a systematic evaluation of both the likelihood of failure and the associated consequence of failure, utilizing the principles of API 580. RBI assessment shall be thoroughly documented, clearly defining all factors contributing to both likelihood and consequence of tank leakage or failure.

6.4.2.4.1 Likelihood Factors

Likelihood factors that should be considered in tank RBI assessments include, but are not limited to, the following:

- a) original thickness, weld type, and age of bottom plates;
- b) analysis methods used to determine the product-side, soil-side and external corrosion rates for both shell and bottom and the accuracy of the methods used;
- c) inspection history, including tank failure data;
- d) soil resistivity;
- e) type and quality of tank pad/cushion;
- f) water drainage from berm area;
- g) type/effectiveness of cathodic protection system and maintenance history;
- h) operating temperatures;
- i) effects on internal corrosion rates due to product service;
- j) internal coating/lining/liner type, age and condition;
- k) use of steam coils and water draw-off details;
- l) quality of tank maintenance, including previous repairs and alterations;
- m) design codes and standards and the details utilized in the tank construction, repair and alteration (including tank bottoms);
- n) materials of construction;
- o) effectiveness of inspection methods and quality of data;
- p) functional failures, i.e. floating roof seals, roof drain systems, etc.;
- q) settlement data.

6.4.2.4.2 Consequence Factors

Consequence factors that should be considered in tank RBI assessments include, but are not limited to, the following:

- a) tank bottom with a release prevention barrier (RPB);

- b) product type and volume;
- c) mode of failure (i.e. slow leak to the environment, tank bottom rupture or tank shell brittle fracture);
- d) identification of environmental receptors such as wetlands, surface waters, ground waters, drinking water aquifers, and bedrock;
- e) distance to environmental receptors;
- f) effectiveness of leak detection systems and time to detection;
- g) mobility of the product in the environment, including, releases to soil, product viscosity and soil permeability;
- h) sensitivity characteristics of the environmental receptors to the product;
- i) cost to remediate potential contamination;
- j) cost to clean tank and repair;
- k) cost associated with loss of use;
- l) impact on public safety and health;
- m) dike containment capabilities (volume and leak tightness).

More qualitative approaches may be applicable that do not involve all of the factors listed above. In these cases, conservative assumptions must be used and conservative results should be expected. A case study may be necessary to validate the approach.

The results of the RBI assessment are to be used to establish a tank inspection strategy that defines the most appropriate inspection methods, appropriate frequency for internal, external and on-stream inspections, and prevention and mitigation steps to reduce the likelihood and consequence of tank leakage or failure.

6.4.2.5 Tank owners/operators should review the internal inspection intervals of existing tanks, as they could be modified by the requirements of this section. The following outlines the applicability of the intervals determined in

- a) Tanks that have been internally inspected and whose internal inspection intervals were determined solely by corrosion-rate data per 6.4.2.3 need not be included in this review, as their internal inspection intervals remain unaffected.
- b) Tanks that have never been internally inspected should be reviewed for compliance with 6.4.2.1.
- c) Tanks that have been internally inspected and whose internal schedules were determined by RBI assessment should be reviewed for compliance with 6.4.2.2. If RBI assessment that complies with 6.4.2.4 determined an interval that has already exceeded the applicable maximum interval under 6.4.2.2, or will exceed it within a period of five years from the publication date of this edition of API 653, then the owner/operator may use the RBI assessment to schedule and complete the inspection, independent of the applicable maximum interval, so long as the inspection is completed within the five-year period. After the five-year period, the interval shall not exceed the applicable maximum interval under 6.4.2.2.

6.4.2.6 If RBI assessment or similar service assessment has been performed, the applicable maximum interval under 6.4.2.1 or 6.4.2.2 does not apply to a tank storing highly viscous substances which solidify at temperatures below 110 °F. Some examples of these substances are: asphalt, roofing flux, resid, vacuum bottoms and reduced crude.

6.5 Alternative to Internal Inspection to Determine Bottom Thickness

In cases where construction, size, or other aspects allow external access to the tank bottom to determine bottom thickness, an external inspection in lieu of an internal inspection is allowed to meet the data requirements of Table 4.4. However, in these cases, consideration of other maintenance items may dictate internal inspection intervals. This alternative approach shall be documented and made part of the permanent record of the tank.

6.6 Preparatory Work for Internal Inspection

Specific work procedures shall be prepared and followed when conducting inspections that will assure personnel safety and health and prevent property damage in the workplace (see 1.4).

6.7 Inspection Checklists

Annex C provides sample checklists of items for consideration when conducting in-service and out-of-service inspections.

6.8 Records

6.8.1 General

Inspection records form the basis of a scheduled inspection/maintenance program. (It is recognized that records may not exist for older tanks, and judgments must be based on experience with tanks in similar services.) The owner/operator shall maintain a complete record file consisting of three types of records, namely: construction records, inspection history, and repair/alteration history.

6.8.2 Construction Records

Construction records may include nameplate information, drawings, specifications, construction completion report, and any results of material tests and analyses.

6.8.3 Inspection History

The inspection history includes all measurements taken, the condition of all parts inspected, and a record of all examinations and tests. A complete description of any unusual conditions with recommendations for correction of details which caused the conditions shall also be included. This file will also contain corrosion rate and inspection interval calculations.

6.8.4 Repair/Alteration History

The repair/alteration history includes all data accumulated on a tank from the time of its construction with regard to repairs, alterations, replacements, and service changes (recorded with service conditions such as stored product temperature and pressure). These records should include the results of any experiences with coatings and linings.

6.9 Reports

6.9.1 General

For each external inspection performed per 6.3.2 and each internal inspection performed per 6.4, the authorized inspector shall prepare a written report. These inspection reports along with inspector recommendations and documentation of disposition shall be maintained by the owner/operator for the life of the tank. Local jurisdictions may have additional reporting and record keeping requirements for tank inspections.

6.9.2 Report Contents

Reports shall include at a minimum the following information:

- a) date(s) of inspection;
- b) type of inspection (external or internal);
- c) scope of inspection, including any areas that were not inspected, with reasons given (e.g. limited scope of inspection, limited physical access;
- d) description of the tank (number, size, capacity, year constructed, materials of construction, service history, roof and bottom design, etc.), if available;
- e) list of components inspected and conditions found (a general checklist such as found in Annex C may be used to identify the scope of the inspection) and deficiencies found;
- f) inspection methods and tests used (visual, MFL, UT, etc.) and results of each inspection method or test;
- g) corrosion rates of the bottom and shell;
- h) settlement survey measurements and analysis (if performed);
- i) recommendations per 6.9.3.1;
- j) name, company, API 653 certification number and signature of the authorized inspector responsible for the inspection;
- k) drawings, photographs, NDE reports and other pertinent information shall be appended to the report.

6.9.3 Recommendations

6.9.3.1 Reports shall include recommendations for repairs and monitoring necessary to restore the integrity of the tank per this standard and/or maintain integrity until the next inspection, together with reasons for the recommendations. The recommended maximum inspection interval and basis for calculation that interval shall also be stated. Additionally, reports may include other less critical observations, suggestions and recommendations.

6.9.3.2 It is the responsibility of the owner/operator to review the inspection findings and recommendations, establish a repair scope, if needed, and determine the appropriate timing for repairs, monitoring, and/or maintenance activities. Typical timing considerations and examples of repairs are:

- a) *prior to returning the tank to service*—repairs critical to the integrity of the tank (e.g. bottom or shell repairs);
- b) *after the tank is returned to service*—minor repairs and maintenance activity (e.g. drainage improvement, painting, gauge repairs, grouting, etc.);
- c) *at the next scheduled internal inspection*—predicted or anticipated repairs and maintenance (e.g. coating renewal, planned bottom repairs, etc.);
- d) *monitor condition for continued deterioration*—(e.g. roof and/or shell plate corrosion, settlement, etc.). The owner/operator shall ensure that the disposition of all recommended repairs and monitoring is documented in writing and that reasons are given if recommended actions are delayed or deemed unnecessary.

6.10 Nondestructive Examinations (NDEs)

Personnel performing NDEs shall meet the qualifications identified in 12.1.1.2, but need not be certified in accordance with Annex D. The results of any NDE work, however, must be considered in the evaluation of the tank by an authorized inspector.

APPENDIX B
Fuel Storage Tank Inspection Plan

LOCATION	Area	YEAR FABRICATED /INSTALLED	CAP (Litres)*	API 653 (Last 10 yr Initial Inspection Date)	Planned Internal Inspection Date
STEPHENVILLE GT	TROC	1975/2000	501,000	2000	2014
STEPHENVILLE GT	TROC	1975/2000	501,000	2000	2014
STEPHENVILLE GT	TROC	1975/2000	501,000	2000	2014
McCALLUM	TROC	1998/98	90,800		2015
HARDWOODS GT	TROC	1976/97	2,273,000	1997	2015
PORT HOPE SIMPSON	TRON	1975/75	22,730		2015
PORT HOPE SIMPSON	TRON	1995/95	22,730		2015
L'ANSE au LOUP	TRON	1999/05	22,730		2015
L'ANSE au LOUP	TRON	2003/04	22,730		2015
NAIN	TROL	2001/01	45,400		2016
NAIN	TROL	1974/74	144,140	2002	2016
NAIN	TROL	1974/74	144,140	2002	2016
NAIN	TROL	1974/74	144,140	2002	2016
NAIN	TROL	1987/87	600,000	2006	2016
HAWKES BAY	TRON	1974/96	23,730		2016
HAWKES BAY	TRON	1996/96	23,730		2016
PARADISE RIVER	TROL	2005/2005	45,400		2017
HOPEDALE	TROL	2005/2005	22,700		2017
CHARLOTTETOWN	TRON	2001	10,000		2016
BISHOP FALLS, Salvage	TROC	1996/96	18,000		2017
ST. BRENDAN'S	TROC	1981/2000	68,190	2000	2017
GOOSE BAY, G T	TROL	1990/1991	54,552	2001	2017
GOOSE BAY, G T	TROL	1990/1991	54,552	2001	2017
GOOSE BAY, G T	TROL	1990/1991	54,552	2001	2017
MAKKOVIK	TROL	1982/90	68,190	2006	2017
MAKKOVIK	TROL	1982/90	68,190	2006	2017
MAKKOVIK	TROL	1970/90	45,460	2006	2017
GOOSE BAY, G T	TROL	1990/1991	37,900	2001	2017
WILLIAMS HARBOUR	TRON	2007/07	40,391		2017
WILLIAMS HARBOUR	TRON	2007/07	40,391		2017
WILLIAMS HARBOUR	TRON	2007/07	40,391		2017
NORMAN BAY	TRON	2007	32,400		2017
NORMAN BAY	TRON	2007	32,400		2017
NATUASHIUSH	TROL	2001	45,481	2007	2018
NATUASHIUSH	TROL	2001	45,481	2007	2018
RIGOLET	TROL	1997/97	45,400	2007	2018
RIGOLET	TROL	1997/97	45,400	2007	2018
RIGOLET	TROL	1998/2000	22,730	2007	2018
RIGOLET	TROL	1995/95	90,920	2008	2018
RIGOLET	TROL	1983/95	90,900	2008	2018
GOOSE BAY, NORTH PLANT	TROL	2008	30,363	-	2018
MAKKOVIK	TROL	1990/90	314,000	2006	2018
MAKKOVIK	TROL	1990/90	314,000	2006	2018
MAKKOVIK	TROL	1990/90	314,000	2006	2018
RIGOLET	TROL	1985/85	300,000	2007	2018
GREY RIVER	TROC	1990/90	22,730	2009	2019
GREY RIVER	TROC	1990/90	22,730	2009	2019
CARTWRIGHT	TROL	2009	46,202		2019
BLACK TICKLE	TROL	1992/92	257,000	2007	2019
BLACK TICKLE	TROL	1992/92	257,000	2007	2019

LOCATION	Area	YEAR FABRICATED /INSTALLED	CAP (Litres)*	API 653 (Last 10 yr Initial Inspection Date)	Planned Internal Inspection Date
CHARLOTTETOWN	TRON	1984/84	300,000	2008	2019
BISHOP FALLS, Hanger	TROC	10/20/2010	10,000		2020
LITTLE BAY ISLANDS	TROC	1990/90	22,730		2020
GOOSE BAY, NORTH PLANT	TROL	1996	45,400	2010	2020
GOOSE BAY, NORTH PLANT	TROL	1996	45,400	2010	2020
POSTVILLE	TROL	2011	319,000		2021
POSTVILLE	TROL	2011	319,000		2021
NORMAN BAY	TRON	2011	20,000		2021
ST. LEWIS	TRON	2012	45,000		2022
ST. LEWIS	TRON	2012	45,000		2022
MARY'S HARBOUR	TRON	1990/90	314,000	2012	2024
MARY'S HARBOUR	TRON	1990/90	314,000	2012	2024
RAMEA	TROC	2014/2014	30,000	-	2024
RAMEA	TROC	2014/2014	30,000	-	2024
HOLYROOD CT	TROC	2015/2015	1,250,000	-	2025
HOLYROOD CT	TROC	2015/2015	1,250,000	-	2025

** Tanks with a storage capacity of less than 10,000 Liters will not be subject to an internal inspection. Typically these tanks are smaller in size and are not equipped with an access hatch to permit the completion of an internal inspection.*

**A REPORT TO
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**Construct Overhead Distribution Line
Pilley's Island – Long Island**

July 2015

SUMMARY

This project consists of installing an overhead distribution line which will extend from Pilley's Island to Long Island, spanning across the Long Island Tickle. This line will replace the submarine cable which currently supplies power to Long Island. This project is justified based on the fact that, in 2014, an iceberg severely damaged the existing cables leaving Long Island with a single damaged submarine cable to provide power. Failure to replace this distribution line will negatively affect the reliable supply of electricity to Hydro's customers on Long Island.

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1 INTRODUCTION

Hydro provides service to residents in select rural communities within the province through the use of existing distribution systems. The distribution systems typically consist of a substation coupled with a wood pole distribution line that supplies power from the station to service drops throughout the community. Currently, Long Island is being supplied by a submarine cable from Pilley's Island which, in 2014, was damaged by an iceberg that also severely damaged the spare cables.

In 1980, four submarine cables were installed across the Long Island Tickle to supply three phase power to Long Island. The cable configuration was three energized phase conductors plus one spare. In 2008, after the only three phase load on Long Island was removed, the cable configuration was changed to one energized conductor plus three spares.

This project is justified because, in 2014, an iceberg passed through the Long Island Tickle, contacting the four submarine cables and damaging each of them severely. Hydro had a diving inspection completed and confirmed all of the cables were damaged. Hydro contacted Orton Consulting Engineers International to perform a condition assessment of the cables and found only one cable to be suitable to supply power on an ongoing basis.

After analyzing four alternatives, Hydro has determined the least cost alternative to provide reliable power to the communities of Lushes Bight, Beaumont, and Beaumont North on Long Island is to supply power via overhead distribution line.

2 PROJECT DESCRIPTION

The scope of work for this project shall include:

- Installation of a 630 m overhead water crossing (Including Primary and Neutral Conductors supported on wood pole structures), and
- Installation of approximately 1 km of new 7,200 volt single phase distribution line from the new wood pole structure to tie into the existing distribution system.

All work to be completed by a contractor. Project management will be completed by Hydro.

3 JUSTIFICATION

Four submarine cables were originally installed 35 years ago, and have exceeded their life expectancy of 30 years. In 2007, the only three phase customer on Long Island shut down and the cables were reconfigured to supply single phase power, leaving three cables to serve as spares.

In addition to age deterioration, in 2014, an iceberg passed through the Long Island Tickle and contacted the submarine cables. Hydro had a diving inspection completed and a video captured the damage sustained by the cables. Appendix A contains pictures from the diving inspection.

The damage due to iceberg contact left three out of four cables unable to supply power, and the fourth cable damaged but still operable. Given the condition of the remaining cable, a mobile diesel generator has been rented and positioned on Long Island in standby to provide power in the event that the damaged submarine cable fails.

If the remaining cable fails, the customers on Long Island will be supplied by Diesel generation which is less efficient, more expensive to supply and not a reliable long term solution.

3.1 Existing System

South Brook – Line 4

The portion of the feeder that is submarine is approximately 0.9 kilometers, but is only a portion of the full feeder. The feeder is 15.7 kilometers long, including the submarine portion, and is fed from the Long Island Stepdown Transformer on Pilley's Island.

No major work or upgrades on this feeder in recent years. Table 1 lists some of the investments Hydro has made to improve reliability in the past 5 years.

Table 1: South Brook Line 4 - Major Work or Upgrades

Year	Major Work/Upgrade (\$000)	Comments
2014	2.5	Replace Porcelain Cutouts
2013	5.8	Replace Porcelain Cutouts
2012	7.9	Replace Poles, Transformers, and Conductor
2010	4.4	Replace Poles, Transformers, and Conductor

3.2 Operating Experience

The feeder containing the submarine cable is in continuous operation providing service to approximately 430 customers in the communities of Lushes Bight, Beaumont, and Beaumont North.

3.2.1 Reliability Performance

Hydro tracks all distribution system outages using industry standard indexes, SAIFI and SAIDI which are explained as follows:

SAIDI- indicates the System Average Interruption Duration Index for customers served per year, or the average length of time a customer is without power in the respective distribution system per year.

SAIFI - is the System Average Interruption Frequency Index per year which indicates the average of sustained interruptions per customer served per year or the average number of power outages a customer has experienced in the respective distribution system per year.

Table 2 lists the 2010 to 2014 SAIFI and SAIDI data for the line, 2010 to 2014 corporate values, and the latest CEA five year average (2009 to 2013) for comparison

3.2.1.1 Outage Statistics

Table 2: Outage Statistics - SAIFI SAIDI Data

Five Year Averages (2010 to 2014)				
Location	All Causes		Defective Equipment	
	SAIFI	SAIDI	SAIFI	SAIDI
South Brook Line 4	0.24	0.49	0.23	0.28
Hydro Corporate	5.25	13.78	0.55	1.28
CEA (2009 – 2013)	2.94	9.83	0.42	1.10

Although the reliability performance for South Brook Line 4 is better than the Hydro average, the submarine portion of the line is damaged and the failure should be addressed prior to complete failure. The work should be conducted proactively to avoid a major failure of the distribution line feeding the customers in the area. Since the iceberg damage, no additional major failures have occurred on the one remaining submarine cable. The above statistics are based on the number of outages experienced by the full length of line for numerous reasons, including planned maintenance, inspections and unforeseen failures. These statistics are not representative of failure only and are not meant to be a justification for the required work.

3.2.2 Legislative or Regulatory Requirements

There are no legislative or regulatory requirements associated with this project.

3.2.3 Safety Performance

This project is not justified because of poor safety performance.

3.2.4 Environmental Performance

This project is not justified because of poor environmental performance.

3.2.5 Industry Experience

This project is not justified because of experience in the utility industry.

3.2.6 Vendor Recommendations

The diving inspections were completed in 2014 by Crotty Diving Services, and the cables condition assessments were completed by Harry Orton of Orton Consulting Engineers International in early 2015. Harry Orton recommended the cables not be recovered and repaired as the cable is too badly damaged, and the concentric neutral of the cables did not remain intact.

3.2.7 Maintenance or Support Arrangements

A visual inspection of distribution feeders is performed every eight years to evaluate the condition of the line. This inspection is completed by Hydro personnel and any corrective maintenance required is reported, scheduled and completed. The inspection schedule is determined through a reliability centered maintenance program initiated by Hydro and is dependent on a variety of factors including geographical location, line age, and customer usage. Inspection schedules may vary between lines depending on the existing circumstances.

3.2.8 Maintenance History

The five-year maintenance history for South Brook Line 4 is shown in the following table:

Table 3: South Brook Line 4 - Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$ 000)
2014	19.1	0.0	19.1
2013	0.0	0.3	0.3
2012	0.4	0.0	0.4
2011	0.3	0.7	1.0
2010	0.2	0.4	0.6

The \$19,100 spent in 2014 was to perform the diving inspection to assess the condition of the damaged cables.

3.2.9 Historical Information

No similar projects have been completed by Hydro in the past five years.

3.2.10 Anticipated Useful Life

The service life of a distribution line structure is generally broken down as follows:

Poles	-	37 years
Conductors	-	55 years

3.3 Forecast Customer Growth

There is no significant load growth on these systems for the next five years, and therefore, load growth is not anticipated to have an impact on this project.

3.4 Development of Alternatives

Four alternatives were considered to address the failed submarine cables supplying the customers on Long Island. The four alternatives are as follows;

Alternative 1

Recover sufficient cable from the ocean floor to complete a repair on two cables to allow for single phase service plus one spare cable. The cable is 35 years old and past its recommended service life however, rejuvenation by injecting silicone fluid into the conductor has proved to be very effective in extending cable life of older cables. However, Hydro sent the video of the diving inspection on the cables to Harry Orton of Orton Consulting Engineers International who determined the cable has been so badly damaged in sections that rejuvenation is no longer an option.

Alternative 2

Replace and protect two cables to allow for single phase service plus one spare cable. This would require the installation of two new submarine cables across the Long Island Tickle, and protection of each cable. In this alternative, the possibility of iceberg contact remains,

but is highly remote. The submarine cables across the Long Island Tickle have experienced one iceberg contact in 35 years.

Alternative 3

Install a diesel plant on Long Island to supply single phase power. The plant will require one 150kW and two 300kW diesel units, as well as capacity for a fourth unit to allow for expansion. The location of the diesel plant is expected to be the middle of the communities on Long Island to allow for separation of the existing distribution line into two separate feeders to help pick up the load during cold load pickup. This alternative will require the highest cost to install and maintain of the four alternatives analyzed.

Alternative 4

Extend the overhead distribution line from Pilley's Island to Long Island, spanning across the Long Island Tickle. This alternative will require the installation of two, transmission type structures to provide suitable overhead clearance across the Long Island Tickle. Overhead clearance is designed to be approximately 24 meters, which exceeds required clearance of 16 meters. (CAN/CSA C22.3 No 1-M01 Overhead Systems, clause 4.3.3, Table 3)

3.5 Evaluation of Alternatives

Alternative 1 – Recover and Repair Submarine Cable

The total cost of this alternative was not estimated as the diving inspections were examined by Harry Orton of Orton Consulting Engineers International, and it was determined that outer protective casing and the concentric neutral of the cable was damaged, and in some sections missing, leaving no ability to recover and rejuvenate any of the four submarine cables.

Alternative 2 – Replace and Protect Submarine Cable

The total cost of this alternative is \$2,020,300. This alternative would provide the same service to the residents of Lushes Bight, Beaumont, and Beaumont North as existed prior to

iceberg contact in 2014. This alternative is preferred to recovering and repairing the cable as the condition of the cable does not allow for recovery and repair. This alternative is also preferred to installing a diesel plant on Long Island due to a lower cost to install and maintain. This alternative is not preferred when compared to installing an overhead distribution line as it is higher cost to install and inspect.

Alternative 3 – Install Diesel Plant on Long Island

The total cost of this alternative is \$7,138,500. This alternative is the most expensive to install and provides the least electrical efficiency. A diesel plant also requires more maintenance and costs more to supply power. The diesel plant alternative is not viable based on close proximity and ability to use Hydro's island interconnected distribution system.

Alternative 4 – Overhead Distribution Line

The total cost of this alternative is \$1,239,900. Hydro has chosen Alternative 4 as the best option to alleviate supply issues with the Long Island submarine cable due to the following reasons;

- Lowest cost of the four alternatives evaluated;
- Allows for visual inspection and ease of maintenance of the entire line; and
- Removes the possibility of iceberg damage.

3.5.1 Energy Efficiency Benefits

There are no energy efficiency benefits that can be attributed to this project.

3.5.2 Economic Analysis

The economic useful lives of the first three alternatives is 30 years whereas, the economic useful life of an overhead distribution line is 37 years. The breakdown of budgetary estimates is as follows:

- Alternative 1 – Recover and Repair Submarine Cable. No estimate was completed for this alternative as cable damage is too great to repair.

- Alternative 2 – Replace and Protect Submarine Cable.

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	1,000.0	0.0	0.0	1,000.0
Labour	300.0	0.0	0.0	300.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	200.0	0.0	0.0	200.0
Other Direct Costs	80.0	0.0	0.0	80.0
Interest and Escalation	124.3	0.0	0.0	124.3
Contingency	316.0	0.0	0.0	316.0
TOTAL	2,020.3	0.0	0.0	2,020.3

- Alternative 3 – Install Diesel Plant on Long Island.

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	900.0	0.0	0.0	900.0
Labour	1,300.0	0.0	0.0	1,300.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	3,180.0	0.0	0.0	3,180.0
Other Direct Costs	220.0	0.0	0.0	220.0
Interest and Escalation	418.5	0.0	0.0	418.5
Contingency	1,120.0	0.0	0.0	1,120.0
TOTAL	7,138.5	0.0	0.0	7,138.5

- Alternative 4 – Overhead Distribution Line

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	358.7	0.0	0.0	358.7
Labour	200.0	0.0	0.0	200.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	360.0	0.0	0.0	360.0
Other Direct Costs	60.0	0.0	0.0	60.0
Interest and Escalation	65.5	0.0	0.0	65.5
Contingency	195.7	0.0	0.0	195.7
TOTAL	1,239.9	0.0	0.0	1,239.9

4 CONCLUSION

This project is required to ensure that a reliable energy supply is available for the customers in Lushes Bight, Beaumont, and Beaumont North, serviced by the submarine cable to Long Island. Since the submarine cables have been severely damaged by iceberg contact, they have exceeded their useful lives and, it is recommended to replace the power supply to Long Island.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 4.

Table 4: Long Island Overhead Water Crossing Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	358.7	0.0	0.0	358.7
Labour	200.0	0.0	0.0	200.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	360.0	0.0	0.0	360.0
Other Direct Costs	60.0	0.0	0.0	60.0
Interest and Escalation	65.5	0.0	0.0	65.5
Contingency	195.7	0.0	0.0	195.7
TOTAL	1,239.9	0.0	0.0	1,239.9

4.2 Project Schedule

The anticipated project schedule is shown in Table 5.

Table 5: Long Island Overhead Water Crossing Project Schedule

Activity		Start Date	End Date
Planning	Resource Planning	January 2016	January 2016
Design	Assessment Completed	January 2016	February 2016
Procurement	Materials Ordered	February 2016	March 2016
Construction	Monitor Construction Activities	July 2016	August 2016
Commissioning	Inspection Performed by Local Operations Crews	August 2016	September 2016
Closeout	Project Closeout	October 2016	November 2016

APPENDIX A

Submarine Cable Pictures



Pilley's Island to Long Island Submarine Cable

This image shows a section of cable with moderate damage to the outer covering, but little damage to wire armour. No visible damage exists past the wire armour.



Pilley's Island to Long Island Submarine Cable

The top image above shows two cables entangled due to being dragged over each other by the iceberg. The bottom image shows a cable which has been damaged in a section down past the covering and the wire armour to the polyethylene jacket.



Pilley's Island to Long Island Submarine Cable

The bottom image above shows a different section of the two cables entangled due to being dragged over each other by the iceberg. The top image shows a different view of the same cable on the previous page, which is damaged down to the polyethylene jacket.



Pilley's Island to Long Island Submarine Cable

The top picture above shows a cable which has wire armour which is badly damaged and has begun to unravel. The bottom picture also shows a cable with a damaged wire armour but it has not become unraveled as of yet.



Pilley's Island to Long Island Submarine Cable

The picture above shows one cable which has been dragged across the floor of Long Island Tickle and over two of the other cables in this area.



Pilley's Island to Long Island Submarine Cable

This picture shows a better view of the cables which have crossed over each other in the picture on the previous page of this report. Iceberg contacted the cables and dragged them for a distance, causing them to entangle.



Pilley's Island to Long Island Submarine Cable

The picture above shows another section of cables which have become entangled after being contacted by iceberg. This picture shows one cable (left) which is not overly tangled whereas, the other two cables (right) are severely tangled.



Pilley's Island to Long Island Submarine Cable

The above picture shows a cable where the covering is gone, the wire armour has been so badly damaged that it has unraveled, and damage is visible on the polyethylene jacket.



Pilley's Island to Long Island Submarine Cable

This image shows a section of a cable where the covering and wire armour have been completely destroyed, the polyethylene jacket is highly visible, and the damage continues to the concentric neutral.

Upgrade Office Facilities and Control Buildings Condition Assessment and Refurbishment Program

ASSET MANAGEMENT STRATEGY PLAN

July 2015



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1 INTRODUCTION

This strategy report outlines a plan to refurbish Hydro's aging Transmission Rural Operations (TRO) facilities over nine years. The program will include detailed assessments, engineering and refurbishment of the aging facilities including the regional offices, area offices and control buildings at terminal stations within TRO.

Facilities that are sound, well maintained and functional are essential in allowing employees to perform their work in a safe and efficient manner. Many of Hydro's office buildings and facilities in TRO were constructed in the 1970s and 1980s and have not had detailed assessments or any significant upgrades performed since that time.

2 BACKGROUND

2.1 Existing System

Hydro has an array of offices and buildings which are used to facilitate operating work across the TRO regions in Newfoundland and Labrador. Most buildings are regional offices, area offices and control buildings at terminal station sites. The scope of this initiative will be to manage and correct any unsuitable conditions at these regional offices, area offices and control building facilities.

There are currently 37 existing sites that have been identified by operations as having aging infrastructure in need of improvement and all sites contain office buildings and other facilities to accommodate daily rural operations.

Facilities maintenance crews perform general maintenance work on the TRO buildings in order to keep them operational, however, some of the buildings are in excess of forty years old and many of them have not had significant upgrades since they were initially built. These structures are in the range of 25-40 years old and as per the attached Condition Assessments (see Appendix A). It is deemed that these upgrades will extend the useful life of these buildings. Some of the priority areas identified on the condition assessments completed for Bishop's Falls Service building, Port Saunders Regional office indicate that doors, windows and siding are at the end of their life expectancy and need replacement. In addition, the air handling units need to be upgraded at both locations. The lift station at Port Saunders does not function correctly and the septic field needs to be replaced to attain appropriate distances from the building structure. As well, electrical upgrades are required for upgrades to electrical outlet, junction boxes, disconnects, etc.

At the Sunnyside Terminal Station, the roof is in poor condition and will require a complete replacement of the roof membrane system.

In general, operations personnel have identified that the items indicated in the assessment reports at these locations are indicative of most TRO facilities of similar age, suggesting a program to refurbish all TRO facilities, based on condition, is in order.

2.2 Operating Experience

The TRO regional offices, area offices and terminal station facilities are used by personnel as office space, storage space, workshops/maintenance garages, warehouse, and control buildings. These offices, workshops and other structures are essential in continuing the daily planning and operations of Hydro. The terminal station control buildings ensure that reliable electricity is distributed to the customers of Newfoundland and Labrador. All Hydro facilities need to be structurally sound, secure and weather tight to ensure a safe and healthy environment for employees and an appropriate facility for proper equipment operation.

3 IMPLEMENTATION PLAN

This program will introduce a structured and phased approach to performing detailed assessments, detailed engineering and refurbishment of the TRO facilities which include the regional offices, area offices and terminal station facilities.

Assessments will investigate the condition of electrical, plumbing and HVAC systems, structural condition of buildings (including roofs), compliance with National Building code (NBC) and Occupational Health and Safety (OHS) codes, health and safety concerns (including mold and mildew), environmental concerns, energy usage, suitability of washroom and kitchen facilities, storage capacity of buildings and yards as well as the suitability of buildings to accommodate the number of staff and work being performed at each location. Assessments will also provide cost estimates that will be used for capital budgeting of refurbishment work to be carried out in subsequent years.

4 APPROACH

The refurbishments are based on assessments which can be planned detailed assessments by a consultant. Refurbishment based on planned detailed assessments by a consultant will include the regional offices, area offices and terminal station facilities where full building replacement is not considered cost effective. The assessments will identify components in poor condition and code, structural and safety issues within the buildings that are best suited for refurbishment or component replacement. For each site planned for consultant assessment, the work will be implemented as follows:

Year 1 – Detailed Consultant Assessment.

Year 2 – Budget/Cost estimate from detailed Consultant Assessment.

Year 3 – Detailed Engineering/Construction.

Year 4 – Construction.

Building condition assessments of two office facilities and fourteen terminal stations were completed in 2013 and 2014 by Hydro operations. The reports that are relevant to the 2016 refurbishment plan can be found in Appendix A. Refurbishment work was identified in these assessments, including items such as roof, windows and doors replacement, heating unit upgrades, electrical code upgrades, septic system upgrades, exterior upgrades and safety items. Engineering work and selected construction work is to be completed in 2016. The capital program is planned to begin in 2016 and will consist of additional detailed assessments, engineering and refurbishment work with all sites being covered as outlined in the schedule in Appendix B. Additional locations will be added in the coming years to include the 69 kV terminal stations.

5 BUDGET

Hydro reviewed the consultant's condition assessments identified in appendix A. Each recommendation/deficiency was assessed by Hydro to identify capital costs at each location. Only work pertaining to capital costs have been included in the budget estimate. These capital costs have been further divided into 2016 work (priority level 1 work as identified in the condition assessments).

The budget estimate for 2016 is presented in Table 1 below.

Table 1: 2016 Budget Estimate					
Project Cost:	(\$ x1,000)	2016	2017	Beyond	Total
Material Supply		0.0	0.0	0.0	0.0
Labour		227.6	0.0	0.0	227.6
Consultant		231.5	0.0	0.0	231.5
Contract Work		398.0	0.0	0.0	398.0
Other Direct Costs		34.6	0.0	0.0	34.6
Interest and Escalation		64.0	0.0	0.0	64.0
Contingency		178.3	0.0	0.0	178.3
TOTAL		1,134.0	0.0	0.0	1,134.0

The outlined budget details work planned for 2016. It is estimated that the budget each year during this program will be similar magnitude as the budget for 2016, but ultimately will depend on the degree of work identified in future condition assessments.

6 CONCLUSION

The office facilities and control buildings are essential in providing service to the customers of Newfoundland and Labrador. Over the life of this program individual locations will be assessed and the necessary engineering and construction will be completed to correct any deficiencies. These upgrades will ensure that any structural, mechanical and electrical issues are met as well as upgrades to satisfy today's safety standards and building codes.

Completing this work will not only extend the useful life of the buildings but will ensure that Hydro employees have a safe and efficient work place.

APPENDIX A

Condition Assessments

Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL

December 20, 2013

**Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL**

Prepared For:

Newfoundland and Labrador Hydro

Prepared By:



© December 20, 2013

Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
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Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL

December 20, 2013

1 INTRODUCTION

The normal design life of a typical building is in the range of 25 to 30 years. The Bishop's Falls Service Facility is intended for maintenance, operations, and administration purposes for line workers. This facility was built during the construction period within this era and Newfoundland and Labrador Hydro is looking to determine and evaluate the immediate, short, and long term capital renewal/extension/upgrade requirements that can be expected over the next 25 years. The intention is to bring all of the support facilities up to the Newfoundland and Labrador Hydro standard. It is anticipated that this site will continue with similar occupancies, staffing levels and activities for the foreseeable future.

The scope of this evaluation was restricted to the service facility as illustrated within Appendix A.

Coles Associates was retained to undertake an audit and prepare a report to:

- ⊕ Assess the building envelope and systems to identify Priority 1, 2 and 3 (immediate, short and long term) areas where problems are occurring within the building and/or may occur.
- ⊕ Make note of any possible Life Safety and/or Code compliant issues that were visible. (Note: a thorough Life Safety, Building and Fire Code analysis was not performed as part of this Building Condition Audit.)
- ⊕ Investigate the need for expansion and/or relocation of the facilities in addition to the rehabilitation priorities, and
- ⊕ Provide estimates on the costs of all recommendations.

2 EXECUTIVE SUMMARY

In early December of 2013 a team of consultants reviewed the Bishop's Falls facility. The objective was to undertake a Building Condition/Rehabilitation/Relocation/Expansion Assessment Audit.

In summary, it is the purpose of this study to undertake the following tasks:

- ⊕ Establish the current condition of the architectural, structural, mechanical and electrical building components and systems;
- ⊕ Assess deficiencies of the building relative to current code and/or indicated usage;
- ⊕ Determine the need for either rehabilitation, relocation and/or expansion; and
- ⊕ Provide a cost estimate of all recommendations.

The Bishop's Falls Facility is located on the Botwood Highway in Bishop's Falls, NL.

There is no mechanism within the National Building Code (NBC) that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change.

While there may be opportunities to increase the energy efficiency and/or functionality of this facility through such changes as internal/external renovation and/or increased insulation in the roof and walls, as well as the windows, given its age, it is anticipated that this decision point will be based upon a financial payback model as is undertaken for most private clients. There was also no indication that these existing elements were deteriorating into a priority 1 or 2 status.

Following review there are approximately:



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\$212,000 of Priority Level #1 work to be undertaken.
\$194,250 of Priority Level #2 work to be undertaken.
\$161,000 of Priority Level #3 work to be undertaken.

All as defined below. To these amounts and as shown in Section 6, a 30 % contingency has been added in the amount of \$170,175.

3 METHODOLOGY

3.1 Building Audit

The method of study was by site visit by a team of consultants from Coles Associates. Audit Work included tasks to familiarize, visually review, and document the condition of the building.

One visit was made to the facility to conduct interviews with the building manager and a walk-through investigation. The building audits were completed by:

Architectural/	Robert Haggis, RAIC, AIA, NCARB
Structural	
Mechanical	Sean Wheeler, P.Eng.
Electrical	Elliott Coles, E.I.T.

The report was reviewed by Douglas A. Coles, P.Eng., P.E., F.E.C.

3.2 Drawings

Floor plans of the facility were available for the Audit. Floor plans were confirmed, where warranted, from rough measurements taken on site. Site documentation was unavailable.

3.3 Prioritization

The deficiencies/recommendations falling out of these reports and/or walkthrough will be identified indicating three priority levels:

1. **Priority One:** Where immediate attention is required in order to maintain or to re-establish the integrity of a strategic system, process, weather envelope, etc., in order to comply with life safety, Building Code violations and/or those resulting from Orders delivered by the Authority having Jurisdiction (AHJ) to prevent further on-going exposure, damage or deterioration or to remove or lessen a threat to life safety.
2. **Priority Two:** Where systems require attention but present no immediate risk to system integrity or to life safety. The short to intermediate nature of these issues (one to three years) is such as to allow some orderly planning and financial resource development to occur.
3. **Priority Three:** This category identifies intermediate to longer-term issues. In the context of this report and at the heart of the Priority Three issues is the long-term disposition of this facility in total; given the condition of the envelope, the issues of non-compliance with current codes for items such as wall insulation levels; and the implications and costs of its repair.

3.4 Quality Assessment

Throughout the report references are made to the quality of materials and systems. The following provides a guide to the intent of the grading.



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⊕ Good	Suitable for continued use.
⊕ Serviceable	Is able to remain in service with regular maintenance.
⊕ Marginal	Is able to remain in service with heavy maintenance.
⊕ Suspect	Requires further investigation, is not visible though possibly problematic.
⊕ Poor	Requires significant maintenance, repair or replacement.
⊕ End of useful life	Requires replacement. In practical terms, systems tend not to fail all at once. In this instance "outlived its useful life" means that it is time to seriously look at putting a financial plan in place to replace the identified system in the short term.

3.5 National Building Code

The National Building Code (NBC) is a document prepared by the National Research Council of Canada, which historically has been updated every 5 years. It is the purpose of the NBC to establish standards for building construction and systems, the focus of which is occupant safety. It is the underlying intent of the NBC to provide a level of systems and environment within a building, which provide for adequate life safety, environmental conditions (i.e. light levels and air ventilation levels) and mobility (i.e. barrier-free access). While all regulations do not necessarily get more stringent, regulations very often change. In fact, buildings never "catch up" to the state of the current-day Codes.

There is no mechanism in place that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change. At the same time, Authorities Having Jurisdiction have the right to make inspections at their discretion and direct improvements to components and/or systems where they feel life safety is at risk.

In upgrading older buildings, which were not originally designed to incorporate fire ratings or sometimes bulky and space consuming systems, it can be difficult to achieve the letter of the regulation. More often it is the intent to reasonably protect life safety, which is more readily achievable.

Therefore the purpose of the review of the salient requirements of the NBC is to provide a basis of comparison against the current Code requirements and to estimate the capital cost to upgrade the building to these standards.

Specific areas of this report deal with issues that should be undertaken in the short term for reasons of life safety, regardless of the ultimate disposition of the building.

3.6 Standard Classification for Building Elements and Related Site Work – UNIFORMAT II

- ⊕ This standard establishes a classification of building elements and related site work,
- ⊕ The classification serves as a consistent reference for analysis, evaluation, and monitoring,
- ⊕ Referenced documents, E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems,
- ⊕ The classification is hierarchical to allow different levels of aggregation and summarization.

4 BUILDING SUMMARY

In general, the Bishop's Falls facility is a steel frame and CMU block structure on concrete foundations.

Age Approximately (Building Original) 25 years



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Location Bishop's Falls, NL
Ownership Newfoundland and Labrador Hydro

5 BISHOP'S FALLS SERVICE FACILITY

5.1 A SubStructure

5.1.1 A10 Foundations

.1 A1010 STANDARD FOUNDATIONS

- ⊗ The foundations were described as standard frost walls with footings.

IT IS RECOMMENDED THAT:

1. None at this time.

.2 A1020 SPECIAL FOUNDATIONS

- ⊗ Not applicable.

.3 A1030 SLAB ON GRADE

- ⊗ Generally, the majority of the concrete slab is in good to serviceable condition with minor cracking.
- ⊗ The slab has settled slightly near the foundation wall on the north side area encompassing the steam cleaning room, battery room, and electrical room. Although the settlement had occurred, it was not visually evident that this was a continuing issue.

IT IS RECOMMENDED THAT:

1. None at this time.

5.1.2 A20 Basement Construction

.1 A2010 BASEMENT EXCAVATION

- ⊗ Not applicable.

.2 A2020 BASEMENT WALLS

- ⊗ Not applicable.

.3 A2030 BASEMENT COLUMNS

- ⊗ Not applicable.

5.2 B Shell

5.2.1 B10 Superstructure

.1 B1010 FLOOR CONSTRUCTION

- ⊗ See 5.1.1.3 see A1030.

.2 B1020 ROOF CONSTRUCTION

- ⊗ The roof was original to the building.
- ⊗ It consisted of a flat built up membrane roof.
- ⊗ There was evidence of past/current leakage. This evidence was in the form of minor repairs of the West portion of the roof and major modified bitumen and tar patch work around the air handling units of the east portion of the roof. As well there was evidence of stained Acoustic Ceiling Tiles (ACT) throughout the upper floors.
- ⊗ The word "DAMP" was spray painted on the roof membrane. This was unable to be explained by the local personnel; however, anecdotally this area was considered to be restrictive by personnel.



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- ⊕ There is visual evidence of organic growth on the roof membrane. This growth would not be considered to be minor.
- ⊕ There is evidence of ponding deemed around all of the air handling units (AHU).
- ⊕ Also, although the top sheet appeared in serviceable condition the roof itself was considered to be in marginal to poor condition.
- ⊕ The level of insulation was not readily visible but given the age of the building should be considered for increasing with any roof replacement.
- ⊕ Evidence of leaking in some transition flashing.
- ⊕ Evidence of minor rust spots on vertical flutes of metal siding.
- ⊕ Cap flashing was dented and misshapen in various areas which may have been corrected. It is presumed that the flashing was damaged by the wind.
- ⊕ All caulking at transition and cap flashing has reached the end of its lifespan; cracking and uncaulked joints were evident.

IT IS RECOMMENDED THAT:

1. Remove all caulking and replace with new. Installation may be more suitable at the time of roof and flashing replacement - **Priority 2**
2. Replace roof - **Priority 2**

5.2.2 B20 Exterior Enclosure

.1 B2010 EXTERIOR WALLS

- ⊕ The exterior wall was a combination of metal siding and brick veneer, against a CMU block structure.
- ⊕ The level of wall insulation was presumed to be consistent with a building of this age but was not determined from the site visit.
- ⊕ Exterior wall system was considered to be good to serviceable.
- ⊕ Obvious brickwork was undertaken on the south side of the building.
- ⊕ Brick re-pointing may be required in some areas.
- ⊕ Some minor rusting is visible at window lintels.
- ⊕ Additional remedial caulking was evident.
- ⊕ Evidence of minor rust spots on vertical flutes of metal siding which was presumed to be from exterior piping; notably below sprinkler discharge pipes.

Insulation

- ⊕ Presumed to be typical installation for a building of this vintage.

IT IS RECOMMENDED THAT:

1. Monitor and repoint brick as required - **Priority 3**
2. Provide leaders to grade at sprinkler discharge pipes - **Priority 3**
3. Clean and monitor condition of metal siding where rusting has occurred - **Priority 3**

.2 B2020 EXTERIOR WINDOWS

- ⊕ The majority of the exterior windows are aluminum operable double pane.
- ⊕ Some windows are anodized.
- ⊕ Some major caulking has been applied to deteriorating window gasket at the south window off of heavy vehicle and maintenance shop.

IT IS RECOMMENDED THAT:

1. Monitor and replace south window off of the heavy vehicle and maintenance shop - **Priority 2**

.3 B2030 EXTERIOR DOORS

- ⊕ Entrances and exits are insulated hollow metal doors.



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- ⊕ Doors and jambs have begun to deteriorate noticeably.
- ⊕ Otherwise the hardware is in good condition.

IT IS RECOMMENDED THAT:

1. Replace metal doors and jambs; repair and replace mortar as needed – **Priority 1**
2. Replace hardware as warranted by addition study when doors are replaced – **Priority 2**

.4 B2035 EXTERIOR OVERHEAD DOORS

- ⊕ Overhead doors are insulated hollow metal doors, electrically operated and in both accordion and regular high lift style.
- ⊕ The doors are in fair to poor condition.
- ⊕ The hardware is in serviceable condition.
- ⊕ Doors are nearing to the end of their service life.

IT IS RECOMMENDED THAT:

1. Replacement of all accordion style overhead doors – **Priority 1**
2. Replacement of all sectional overhead doors – **Priority 1**

.5 B2040 EXTERIOR STAIRS/ROOF ACCESS LADDERS

- ⊕ The exterior stairs/access were constructed of painted steel members.
- ⊕ Components of the roof access are in need of immediate remediation.
- ⊕ Components of the external stairways are in need of immediate remediation.
- ⊕ Visual rust on the stairs and access ladders was evident.
- ⊕ Anchor points could be improved. Base connection would be a candidate for redesign and modification under any stair replacement program.
- ⊕ Handrails on the roof accesses were less than sturdy.
- ⊕ Roof access systems would be considered to be serviceable.

IT IS RECOMMENDED THAT:

1. Sand-blast/replace and recoat stairways/roof access ways – **Priority 1**
2. Complete preventative maintenance on external stairways and roof access – **Priority 3**
3. Consider manner in which the stairways are attached to the ground – **Priority 2**

.6 B3010 ROOF COVERINGS

- ⊕ See 5.2.1.2 B1020.

IT IS RECOMMENDED THAT:

1. None at this time.

.7 B3020 ROOF OPENINGS

- ⊕ Not applicable.

5.3 C Interiors

5.3.1 C10 Interior Construction

.1 C1010 PARTITIONS

- ⊕ The interior partitions in the building are block wall with no applied surface in the more industrial areas while the office and welfare area tended to be of wood stud and ceramic or drywall. Generally, they are in good to serviceable condition.
- ⊕ Lack of interior partitions is jeopardizing the electrical distribution and transformer units in the heavy equipment and vehicle maintenance shop area and providing for a hazardous condition. It has been suggested that a waterproof protective enclosure around the 600V equipment is required. See electrical section for further information.

IT IS RECOMMENDED THAT:



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1. Construct waterproof enclosure around distribution panels - **Priority 1**
- .2 **C1020 INTERIOR DOORS**
 - ⊗ Metal doors and metal frames are generally present throughout the industrial part of the facility.
 - ⊗ Wood doors and metal frames are generally present throughout the office and welfare areas of the building.
 - ⊗ Doors and frames are in good to serviceable condition.

Hardware

 - ⊗ In general, the hardware throughout the building, closures, kick plates, door knob, lock and key sets/ privacy sets are in good to serviceable condition.
 - ⊗ Some surface rust is evident on some of the hardware.

IT IS RECOMMENDED THAT:

 1. None at this time.
- .3 **C1030 INTERIOR WINDOWS**
 - ⊗ Not applicable.
- .4 **C1040 FITTINGS**

Washroom Accessories

 - ⊗ Generally washroom accessories are in good condition.

Vanities

 - ⊗ The vanities are sound and in good condition.

Millwork

 - ⊗ The millwork is sound and in good condition.

IT IS RECOMMENDED THAT:

 1. None at this time.
- 5.3.2 **C20 Stairs**
 - .1 **C2010 STAIR CONSTRUCTION**
 - ⊗ Interior stairs are constructed of metal stringers, checkerplate treads and metal risers in good condition.
 - ⊗ Handrails are metal tubing in good condition.

IT IS RECOMMENDED THAT:

 1. None at this time.
 - .2 **C2020 STAIR FINISHES**
 - ⊗ Painted metal in good condition.

IT IS RECOMMENDED THAT:

 1. None at this time.
- 5.3.3 **C30 Interior Finishes**
 - .1 **C3010 WALL FINISHES**
 - ⊗ Walls where paint is applied are in good to serviceable condition.
 - ⊗ Ceramic walls are in good to serviceable condition.

IT IS RECOMMENDED THAT:

 1. None at this time.

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.2 C3020 FLOOR FINISHES

- ⊗ Painted concrete in the industrial areas generally is in good to serviceable condition.
- ⊗ Vinyl composite tile with rubber base generally in welfare and office areas generally is in good to serviceable condition.
- ⊗ Some base missing and should be replaced.
- ⊗ Tile in Tool Room 103 is in poor condition and requires replacement.
- ⊗ Tile in Corridor 124 is in poor condition and requires replacement.
- ⊗ The concrete flooring in the shops area are unpainted.

IT IS RECOMMENDED THAT:

1. Replace tile in Room 124 and 103 – **Priority 2**
2. Repair/replace base – **Priority 2**

.3 C3030 CEILING FINISHES

- ⊗ Generally Acoustical Ceiling Tile (ACT) was present in the office and welfare areas and is for the most part in good condition with some staining and cracked tiles noted.

IT IS RECOMMENDED THAT:

1. Replace ceiling tiles which are cracked/stained – **Priority 2**

5.4 D Services

5.4.1 D10 Conveying

.1 D1010 ELEVATORS & LIFTS, D1020 ESCALATORS & MOVING WALKS

- ⊗ Not applicable.

.2 D1090 OTHER CONVEYING SYSTEMS

- ⊗ Not applicable.

5.4.2 D20 Plumbing

.1 D2010 PLUMBING FIXTURES AND TRIM

- ⊗ The water closets throughout are white vitreous china. Water closets are floor mounted 12 litre tank type with regular rim bowls. The water closets throughout the facilities are in serviceable condition.
- ⊗ Lavatories throughout are vitreous china. Lavatories are counter mount type. Lavatory trim is a mixture of blade and round type handles. Trim is in serviceable condition, requiring adjustment and maintenance.
- ⊗ The urinals are standard wall hung units which are fed from a flush tank mounted high on the wall which in turn fills and siphons into the urinals. It is expected that the water flows continuously through the urinals resulting in the high water consumption. This could reduce the life expectancy on the tile field.
- ⊗ Kitchen sink is a double bowl stainless steel sink, with round handled trim. Sink and trim are in serviceable condition, with trim requiring adjustment and maintenance.
- ⊗ Stand-up shower is two piece molded composite with curtain enclosure. Trim is single lever valve with regular shower head. Shower, enclosure trim and shower head are in marginal condition.
- ⊗ The hot water, cold water and sanitary piping servicing these fixtures appears to be in good condition and consistent with late 1980's construction.
- ⊗ The fixtures and associated trim in the facility are not required to meet accessibility requirements for persons with disabilities.

IT IS RECOMMENDED THAT:

1. Replacement of the urinals with ultralow flow flush type urinals – **Priority 2**



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.2 D2020 DOMESTIC WATER DISTRIBUTION

Domestic Cold Water

- ⊗ The facility receives domestic cold water from the municipal system. The service entrance is shared with the sprinkler system and appears to be 1 ½ half inches. There is a pressure reducing valve which drops the building pressure to 50 PSI.
- ⊗ The piping for the domestic cold water and domestic hot water is generally copper pipe throughout. There are signs of light surface rust around the pipes. It is expected that the solder used for the copper pipe is a 50/50 lead-tin mix, which would be typical of the solder used in that time period. A water quality test should be conducted to verify that water is within current national guidelines.
- ⊗ There are no backflow preventers on the service entrance.
- ⊗ Check valves and vacuum breakers were used in limited locations to provide limited backflow prevention.
- ⊗ A full backflow prevention audit should be performed.

Domestic Hot Water

- ⊗ The domestic hot water system supplies hot water for the building including washrooms, showers and sinks.
- ⊗ The domestic hot water is provided from 3 electric hot water heaters. The heaters appear in good condition.
 - The tank in the south of the building is a GSW model SS125EB 10 gallon 1500 W heater located under the lunch room sink.
 - The tank in the center section of the building is a GSW series 6 model 6ETF-1-175, 60 gallon 3000 W heater located in the janitorial room under the stairs.
 - The tank in the North end of the building is a John's Wood Pro model JW50SDEN1 60 gallon 3000 W heater located in the second floor janitorial room.
- ⊗ The heaters are located near fixtures served. No recirculation system is provided in the buildings. All fixtures tested appeared to have hot water available on demand.

IT IS RECOMMENDED THAT:

1. Perform backflow contamination evaluation around the facility – **Priority 3**
2. Test drinking water for inclusion of treatment systems – **Priority 3**

.3 D2030 SANITARY WASTE AND STORM DRAINAGE SYSTEMS

- ⊗ The storm, sanitary and drain, waste and vent lines appear for the most part to be cast-iron.
- ⊗ There was evidence of general leaks. These may contribute to the staining identified in the architectural portion of the report. These leaks were largely attributed to the roof however, we would recommend a further complete visual investigation and remediation (as necessary) of the drainage system be undertaken.
- ⊗ Floor drains and keynotes throughout are in relatively fair to good condition.
- ⊗ Conversations with maintenance staff indicated that all sanitary passed through an oily water sump pit prior to being discharged to a 20,000 L septic tank and tile field located on the far east portion of the site.
- ⊗ A site plan indicating domestic water, storm and sanitary services does not show any connections from the building to the sanitary services. The plan shows one connection to storm services exiting the Northeast corner of the building. Further investigation and updating of the site plan.
- ⊗ Given the above information an investigation to confirm all sanitary fixtures, floor drains and oily water sumps are connected to the sanitary system is warranted.

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- ⊕ The roof of the building is a modified type with roof drains centrally located. There were areas of the roof where water was pulling away from roof drains. Whenever a major roofing project is undertaken consideration should be given to ensure the roof is re-sloped and additional roof drains are added as required.

IT IS RECOMMENDED THAT:

1. A complete visual investigation and remediation (as necessary) of the drainage system be undertaken – **Priority 2**
2. Investigation and updating of the site plan insofar as waste and water lines are concerned – **Priority 3**
3. Investigation to confirm all sanitary fixtures, floor drains and oily water sumps are connected to the sanitary system – **Priority 3**
4. Roof is re-sloped and add additional roof drains as required whenever major roof work is undertaken – **Priority 3**

.4 D2090 OTHER PLUMBING SYSTEMS ACCESSORIES

- ⊕ The oil water sump has a duplex hydromatic pump system and controller installed. The pumps are currently manually operated with the controller disabled.
- ⊕ The sump has Zurn electronic oil/grease alert which is currently switched off. Operators currently dip the sump on a daily basis to check for hydrocarbon contamination.
- ⊕ A 2300 L underground waste lube oil tank is installed near the steam cleaning room. There is no evidence of a containment sump, double wall piping or access for inspection. It is anticipated that the installation is original to the facility. Consideration should be given to upgrading to meet the latest standards and codes.
- ⊕ Maintenance personnel indicated that drainage from the vehicle service pit was not operational. This pit required manual pumping on a regular basis. It was indicated that this was related to the oily water sump issues. Consideration should be given to installing a new oily water separator and monitoring system meeting current standards and environmental regulations.

IT IS RECOMMENDED THAT:

1. Upgrade underground waste lube oil tank and piping system - **Priority 3**
2. Upgrade the oily water separator and monitoring system - **Priority 3**

5.4.3 D30 HVAC

.1 D3010 ENERGY SUPPLY

- ⊕ Not applicable.

.2 D3020 HEATING SYSTEMS

- ⊕ The accommodations facility is heated using Stelpro/Chromalox baseboard electric heaters as well as electric horizontal and vertical unit heaters. The condition of these units appears to be serviceable.
- ⊕ Heating is controlled by line voltage thermostats, with a significant number of thermostats having been switched to low voltage programmable thermostats. The system is functional and should be maintained on a regular basis.
- ⊕ One piece of baseboard in the South Lunch room is beyond useful life.

IT IS RECOMMENDED THAT:

1. Replace baseboard in South Lunch room – **Priority 1**
2. Condition of fins and guards are checked on a regular basis – **Priority 3**



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.3 D3030 COOLING SYSTEMS

- ⊗ Air conditioning is provided to the facility using two wall-mounted built-in air-conditioning units and one roof mounted Trane air-conditioning unit.
- ⊗ The air conditioner in the south office is an Electrolux model HW905800 Reykjavik 9000 BTUs/hour drawing 12 A on a 120 V circuit. Air conditioner was plugged into a wall receptacle. This unit appeared in serviceable condition.
- ⊗ The air conditioner in the center office is a three-quarter ton electronic home unit and appeared in serviceable condition.
- ⊗ Air conditioner controls were integral to the units.
- ⊗ For the roof top Trane unit see section 5.4.3.5 D3050 Ventilation Systems.

IT IS RECOMMENDED THAT:

1. Provide separate electrical circuit for air-conditioning units – **Priority 2**
2. Wall-mounted built-in air-conditioning units to be evaluated for replacement – **Priority 2**
3. Condition of fins to be checked on a regular basis - **Priority 3**

.4 D3040 HVAC DISTRIBUTION SYSTEMS

- ⊗ The ductwork was presumed to be original to the building.
- ⊗ It can be expected to be dirty considering its age.

IT IS RECOMMENDED THAT:

1. Duct cleaning to be undertaken – **Priority 3**

.5 D3050 VENTILATION SYSTEMS

- ⊗ One (1) Penn Fumex model XR94, 4 hp fan is located on the north portion of the building and was off during the site visit. It appears to service the washrooms.
- ⊗ One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the steam cleaning room. The fan appeared to be operational.
- ⊗ One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the machine shop. The fan appeared to be operational.
- ⊗ One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the equipment testing room. The fan appeared to be operational.
- ⊗ One (1) Kramer Tool & Manufacturing stationary rectangular shaker type dust collector is located in a room attached to the south face of the building. It has four (4) 24 inch drums. Air is circulated using a 19 1/8" Dayton 8 hp blower. An under slab 12 inch duct collects dust from:
 - one skill saw,
 - two planers,
 - one large bandsaw,
 - one bandsaw,
 - one table saw,
 - one sander.

The unit returns are directed to the building. The current system does not meet code and should be replaced or removed.

- ⊗ The machine shop has an in-line cabinet fan and heating coil making up air to the room. It appeared to be functional.
- ⊗ The machine shop has one welding fume extraction arm connected to a centrifugal exhaust fan and discharged through the outside wall.
- ⊗ The vehicle maintenance shop has 2 centrifugal exhaust fans which are connected to multiple vehicle exhaust extraction ducts. The operation of the fan is controlled by 2 CO sensors and manual switches. It is unknown when the CO sensors were last calibrated.

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- ⊕ Washrooms are served primarily by ceiling mount wash and exhaust fans, sidewall vented. The main washroom/locker room in the building is served by an in-line exhaust fan mounted above the ceiling. Conversations with staff indicated that the fan may be undersized. Washroom fans are operated by the light switch.
- ⊕ There are four (4) rooftop air handling units. Three (3) Engineered Air units and one (1) Trane unit.
- ⊕ The 3 Engineered Air units were located south, center and north. Each unit is a recirculation unit with electric heat and power exhaust complete with pleated filters. The Trane unit is located on the north portion of the building. All units appear to be original to the building.
- ⊕ The South unit (model LM-3-K, 3000 CFM) was in operation during the site visit. The filters required replacement. The filter showed signs of damage. The unit is in marginal condition and should be considered for replacement.
- ⊕ The central unit is approximately the same size as the South unit although the name tag could not be read. The central unit was not in operation during the site visit. Filters appeared to be in good condition. Occupants in the central portion of the building noted poor air quality. This in part could be due to this system not being operational at this time. Visually, the unit appeared to be in marginal condition and should be considered for replacement.
- ⊕ The North Engineered Air Unit is model LM 6K, 6000 CFM and is the larger of the two units. It was in operation during the site visit. Filters appeared in poor condition. Belts and the fans were loose, a latch was broken on the return air filter access and one blade on the outside air damper was broken. Ducting around the unit appeared to be modified recently. The unit was in marginal condition and should be considered for replacement.
- ⊕ The North Trane unit serves the northernmost section of the building which is primarily offices and storage. The unit has the ability to provide air-conditioning. It was not in operation during the site visit. The disconnect on the roof was switched off suggesting terminal problems. Occupants in the north portion of the building noted poor building air quality. This in part could be due to this system not being operational at this time. Visually, the unit appeared to be in marginal condition and should be considered for replacement.
- ⊕ Fumes from the maintenance garage were noted to be an issue during the inspection. Consideration should be given to adding a small continuously operated exhaust fan to this area to help improve relative building pressures.

IT IS RECOMMENDED THAT:

1. Calibrate carbon monoxide sensors – **Priority 1**
2. Plan for adjusting dust collection system - **Priority 3**
3. Replace filters on a preventive maintenance basis - **Priority 1**
4. Replace all four roof mounted air handling units - **Priority 2**
5. Replace broken outside air damper - **Priority 1**
6. Investigate why the Central Engineered Air unit was nonoperational - **Priority 1**
7. Add a maintenance garage continuous exhaust fan - **Priority 2**
8. Investigate why the North Trane unit was nonoperational - **Priority 1**

.6 D3090 HVAC SYSTEMS & EQUIPMENT

- ⊕ Not applicable.



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5.4.4 **D40 Fire Protection**

.1 **D4010 FIRE EXTINGUISHERS**

- ⊗ A significant number of ABC type fire extinguishers were located around the Facility. Sizes, age and condition of extinguishers varied.
- ⊗ All fire extinguishers were fully charged and had valid inspection tags.

IT IS RECOMMENDED THAT:

1. Inspect fire extinguishers on an annual basis – **Priority 1**

.2 **D4020 AUTOMATIC SPRINKLERS**

- ⊗ The automatic sprinkler system service entrance is located in the mechanical storage room.
- ⊗ The system has four (4) zones from south to north: civil works, terminals, garage and transmission.
- ⊗ The incoming line is pressurized 90 PSI.
- ⊗ The sprinkler verification certificate by Viking is dated June 2009.
- ⊗ There are rust stains on the east face of the building where zone test connection pipes exit the building suggesting the system is leaking.
- ⊗ The system appears in good condition.
- ⊗ Discussions with maintenance personnel indicated the system was connected to municipal system which may have flow restrictions.
- ⊗ There are no backflow prevention on the service entrance.

IT IS RECOMMENDED THAT:

1. Verify automatic sprinkler system on an annual basis - **Priority 1**
2. Confirm the adequacy of the incoming fire water line from the municipality and replace if required – **Priority 1**

5.4.5 **D50 Electrical**

.1 **D5010 ELECTRICAL SERVICE & DISTRIBUTION**

Main Service Equipment

- ⊗ The Bishop Falls Service Building is fed by an aerial utility line to hydro pole which is then fed underground to a padmount utility transformer located at the north-east corner of the building.
- ⊗ The utility service is then fed underground to the main electrical room and a 1200 A, 600 V, 3-phase, 4-wire, Federal Pioneer two (2) section switchboard c/w 1200 A main breaker, utility meter and distribution cells.
- ⊗ The distribution section of the switchboard contains one (1) 300A/3P breaker feeding distribution panel 'DB' (Carpentry Shop), one (1) 450A/3P breaker feeding distribution panel 'DC' (Terminals and Machine Shop), one (1) 600A/3P breaker feeding distribution panel 'DE' (Maintenance Garage), one (1) and 30A/3P breaker feeding transformer 'NT4' for the Fire Alarm System.
- ⊗ The Communications service is fed in a similar manner underground from hydro pole located at the northeast corner of the building to the communications backboard located in the main electrical room.
- ⊗ The PVC conduit for the main power and communications services currently do not have the weather heads installed and are filled with water. This results in a hazardous condition.

Wiring System



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- ✦ The age of the existing wiring is presumed to be original to the building with the normal number of adjustments typical of a building of this function and age.
- ✦ All exposed teck cabling to Roof units and interior AC 90 feeders appear to be in good condition.
- ✦ 30A, 600V unfused disconnect switches for three (3) rooftop air handling units were rusting at joints and appeared to be losing their weather resistance/integrity.
- ✦ The 600V distribution panel and transformer in the carpentry shop and heavy vehicle maintenance shop area are directly exposed to water spray and ambient contamination from wood shop and metal working functions which can be considered a fire hazard.
- ✦ High voltage bus for gantry crane has been exposed to water as a result of roof leaks.
- ✦ In various locations, existing nylon faceplates for wiring devices were cracked or damaged.
- ✦ The majority of wiring devices throughout the facility appeared in reasonable to serviceable condition.
- ✦ It was noted that a large number of offices were outfitted with power bars and extension cords for supplying power to equipment.

IT IS RECOMMENDED THAT:

1. Install weather heads on the incoming services - **Priority 1**
2. Install a proper enclosure around the 600V distribution panels and transformers in the shops area and provide NEMA Type 3S sprinkler proof enclosures for all exposed electrical distribution equipment - **Priority 1**
3. Provide protection from the roof leaking onto the gantry crane high voltage bus until roof replacement is completed - **Priority 1**
4. Rusting disconnect switches at rooftop air handling units to be replaced with NEMA Type 4X disconnect switches - **Priority 2**
5. Replace all damaged nylon faceplates with stainless steel faceplates - **Priority 3**
6. To avoid tripping and fire hazards, duplex receptacles in offices should be replaced with quadruplex receptacles to eliminate the use of power bars and extension cords - **Priority 3**

.2 D5020 LIGHTING AND BRANCH WIRING

Interior Lighting

- ✦ Lighting in the buildings is accomplished through a combination of incandescent and fluorescent ceiling mounted and task luminaires and metal halide high bay luminaires for general lighting in workshop and garage areas.
- ✦ Lighting levels were measured and were found to be in accordance with the Illuminating Engineering Society (IES) recommended lighting levels throughout most of the building.
- ✦ Building personnel noted that continuing maintenance and lamp changes for the metal halide luminaires was becoming an issue.

Exterior Light Fixtures

- ✦ There are approximately twenty (20) existing wall mounted low pressure sodium (LPS) wall packs complete with integral button type photocell located around the perimeter of the building. Most of these wall packs were damaged, rusted and had flaking paint.



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Emergency Lighting

- ⊕ Emergency lighting were wall mounted plug-in type with incandescent lamps.
- ⊕ It was noted that there is inadequate emergency lighting with the corridor outside offices 213 and 214.

Exit Lights

- ⊕ The majority of exit lights were illuminated incandescent types complete with test switch and battery backup, however, several photo luminescent types remain installed.
- ⊕ Exit lights outside Kitchen 203, Corridor 206 and Boardroom 224 were not operational when tested.

Telephone/Data

- ⊕ The telephone/data system demarcation point is in the main electrical room in the northeast corner of the building.
- ⊕ There is existing data and telephone in all the main offices, kitchen and workshop areas.
- ⊕ A wire basket spans the length of the building to provide distribution of communication cables.

Door Intercom System

- ⊕ Not applicable.

Security Systems

- ⊕ Not applicable.

Card Access System

- ⊕ The existing proximity card readers were located at exterior doors and the access control system is fed to several access control panels located in Room 206.

Closed Circuit Camera System

- ⊕ The existing CCTV system is located at various exterior doors and fed to head and equipment located in Room 206.

IT IS RECOMMENDED THAT:

1. All exterior LPS wall packs be replaced with LED exterior wall pack complete with integral button type photocell to improve efficiency and reduce maintenance - **Priority 2**
2. New dual head emergency lighting unit be installed in the corridor outside offices 213 and 214 to achieve required emergency lighting levels - **Priority 1**
3. Single remote heads should be installed in the cold room adjacent to the carpentry shop and all electrical and mechanical rooms - **Priority 3**.
4. Exit lights outside Kitchen 203, Corridor 206 and Boardroom 223 be replaced with illuminated LED exit lights complete with test switch and battery backup - **Priority 1**
5. All existing metal halide high bay fixtures be replaced with LED or T5HO high bays to improve efficiency and reduce maintenance - **Priority 3**
6. All existing photo luminescent type exit lights to be replaced with illuminated LED exit lights complete with test switch and battery backup - **Priority 1**

.3 D5090 OTHER ELECTRICAL SYSTEMS

Fire Alarm and Detection

- ⊕ Existing conventional initiation and notification fire alarm system fed to an Edwards 6616 fire alarm control panel located adjacent to the Southeast building entrance.



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IT IS RECOMMENDED THAT:

1. None at this time

Reference Review:

For the purpose of this investigation, the following building codes and standards were reviewed:

- ⊗ NBCC – National Building Code of Canada
- ⊗ CEC – Canadian Electric Code
- ⊗ IES – Illuminating Engineering Society
- ⊗ NFPA – National Fire Protection Association

5.5 E Equipment & Furnishings

5.5.1 E10 Equipment

.1 E1010 COMMERCIAL EQUIPMENT

- ⊗ Not applicable.

IT IS RECOMMENDED THAT:

1. None at this time.

.2 E1020 INSTITUTIONAL EQUIPMENT

- ⊗ Not applicable.

.3 E1030 VEHICULAR EQUIPMENT

- ⊗ Not applicable.

.4 E1090 OTHER EQUIPMENT

- ⊗ Not applicable.

5.5.2 E20 Furnishings

.1 E2010 FIXED FURNISHINGS

- ⊗ Fixed cabinetry and showing looked to be in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. None at this time.

.2 E2020 MOVABLE FURNISHINGS

- ⊗ Not applicable.

5.6 F Special Construction & Demolition

5.6.1 F10 Special Construction

.1 F1010 SPECIAL STRUCTURES

- ⊗ Not applicable.

.2 F1020 INTEGRATED CONSTRUCTION

- ⊗ Not applicable.

.3 F1030 SPECIAL CONSTRUCTION SYSTEMS

- ⊗ Not applicable.

.4 F1040 SPECIAL FACILITIES

- ⊗ Not applicable.

.5 F1050 SPECIAL CONTROLS AND INSTRUMENTATION

- ⊗ Not applicable.



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5.7 G Building Site Work

5.7.1 G10 Site Preparation

- .1 G1010 SITE CLEANING
 - ⊗ Not applicable.
- .2 G1020 SITE DEMOLITION AND RELOCATION
 - ⊗ Not applicable.
- .3 G1030 SITE EARTHWORK
 - ⊗ Not applicable.

5.7.2 G20 Site Improvements

- .1 G2010 ROADWAYS
 - ⊗ Driveway appears adequate.

IT IS RECOMMENDED THAT:

1. None at this time.

- .2 G2020 PARKING LOTS
 - ⊗ The parking lot and site is asphalt.
 - ⊗ Adequate parking space for the number of occupants.
 - ⊗ Some minor cracking evident throughout the asphalt parking lot abutting the structure.

IT IS RECOMMENDED THAT:

1. None at this time.

- .3 G2030 PEDESTRIAN WALKWAYS
 - ⊗ Not applicable.
- .4 G2040 SITE DEVELOPMENT (FENCING)
 - ⊗ Not applicable.

IT IS RECOMMENDED THAT:

1. None at this time.

- .5 G2050 LANDSCAPING
 - Grass
 - ⊗ Not applicable.

5.7.3 G40 Site Electrical Utilities

- .1 G4010 ELECTRICAL DISTRIBUTION
 - ⊗ Not applicable.
- .2 G4090 OTHER SITE ELECTRICAL UTILITIES
 - ⊗ Not applicable.

5.7.4 G90 Other Site Construction

- .1 G9010 SERVICE AND PEDESTRIAN TUNNELS
 - ⊗ Not applicable.
- .2 G9090 OTHER SITE SYSTEMS & EQUIPMENT
 - ⊗ Not applicable.



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5.8 Planning

5.8.1 BARRIER FREE DESIGN

- ⊗ As this facility is used for maintenance personnel requiring good physical mobility, barrier free design was not considered applicable.
- ⊗ Washroom facilities and majority of access points did not meet accessible requirements as set out by the current National Building Code of Canada or current CSA standards.

5.9 Life Safety Code Analysis

- ⊗ Facility meets current code for Life Safety.

5.10 Fire and Life Safety Deficiencies

5.10.1 Structural Resistance to Fire

- ⊗ Not applicable.

5.10.2 Fire & Smoke Barriers

- ⊗ Missing fire stopping at internal firewalls where walls meet roof structure and at a variety of Mechanical and Electrical penetrations.

IT IS RECOMMENDED THAT:

1. Undertake a full Fire Barrier report and repair as required – **Priority 1**

5.10.3 Basic Detection and Alarm Application

- ⊗ Not applicable.

5.10.4 Automatic Fire Suppression

- ⊗ Not applicable.

5.10.5 Water Supplies

- ⊗ See Mechanical.

5.10.6 Fire Department

- ⊗ Not applicable.

5.10.7 Operation and Maintenance

- ⊗ Not applicable.

5.10.8 Emergency Lighting

- ⊗ See Electrical.

5.10.9 Egress

- ⊗ Adequate per NFPA requirements.
- ⊗ Travel distances to exits may not meet current National Building Code of Canada requirements, which are more stringent than NFPA.

6 TABLE OF PROBABLE COSTS

Recommendation /Deficiency	Priority 1 Opinion of Probable Cost	Priority 2 Opinion of Probable Cost	Priority 3 Opinion of Probable Cost	
Section 5.2.1.2.1		\$5,000		
Section 5.2.1.2.2		\$45,000		



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Section 5.2.2.1.1			\$22,500	
Section 5.2.2.1.2			\$7,000	
Section 5.2.2.1.3			\$13,500	
Section 5.2.2.2.1		\$2,500		
Section 5.2.2.3.1	\$41,000			
Section 5.2.2.3.2		\$11,000		
Section 5.2.2.4.1	\$75,000			
Section 5.2.2.4.2	\$35,000			
Section 5.2.2.5.1	\$25,000			
Section 5.2.2.5.2			\$5,000	
Section 5.2.2.5.3		\$3,500		
Section 5.3.1.1.1	\$12,500			
Section 5.3.3.2.1		\$2,500		
Section 5.3.3.2.2		\$250		
Section 5.3.3.3.1		\$500		
Section 5.4.2.1.1		\$4,000		
Section 5.4.2.2.1			\$2,500	
Section 5.4.2.2.2			\$1,000	
Section 5.4.2.3.1		\$5,000		
Section 5.4.2.3.2			\$2,500	
Section 5.4.2.3.3			\$5,000	
Section 5.4.2.3.4			\$5,000	
Section 5.4.2.4.1			\$25,000	
Section 5.4.2.4.2			\$5,000	
Section 5.4.3.2.1	\$500			
Section 5.4.3.2.2			\$500	
Section 5.4.3.3.1		\$2,500		
Section 5.4.3.3.2		\$2,500		
Section 5.4.3.3.3			\$500	
Section 5.4.3.4.1			\$10,000	
Section 5.4.3.5.1	\$1,000			
Section 5.4.3.5.2			\$2,000	
Section 5.4.3.5.3	\$1,000			
Section 5.4.3.5.4		\$90,000		
Section 5.4.3.5.5	\$1,000			
Section 5.4.3.5.6	\$500			



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Section 5.4.3.5.7		\$5,000		
Section 5.4.3.5.8	\$500			
Section 5.4.4.1.1	\$500			
Section 5.4.4.2.1	\$1,000			
Section 5.4.4.2.2	\$1,000			
Section 5.4.5.1.1	\$2,000			
Section 5.4.5.1.2		\$12,000		See 5.3.1.1.1
Section 5.4.5.1.3	\$2,000			
Section 5.4.5.1.4				See 5.4.3.5.4
Section 5.4.5.1.5			\$3,000	
Section 5.4.5.1.6			\$20,000	
Section 5.4.5.2.1		\$15,000		
Section 5.4.5.2.2	\$1,000			
Section 5.4.5.2.3			\$1,000	
Section 5.4.5.2.4	\$500			
Section 5.4.5.2.5			\$30,000	
Section 5.4.5.2.6	\$5,000			
Section 5.10.2.1	\$5,000			
TOTAL	\$211,000	\$194,250	\$161,000	\$566,250
Contingency 30%				\$169,875
Total				\$736,125

Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL

December 20, 2013

7 USE OF REPORT

This report is prepared for the exclusive use of Newfoundland and Labrador Hydro for the expressed purpose of preparing a summary condition report for the identified property. This report should not be considered transferable, and should not be relied upon for any other purpose.

The service provided for this project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time and similar locality. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. We reserve the right to revise or amend our opinion in this report in the event new information, documentation, or evidence becomes available.

Sincerely,

Coles Associates Ltd.
Per: Douglas A. Coles, P.Eng., P.E., F.E.C.
Vice President



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Building Conditions Assessment and
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Bishop's Falls, NL

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Appendix A

Photographs



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Photo #7: repointing cone

Photo #8: Rusting from Leaking test head



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Photo #9: Exterior Door



Photo #10: Exterior Door Jamb



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Photo #11: Overhead Accordion Door

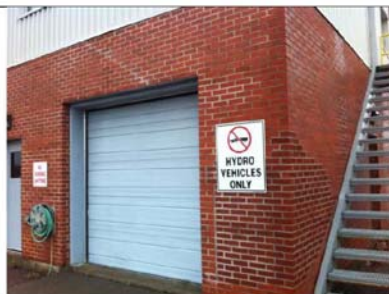


Photo #12: Overhead Sectional Door



Photo #13: Rusting Stair Stringer



Photo #14: Roof Access



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Photo #15: Ground Connection on Stair



Photo #16: 600V equipment Exposed directly to Shop



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Photo #19: Stained Ceiling tile



Photo #20: Urinal tank



Photo #21: Office A/C



Photo #22: Zurn Alert



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Photo #23: Duplex Oil Water system



Photo #24: Roof top units



Photo #25: No weatherheads



Photo #26: Rusting Disconnect



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Photo #27: Wall Pack



Photo #28: Exit Light with Faulty Test Switch



Photo #29: Metal Halide High Bays



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Appendix B

Existing Floor Plans



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Security & Fire Safety Solutions

Access Control System Test & Inspect

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Date of Inspection April 21/2014

General information			
Customer (or facility name)	NL Hydro	JCI Contract/Ticket #	
Address		JCI Area/Branch	722
City	Bishop's Falls	Sold by	Jim King
Province	NL	Inspection Date/Period	
Tom Foss	Jim Saunders	T&I Tech #1 (name)	Paul Noseworthy
Phone	709-258-2338	T&I Tech #2 (name)	Craig Kennedy
Fax		T&I Tech #3 (name)	Dwayne White
Email Address	tfoss@nlh.nl.ca	T&I Tech #4 (name)	

Summary of Test & Inspect Results	
Overview	
Age of Equipment	4 + years old.
Maintenance Practices	
	Inspection Task Sheets
Site Inspected	April 21-22 2014
Workstation Computer(s)	n/a
Communication Equipment	Customer supplied network
Panel Devices	ok
Access Point	ok
I/O Devices	ok
Additional Comments	

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Johnson Controls Security & Fire Safety Solutions

Access Control System Test & Inspect

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Panel Devices

Panel Equipment Device Legend	Applicable Test / Inspection Items						
	Visual	Combs	Voltages	Ground	Battery	Tamper	Ver.
PANEL = Panel W CPU	ok	ok	ok	ok	ok		
EXP = Expansion Panel	ok	ok	ok	ok	ok		
DOOR = Door Controller Device	ok	ok	ok	ok	ok		
TERM = Reader Terminal	ok	ok	ok	ok	ok		
ALM = Input Device	ok	ok	ok	ok	ok		
OUT = Output Device	ok	ok	ok	ok	ok		
I/O = Input/output Device							
PWR = Power Supply (external)	ok		ok	ok	ok		

Test/Inspect Task Description	Where applicable Perform the following:
Visual Inspection	Visually check all connections for secure connectivity Visually check components for damage/wear/condition
Communications Verification	Visually check transmit and receive LED's Verify bi-directional communications (forward & reverse Polling) Test input Points for Open/Short/Secure/Alarm states Check resistance of AUX access/input Points Check calibration of 4-state alarm Points Test output relays for ON and OFF switching
Voltages	Check input voltages to Power supply/transformer Check output voltages from Power supply/transformer Check Power on indicator light
Ground	Check reference ground resistance to earth ground
Battery	Check UPS battery operation (remove AC source) Check and record age of battery (use ? if unknown)
Tamper	Test tamper switch function
Version	Record Panel firmware or software version
Comments	Record all Points of failure in the comments section below the Panel Devices Test & Inspect Sheet. Use a separate sheet if necessary to record additional comments (see additional comments Page)

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Access Control System Test & Inspect

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Panel Devices Test & Inspect Check Sheet

Device Type (see legend)	Visual		Combs		Voltages		Ground		Battery			Tamper									
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	P	F	Age	Pass	Fail								
Panel – BFCK4	✓		✓		✓		✓		✓												
Panel – BFCK5	✓		✓		✓		✓		✓												
Panel – BFL1A01	✓		✓		✓		✓		✓												
Panel – BFL1S01	✓		✓		✓		✓		✓												
Panel – BFL2A01	✓		✓		✓		✓														
Door – BFCK4	✓		✓		✓		✓														
Door – BFCK5	✓		✓		✓		✓														
Door – BFL1A01	✓		✓		✓		✓														
Door – BFL1S01	✓		✓		✓		✓														
Door – BFL2A01	✓		✓		✓		✓														
CONTROLLERS																					
	Power	Data1	Data 0	Comm +	Comm -	RDR2S	Reader														
BFCK4 Controller	27.24 vdc	5 vdc	5 vdc	2.7 vdc	2.4 vdc	27.24 vdc	27.24 vdc														
BFCK5 Controller	27.64 vdc	5 vdc	5 vdc	2.6 vdc	2.4 vdc	27.64 vdc	27.64 vdc														
BFL1A01 Controller	27.3 vdc	4.9 vdc	5 vdc	2.7 vdc	2.5 vdc	27.3 vdc	27.3 vdc														
BFL1S01 Controller	27.7 vdc	5 vdc	5 vdc	2.6 vdc	2.5 vdc	27.7 vdc	27.7 vdc														
BFL2A01 Controller	27.5 vdc	4.9 vdc	4.9 vdc	2.6 vdc	2.4 vdc	27.5 vdc	27.5 vdc														
POWER SUPPLIES																					
	Voltage	Bat 1	Bat 2																		
BFCK4- P/S 1	27.7 vdc	13.8 vdc	13.8 vdc																		
BFCK4- P/S 2	27.2 vdc	13.6 vdc	13.6 vdc																		
BFCK4- P/S 3	27.5 vdc	13.7 vdc	13.7 vdc																		
BFCK5- P/S 1	27.4 vdc	13.6 vdc	13.7 vdc																		
BFCK5- P/S 2	27.4 vdc	13.7 vdc	13.8 vdc																		
BFCK5- P/S 3	27.4 vdc	13.7 vdc	13.7 vdc																		

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POWER SUPPLIES CONTINUED											
	Voltage	Bat 1	Bat 2								
BFL1A01- P/S 1	27.5 vdc	13.8 vdc	13.8 vdc								
BFL1A01- P/S 2	27.3 vdc	13.6 vdc	13.6 vdc								
BFL1A01- P/S 3	27.5 vdc	13.8 vdc	13.8 vdc								
BFL2A01- P/S 1	27.5 vdc	13.8 vdc	13.8 vdc								
BFL2A01- P/S 2	27.3 vdc	13.6 vdc	13.6 vdc								
BFL1S01- P/S 1	27.5 vdc	13.7 vdc	13.7 vdc								

Access Point	
Test/Inspect Item	Where applicable Perform the following:
Reader Type/Brand	Enter the reader type that represents the general reader technology used at the facility. Any special readers not listed should be noted in the comments.
Reader	Visually check all connections for secure connectivity Visually check components for damage/wear/condition Inspect mounting Points for secure fit/mounting Test Reader function (reads card, and grants access) Test read range of Proximity Reader compare to specified range Visually check access granted/denied LED's on reader Verify keypad button function (all button work) Run a history report for all readers and record discrepancies along with specific access Point.
Door Lock Hardware	Inspect mounting Points for secure fit/mounting Visually inspect door for alignment Check key function operation (on keyed locks) Check engagement of lock Test fail safe/fail secure mode operates on door lock hardware Test delayed egress operation
AUX (auxiliary) Access device	Inspect mounting Points for secure fit/mounting Check resistance of detect and non-detect states
Alarm Contact	Inspect mounting Points for secure fit/mounting Check resistance of open/closed state
Power Supply	Check input voltages to Power supply/transformer Check output voltages from Power supply/transformer Check Power on light Check UPS battery operation (remove AC source) Check and record age of battery (use ? if unknown)
Audible (sounder, enunciator)	Inspect mounting Points for secure fit/mounting Test sounding function operation

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Access Control System Test & Inspect

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Gate (arm/sliding)	Inspect mounting Points for secure fit/mounting Visually check components for damage/wear/condition Test operation of safety devices Inspect level of gate arm Inspect belts Check transmission oil level Check heater operation Inspect chain lubrication
Comments	Record all Points of failure in the comments section below the Access Point Test & Inspect Check Sheet. Use a separate sheet if necessary to record additional comments (see additional comments Page)

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Upgrade Office Facilities and Control Buildings
Appendix A

Johnson Controls Security & Fire Safety Solutions

Access Control System Test & Inspect

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Access Point Test & Inspect Check Sheet

Reader Type/Brand HID ProxPro L76-BLK-2W Proximity

Access Point (location or ID#)	Reader		Lock		AUX		Alm Contact		Power			Audible		Gate		Panel
	Pass	Fail	Pass	Fail	Pass	Fail	Pass	Fail	P	F	Age	Pass	Fail	Pass	Fail	Terminal
Facilities Maintenance Dr 2 In	✓		✓				✓		✓							BFCK4 Term 1
Facilities Maintenance Dr 2 Out	✓		✓				✓		✓							BFCK4 Term 2
Facilities Maintenance Dr 1 In	✓		✓				✓		✓							BFCK4 Term 3
Facilities Maintenance Dr 1 Out	✓		✓				✓		✓							BFCK4 Term 4
Terminals Dr 1 In	✓		✓				✓		✓							BFCK4 Term 5
Terminals Dr 1 Out	✓		✓				✓		✓							BFCK4 Term 6
Terminals Level 2 In	✓		✓				✓		✓							BFCK4 Term 7
Terminals Level 2 Out	✓		✓				✓		✓							BFCK4 Term 8
Equipment Maintenance Dr 2 In	✓		✓				✓		✓							BFCK4 Term 9
Equipment Maintenance Dr 2 Out	✓		✓				✓		✓							BFCK4 Term 10
Battery Room Door	✓		✓				✓		✓							BFCK4 Term 11
High Pressure Room Door	✓		✓				✓		✓							BFCK4 Term 13
Equipment Maintenance Dr 1 In	✓		✓				✓		✓							BFCK4 Term 15
Equipment Maintenance Dr 1 Out	✓		✓				✓		✓							BFCK4 Term 16

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Upgrade Office Facilities and Control Buildings
Appendix A

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Access Control System Test & Inspect

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Compressor Room Door Level 2 Out	✓		✓				✓		✓							BFCK5 Term 1
Compressor Room Door Level 2 In	✓		✓				✓		✓							BFCK5 Term 2
Elect/Network Services Dr In	✓		✓				✓		✓							BFCK5 Term 3
Elect/Network Services Dr Out	✓		✓				✓		✓							BFCK5 Term 4
Line Crew Repair Dr In	✓		✓				✓		✓							BFCK5 Term 5
Line Crew Repair Dr Out	✓		✓				✓		✓							BFCK5 Term 6
Line Crew Door 1 In	✓		✓				✓		✓							BFCK5 Term 7
Line Crew Door 1 Out	✓		✓				✓		✓							BFCK5 Term 8
Machine Shop Door In	✓		✓				✓		✓							BFCK5 Term 9
Machine Shop Door out	✓		✓				✓		✓							BFCK5 Term 10
Line Crew Door 2 In	✓		✓				✓		✓							BFCK5 Term 11
Line Crew Door 2 Out	✓		✓				✓		✓							BFCK5 Term 12
Terminals Door 3 In	✓		✓				✓		✓							BFCK5 Term 13
Terminals Door 3 Out	✓		✓				✓		✓							BFCK5 Term 14
Offices Level 2 In	✓		✓				✓		✓							BFCK5 Term 15
Offices Level 2 Out	✓		✓				✓		✓							BFCK5 Term 16
Main Door In	✓		✓				✓		✓							BFL1A01 Term 1
Main Door Out	✓		✓				✓		✓							BFL1A01 Term 2
Data Closet	✓		✓				✓		✓							BFL1A01 Term 3
Warehouse Receiving Door In	✓		✓				✓		✓							BFL1A01 Term 5
Warehouse Receiving Door Out	✓		✓				✓		✓							BFL1A01 Term 6

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Appendix A

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Access Control System Test & Inspect

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Warehouse Shipping Door In	✓		✓				✓		✓							BFL1A01 Term 7
Warehouse Shipping Door Out	✓		✓				✓		✓							BFL1A01 Term 8
Gate Exit Reader	✓		✓				✓		✓							BFL Gate Term 1
Gate Enter Reader	✓		✓				✓		✓							BFL Gate Term 2
Rear Entrance In	✓		✓				✓		✓							BFL2A01 Term 1
Rear Entrance Out	✓		✓				✓		✓							BFL2A01 Term 2
Receiving In	✓		✓				✓		✓							BFL2A01 Term 3
Receiving Out	✓		✓				✓		✓							BFL2A01 Term 4
Tech Services In	✓		✓				✓		✓							BFL2A01 Term 5
Tech Services Out	✓		✓				✓		✓							BFL2A01 Term 6
Supply Chain Door 1 In	✓		✓				✓		✓							BFL2A01 Term 7
Supply Chain Door 1 Out	✓		✓				✓		✓							BFL2A01 Term 8
Supply Chain Door 2 In	✓		✓				✓		✓							BFL2A01 Term 9
Supply Chain Door 2 Out	✓		✓				✓		✓							BFL2A01 Term 10
Salvage Stores Front In	✓		✓				✓		✓							BFL2A01 Term 11
Salvage Stores Front Out	✓		✓				✓		✓							BFL2A01 Term 12
Salvage Stores Rear In	✓		✓				✓		✓							BFL2A01 Term 13
Salvage Stores Rear Out	✓		✓				✓		✓							BFL2A01 Term 14

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Comments:																				

ROUTINE MAINTENANCE

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➤ **Perform the following routine maintenance on the CK721:**

1. Periodically check the continuity of the grounding circuit.
2. Perform operational testing monthly (see "Testing Procedure" on Page 5-2).
3. Replace the lithium battery every five years or after extended (five days) Power interruption (Panasonic CR 2025 or equivalent).
4. If installed, replace the lead-acid backup batteries every three years (either Power Sonic PS-1270, 12 VDC, 7 Ah or equivalent; or Power Sonic PS-1228, 12 VDC, 2.8 Ah or equivalent.)

IMPAIRED PERFORMANCE CONDITIONS

A list of conditions that may cause impaired Performance is provided in Table 5-1, with Reference Pages.

Table 5-1: Impaired Performance Conditions

Condition Information Location

Unit environment not as specified. Table 1-5.

Unit Power and grounding not as

Specified.

Page 2-9, Table 2-3, Page 2-24, Page 2-36,

Table 2-5, Table 3-2, and Appendix A.

Cable length or type not as specified. Page 2-16, Table 3-1, and Figure 3-19.

Backup battery not replaced correctly. This chapter.

Maintenance CK721 Installation and Operation

5-2 24-10025-8 Rev. -

TESTING PROCEDURE

➤ **Check for Proper operation of the CK721 as follows:**

1. Verify POWER LED on the CK721.
2. Verify that the FAULT LED on the CK721 is not on.
3. Verify the RS485B LED is flashing to show activity on the bus.
4. Present a *valid* card to a reader, and then verify that access is granted (green Lamp lights).
5. Present an *invalid* card to a reader, and then verify that access is denied (red Lamp lights).

Check Backup Battery Operation

➤ **if the optional backup battery is installed:**

1. Disable Primary AC input voltage to the enclosure.
2. Verify that the CK721 continues to operate.
3. Reapply Primary AC voltage to the enclosure.

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Additional Comments

Gate housings in rough condition, insulation falling off inside and breaking down

Gate housing heaters not outputting much heat

Door closure should be replaced

Replaced 1 defective battery

Newfoundland and Labrador Hydro

Site Condition Assessment
Port Saunders, NL

December 22, 2014

**Site Condition Assessment
Port Saunders, NL**

Prepared For:

Newfoundland and Labrador Hydro

Prepared By:



© December 22, 2014

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1 INTRODUCTION

The normal design life of a typical building is in the range of 25 to 30 years. The Office and Pump House Buildings at Port Saunders were built in the early 1980's, and the Warehouse Building was built in 2006. Newfoundland and Labrador Hydro is looking to determine and evaluate the immediate, short, and long term capital renewal/extension/upgrade requirements that can be expected for these facilities over the next 25 years. The intention is to bring all of the support facilities up to the Newfoundland and Labrador Hydro standard. It is anticipated that this site will continue with similar occupancies, staffing levels and activities for the foreseeable future.

The scope of this evaluation was restricted to the facilities as illustrated within Appendix A.

Coles Associates was retained to undertake an audit and prepare a report to:

- ✦ Assess the building envelope and systems to identify Priority 1, 2 and 3 (immediate, short and long term) areas where problems are occurring within the building and/or may occur.
- ✦ Make note of any possible Life Safety and/or Code compliant issues that were visible. (Note: a thorough Life Safety, Building and Fire Code analysis was not performed as part of this Building Condition Audit.)
- ✦ Investigate the need for expansion and/or relocation of the facilities in addition to the rehabilitation priorities, and
- ✦ Provide estimates on the costs of all recommendations.

2 EXECUTIVE SUMMARY

In October 2014 a team of consultants reviewed the buildings at the line maintenance Facility, located in Port Saunders, NL. The objective was to undertake a Site Condition/ Rehabilitation/ Relocation/ Expansion Assessment Audit.

In summary, it is the purpose of this study to undertake the following tasks:

- ✦ Establish the current condition of the architectural, structural, mechanical and electrical building components and systems;
- ✦ Assess deficiencies of the building relative to current code and/or indicated usage;
- ✦ Determine the need for either rehabilitation, relocation and/or expansion; and
- ✦ Provide a cost estimate of all recommendations.

There is no mechanism within the National Building Code (NBC) that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change.

While there may be opportunities to increase the energy efficiency and/or functionality of this facility through such changes as internal/external renovation and/or increased insulation in the roof and walls, as well as the windows, given its age, it is anticipated that this decision point will be based upon a financial payback model as is undertaken for most private clients.

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Following review there are approximately:

\$104,425 of Priority Level #1 work to be undertaken.
\$116,740 of Priority Level #2 work to be undertaken.
\$ 77,125 of Priority Level #3 work to be undertaken.

All as defined below. To these amounts and as shown in Section 15, a 30% contingency has been added in the amount of \$89,487.

3 METHODOLOGY

3.1 Building Audit

The method of study was by site visit by a team of consultants from Coles Associates. Audit work included tasks to familiarize, visually review, and document the condition of the building.

One visit was made to the facilities to conduct interviews with the building management and a walk-through investigation. The building audits were completed by:

Architectural/Structural	Robert Haggis, RAIC, AIA, NCARB
Mechanical	Sean Wheeler, P.Eng.
Electrical	Elliott Coles, P.Eng.

The report was reviewed by Douglas A. Coles, P.Eng., P.E., F.E.C.

3.2 Drawings

Floor plans of the facilities were available for the Audit. Floor plans were confirmed, where warranted, from rough measurements taken on site. Site documentation was unavailable.

3.3 Prioritization

The deficiencies/recommendations falling out of these reports and/or walkthrough will be identified indicating three priority levels:

1. **Priority One:** Where immediate attention is required in order to maintain or to re-establish the integrity of a strategic system, process, weather envelope, etc., in order to comply with life safety, Building Code violations and/or those resulting from Orders delivered by the Authority having Jurisdiction (AHJ) to prevent further on-going exposure, damage or deterioration or to remove or lessen a threat to life safety.
2. **Priority Two:** Where systems require attention but present no immediate risk to system integrity or to life safety. The short to intermediate nature of these issues (one to three years) is such as to allow some orderly planning and financial resource development to occur.
3. **Priority Three:** This category identifies intermediate to longer-term issues. In the context of this report and at the heart of the Priority Three issues is the long-term disposition of this facility in total; given the condition of the envelope, the issues of non-compliance with current codes for items such as wall insulation levels; and the implications and costs of its repair.



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3.4 Quality Assessment

Throughout the report references are made to the quality of materials and systems. The following provides a guide to the intent of the grading.

- | | |
|----------------------|--|
| ⊕ Good | Suitable for continued use. |
| ⊕ Serviceable | Is able to remain in service with regular maintenance. |
| ⊕ Marginal | Is able to remain in service with heavy maintenance. |
| ⊕ Suspect | Requires further investigation, is not visible though possibly problematic. |
| ⊕ Poor | Requires significant maintenance, repair or replacement. |
| ⊕ End of useful life | Requires replacement. In practical terms, systems tend not to fail all at once. In this instance "outlived its useful life" means that it is time to seriously look at putting a financial plan in place to replace the identified system in the short term. |

3.5 National Building Code

The National Building Code (NBC) is a document prepared by the National Research Council of Canada, which historically has been updated every 5 years. It is the purpose of the NBC to establish standards for building construction and systems, the focus of which is occupant safety. It is the underlying intent of the NBC to provide a level of systems and environment within a building, which provide for adequate life safety, environmental conditions (i.e. light levels and air ventilation levels) and mobility (i.e. barrier-free access). While all regulations do not necessarily get more stringent, regulations very often change. In fact, buildings never "catch up" to the state of the current-day Codes.

There is no mechanism in place that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change. At the same time, Authorities Having Jurisdiction have the right to make inspections at their discretion and direct improvements to components and/or systems where they feel life safety is at risk.

In upgrading older buildings, which were not originally designed to incorporate fire ratings or sometimes bulky and space consuming systems, it can be difficult to achieve the letter of the regulation. More often it is the intent to reasonably protect life safety, which is more readily achievable.

Therefore the purpose of the review of the salient requirements of the NBC is to provide a basis of comparison against the current Code requirements and to estimate the capital cost to upgrade the building to these standards.

Specific areas of this report deal with issues that should be undertaken in the short term for reasons of life safety, regardless of the ultimate disposition of the building.

3.6 Standard Classification for Building Elements and Related Site Work – UNIFORMAT II

- ⊕ This standard establishes a classification of building elements and related site work,
- ⊕ The classification serves as a consistent reference for analysis, evaluation, and monitoring.
- ⊕ Referenced documents, E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems,
- ⊕ The classification is hierarchical to allow different levels of aggregation and summarization.



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4 BUILDING SUMMARY

The Office and Warehouse Buildings are typical steel structures with common frost wall and spread footings. A primary steel structure supports an insulated steel roof, purlins and steel exterior walls. Interior walls are of block, steel stud and GWB. The original Office Building was constructed in the 1980's with a major addition in 1998, with multiple renovations since. The Warehouse Building of similar construction was built around 2006, along with some additional storage ramps in the storage yard. The Pump House building located to north side of Office Building is in fair condition. The structure is built of wood with vinyl siding and a gabled roof structure. The building is supported on a concrete 'raft' slab. The Pump House is assumed to be built in the 1980's when the original Office Building was constructed.

Age	Office Building: early 1980's / major addition in 1998 (Approx. 34 years) Pump House: assumed early 1980's (Approx. 34 years) Warehouse: 2006 (8 years)
Location	Port Saunders, NL
Ownership	Newfoundland and Labrador Hydro

5 A SUBSTRUCTURE

5.1 A10 Foundations

5.1.1 A1010 Standard Foundations

- ⊕ Office Building & Warehouse Building: Typical concrete frost walls and footings in good to serviceable condition. Some minor cracking evident on Office Building foundation.
- ⊕ Pump House: Concrete raft slab is in fair condition and nearing end of lifespan. No grade insulation evident with some major cracking and pitting visible.

5.1.2 A1020 Special Foundations

- ⊕ Not applicable.

5.1.3 A1030 Slab on Grade

- ⊕ Concrete slab visibly in fair to serviceable condition with minor cracking evident.
- ⊕ Entry slab at main office entry is cracking with some major pitting and frost heave evident and water entering joint at foundation wall.
- ⊕ Major cracking visible at garage door entry pad onto maintenance space.
- ⊕ Settlement of slab at garage door onto warehouse space in office building; possibly due to frost heave.
- ⊕ Settlement at interior perimeter throughout office visible; floor slightly slopes towards exterior wall.
- ⊕ Some major pitting of concrete pad at door on south end of Office Building.
- ⊕ Entire corridor at "lean-to" addition is sloping towards the west.
- ⊕ Pump House: slab has minor to major cracks.

IT IS RECOMMENDED THAT:

1. Office Building: Replace pad at main entry– **Priority 2**
2. Office Building: Patch/repair, and/or remove garage door pad - **Priority 2**
3. Office Building: Monitor interior slab at perimeter and area at 'lean-to' addition for further settling – **Priority 1**
4. Warehouse: Monitor slab at garage door – **Priority 1**
5. Warehouse and Office Building: Caulk and/or grout exposed joints at garage door sills to mitigate further water infiltration – **Priority 1**



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6. Pump House: Patch and repair all cracked and pitted areas in slab and foundation – **Priority 2**
7. Pump House: Replace slab and foundation with typical frost wall, footings and slab on grade – **Priority 3**

5.2 A20 Basement Construction

5.2.1 A2010 Basement Excavation

- ⊗ Not applicable.

5.2.2 A2020 Basement Walls

- ⊗ Not applicable.

5.2.3 A2030 Basement Columns

- ⊗ Not applicable.

6 B SHELL

6.1 B10 Superstructure

6.1.1 B1010 Floor Construction

- ⊗ Not applicable.

6.1.2 B1020 Roof Construction

- ⊗ Steel purlins and insulated roof on primary steel structure in good condition on Office and Maintenance Building.
- ⊗ Pump House: Gable wood trusses appear in good to serviceable condition.

6.2 B20 Exterior Enclosure

6.2.1 B2010 Exterior Walls

- ⊗ Steel purlins with vertical steel siding. Steel siding in fair condition and nearing end of serviceable life span on office building.
- ⊗ Areas of major rust evident at base of siding on west side. Steel at south west corner is fully rusted through and disintegrating. Area for potential water infiltration for propagation of mold.
- ⊗ Powder coat paint finish fading.
- ⊗ Some major to minor dented siding on west side.
- ⊗ Some major rusting evident at garage door onto maintenance space in Office Building.
- ⊗ Steel siding at office addition in good to serviceable condition.
- ⊗ The Pump House is a wood stick frame with vinyl siding. Siding cracked, faded and nearing end of life span.
- ⊗ Steel siding on maintenance building in good condition, minor dents on south and east sides.

Insulation

- ⊗ Drawings suggest R20 batt insulation between horizontal purlins and/or framing studs.

IT IS RECOMMENDED THAT:

1. Office Building: Cut/replace and repair metal siding and steel sill on west side – **Priority 1**
2. Office Building: Replace steel siding at original portion of building – **Priority 2**
3. Pump House: Replace deteriorating vinyl siding with metal siding – **Priority 2**



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6.2.2 B2020 Exterior Windows

- ✦ Aluminum windows on east side of office building are in good to serviceable condition.
- ✦ Caulking on some office space windows are cracking and falling away from glazing.
- ✦ Aluminum windows on south end of office building are nearing end of life span.
- ✦ Glazing unit cracked on south side of kitchen in office building. Glazing unit cracked in Line Supervisor office.
- ✦ Pump House: Wood window frame and vinyl insert at end of life span.
- ✦ Maintenance Building: Aluminum windows in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Office Building: Replace all caulking in disrepair on east side of building – **Priority 1**
2. Office Building: Replace glazing unit in kitchen and Line Supervisor office – **Priority 1**
3. Office Building: Replace aluminum windows on south side of building – **Priority 2**
4. Pump House: Replace window – **Priority 2**

6.2.3 B2030 Exterior Doors

- ✦ Steel frames and doors in fair to serviceable condition on south and west end of Office building; some general repair required i.e. door sweeps, rusted hinges and chipping paint.
- ✦ Aluminum main office entry door to Office building in serviceable condition.
- ✦ Some rusting and paint chipping visible on east man door to Maintenance Building.
- ✦ Metal doors with wood jambs and trim in disrepair on Pump House; wood rotting at base.

IT IS RECOMMENDED THAT:

1. Pump House: Replace wood door jambs and trims and paint metal doors – **Priority 1**
2. Maintenance Building: Sand rust and paint east side man door – **Priority 2**
3. Office Building: Provide general maintenance to all steel man doors and frames with new paint, door sweeps and gasketing – **Priority 2**

6.2.4 B2035 Exterior Overhead Doors

- ✦ Insulated steel sectional O/H door in good to serviceable condition off of Warehouse space in Office Building. Some rust evident at steel jambs.
- ✦ Insulated steel sectional O/H door off of Maintenance space in Office Building is in fair to serviceable condition. Steel jamb showing signs of rust. Wood door stop showing signs of rot at base and paint chipping heavily.
- ✦ Pump House: O/H insulated door in good to serviceable condition. Wood door jambs rotting and in disrepair.

IT IS RECOMMENDED THAT:

1. Office Building: Sand and paint all rust areas on garage door jambs – **Priority 2**
2. Office Building: Replace wood door stop at garage door and repaint all – **Priority 1**
3. Pump House: Replace and/or repair O/H door wood jambs and trims – **Priority 1**

6.2.5 B2040 Exterior Stairs/Roof Access Ladders

- ✦ Exterior roof ladder looks in good to serviceable condition.

6.2.6 B3010 Roof Coverings

- ✦ Standing seam metal roof in fair to serviceable condition; no major rust evident.
- ✦ Steel flashing at transition between primary roof and "lean-to" addition at rear has been heavily caulked and in need of replacement.
- ✦ Aluminum flashings/fascias in good to serviceable condition.
- ✦ Some standing water evident on low-pitched roof at rear.



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- ⊕ No gutter on east side of building.
- ⊕ Gutters and downspouts on west end are in fair to serviceable condition.
- ⊕ Exposed steel fasteners are showing signs of major rust.
- ⊕ Pump House: Asphalt shingle roof in fair to serviceable condition; nearing end of life.
- ⊕ Maintenance Building: Metal roof in good condition.

IT IS RECOMMENDED THAT:

1. Office Building: Add gutter to east end – **Priority 2**
2. Office Building: Monitor standing water at east roof – **Priority 1**
3. Office Building: Replace steel flashing at roof transition – **Priority 2**
4. Office Building: Replace rusted fasteners – **Priority 2**
5. Pump House: Replace asphalt roofing shingles – **Priority 2**

6.2.7 B3020 Roof Openings

- ⊕ Not applicable.

7 C INTERIORS

7.1 C10 Interior Construction

7.1.1 C1010 Partitions

- ⊕ Steel studded walls c/w GWB finish in all office spaces are in good to serviceable condition.
- ⊕ Steel stud walls with steel and plywood finish on garage area side are in good to serviceable condition. Some fire and smoke stopping/caulking required at penetrations.
- ⊕ Some GWB corners in disrepair.
- ⊕ Maintenance Building: Steel stud c/w GWB and steel siding in good to serviceable condition.
- ⊕ Pump House: painted plywood walls are in fair to serviceable condition.

IT IS RECOMMENDED THAT:

1. Provide fire/smoke stopping and caulking at penetrations through walls off of garage and maintenance space – **Priority 1**
2. Repair all damaged corners and provide pvc bumpers – **Priority 2**

7.1.2 C1020 Interior Doors

- ⊕ Steel frames with wood and steel doors in fair to serviceable condition. Some general painting required on doors and frames in areas.
- ⊕ Maintenance Building: Steel door and frames in good condition.

Hardware

- ⊕ Generally in good to serviceable condition.

7.1.3 C1030 Interior Windows

- ⊕ Maintenance Building: Interior viewing window in good to serviceable condition.

7.1.4 C1040 Fittings

Washroom Accessories

- ⊕ Good to serviceable condition.
- ⊕ Shower unit in shower room of Office building in fair to serviceable condition; some caulking required at base.



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Vanities

- ✦ Good to serviceable condition.
- ✦ Minor staining evident in sink in women's washroom.

Millwork

- ✦ Good to serviceable condition.
- ✦ Kitchen millwork in Office Building in good to serviceable condition.
- ✦ Kitchenette millwork in Maintenance Building in good condition.

IT IS RECOMMENDED THAT:

1. Repair and provide caulking at base of shower – **Priority 2**

7.2 C20 Stairs

7.2.1 C2010 Stair Construction

- ✦ Not applicable.

7.2.2 C2020 Stair Finishes

- ✦ Not applicable.

7.3 C30 Interior Finishes

7.3.1 C3010 Wall Finishes

- ✦ Washrooms have vinyl wall coverings in serviceable condition.
- ✦ Generally most painted GWB and plywood walls are in fair to serviceable condition. Chipping evident at most corners.
- ✦ Pump House: Painted plywood walls in good to serviceable condition.
- ✦ Maintenance Building: Painted GWB in good to serviceable condition. Metal in good condition.

IT IS RECOMMENDED THAT:

1. Paint interior walls; with exception to main reception area – **Priority 2**

7.3.2 C3020 Floor Finishes

- ✦ In general, VCT tile flooring throughout is in fair condition and nearing end of useful life. (assumed minor percentage of asbestos contained in most floor tiles)
- ✦ Grouted transition at main entry in disrepair.
- ✦ Tile cracked at thresholds onto main office reception.
- ✦ Stains on carpet in office off reception area.
- ✦ Rubber base throughout in fair to serviceable condition.
- ✦ Maintenance garage and storage garage floor in office building requires new paint.
- ✦ Some obvious floor settlement evident at threshold between original building and "lean-to" addition at rear; flooring has been affected at threshold between new and old.
- ✦ VCT floor requires replacement in Store clerk and warehouse foyer rooms in office building.
- ✦ Maintenance Building: VCT in office, kitchen, entry in good to serviceable condition.
- ✦ Maintenance Building: Painted concrete floor in storage area in good to serviceable condition, minor painting required at yellow painted areas adjacent to garage door.

IT IS RECOMMENDED THAT:

1. Office Building: replace all VCT flooring and rubber base throughout – **Priority 2**
2. Office Building: replace all re-grout tile floor at main door entry – **Priority 1**
3. Office Building: replace tile floor in store clerk and warehouse foyer – **Priority 1**
4. Office Building: replace carpet tile in office off of reception area – **Priority 2**



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5. Office Building: repaint all exposed concrete floors in garage areas – **Priority 2**
 6. Maintenance Garage: Re-paint yellow entry area at garage door in Warehouse Building – **Priority 2**
- 7.3.3 **C3030 Ceiling Finishes**
- ⊕ Acoustic ceiling tile throughout office areas in fair to serviceable condition.
 - ⊕ Various tiles with holes or cracks and require replacement.

IT IS RECOMMENDED THAT:

1. Office Building: Replace all damaged ceiling tiles – **Priority 2**

8 D SERVICES

8.1 D10 Conveying

- 8.1.1 **D1010 Elevators & Lifts, D1020 Escalators & Moving Walks**
- ⊕ Not applicable.
- 8.1.2 **D1090 Other Conveying Systems**
- ⊕ Not applicable.

8.2 D20 Plumbing

- 8.2.1 **D2010 Plumbing Fixtures and Trim**
- ⊕ The water closets throughout are white vitreous china. Water closets are floor mounted 6 litre and 12 litre tank type with regular rim bowls. Flush valve in female washroom requires adjustment. The water closets throughout the facilities are in good to serviceable condition.
 - ⊕ Lavatories throughout are vitreous china. Lavatories are a mixture of wall and counter mount type. Lavatory trim is a mixture of round and blade type handles. A number of faucets appear to be missing the flow control device / aerator. Trim is in serviceable to marginal condition, requiring adjustment and maintenance.
 - ⊕ The urinals are standard wall hung units with automatic flush valves. Urinals appear to be in good condition.
 - ⊕ Shower is a PVC panel molded stone base with plastic round handle trim and standard shower head. The shower appears to be no longer used.
 - ⊕ A molded stone laundry tub with round handle trim and a hose is located in the warehouse area of the building. There is no vacuum breaker or backflow prevention on the hose. Sink and trim are in serviceable condition, with trim requiring adjustment and maintenance. Appears to be a drainage issue.
 - ⊕ There is a washer and dryer located on the warehouse area of the building appear in good condition.
 - ⊕ There are two Unitary eyewash station, one located in the warehouse area and one located in the electrical maintenance area. It is documented on tags to be inspected and re-filled/water replaced on a semi - regular basis (last inspections September 2014 and October 2014 respectively). One unit was empty and one unit was filled below the 5 minute mark. Water should be replaced every 6 months. There are materials around the eyewash which could limit access. Appears to be in serviceable condition.
 - ⊕ Kitchen sink is a double bowl stainless steel sink, with round handled trim. Sink and trim are in serviceable to marginal condition, with trim requiring adjustment and maintenance.



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IT IS RECOMMENDED THAT:

1. Adjust flush valve in female washroom – **Priority 3**
2. Provide new flow control / aerators on faucets – **Priority 3**
3. Replace faucets in female washroom and male washroom – **Priority 3**
4. Remove/decommission shower – **Priority 3**
5. Maintain clear path around eyewash – **Priority 1**
6. Maintain level in eyewash, replace water every 6 months – **Priority 1**

8.2.2 D2020 Domestic Water Distribution

Domestic Cold Water

- ⊕ The facility receives domestic cold water from an artesian type well. Water is supplied from the well by an unknown submersible well pump. The pump feeds a ProSource PS220-T52 pressure tank with the pressure switch set at 30 psig on and 40 psig. Consideration should be given to increasing the high set point to 50 psi.
- ⊕ The building has a water softener near the well pump with a potassium permanganate injection tank. Potassium permanganate is typically used in water systems with high sulfur and iron contents. Water is currently labelled unfit for human consumption. Staff has indicated sulfur issues with the water system. Consideration should be given to testing the water and installing a water treatment system for the issues identified.
- ⊕ The piping for the domestic cold water and domestic hot water is generally copper pipe throughout. It is expected that 50%/50% tin/lead solder (which would be typical of the era) would have been used during construction and water quality tests should be conducted to verify that water quality is within the national guidelines.
- ⊕ A spot check of the piping seems to indicate that there is moderate corrosion around piping and fittings. Staff should continue to monitor condition, and begin major retrofit as leaks begin to appear.
- ⊕ No check valves and vacuum breakers were noted to provide backflow prevention.

Domestic Hot Water

- ⊕ The domestic hot water system supplies hot water for the building including washrooms, showers and sinks.
- ⊕ The domestic hot water is provided from 2 electric hot water heaters. The heaters appear in good condition.
 - The tank in the center of the building near the washrooms is a GSW Model SSE40SDE 40 US gallon 2255 W 208 volt heater located under the stairwell.
 - The tank in the north of the building near the laundry sinks is a John Wood Model JW50SDE130 50 US gallon 2255 W 208V heater
- ⊕ The heaters are located near fixtures served. No recirculation system is provided in the buildings. Most fixtures tested appeared to have hot water available on demand.

IT IS RECOMMENDED THAT:

1. Continue to test drinking water for inclusion of treatment systems – **Priority 2**
2. Provide water treatment system to meet Canadian drinking water standards – **Priority 2**
3. Provide vacuum breakers on laundry sinks and hose bibs – **Priority 3**
4. Continue to monitor water piping condition, as leaks begin to appear, consider major system retrofit – **Priority 3**

8.2.3 D2030 Sanitary Waste and Storm Drainage Systems

- ⊕ The sanitary and drain, waste and vent lines appear to be a mixture of ABS and Cast Iron. System appears to be in serviceable condition.
- ⊕ During the site inspection no oily water separation was noted.



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- ⊕ A hazard assessment should be completed concerning storage of petroleum products, specifically spill containment. Make sure procedures are followed.
- ⊕ Sanitary service is located in the line crew office. No back water valve is installed.
- ⊕ Documentation was provided indicating the location of the lift station, septic tank and septic field.
- ⊕ The lift station was noted to be a 6 ft deep 4 ft wide concrete manhole. The manhole has one sealed plastic sump basin with sewage pump to lift sewage from the new warehouse to the septic tank, and one effluent pump directed to a rock pit to manage storm water infiltration. The manhole has a heavy duty steel cover. Staff have indicated the pit and both pumps have experienced freezing damage and rarely function correctly. Pit was filled with water during time of inspection.
- ⊕ The septic tank is located directly outside the building with a wooden plank cover and steel access chamber. The tank is fiberglass and appears in reasonable condition.
- ⊕ Staff have indicated the diversion structure is located under the main access walkway to the building and may be in questionable condition.
- ⊕ The septic field consists of three pipes extending 5 meters along the south side of the building, within the area 20 ft or less from the foundation. The soil appears to be saturated (muddy and swampy). There is no grass cover over the septic field. It was indicated that drainage piping (weeping tile) has been installed approximately 2 ft above the septic field pipes. Staff have indicated there have been issues with the operation of the septic field in the past.
- ⊕ It is unknown how the washer and laundry sink located in the north side of the building is connected to the septic system. Water is backing up in the sink and does not appear to be functioning correctly.
- ⊕ Two vent pipes near center of roof appear to potentially be susceptible to snow build up and blockage.

IT IS RECOMMENDED THAT:

1. Perform risk assessment concerning storage of petroleum products and containment of spills. Insure procedures are followed – **Priority 3**
 2. Lift station as currently designed does not function correctly. Consideration should be given to moving sealed lift station back to inside the warehouse area, removing the manhole, or replacing the existing lift station and manhole with a system installed at a depth to prevent freezing and sufficient backup and alarming capability – **Priority 1**
 3. Place warning tape to stay away from parking near existing septic tank – **Priority 1**
 4. Give consideration for replacing existing diversion structure – **Priority 3**
 5. Replace existing septic field. Locate a minimum of 20 ft from the building, 10 ft from the property line, 50 ft from a well or body of water. Provide grass cover over septic field, perform permeability test of soil in the area. Design new septic field based on soil conditions and building occupancy – **Priority 1**
 6. Locate laundry and washer sanitary system. Provide remediation as required – **Priority 1**
 7. Extend two vent pipes near center of the building to prevent icing / blockage – **Priority 3**
- 8.2.4 **D2090 Other Plumbing Systems Accessories**
- ⊕ Not applicable.
- 8.3 **D30 HVAC**
- 8.3.1 **D3010 Energy Supply**
- ⊕ Not applicable.



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8.3.2 D3020 Heating Systems

- ⊕ Office Building: Electric heaters in admin area should be replaced as they are beginning to show signs of corrosion (3 approximately 1000W heaters), and one in line crew room.
- ⊕ The facility is heated using Stelpro / Chromalox / Ouellet baseboard electric heaters as well as electric horizontal unit heaters. The condition of these units appears to be serviceable.
- ⊕ Heating is controlled by a mixture of digital and dial line voltage thermostat, and internal controls in the garage areas. System appears in marginal condition.

IT IS RECOMMENDED THAT:

1. Continue to upgrade thermostats to digital programmable – **Priority 3**
2. Condition of fins and guards are checked on a regular basis – **Priority 3**
3. Replace old heaters in admin and line crew area – **Priority 3**

8.3.3 D3030 Cooling Systems

- ⊕ The building has a Carrier Model 50TFF012---501GA 8.3 Ton Rooftop air conditioning unit with area zone dampers. The central control for the unit is located in the tech storage room centrally located in the building. Staff have indicated the building is typically uncomfortable. Condition of the filters for the unit is unknown. The replace filter light is on.
- ⊕ The Carrier unit has a neptronics humidifier which is not operational.
- ⊕ A Liebert Model MMD12E-P0000 mini mate split system with a 1 ton capacity is located in the communications room. The condenser discharges heat into the warehouse area.

IT IS RECOMMENDED THAT:

1. Move rooftop air conditioning unit control to south side of the building – **Priority 3**
2. Replace roof top air conditioning unit filters every 6 months – **Priority 3**
3. Finish installation and commissioning of Neptronics Humidifier – **Priority 3**

8.3.4 D3040 HVAC Distribution Systems

- ⊕ The roof top air conditioning unit has a ducted supply and return.
- ⊕ There appear to be VAV boxes controlling the air distributed to each individual room.
- ⊕ The office areas were noted as being cold most of the time. Insulation has been placed inside of supply air diffusers to limit the amount of air flow provided by each diffuser.
- ⊕ There are markings on the ductwork suggesting an air balance had been previously completed on the system.

IT IS RECOMMENDED THAT:

1. Provide reheat coils in air handling unit duct work to temper air provided to various zones – **Priority 3**

8.3.5 D3050 Ventilation Systems

- ⊕ The three washrooms are exhausted from a ACME Centri Master Model PRN100 Direct Drive Centrifugal Exhaust Fan with a capacity of approximately 500 CFM. Exhaust fan does not appear to be operational.
- ⊕ There is range hood over the stove which is ducted outdoors.
- ⊕ There is no ventilation in the Warehouse area of the building.
- ⊕ There is no ventilation system in the new warehouse building.

IT IS RECOMMENDED THAT:

1. Repair washroom exhaust fan – **Priority 1**



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2. Provide minimum ventilation for warehouse area of the building in accordance with ASHRAE – **Priority 2**
3. Provide minimum ventilation for new warehouse building in accordance with ASHRAE – **Priority 2**

8.3.6 **D3090 HVAC Systems & Equipment**

- ⊗ Not applicable.

8.4 D40 Fire Protection

8.4.1 **D4010 Fire Extinguishers**

- ⊗ A significant number of ABC type fire extinguishers were located around the Facility. Sizes, age and condition of extinguishers varied.
- ⊗ All fire extinguishers were fully charged and had valid monthly inspection tags.
- ⊗ One fire extinguisher in the new warehouse was noted as discharged and should be refilled or replaced.
- ⊗ All fire extinguishers in the new warehouse have elapsed the 6 year recertification period.
- ⊗ Wall bracket for fire extinguisher in main office was broken.

IT IS RECOMMENDED THAT:

1. Inspect fire extinguishers on an annual basis – **Priority 1**
2. Perform 6 year maintenance of all fire extinguishers in warehouse – **Priority 1**
3. Recharge fire extinguisher in warehouse – **Priority 1**
4. Replace fire extinguisher wall bracket in main office – **Priority 3**

8.4.2 **D4020 Automatic Sprinklers**

- ⊗ Not applicable.

8.5 D50 Electrical

8.5.1 **D5010 Electrical Service & Distribution**

Main Service Equipment

- ⊗ The electrical service for the office building is a 120/280V, 3 Phase, 4 wire, 400A service fed underground to the main electrical room. The service is fed through a Square-D, 400A service rated fused disconnect switch to a BEL splitter trough, and then from the splitter trough to the associated branch circuit panel boards located throughout the building. The main electrical distribution equipment appeared to be in good serviceable condition.
- ⊗ The electrical service for the maintenance building is a 120/240V, single phase, three wire, 125A service fed overhead to a service rated panelboard located on the south east interior wall of the building. The overhead service as well as the service rated panelboard appeared to be in good serviceable condition.
- ⊗ Electrical power for the Pump House building is fed underground off the office building service from a 100A fused disconnect switch located in the office building electrical room.

Panelboards

- ⊗ Panelboard #1 is located in the office building electrical room and is Square-D, 120/208V, three phase, four wire, 200A main breaker, 42 circuit panelboard which appeared to be relatively new and in good serviceable condition.
- ⊗ Panelboard #2 is located in the office building electrical room and is Federal Pioneer, 120/208V, three phase, four wire, 100A main breaker, 42 circuit panelboard.



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- Panelboard #2 appeared to be in reasonable condition; however, Federal Pioneer panelboards are becoming increasingly difficult to source replacement parts and circuit breakers for. Replacement of this panelboard should be considered in an effort to avoid potential maintenance issues in the future.
- ⊕ Panelboard #3 is located in the office building electrical room and is Federal Pioneer, 120/208V, three phase, four wire, 100A main breaker, 42 circuit panelboard. Panelboard #3 appeared to be in reasonable condition; however, Federal Pioneer panelboards are becoming increasingly difficult to source replacement parts and circuit breakers for. Replacement of this panelboard should be considered in an effort to avoid potential maintenance issues in the future. Panelboard #3 was also tagged-out to disconnect power to an adjacent lift station. Tag out date was May 20th, 2014.
 - ⊕ Panelboard #4 is located in the office building electrical room and is Federal Pioneer, 120/208V, three phase, four wire, 200A main breaker, 42 circuit panelboard. Panelboard #4 appeared to be in reasonable condition; however, Federal Pioneer panelboards are becoming increasingly difficult to source replacement parts and circuit breakers for. Replacement of this panelboard should be considered in an effort to avoid potential maintenance issues in the future. In addition to this, panelboard #4 also has exposed busway – filler plates should be installed to cover up this exposed busway.
 - ⊕ Panelboard LP1 is located in the maintenance building and is Square-D, 120/240V, single phase, three wire, 125A main breaker, 42 circuit panelboard which appeared to be good serviceable condition.
 - ⊕ The panelboard located in the Pump House is a Amalgamated Electric, 120/208V, three phase, four wire, 150A main lug, 18 circuit panelboard. This panelboard appeared to be nearing the end of its serviceable life and its replacement should be considered. In addition to this, the panel had exposed busway which should be covered up with filler plates, and there were materials piled in front of the panelboard and adjacent disconnect switch.
 - ⊕ Branch circuit breakers connected to exit signs, access control, and CCTV systems should be painted red and provided with lock on devices so they are not inadvertently turned off.

Wiring Devices

- ⊕ Office Building: Only 685mm of clear workable space in front of main disconnect switch. A minimum clear workable space of 1000mm is required to be maintained in front of the switch in accordance with CSA 22.1-12, Article 2-308. (the switch had an inspection sticker on it)
- ⊕ Office Building: There is a 100A disconnect switch mounted horizontally below the main splitter trough. Given its location and workable clearance, this switch should be relocated or reviewed by the local authority having jurisdiction (AHJ).
- ⊕ Office Building: It was noted that some of the receptacles along the kitchen counters should be replaced with ground fault circuit interrupting (GFCI) receptacles as they are within 1500mm from kitchen sinks (Reference CSA C22.112, Article 26-700 (11)).
- ⊕ Office Building: At the time of review a new data rack was being installed in the communications room, so the space was limited, however, it was noticed that a 60A disconnect switch located on the south wall of the communications room was obstructed by the UPS system. Workable clearance should be provided in front of this switch. Further, there were acoustic tiles removed from the ceiling of the



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communications room that should be replaced to maintain fire rating of the room, mitigate possible smoke ingress, and seal room for existing AC cooling.

- ⊕ Office Building: There appeared to be a sufficient quantity of receptacles throughout the building, although several faceplates and receptacles were broken or damaged and should be replaced with new. Stainless steel faceplates should be considered for durability.
- ⊕ Office Building: In the warehouse and storekeeper rooms electrical junction boxes were found that were installed such that they were inaccessible and unable to remove junction box covers. Electrical boxes are to be accessible in accordance with CSA C22.1-12 article 12-3014.
- ⊕ Office Building: In the warehouse and storekeeper rooms electrical junction boxes were found that were missing knockout fillers, and were not supported independent from the connected conduit run.
- ⊕ Office Building: In the small office adjacent to the warehouse, there is a receptacle within 1.5m of the shop sink. This receptacle is required to be GFCI protected.
- ⊕ Most exterior receptacles are damaged and should be replaced including the receptacle used for vehicle block heaters at south end of the parking lot. All exterior receptacle covers and receptacles should be replaced with waterproof, gasketed while in use covers in accordance with CSA 22.1-12 article 26-702.

Wiring Systems

- ⊕ Wiring in the office building and maintenance shop is RW90 copper conductor in electrical metallic tubing (EMT), PVC, and flexible interlocked armor (AC90) and in some places Teck 90 cabling was used for exterior branch circuit wiring. Wiring in the Pump House is a combination of RW90 copper conductor in electrical metallic tubing (EMT), PVC and NMD. Communications cabling was in PVC conduit or free air. Low voltage cabling for network cameras is run in conduit.

IT IS RECOMMENDED THAT:

1. Replace Federal Pioneer panelboard and all associated branch circuit breakers with new - **Priority 3**
2. Install circuit breaker filler plates in panelboard #4 - **Priority 1**
3. Replace Pump House panelboard - **Priority 3**
4. Relocate materials in front of Pump House panelboard - **Priority 1**
5. Install circuit breaker filler plates in Pump House panelboard - **Priority 1**
6. Paint critical system circuit breakers red and provide lock on circuit breaker devices - **Priority 3**
7. 100A disconnect switch should be relocated to provide adequate access and clearance or the location be approved by the AHJ - **Priority 1**
8. Install GFCI protected receptacle around kitchen sink - **Priority 1**
9. Verify that after all work to communications is done that there is sufficient clearance in front of the 60A disconnect switch, and that all acoustic ceiling tiles have been replaced **Priority 1**
10. Replace broken and damaged faceplates throughout the office building with new stainless steel faceplates - **Priority 3**
11. Relocate electrical junction boxes so that they are accessible - **Priority 1**
12. Replace junction box knockouts and properly support conduit runs **Priority 1**
13. Install GFCI protected receptacle around shop sink - **Priority 1**
14. Waterproof while-in-use receptacle covers be installed on all exterior GFCI receptacles, and replace all damaged block heater receptacle with new - **Priority 1**

8.5.2 D5020 Lighting

Interior Lighting

- ⊕ Office Building: Lighting in the office building was achieved with 2 lamp 1' x 4', T8 fluorescent lensed troffers in the corridors and administrative areas and 2 lamp, T8 fluorescent surface and suspended wrap in the workshop and storage areas. Average horizontal lighting levels when measured from the workplane were found to be:
 - 25 fc in the corridors
 - 50 fc in the kitchen
 - 38 fc in the administrative areas and offices
 - 20 fc electrical workshop
 - 20fc in the maintenance area
- ⊕ In the Office Building, most of the areas satisfy the minimum lighting levels recommend by the IES; however, the electrical workshop and maintenance areas should have additional luminaires installed above the work bench to bring task lighting levels up.
- ⊕ Office Building: Missing lens in T8 troffer in admin foyer to be installed.
- ⊕ Pump House: Lighting in the Pump House was achieved with 2 lamp T12 fluorescent surface mounted wrap luminaires. Several luminaires were missing lenses and a few lamps were burnt out. Lighting levels were unattainable due to a significant amount of lamps being burnt out.
- ⊕ Warehouse: Lighting in the warehouse was achieved with an array of 2 lamp T8 fluorescent suspended strips luminaires c/w reflectors, and the approximate lighting level was measured at 18 fc vertical average illuminance and approximately 13 fc horizontal average illuminance at the workplane throughout the warehouse. These lighting levels just meet the minimum lighting levels recommended by IES.

Exterior Lighting

- ⊕ Office Building: Exterior façade lighting was achieved by a series of high pressure sodium (HPS) wall packs installed around the perimeter of the building. All HPS luminaires appeared visually to be in reasonable condition.
- ⊕ Pump House: Exterior façade lighting was achieved by incandescent wall packs located above the two entrances into the building. One luminaire was removed and had an uncovered junction box, and the other appear to be nearing the end of its designed life and should be replaced.
- ⊕ Warehouse: Exterior façade lighting was achieved by two wall mounted "Jam-Jar" style incandescent luminaires were located adjacent to exterior doors and appeared to be in reasonable condition. It was noticed that there is not any exterior lighting around the garage door into the warehouse, and installation of a wall pack above the garage door should be considered.

Lighting Control

- ⊕ Interior lighting throughout all three buildings is controlled by local 120V, 15A single pole or three-way toggle style switches. In an effort to increase efficiency and reduce maintenance costs, replacement of the existing single pole toggle switches with wall or ceiling mounted occupancy sensors should be considered in the washrooms and storage closets.
- ⊕ Exterior façade lighting for the office building is controlled by a photocell and mechanical lighting contactor which appeared to be in good working order. Both the exterior façade lighting for the Pump House and warehouse is controlled by a local switch.

Emergency Lighting

- ⊕ Office Building: Most of the emergency lighting units are halogen MR16 style units in good working condition; however a few are older PAR style units that are most likely coming to the end of their serviceable life. Replacement of the older PAR style emergency lights should be considered and until they are replaced periodic testing should be completed to ensure proper operation.
- ⊕ Office Building: An emergency lighting unit in the communication room was not operational when tested.
- ⊕ Office Building: A single or dual head emergency light should be installed in the kitchen and main administrative area to provide illumination levels in accordance with NBC article 3.2.7.3 along paths of egress.
- ⊕ Pump House: there are no emergency lighting systems installed.
- ⊕ Warehouse: Emergency lighting units were tested and all appeared to function properly.
- ⊕ Warehouse: Single remote head should be installed in the foyer provide illumination levels in accordance with NBC article 3.2.7.3 along the path of egress.

Exit Signs

- ⊕ Office Building: Existing exit signs are LED backlit type, ceiling or wall mounted with red lettering. The age of the exit signs are unknown; however, they appear to be in good condition. Periodic testing of the exit signs should be completed to ensure proper operation.
- ⊕ A ceiling mounted exit sign should be installed in the hallway outside the technical customer service clerk office and kitchen as the existing exit sign is not clearly visible from the end of the hallway when walking from the service room. Exit signs should be clearly visible and unobstructed in accordance with NBC article 3.4.5.1.2.
- ⊕ Pump House: there are no exit signs installed.
- ⊕ Warehouse: Exit signs are photoluminescent type. These should be tested monthly with the fire extinguishers to ensure operation in accordance with NBC section 3.4.5.1 article 3b. They were checked at the time of review for operation and appeared to be illuminating dimly.

IT IS RECOMMENDED THAT:

1. Install additional suspended 1 lamp T8 fluorescent task luminaires - **Priority 2**
2. Luminaires that are missing lenses, should have new lenses installed in the Pump House and office building **Priority 2**
3. Replace all T12 fluorescent lamps and magnetic ballast luminaires in the Pump House with new high-efficiency T8 or T5 lamps and electronic ballasts. - **Priority 3**
4. Replace the Pump House incandescent exterior lighting with LED wallpacks c/w integral button type photocell - **Priority 1**
5. Install an exterior LED wallpack above the warehouse garage door **Priority 1**
6. In the office building replace all existing PAR style emergency lighting units **Priority 2**
7. In the office building repair or replace all emergency lights that are not operational **Priority 1**
8. In the office building install additional emergency lighting units in the Kitchen and main administrative areas **Priority 1**
9. In the warehouse install additional remote emergency lighting head in the foyer **Priority 1**
10. Install an additional exit sign in the corridor outside the kitchen **Priority 1**
11. Periodic testing be conducted on the exit signs (both backlit and photoluminescent) and emergency lighting units to ensure proper operation - **Priority 1**

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8.5.3 D5030 Communications & Security

Telephone/Data

- ⊛ Office Building: The communications service is fed underground from the south side of the building, with a Corning fiber optic cable to a fiber to copper media converter located in the main electrical service room. From here telephone cable is fed to a set of BIX Blocks located at the south end of the service room and then out to associated telephone outlets with Cat 5e CMR run free air. Data drops are run from a Cisco PoE switch and corresponding patch panels. Data drops are run with Cat 5e CMR run free air to outlets. The data system is powered through a Powerware 9 UPS system located in the main communications room. There were also several wireless access points located throughout the building which appeared to be in good condition.
- ⊛ Office Building: Obsolete/disconnected data drop in south west corner of admin room and east corner of admin office should be removed and covered with a blank faceplate.
- ⊛ Pump House: there are no telephone/data systems installed.
- ⊛ Warehouse: telephone and data for the ware house is run underground from the Office building to a set of BIX blocks and data patch panel located on the south wall of the warehouse. Telephone outlets are wired from this location with Cat 5e CMR cable run in PVC conduit and free air. Data outlets are wired with Cat 5e CMR cable run in PVC conduit and free air. Communications equipment and wiring appeared to be in good condition.
- ⊛ There was a bi-directional signal booster located in the electrical workshop. The unit appeared new, but was not plugged in.

Audio Visual Systems

- ⊛ Not applicable.

Cablevision

- ⊛ Not applicable.

Door Intercom System

- ⊛ Not applicable.

Paging/Sound System

- ⊛ Office Building: There is an existing site alarm system which has exterior horns located at the north and south corners of the building. The horns looked in good condition; however, the horn located at the south corner of the building did not appear to be positioned properly and should be repositioned to suit the site.
- ⊛ Pump House: No paging/sound systems are installed.
- ⊛ Warehouse: There is an existing site alarm system which has an exterior horn located at the south corner of the building and an interior horn located adjacent to the communications backboard on the south wall of the warehouse. Both paging horns appeared to be in good condition.

Card Access System

- ⊛ Office Building: There is a proximity card access control system which is located adjacent to the latch on both the interior and exterior sides of all exit doors. The proximity card readers are then wired to the access control system head end unit located in a cabinet in the communications closet. The proximity card access system appears to be in good to serviceable condition.
- ⊛ Pump House: no access control systems are installed.



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- ⊕ Warehouse: There is a proximity card access control system which is located adjacent to the latch on both the interior and exterior sides of all exit doors. The proximity card readers are then wired to the access control system head end unit located in a cabinet located adjacent to the communications backboard on the south wall of the warehouse. The proximity card access system appears to be in good to serviceable condition.

Closed Circuit Camera System

- ⊕ Office Building: There are three (2) PELCO exterior rated networkable cameras located at the north, south corners of the building. The cameras are hardwired back to a central CCTV cabinet and NVR located in the communications room. System appeared to be in good condition.
- ⊕ Pump House: no CCTV systems are installed.
- ⊕ Warehouse: no CCTV systems are installed.

Fire Alarm and Detection

- ⊕ Office Building: At the time of review the library adjacent to the service room was being used as an office, and the doorway leading into the service room was propped open. Understanding that work was being done in the service room, the library door should be closed to maintain fire rating and eliminate access of unauthorized personnel through the service room. Local smoke alarms are located throughout the facility to provide a level of fire protection.
- ⊕ Pump House: no fire alarm devices are installed.
- ⊕ Warehouse: The fire alarm control panel appeared to have a CPU fault at the time the audit was conducted and a fire alarm verification sticker was indicated the last verification was completed in February 2007. The fire alarm system should be inspected and tested in accordance with CAN/ULC-S536-04.

IT IS RECOMMENDED THAT:

1. Remove obsolete data cabling back to source and blank off outlet box **Priority 1**
2. Reposition paging horn located on east exterior façade of office building **Priority 1**
3. Limit entrance to electrical room from library **Priority 1**
4. Fire alarm system should be inspected and tested in annually to CAN/ULC-S535-04 - **Priority 1**

Reference Review:

For the purpose of this investigation, the following building codes and standards were reviewed:

- ⊕ NBCC; National Building Code of Canada (2010);
- ⊕ CEC; Canadian Electrical Code; CSA C22.1-12;
- ⊕ Inspection and Testing of Fire Alarm Systems; CSA/ULC-S536-04
- ⊕ IES Lighting Handbook 10th Edition(2010)

The scope of this investigation did not cover a detailed analysis of concealed cabling, cabling terminations or fire alarm system verification.

9 E EQUIPMENT & FURNISHINGS

9.1 E10 Equipment

- 9.1.1 **E1010 Commercial Equipment**
 - ⊕ Not applicable.
- 9.1.2 **E1020 Institutional Equipment**
 - ⊕ Not applicable.



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9.1.3 **E1030 Vehicular Equipment**

⊗ Not applicable.

9.1.4 **E1090 Other Equipment**

⊗ Not applicable.

9.2 E20 Furnishings

9.2.1 **E2010 Fixed Furnishings**

⊗ Not applicable.

9.2.2 **E2020 Movable Furnishings**

⊗ Not applicable.

10 F SPECIAL CONSTRUCTION & DEMOLITION

10.1 F10 Special Construction

10.1.1 **F1010 Special Structures**

⊗ Not applicable.

10.1.2 **F1020 Integrated Construction**

⊗ Not applicable.

10.1.3 **F1030 Special Construction Systems**

⊗ Not applicable.

10.1.4 **F1040 Special Facilities**

⊗ Not applicable.

10.1.5 **F1050 Special Controls and Instrumentation**

⊗ Not applicable.

11 G BUILDING SITE WORK

11.1 G10 Site Preparation

11.1.1 **G1010 Site Cleaning**

⊗ Not applicable.

11.1.2 **G1020 Site Demolition and Relocation**

⊗ Not applicable.

11.1.3 **G1030 Site Earthwork**

⊗ Not applicable.

11.2 G20 Site Improvements

11.2.1 **G2010 Roadways**

⊗ Some minor pot holes through gravel yard.

11.2.2 **G2020 Parking Lots**

⊗ Not applicable.

11.2.3 **G2030 Ramps**

⊗ A – 8' x 78' PT ramp on buried posts in good condition – one broken cross member.

⊗ B – 6' x 78' PT ramp at south end of Maintenance Building in good to serviceable condition; some minor settling.



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- ⊕ C – 6' x 12' PT ramp in fair to serviceable condition.
- ⊕ D – 6' x 238' PT ramp in fair to serviceable condition, minor rusting on painted steel at south end.
- ⊕ E – Helicopter ramp in disrepair – fire extinguisher and pole sock missing.
- ⊕ F – Pole yard ramps primitive construction. Some vertical braces at rear are rotting out; nearing end of life. Posts are from 1992.

IT IS RECOMMENDED THAT:

1. Fix broken bracket – **Priority 1**
2. Sand and paint rusted steel – **Priority 2**

11.2.4 G2040 Site Development (Fencing)

- ⊕ Site fencing in good to serviceable condition.
- ⊕ Gate at south east corner is in disrepair and northwest corner.
- ⊕ Barb wire on east side and south side is rusted; some clips broken.

IT IS RECOMMENDED THAT:

1. Replace gate at east corner – **Priority 1**
2. Replace rusted barb wire and broken clips at east side – **Priority 2**

**11.2.5 G2050 Landscaping
Grass**

- ⊕ Not applicable.

11.3 G40 Site Electrical Utilities

11.3.1 G4010 Electrical Distribution

- ⊕ Not applicable.

11.3.2 G4090 Other Site Electrical Utilities

- ⊕ Not applicable.

11.4 G90 Other Site Construction

11.4.1 G9010 Service and Pedestrian Tunnels

- ⊕ Not applicable.

11.4.2 G9090 Other Site Systems & Equipment

- ⊕ Not applicable.

12 PLANNING

12.1 Barrier Free Design

- ⊕ The Maintenance Building and Pump House are used for maintenance personnel requiring good physical mobility, barrier free design was not considered applicable, nor is it required by NBCC. However, the Office Building serves primarily as an administrative space and there may be a future need for barrier free construction. This requirement should be reviewed against corporate standard as the majority of washroom spaces, door thresholds and widths do not facilitate all barrier-free requirements as set out in the NBCC or the CSA (Canadian Standards Association).

13 LIFE SAFETY CODE ANALYSIS

- ⊕ Facility meets current code for Life Safety.



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14 FIRE AND LIFE SAFETY DEFICIENCIES

14.1 Structural Resistance to Fire

- ⊕ Not applicable.

14.2 Fire & Smoke Barriers

- ⊕ Although not required by NBCC, we recommend the current electrical room in the Office Building be secured and finished with a 1 hour fire rating. No rated ceiling exists in the electrical room space. No door closing devices exist at the two access points. Furthermore, the electrical room seems to be used as a common path of travel to traverse from one main corridor to another. This egress path should be restricted to trained personal only and secured with appropriate hardware and auto-closing devices as noted above.

14.3 Basic Detection and Alarm Application

- ⊕ See Electrical.

14.4 Automatic Fire Suppression

- ⊕ Not applicable.

14.5 Water Supplies

- ⊕ See Mechanical.

14.6 Fire Department

- ⊕ Not applicable.

14.7 Operation and Maintenance

- ⊕ Not applicable.

14.8 Emergency Lighting

- ⊕ See Electrical.

14.9 Egress

- ⊕ Adequate per NFPA and NBCC requirements.
- ⊕ Travel distances to exits meet current National Building Code of Canada requirements, which are more stringent than NFPA.

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15 TABLE OF PROBABLE COSTS

Recommendation / Deficiency	Priority 1 Opinion of Probable Cost	Priority 2 Opinion of Probable Cost	Priority 3 Opinion of Probable Cost	
Section 5.1.3.1		\$1,500		
Section 5.1.3.2		\$1,500		
Section 5.1.3.3	\$0			
Section 5.1.3.4	\$0			
Section 5.1.3.5	\$650			
Section 5.1.3.6		\$1,050		
Section 5.1.3.7			\$8,200	
Section 6.2.1.1	\$2,100			
Section 6.2.1.2		\$17,750		
Section 6.2.1.3		\$6,490		
Section 6.2.2.1	\$350			
Section 6.2.2.2	\$650			
Section 6.2.2.3		\$3,250		
Section 6.2.2.4		\$650		
Section 6.2.3.1	\$1,050			
Section 6.2.3.2		\$1,050		
Section 6.2.3.3		\$2,000		
Section 6.2.4.1		\$400		
Section 6.2.4.2	\$325			
Section 6.2.4.3	\$550			
Section 6.2.6.1		\$800		
Section 6.2.6.2	\$0			
Section 6.2.6.3		\$3,150		
Section 6.2.6.4		\$450		
Section 6.2.6.5		\$1,200		
Section 7.1.1.1	\$500			
Section 7.1.1.2		\$1,200		
Section 7.1.4.1		\$150		
Section 7.3.1.1		\$14,000		
Section 7.3.2.1		\$32,000		
Section 7.3.2.2	\$450			
Section 7.3.2.3	\$2,100			
Section 7.3.2.4		\$950		



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Section 7.3.2.5		\$2,200		
Section 7.3.2.6		\$250		
Section 7.3.3.1		\$900		
Section 8.2.1.1			\$500	
Section 8.2.1.2			\$500	
Section 8.2.1.3			\$4,000	
Section 8.2.1.4			\$2,000	
Section 8.2.1.5	\$500			
Section 8.2.1.6	\$500			
Section 8.2.2.1		\$1,000		
Section 8.2.2.2		\$10,000		
Section 8.2.2.3			\$500	
Section 8.2.2.4			\$0	
Section 8.2.3.1			\$1,000	
Section 8.2.3.2	\$50,000			
Section 8.2.3.3	\$500			
Section 8.2.3.4			\$10,000	
Section 8.2.3.5	\$25,000			
Section 8.2.3.6	\$5,000			
Section 8.2.3.7			\$2,000	
Section 8.3.2.1			\$2,000	
Section 8.3.2.2			\$500	
Section 8.3.2.3			\$8,000	
Section 8.3.3.1			\$4,000	
Section 8.3.3.2			\$500	
Section 8.3.3.3			\$5,000	
Section 8.3.4.1			\$20,000	
Section 8.3.5.1	\$5,000			
Section 8.3.5.2		\$5,000		
Section 8.3.5.3		\$5,000		
Section 8.4.1.1	\$500			
Section 8.4.1.2	\$1,000			
Section 8.4.1.3	\$500			
Section 8.4.1.4			\$500	
Section 8.5.1.1			\$6,000	
Section 8.5.1.2	\$100			
Section 8.5.1.3			\$1,275	

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Section 8.5.1.4	\$50			
Section 8.5.1.5	\$100			
Section 8.5.1.6			\$100	
Section 8.5.1.7	\$1,000			
Section 8.5.1.8	\$100			
Section 8.5.1.9	\$0			
Section 8.5.1.10			\$150	
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Section 8.5.2.8	\$500			
Section 8.5.2.9	\$150			
Section 8.5.2.10	\$200			
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Section 8.5.3.1	\$150			
Section 8.5.3.2	\$50			
Section 8.5.3.3	\$0			
Section 8.5.3.4	\$1,500			
Section 11.2.3.1	\$200			
Section 11.2.3.2		\$1,200		
Section 11.2.4.1	\$1,000			
Section 11.2.4.2		\$750		
TOTAL	\$104,425	\$116,740	\$77,125	\$298,290
Contingency 30%				\$89,487
Total				\$387,777

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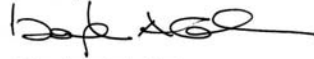
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16 USE OF REPORT

This report is prepared for the exclusive use of Newfoundland and Labrador Hydro for the expressed purpose of preparing a summary condition report for the identified property. This report should not be considered transferable, and should not be relied upon for any other purpose.

The service provided for this project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time and similar locality. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. We reserve the right to revise or amend our opinion in this report in the event new information, documentation, or evidence becomes available.

Sincerely,



Coles Associates Ltd.
Per: Douglas A. Coles, P.Eng., P.E., F.E.C.
Vice President



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Appendix A

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Photo: Section 5.1.3.1



Photo: Section 5.1.3.2



Photo: Section 5.1.3.3.a



Photo: Section 5.1.3.3.b



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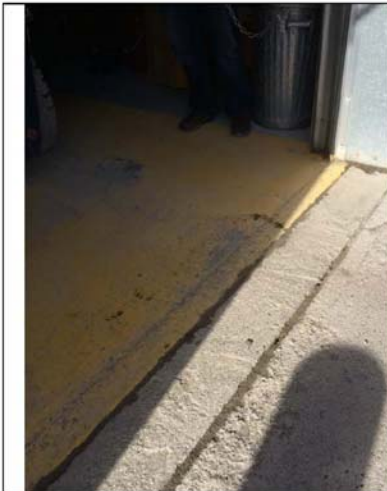


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Photo: Section 5.1.3.6.a



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Photo: Section 5.1.3.6.b



Photo: Section 5.1.3.7



Photo: Section 6.2.1.1



Photo: Section 6.2.1.2.a



Photo: Section 6.2.1.2.b



Photo: Section 6.2.1.3



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Photo: Section 6.2.2.2.a



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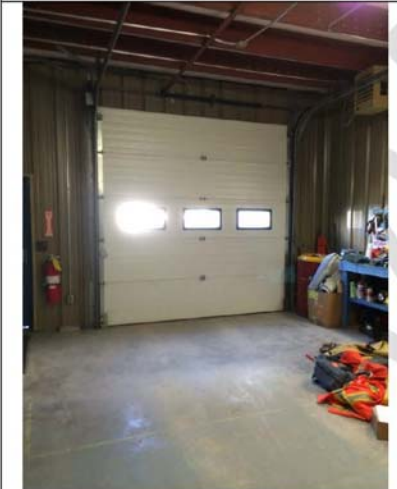


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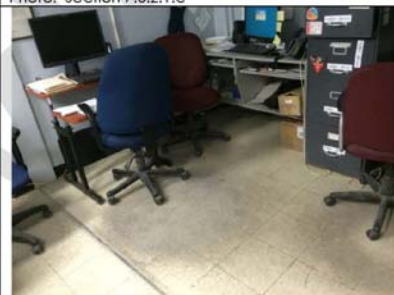


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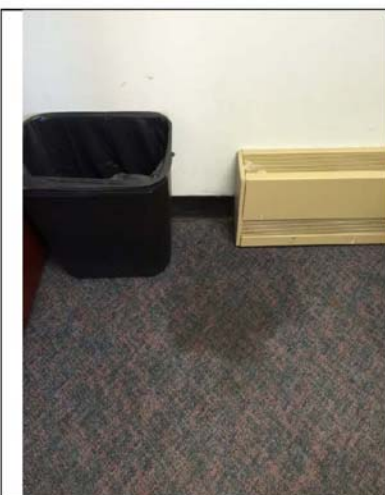


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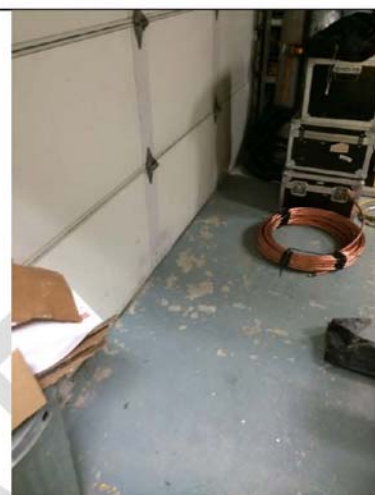


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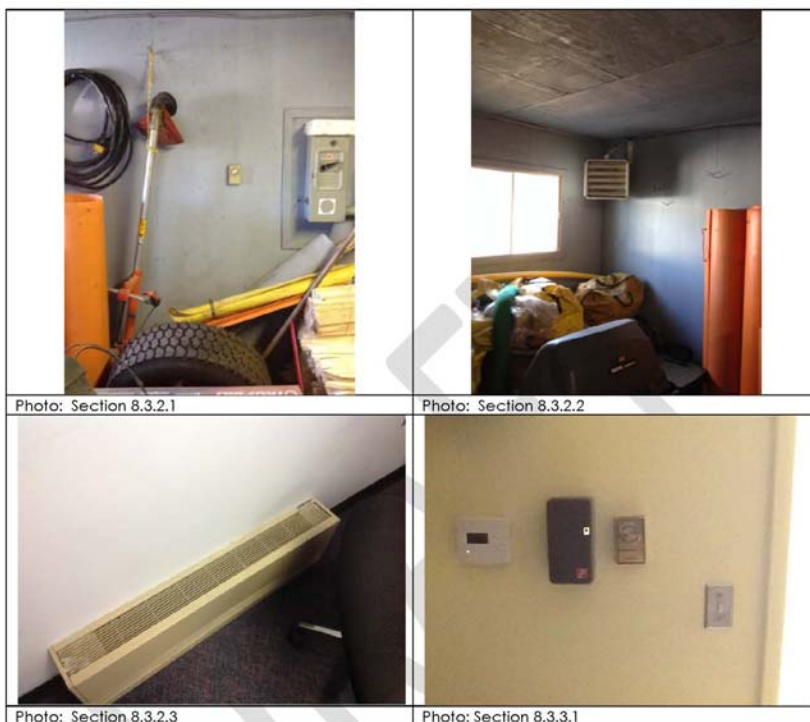


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Photo: Section 8.3.4.1



Photo: Section 8.3.5.1

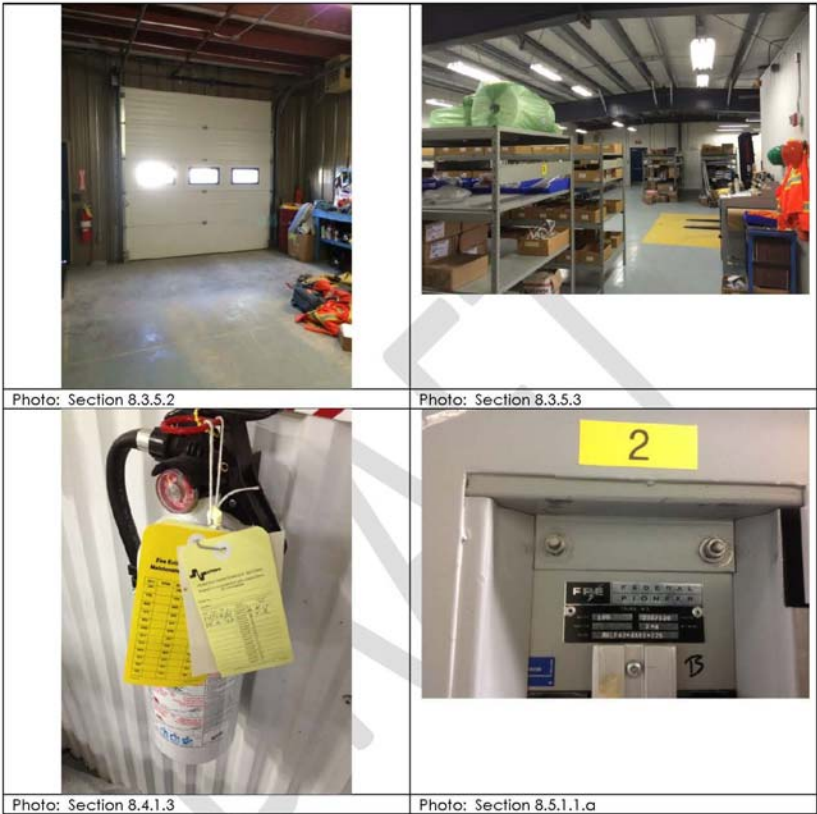


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Photo: Section 8.5.1.5



Photo: Section 8.5.1.7



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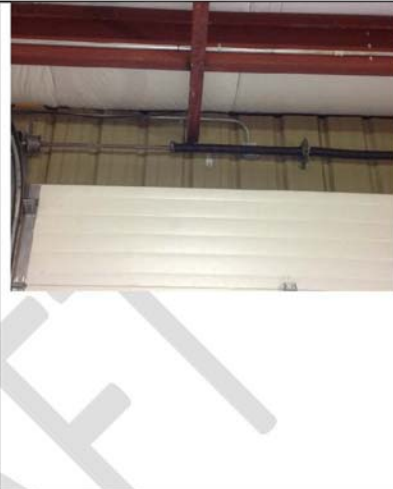


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Photo: Section 8.5.2.2.a

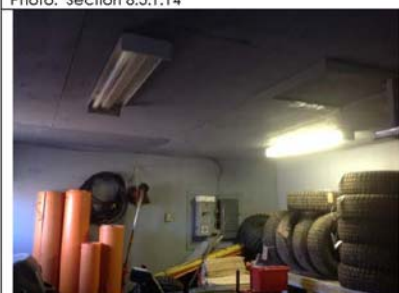


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Photo: Section 8.5.2.4.a



Photo: Section 8.5.2.4.b



Photo: Section 8.5.2.5



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Photo: Section 8.5.2.7



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Photo: Section 8.5.3.2



Photo: Section 8.5.3.3



Photo: Section 8.5.3.4



Photo: Section 11.2.3.1



Photo: Section 11.2.3.2



Photo: Section 11.2.4.1



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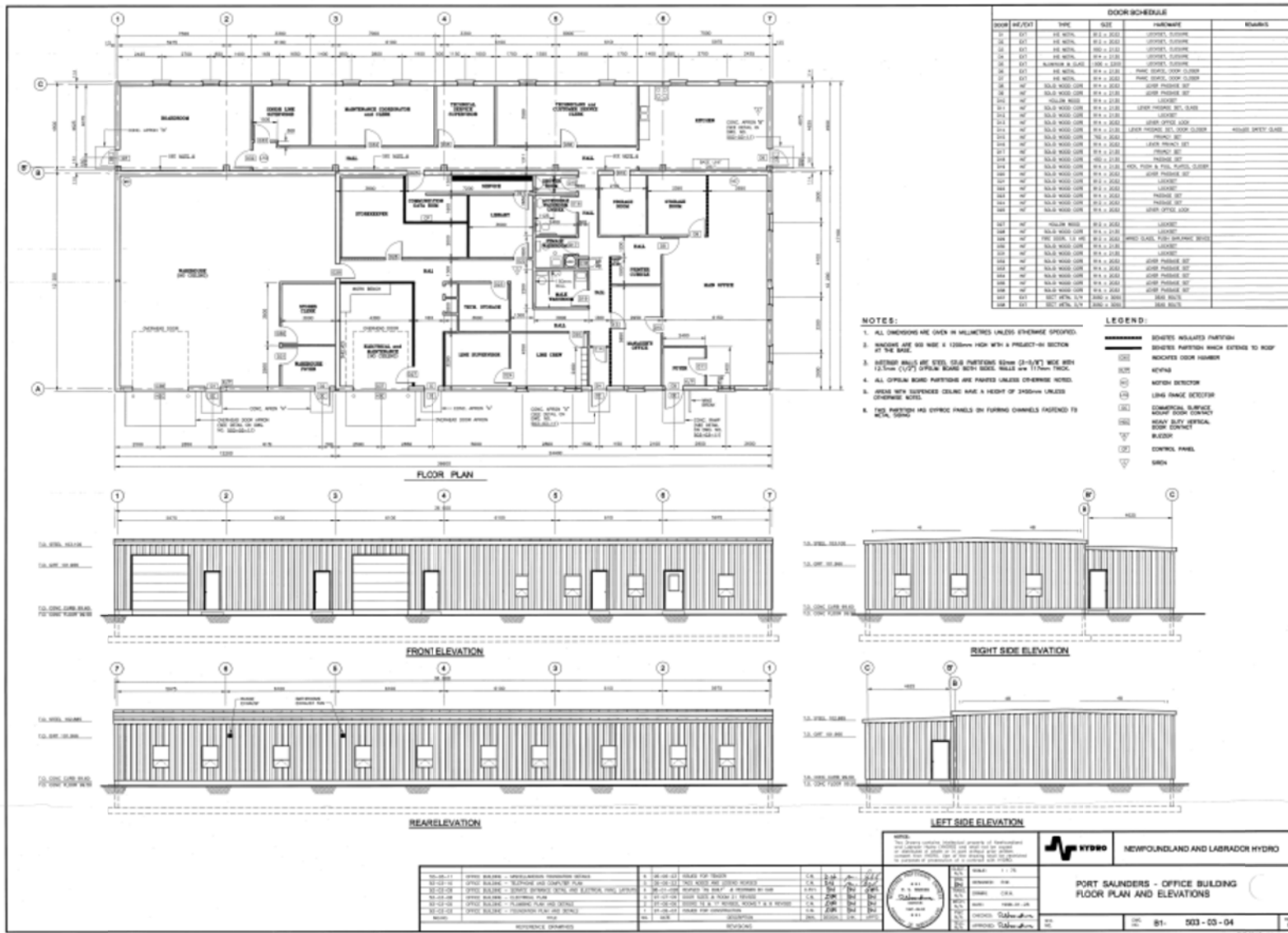
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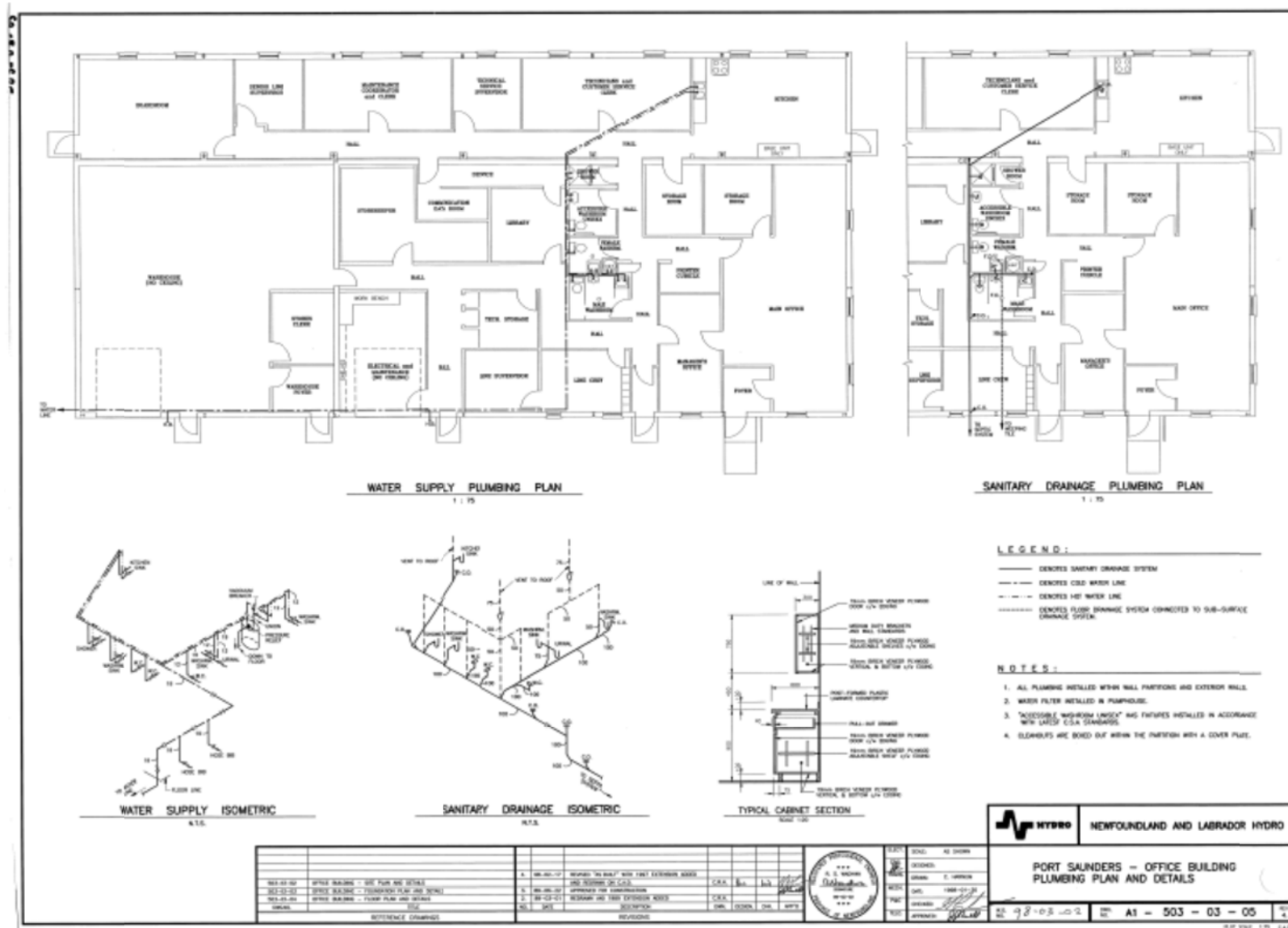
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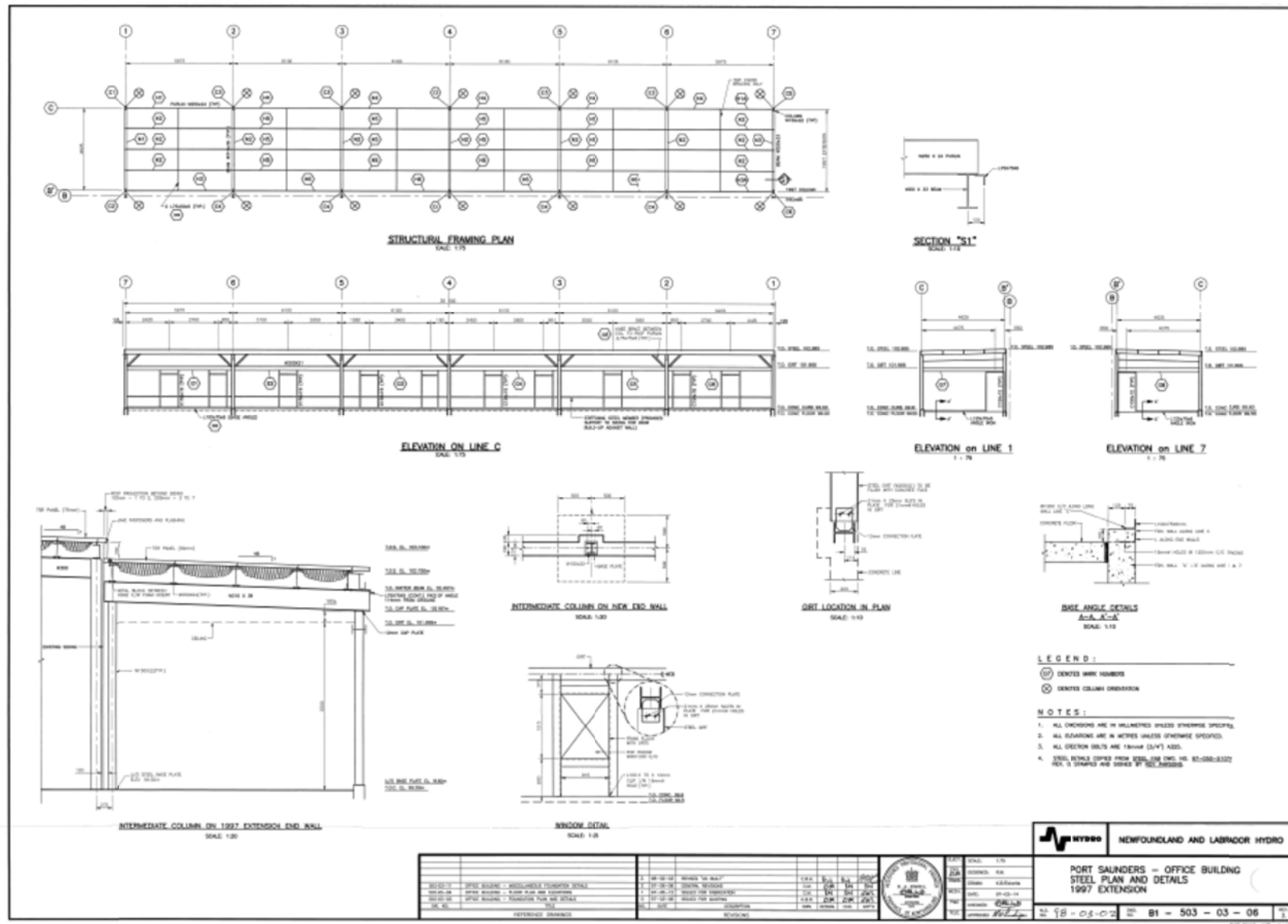
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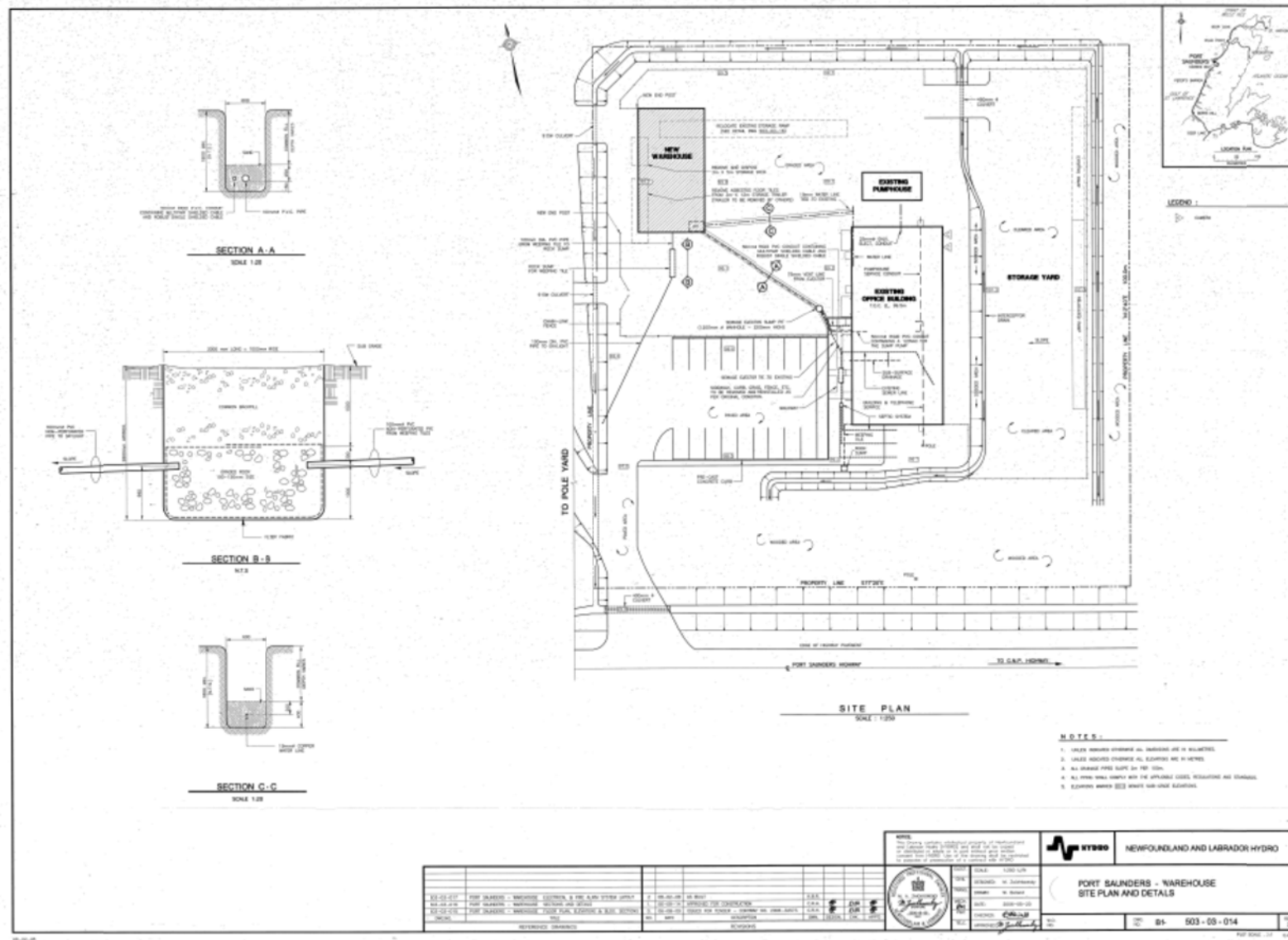


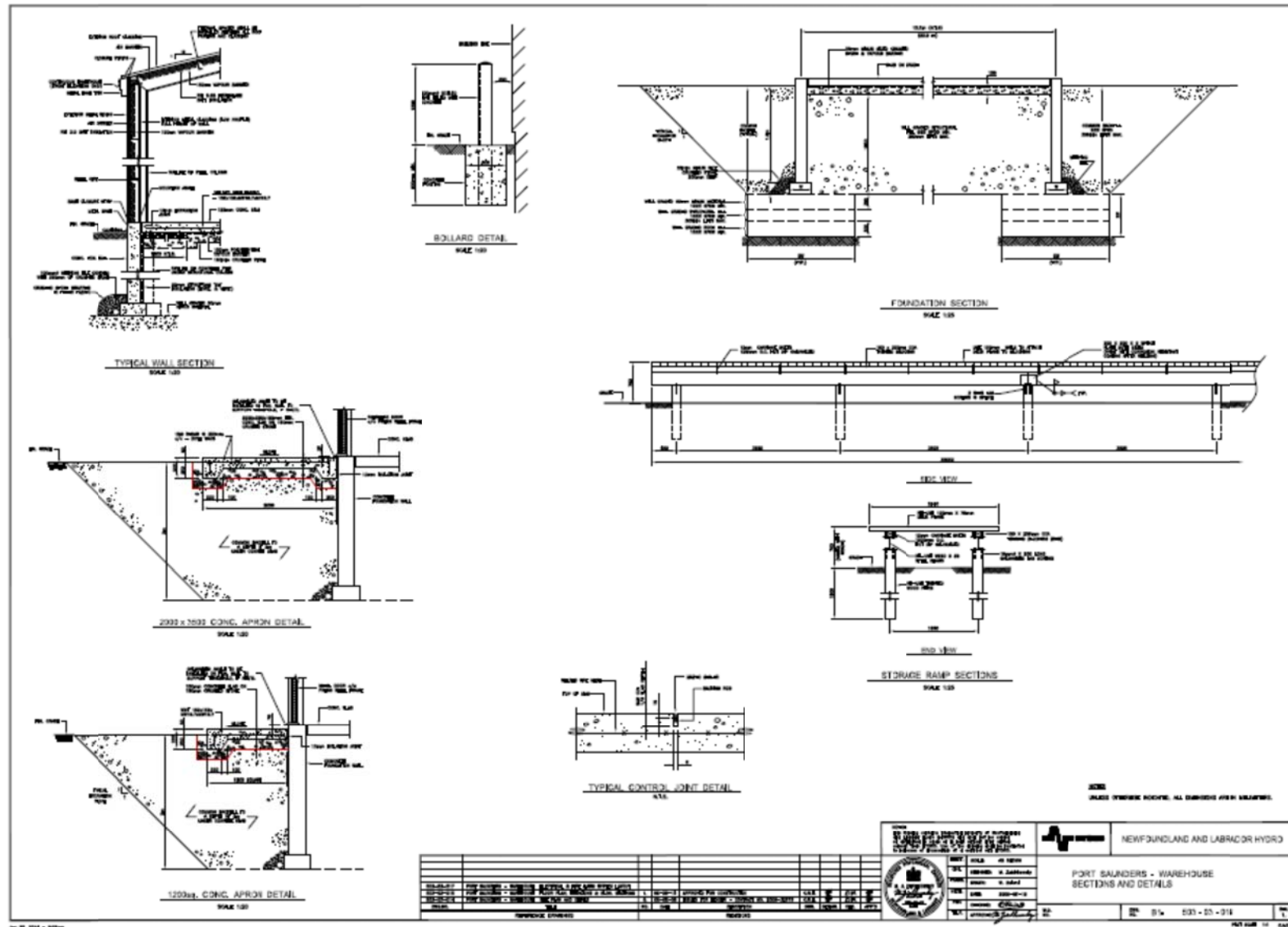
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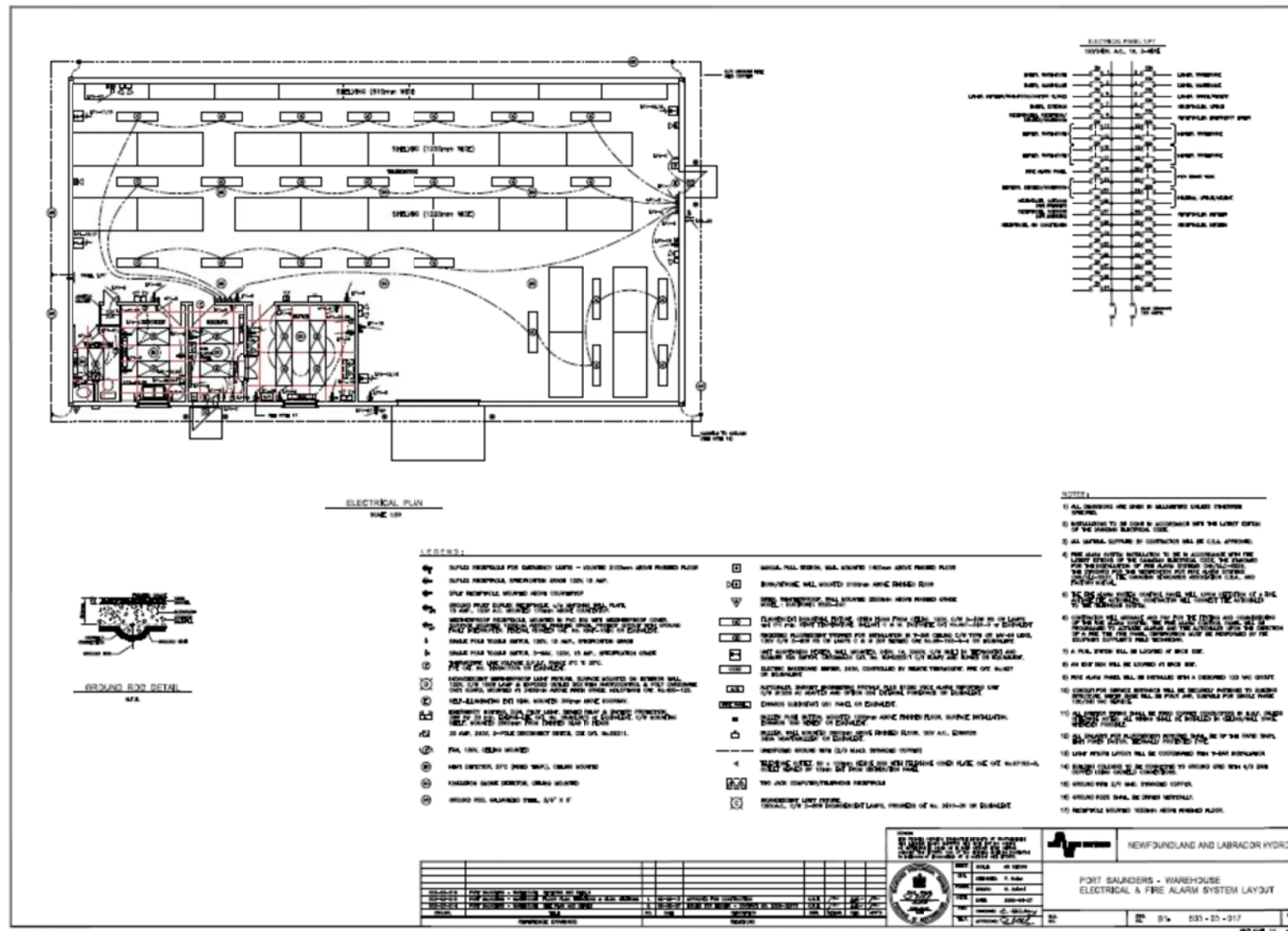












Building Conditions Assessment
Control Building
Sunnyside Terminal Station, NL

December 23, 2014

**Building Conditions Assessment
Control Building
Sunnyside Terminal Station, NL**

Prepared For:

Newfoundland and Labrador Hydro

Prepared By:



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Building Conditions Assessment
Control Building
Sunnyside Terminal Station, NL

December 23, 2014

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1 INTRODUCTION

The normal design life of a typical building is in the range of 25 to 30 years. The Control Building at Sunnyside Terminal Station was built in 1966, with an addition assumed to have been built in the mid 1980's. Newfoundland and Labrador Hydro is looking to determine and evaluate the immediate, short, and long term capital renewal/extension/upgrade requirements that can be expected for this facility over the next 25 years. The intention is to bring all of the support facilities up to the Newfoundland and Labrador Hydro standard. It is anticipated that this site will continue with similar occupancies, staffing levels and activities for the foreseeable future.

The scope of this evaluation was restricted to the facility as illustrated within Appendix A.

Coles Associates was retained to undertake an audit and prepare a report to:

- ✦ Assess the building envelope and systems to identify Priority 1, 2 and 3 (immediate, short and long term) areas where problems are occurring within the building and/or may occur.
- ✦ Make note of any possible Life Safety and/or Code compliant issues that were visible. (Note: a thorough Life Safety, Building and Fire Code analysis was not performed as part of this Building Condition Audit.)
- ✦ Investigate the need for expansion and/or relocation of the facilities in addition to the rehabilitation priorities, and
- ✦ Provide estimates on the costs of all recommendations.

2 EXECUTIVE SUMMARY

In November 2014 a team of consultants reviewed the Control Building at the Sunnyside Terminal Station, located near Clarenville, NL. The objective was to undertake a Building Condition/ Rehabilitation/ Relocation/ Expansion Assessment Audit.

In summary, it is the purpose of this study to undertake the following tasks:

- ✦ Establish the current condition of the architectural, structural, mechanical and electrical building components and systems;
- ✦ Assess deficiencies of the building relative to current code and/or indicated usage;
- ✦ Determine the need for either rehabilitation, relocation and/or expansion; and
- ✦ Provide a cost estimate of all recommendations.

There is no mechanism within the National Building Code (NBC) that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change.

While there may be opportunities to increase the energy efficiency and/or functionality of this facility through such changes as internal/external renovation and/or increased insulation in the roof and walls, as well as the windows, given its age, it is anticipated that this decision point will be based upon a financial payback model as is undertaken for most private clients.



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Following review there are approximately:

\$48,650 of Priority Level #1 work to be undertaken.
\$45,800 of Priority Level #2 work to be undertaken.
\$48,750 of Priority Level #3 work to be undertaken.

All as defined below. To these amounts and as shown in Section 15, a 30% contingency has been added in the amount of \$42,960.

3 METHODOLOGY

3.1 Building Audit

The method of study was by site visit by a team of consultants from Coles Associates. Audit work included tasks to familiarize, visually review, and document the condition of the building.

One visit was made to the facility to conduct interviews with the building management and a walk-through investigation. The building audits were completed by:

Architectural/Structural	Robert Haggis, RAIC, AIA, NCARB
Mechanical	Andrew Pickard, E.I.T.
Electrical	Elliott Coles, P.Eng.
The report was reviewed by Douglas A. Coles, P.Eng., P.E., F.E.C.	

3.2 Drawings

Floor plans of the facility were available for the Audit. Floor plans were confirmed, where warranted, from rough measurements taken on site. Site documentation was unavailable.

3.3 Prioritization

The deficiencies/recommendations falling out of these reports and/or walkthrough will be identified indicating three priority levels:

1. **Priority One:** Where immediate attention is required in order to maintain or to re-establish the integrity of a strategic system, process, weather envelope, etc., in order to comply with life safety, Building Code violations and/or those resulting from Orders delivered by the Authority having Jurisdiction (AHJ) to prevent further on-going exposure, damage or deterioration or to remove or lessen a threat to life safety.
2. **Priority Two:** Where systems require attention but present no immediate risk to system integrity or to life safety. The short to intermediate nature of these issues (one to three years) is such as to allow some orderly planning and financial resource development to occur.
3. **Priority Three:** This category identifies intermediate to longer-term issues. In the context of this report and at the heart of the Priority Three issues is the long-term disposition of this facility in total; given the condition of the envelope, the issues of non-compliance with current codes for items such as wall insulation levels; and the implications and costs of its repair.



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3.4 Quality Assessment

Throughout the report references are made to the quality of materials and systems. The following provides a guide to the intent of the grading.

- ⊕ Good Suitable for continued use.
- ⊕ Serviceable Is able to remain in service with regular maintenance.
- ⊕ Marginal Is able to remain in service with heavy maintenance.
- ⊕ Suspect Requires further investigation, is not visible though possibly problematic.
- ⊕ Poor Requires significant maintenance, repair or replacement.
- ⊕ End of useful life Requires replacement. In practical terms, systems tend not to fail all at once. In this instance "outlived its useful life" means that it is time to seriously look at putting a financial plan in place to replace the identified system in the short term.

3.5 National Building Code

The National Building Code (NBC) is a document prepared by the National Research Council of Canada, which historically has been updated every 5 years. It is the purpose of the NBC to establish standards for building construction and systems, the focus of which is occupant safety. It is the underlying intent of the NBC to provide a level of systems and environment within a building, which provide for adequate life safety, environmental conditions (i.e. light levels and air ventilation levels) and mobility (i.e. barrier-free access). While all regulations do not necessarily get more stringent, regulations very often change. In fact, buildings never "catch up" to the state of the current-day Codes.

There is no mechanism in place that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change. At the same time, Authorities Having Jurisdiction have the right to make inspections at their discretion and direct improvements to components and/or systems where they feel life safety is at risk.

In upgrading older buildings, which were not originally designed to incorporate fire ratings or sometimes bulky and space consuming systems, it can be difficult to achieve the letter of the regulation. More often it is the intent to reasonably protect life safety, which is more readily achievable.

Therefore the purpose of the review of the salient requirements of the NBC is to provide a basis of comparison against the current Code requirements and to estimate the capital cost to upgrade the building to these standards.

Specific areas of this report deal with issues that should be undertaken in the short term for reasons of life safety, regardless of the ultimate disposition of the building.

3.6 Standard Classification for Building Elements and Related Site Work – UNIFORMAT II

- ⊕ This standard establishes a classification of building elements and related site work.
- ⊕ The classification serves as a consistent reference for analysis, evaluation, and monitoring.
- ⊕ Referenced documents, E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems.
- ⊕ The classification is hierarchical to allow different levels of aggregation and summarization.



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4 BUILDING SUMMARY

The original building was built in 1966 and is a precast concrete structure on typical frost wall foundation and footings. The addition to the south is a prefab steel structure assumed to be constructed in the mid 1980's. In general, the building appears in fair to serviceable condition.

Age	48 years
Location	Sunnyside, NL
Ownership	Newfoundland and Labrador Hydro

5 A SUBSTRUCTURE

5.1 A10 Foundations

5.1.1 A1010 Standard Foundations

- ⊕ Exposed concrete foundation walls on original portion of structure carry multiple areas of cracking, chipping and pitting; worse case on north and east sides.
- ⊕ Minimal cracks evident on addition foundation. Paint finish is beginning to chip and fade.

IT IS RECOMMENDED THAT:

1. Patch and repair all areas where exposed foundation wall is damaged – **Priority 1**
2. Repaint new and old foundations – **Priority 2**

5.1.2 A1020 Special Foundations

- ⊕ Concrete entry pad at south east exit door in original structure has some major chipping/pitting occurring at its base.
- ⊕ Concrete entry pad at east exit door of addition is slightly pulled away from building face.
- ⊕ Some minor chipping evident at main entry door slab on west side.

IT IS RECOMMENDED THAT:

1. Patch and repair entry slabs on south and west side of building – **Priority 1**
2. Shift slab back against foundation at east side of building – **Priority 2**

5.1.3 A1030 Slab on Grade

- ⊕ Typical concrete slab on grade in place. Areas of exposed slab appear in serviceable condition.
- ⊕ Some cracking and pitting evident in slab finish at main entry door sill on west side.

IT IS RECOMMENDED THAT:

1. Patch and repair concrete slab at main entry door – **Priority 1**

5.2 A20 Basement Construction

5.2.1 A2010 Basement Excavation

- ⊕ Not applicable.

5.2.2 A2020 Basement Walls

- ⊕ Not applicable.

5.2.3 A2030 Basement Columns

- ⊕ Not applicable.



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6 B SHELL

6.1 B10 Superstructure

6.1.1 B1010 Floor Construction

- ⊕ Not applicable.

6.1.2 B1020 Roof Construction

- ⊕ Original building has a precast concrete panel roof and appears in good to serviceable condition.
- ⊕ Addition has a structural steel and Q-Deck roof structure and appears in good to serviceable condition.

6.2 B20 Exterior Enclosure

6.2.1 B2010 Exterior Walls

- ⊕ Original building is a precast block and panel wall and appears in fair to serviceable condition.
- ⊕ All joints between panels are cracking and/or falling away from building.
- ⊕ Some minor cracking and pitting evident at corners and edges of panels.
- ⊕ Addition is a steel structure c/w insulated steel stud, faced with steel siding and appears in good to serviceable condition.
- ⊕ Metal siding paint finish is beginning to fade and some small areas of rust exist at the corner base flashing.

Insulation

- ⊕ Assumed typical batt insulation in place for building age and construction type.

IT IS RECOMMENDED THAT:

1. Remove and replace all caulking between concrete panels – **Priority 1**
2. Sand, prime and paint minor rust spots on metal siding – **Priority 1**
3. Repaint metal siding – **Priority 3**

6.2.2 B2020 Exterior Windows

- ⊕ Not applicable.

6.2.3 B2030 Exterior Doors

- ⊕ Metal doors and frames at main entry, on west, south side exit door and east side exit door from kitchen space, show signs of heavy rust and are at the end of their life span.
- ⊕ In general all door hardware is in fair to serviceable condition.
- ⊕ Door hinge on east side exit door is rusted and detached from door; making it very difficult to open in the event of an emergency.
- ⊕ South door off of control room is missing door sweep and water infiltration is evident.

IT IS RECOMMENDED THAT:

1. Fix door on eastside by reattaching hinge (immediately and prior to new installation) – **Priority 1**
2. Replace all doors and frames – **Priority 1**

6.2.4 B2035 Exterior Overhead Doors

- ⊕ Not applicable.

6.2.5 B2040 Exterior Stairs/Roof Access Ladders

- ⊕ Not applicable.



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6.2.6 **B3010 Roof Coverings**

- ⊕ Built up modbit roof over entire structure is in disrepair and exists well beyond intended life span. Areas of major cracking and patchwork over top sheet, along with major water pooling away from roof drains.
- ⊕ Built-up curb for mechanical air handling unit is in disrepair with some major patch work evident.
- ⊕ Cap flashing is in fair condition.

IT IS RECOMMENDED THAT:

1. Remove and replace entire built-up roof system; inclusive of AHU curb. May consider replacing cap flashing as wall with new roof insulation – **Priority 1**

6.2.7 **B3020 Roof Openings**

- ⊕ Not applicable.

7 C INTERIORS

7.1 C10 Interior Construction

7.1.1 **C1010 Partitions**

- ⊕ Interior CMU block walls in addition appear in fair to serviceable condition.
- ⊕ Evidence of movement in block wall onto communication room showing signs of movement from weight of metal door and mortar joints are cracking.
- ⊕ In general GWB walls appear in fair to serviceable condition with some minor scuffs and patchwork.
- ⊕ GWB corners at east side door are heavily damaged.
- ⊕ Patch work required at GWB behind sink in washroom.
- ⊕ GWB at south wall in compressor room is in disrepair.

IT IS RECOMMENDED THAT:

1. Monitor cracked mortar in wall around communication door; repoint affected joints – **Priority 1**
2. Repair GWB corners in door threshold at east side door; verify steel stud wall plate is not rusted out – **Priority 1**
3. Patch and repair wall behind sink – **Priority 1**
4. Patch and repair GWB on south wall in compressor room – **Priority 1**

7.1.2 **C1020 Interior Doors**

- ⊕ All metal doors and frames appear in fair to serviceable condition.
- ⊕ Paint finish on doors and framing are chipping and worn.
- ⊕ Door into battery storage room requires a 45min rated door and frame complete with a closing device.

Hardware

- ⊕ Door handle missing from door off electrical room to corridor.

IT IS RECOMMENDED THAT:

1. Repaint all doors and frames – **Priority 2**
2. Provide missing handle for electrical room door – **Priority 1**
3. Verify door into battery storage room carries a 45min rated door and closing device. Replace as required – **Priority 1**



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7.1.3 **C1030 Interior Windows**

- ⊗ Not applicable.

7.1.4 **C1040 Fittings**

Washroom Accessories

- ⊗ In general, accessories appear in good to serviceable condition.

Vanities

- ⊗ Not applicable.

Millwork

- ⊗ Kitchen cabinets appear in fair to serviceable condition.

7.2 **C20 Stairs**

7.2.1 **C2010 Stair Construction**

- ⊗ Not applicable.

7.2.2 **C2020 Stair Finishes**

- ⊗ Not applicable.

7.3 **C30 Interior Finishes**

7.3.1 **C3010 Wall Finishes**

- ⊗ Painted walls throughout appear in fair to serviceable condition.

IT IS RECOMMENDED THAT:

1. Repaint all walls – **Priority 2**

7.3.2 **C3020 Floor Finishes**

- ⊗ In general, VCT flooring appears in fair condition, nearing end of life span.
- ⊗ VCT flooring in compressor room in disrepair.
- ⊗ VCT flooring at main entry door is heavily cracked and missing at threshold.
- ⊗ Painted concrete floor in battery storage is in fair to serviceable condition.
- ⊗ Rubber base is missing and/or detaching from walls in various areas and nearing end of intended lifespan.
- ⊗ Elevated vinyl floor panels in comm room appear in fair to serviceable condition.

IT IS RECOMMENDED THAT:

1. Patch and repair flooring at entry door – **Priority 1**
2. Replace flooring in compressor room – **Priority 1**
3. Repair damaged rubber base – **Priority 1**
4. Replace all vinyl tile and rubber base – **Priority 2**
5. Repaint concrete floor in battery storage room – **Priority 2**

7.3.3 **C3030 Ceiling Finishes**

- ⊗ Acoustic tile ceiling in fair condition with multiple stained and cracked tiles throughout. Stains experienced from multiple roof leaks.
- ⊗ Painted metal walls and ceiling in comm room in fair to serviceable condition.

IT IS RECOMMENDED THAT:

1. Replace all tiles in acoustic tile ceiling after new roof membrane is installed – **Priority 2**
2. Repaint ceiling in comm room – **Priority 2**



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8 D SERVICES

8.1 D10 Conveying

8.1.1 D1010 Elevators & Lifts, D1020 Escalators & Moving Walks

- ⊕ Not applicable.

8.1.2 D1090 Other Conveying Systems

- ⊕ Not applicable.

8.2 D20 Plumbing

8.2.1 D2010 Plumbing Fixtures and Trim

- ⊕ The water closet is a Mansfield 4.8 litre per flush, 2-piece, uninsulated tank type with an elongated rim bowl utilizing a vertical shut off. The water closet is in serviceable condition.
- ⊕ Lavatory is a pedestal floor mounted, vitreous china with single lever type handle. Lavatory is in serviceable condition. Lavatory trim is in serviceable condition.
- ⊕ There is a unitary eyewash station located outside of the lunchroom. It is documented on tags to be inspected and re-filled/water replaced on a semi - regular basis (last inspection July 2014 / last refill September 2014). Water should be replaced every 6 months. Appears to be in serviceable condition. Maintain a clear path to access eyewash station.
- ⊕ Kitchen sink is a single bowl stainless steel counter mount sink with a single lever type trim. Sink and trim are in serviceable condition.

8.2.2 D2020 Domestic Water Distribution

Domestic Cold Water

- ⊕ The facility receives domestic cold water from an artesian type well. Water is supplied from the well by an unknown submersible well pump located on the north west side of the building. The pump feeds a pressure tank of unknown make and model. Condition of the system was in serviceable condition.
- ⊕ The building has no water filter.
- ⊕ The piping for the domestic cold water and domestic hot water is generally copper pipe throughout with some pex piping in areas. It is expected that 50%/50% tin/lead solder (which would be typical of the era) would have been used during construction and water quality tests should be conducted to verify that water quality is within the national guidelines.
- ⊕ A spot check of the piping seems to indicate that there is moderate corrosion around piping and fittings. Staff should continue to monitor condition, and begin major retrofit as leaks begin to appear.
- ⊕ No check valves and vacuum breakers were noted to provide backflow prevention.
- ⊕ Minimal piping insulation is used throughout the facility. Pipe insulation should be added to the systems in areas that present moisture/mildew growth concerns.

Domestic Hot Water

- ⊕ The domestic hot water system supplies hot water for the building including washrooms and sinks.
- ⊕ The domestic hot water tank was located below the kitchen sink in the lunch room. The hot water heater is manufactured by Ariston model number GL8Ti with a 7-gallon tank and was noted to be in serviceable condition.

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- ⊕ The hot water heater is located near fixtures served in the kitchen. No recirculation system is provided in the building. The washroom fixture appears to take approximately 3 minutes to supply hot water and was only noted to be warm.
- ⊕ Hot water temperature to be reduced as it was noted to be approximately 140-150 degrees Fahrenheit at the kitchen faucet.
- ⊕ Piping is not insulated in most areas of the building. Insulation should be considered as required, specifically near the tank as an energy savings measure.

IT IS RECOMMENDED THAT:

1. Test drinking water for inclusion of treatment systems – **Priority 3**
 2. Remove the existing copper piping serving the original hot water heater location – **Priority 3**
 3. Insulate domestic hot and cold water piping – **Priority 3**
- 8.2.3 **D2030 Sanitary Waste and Storm Drainage Systems**
- ⊕ The facility has a flat roof with two (2) centrally located roof drains.
 - ⊕ Storm piping appears to be primarily cast iron and ABS and was noted to be in marginal condition. Signs of corrosion exist on the piping and staining throughout the facility on the acoustic tiles. Storm piping should be repaired / replaced.
 - ⊕ Storm piping is not insulated in most areas of the building. Insulation should be added to the system that presents moisture / mildew growth concerns.
 - ⊕ The sanitary and drain, waste and vent lines appear to be ABS. System appears to be in serviceable condition.
 - ⊕ No documentation was present indicating the location of the septic tank and septic field but it is believed to be located on the East side of the building.
 - ⊕ Two (2) vent pipes penetrate the roof. Height and diameter appear to be insufficient to reduce risk of freezing and snow buildup.

IT IS RECOMMENDED THAT:

1. Make a diagram showing the location of the septic field, septic tank – **Priority 3**
2. Replace storm piping throughout building come with insulation – **Priority 3**
3. Install waterproof concrete riser over septic tank to simplify access – **Priority 3**
4. Increase height and diameter of vent pipes in roof – **Priority 3**

8.2.4 **D2090 Other Plumbing Systems Accessories**

- ⊕ Two reciprocating air compressors and a desiccant type air dryer appeared to serve the switch yard. System was not reviewed in detail, as it was in general terms outside the scope of work.
- ⊕ Two pressure tanks were located outside the building. They did not appear to have any inspection tags from the provincial authority having jurisdiction. This may be a result of an exemption provided to the utility for unmanned switch yards.
- ⊕ Dornick Hunter ES2300 Oil/Water Separator is provided on the compressed air system. It is unknown the last time the system was serviced. The maintenance manual recommends replacing carbon bags quarterly along with annual cleaning and servicing of the system. Quality of discharge water should be part of regular maintenance checks.

IT IS RECOMMENDED THAT:

1. Perform quarterly and annual cleaning and maintenance on oil/water separator – **Priority 1**



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8.3 D30 HVAC

8.3.1 D3010 Energy Supply

- ⊕ Not applicable.

8.3.2 D3020 Heating Systems

- ⊕ Facility is heated using electric baseboards throughout the building. Baseboards appeared old and several were dented and missing parts. These heaters appear to be in serviceable condition as several were replaced with new.
- ⊕ Heating is controlled by dial line voltage thermostats. System appears in marginal condition.
- ⊕ Heater in battery room is a Chromalux explosion proof, electric baseboard which was noted to be at the end of its useful life and should be replaced.

IT IS RECOMMENDED THAT:

1. Replace old heaters in the facility – **Priority 3**
2. Replace all thermostats with digital – **Priority 3**
3. Replace electric baseboard heater in the battery room as required based on ventilation needs – **Priority 3**

8.3.3 D3030 Cooling Systems

- ⊕ Cooling to the communications room is provided by a roof mounted Trane Model # TCC024F100BF 2 Ton air handling unit providing both cooling and heating. Unit is at the end of its useful life and should be replaced. It was noted by facility staff that water is entering the unit.

IT IS RECOMMENDED THAT:

1. Perform annual maintenance checks on cooling unit – **Priority 3**
2. Replace air handling unit with like unit or split a/c unit – **Priority 2**

8.3.4 D3040 HVAC Distribution Systems

- ⊕ Not applicable.

8.3.5 D3050 Ventilation Systems

- ⊕ The battery room is exhausted by a Carnes Company EWDA683 12 inch sidewall centrifugal exhaust fan. Visually the unit appears to be slightly damaged and operates very loud and is in poor condition and it was noted by staff that water enters the building around the fan.
- ⊕ No fresh air intake louver exists in Battery room.
- ⊕ Battery room requires a minimum of 4 continuous air changes per hour (approximately 200 CFM). Additional ventilation should be provided dependent on potential level of hydrogen generation.
- ⊕ Washroom exhaust fan is 12" roof mounted exhaust fan of unknown make and model. System was not functioning at the time of the site visit and is in suspect condition.
- ⊕ Kitchen exhaust fan is a 12" wall mounted exhaust fan of unknown make and model. System was not functioning at the time of the site visit and is at the end of its useful life. Currently the inside of the building has tuck tape ceiling fan off as it was noted by staff that water enters the building around the fan opening.
- ⊕ The control room, exhaust fan is a 12" roof mounted exhaust fan of unknown make or model. Visually the unit appears to be dented and damaged and in suspect condition. This exhaust fan ducting is terminated above the ceiling space. The fan was not operational during the site visit.



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IT IS RECOMMENDED THAT:

1. Provide battery room fresh air louver – **Priority 3**
2. Replace battery room exhaust fan – **Priority 3**
3. Replace kitchen exhaust fan – **Priority 3**
4. Replace washroom exhaust fan – **Priority 3**
5. Replace control room exhaust fan – **Priority 3**

8.3.6 D3090 HVAC Systems & Equipment

- ⊕ Not applicable.

8.4 D40 Fire Protection

8.4.1 D4010 Fire Extinguishers

- ⊕ Two (2) ABC type (Dry Chemical) and two (2) CO₂ (Carbon Dioxide) fire extinguishers were located around the Facility. Size, age and condition of extinguishers varied.
- ⊕ All fire extinguishers were fully charged and had valid monthly inspection tags.

IT IS RECOMMENDED THAT:

1. Inspect fire extinguishers on an annual basis – **Priority 1**

8.4.2 D4020 Automatic Sprinklers

- ⊕ Not applicable.

8.5 D50 Electrical

8.5.1 D5010 Electrical Service & Distribution

Main Service Equipment

- ⊕ Terminal station power is a 120/280V, 3 Phase, 400A service fed underground from the north side of the building to the station electrical room to a wall mounted new ASCO automatic transfer switch. There is also a 120VDC rectification, battery, and distribution system throughout the station, which is used for the station emergency VDC systems. The transfer switch is connected to a 225A main breaker Federal Pioneer distribution panelboard A1 which is connected to electric heater, compressor, branch circuit panelboards B1, C1, D1 and other larger station loads. Most of the distribution equipment was Federal Pioneer. Electrical service and distribution equipment has a typical service life of approximately forty years and although a few disconnects and VDC panelboards appeared relatively new, and it is expected that most of the equipment is nearing the end of its design life and a replacement of some of the older equipment should be considered. Periodic testing and maintenance should be conducted on the older equipment to ensure safe and proper operation of the equipment until they are replaced.
- ⊕ Hydrogen from batteries in battery room discharged via exhaust fan on time clock. Conditions of batteries monitored through Argus battery distribution system and Primax rectifiers. Batteries and the battery rack appeared to be in good serviceable condition.
- ⊕ Not sufficient clear working space in front of rectification equipment. A clear working space of 1m is to be provided in accordance with CSA 22.1-12 article 2-308.
- ⊕ At the time of the audit, work was being conducted on the VAC and VDC electrical distribution systems so access into the station service room and to the associated panelboards was limited.
- ⊕ While on site the electrical distribution system was discussed with a contractor who was installing a new pony panel off of panelboard D1. The contractor indicated



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there was an unbalanced phase coming off the 12kV service transformer and that the phase was measured at approximately 200V. This unbalanced leg is for the most part unusable due to its variance from 120V and is well outside the acceptable voltage variance limits. Furthermore, the unbalanced leg also has required that several panels to be installed to accommodate the buildings various branch circuits. 12kV transformer coil should be investigated.

Panelboards

- ⊕ Panelboards A1, B1, C1, E1, the communications room panelboard as well as the two 120 VDC panelboards are all Federal Pioneer panelboards. Federal Pioneer panel boards are becoming increasingly difficult to source replacement parts and circuit breakers for. Replacement of this panel board should be considered in an effort to avoid potential maintenance issues in the future.
- ⊕ The latching mechanism on the cover of panelboard A1 was broken and should be replaced.
- ⊕ Filler plates missing from panels A1, B1, E1 and communications room panelboard.
- ⊕ Panelboards B1, C1 and E1 had door hinges retrofitted to the covers for easy access to the panelboard bus bars which is unsafe and modifies the panelboard enclosure voiding its certification listing.
- ⊕ Branch circuit breakers connected to the 120VDC systems, exit signs, and CCTV systems should be painted red and provided with lock on devices so they are not inadvertently turned off.

Wiring Devices

- ⊕ It was noted that some of the receptacles along the kitchen counters and the washroom should be replaced with ground fault circuit interrupting (GFCI) receptacles as they are within 1500mm from sinks (Reference CSA C22.112, Article 26-700 (11)).
- ⊕ There appeared to be a sufficient quantity of receptacles throughout the building, although several faceplates and receptacles were broken or damaged and should be replaced with new. Stainless steel faceplates should be considered for durability.
- ⊕ Several electrical junction boxes were missing covers in the accessible ceiling space.
- ⊕ Disconnect for outdoor motor starter was starting to corrode. Should consider replacing with a NEMA 4x rated motor starter.
- ⊕ All exterior receptacle covers and receptacles should be replaced with waterproof, gasketed while in use covers in accordance with CSA 22.1-12 article 26-702.
- ⊕ Exhaust fan in the lunch room is not operational and the manual motor switch on the east wall should be replaced.
- ⊕ A proper floor box should be installed below the station work desk for power and communications to mitigate accidentally ripping out cords.

Wiring Systems

- ⊕ In the RF shield penetration closet there is a ground conductor which is complete with lug connector but was not connected to the RF shield ground bus. RF shield ground loop should be verified.
- ⊕ Wiring is a RW90 copper conductor in electrical metallic tubing (EMT), PVC, and flexible interlocked armor (AC90) and in some places Teck 90 cabling was used for branch circuit wiring. Communications cabling was in PVC conduit or free air. Low voltage cabling for network cameras is run in conduit.
- ⊕ Power cabling is run in free air in floor trenches in the electrical room.



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- ⊕ It did not appear that the cable tray running into the communications room and through the electrical room was properly bonded. Bonding of the cable tray should be completed in accordance with CSA 22.1-12 Article 12-2208.
- ⊕ Conduit run in the north west corner of the compressor room was not securely fastened to elbow.
- ⊕ 4" PVC conduit penetrating through west exterior façade of building does not appear to be sealed.
- ⊕ In the compressor room a run of armored cable is unraveling and not making a secure connection with electrical box.

IT IS RECOMMENDED THAT:

1. Unbalanced phase be investigated and action be taken to properly balance all three phases to provide a safe and stable electrical distribution - **Priority 1**
2. Equipment located around the rectifiers is to be moved to ensure that the required 1 m of clear working space is provided around the equipment and is maintained - **Priority 1**
3. Replace all Federal Pioneer panelboards and all associated branch circuit breakers with new - **Priority 2**
4. Replace the latching mechanism on panelboard A1- **Priority 1**
5. Provide new panelboard covers for panelboards B1, C1 and E1 - **Priority 1**
6. Install circuit breaker filler plates in the communications room panelboard as well as panelboards A1, B1, and E1 - **Priority 1**
7. Paint critical system circuit breakers red and provide lock on circuit breaker devices - **Priority 3**
8. Install GFCI protected receptacle around kitchen sink and washroom - **Priority 1**
9. Replace broken, damaged, and missing receptacle faceplates throughout the building with new stainless steel faceplates - **Priority 2**
10. Missing corroded rooftop manual starter with new NEMA 4x rated manual starter- **Priority 1**
11. Waterproof while-in-use receptacle covers be installed on all exterior GFCI receptacles,- **Priority 1**
12. Replace manual motor switch timer for lunch room exhaust fan - **Priority 2**
13. Proper floor box be installed below the control room work desk - **Priority 3**
14. Verify ground continuity of RF shield and all associated systems - **Priority 1**
15. Bonding of the cable tray should be verified and provided as required - **Priority 1**
16. Securely fasten conduit to associated elbow - **Priority 2**
17. Properly seal electrical conduit penetrating through exterior block wall - **Priority 2**
18. Securely fasten armored cable to electrical box **Priority 2**

8.5.2 D5020 Lighting

Interior Lighting

- ⊕ Lighting in the station was achieved with 4 lamp T12 lensed troffers and 2 lamp T12 lensed wrap luminaires in the communications room and lunch room. There was also several square incandescent VDC downlights and sealed wrap 2 lamp T12 luminaires were located in the battery room. Average lighting levels were approximately 60 fc at the workplane in the control and communications room and approximately 40 fc at the workplane in all other areas, which is sufficient illumination for the space and task.
- ⊕ Several luminaire lenses were broken and should be replaced.
- ⊕ Debris from troffer lenses should be cleaned.



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Exterior Lighting

- ⊕ Wall mounted "Jam-Jar" style incandescent luminaires were located adjacent to exterior doors around the exterior of the building. The two luminaires located adjacent to the west exterior door appear to be nearing the end of their designed life and should be replaced.

Lighting Control

- ⊕ Lighting is controlled by 120V, 15A single pole or three-way toggle style switches. In an effort to increase efficiency and reduce maintenance costs, replacement of the existing single pole toggle switches with wall or ceiling mounted occupancy sensors should be considered in the washroom, electrical room, compressor room and lunch room.
- ⊕ Exterior facade and site lighting is controlled through photocell and Allen Bradley lighting contactor which visually appeared in good condition, but should be checked for correct operation as exterior wall packs were 'on' during the audit.

Emergency Lighting

- ⊕ Emergency lighting is achieved through the VDC luminaires located throughout the facility, as well as one plug in style emergency lighting unit located in the south corridor between the communications and electrical room. This unit was tested at the time of review and was found to be non-operational. This unit should be repaired or replaced with a functional unit.
- ⊕ The Cutler Hammer emergency lighting contactor located in the electrical room appeared to be in good working order; however, when the system was tested, the down lights were not operational. This system should be fixed and periodic testing should be completed to ensure proper operation.

Exit Signs

- ⊕ Existing exit sign located at the east end of the control room is an incandescent type, ceiling mounted with backlit red lettering. The age of the exit sign is unknown; however, it appears to be nearing the end of its serviceable life. Periodic testing of the exit sign should be completed to ensure proper operation.
- ⊕ Paper exit signs are located over the east lunch room and west control room doors. Replacement of these exit signs with LED backlit exit signs should be considered.

IT IS RECOMMENDED THAT:

1. Replace all T12 fluorescent lamps and magnetic ballast strip luminaires and troffers with new high-efficiency T8 or T5 lamps and electronic ballasts, and replace all incandescent lamps with CFL or LED - **Priority 3**
2. Luminaires that are missing lenses, should have new lenses installed **Priority 2**
3. Clean debris from lenses - **Priority 3**
4. Replace incandescent exterior lighting with LED wallpacks c/w integral button type photocell - **Priority 2**
5. Replace the existing single pole toggle switches with wall or ceiling mounted occupancy sensors in the washroom, electrical room, compressor room and lunch room - **Priority 3**
6. Emergency lighting unit should be repaired or replaced - **Priority 1**
7. Emergency VDC lighting system should be repaired so that all emergency lighting units are functioning properly - **Priority 1**
8. Periodic testing be conducted on the exit signs and emergency lighting units to ensure proper operation - **Priority 1**



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9. An additional exit signs should be installed above the east and west exit doorways –
Priority 3

8.5.3 **D5030 Communications & Security**

Telephone/Data

- ⊕ Communications service for the building is fed underground from the west side of the building with fibre optic cable, to the fibre to copper media converter and set of BIX blocks located on the north wall of the communications room. Telephone outlets are wired from this location with Cat 5e CMR cable run free air. Data outlets are wired from a switch located in the communications room with Cat 5e CMR cable run free air. Communications equipment and wiring appeared to be in good condition.
- ⊕ Communication cabling is run in free air in floor trenches in the communications room, control room, and above the accessible ceiling space elsewhere.

Audio Visual Systems

- ⊕ Not applicable.

Cablevision

- ⊕ Not applicable.

Door Intercom System

- ⊕ Not applicable.

Security Systems

- ⊕ There is no central security system installed in the building, but there is a contact on the communications room door which relays an alarm to Network Services in St. John via the SCADA system when the door is ajar. The door contact was functional at the time of review.

Paging/Sound System

- ⊕ There is an existing site alarm system located on the east side of the exterior building façade which does not appear to be functional. If the site alarm system is deemed to be obsolete it should be removed.

Card Access System

- ⊕ Not applicable.

Closed Circuit Camera System

- ⊕ There are three (3) PELCO exterior rated networkable camera domes located at the south east, south west and north west corners of the building. The cameras are hardwired back to a central CCTV NVR rack mounted in the communications room.
- ⊕ Exterior PVC conduit is not fastened to PVC elbow for camera at southwest corner of building.
- ⊕ Power supplies located in the CCTV cabinet are currently powered from an extension cord plugged into a general purpose receptacle. CCTV power should be hardwired.

Fire Alarm and Detection

- ⊕ Fire alarm system consists of one 9VDC local smoke alarm located in the corridor outside the lunch room. Although not required by code, it is recommended that a fire alarm system or fire alarm devices be installed which is capable of communicating alarms locally via audible notification and also through the existing SCADA or other networked system to a central receiving station.

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IT IS RECOMMENDED THAT:

1. Verify if existing site alarm system is operational and if determined to be obsolete, remove all existing conduit and wiring back to source - **Priority 3**
2. Securely fasten conduit to associated elbow - **Priority 2**
3. Hardwire CCTV head end equipment **Priority 2**
4. Install a fire alarm system or fire alarm device which is capable of communicating alarms locally via audible notification and also through the existing SCADA or other networked system to a central receiving station - **Priority 2**

Reference Review:

For the purpose of this investigation, the following building codes and standards were reviewed:

- ⊕ NBCC: National Building Code of Canada (2010);
- ⊕ CEC: Canadian Electrical Code; CSA C22.1-12;
- ⊕ Inspection and Testing of Fire Alarm Systems; CSA/ULC-S536-04
- ⊕ IES Lighting Handbook 10th Edition(2010)

The scope of this investigation did not cover a detailed analysis of concealed cabling, cabling terminations or fire alarm system verification.

9 E EQUIPMENT & FURNISHINGS

9.1 E10 Equipment

- 9.1.1 **E1010 Commercial Equipment**
⊕ Not applicable.
- 9.1.2 **E1020 Institutional Equipment**
⊕ Not applicable.
- 9.1.3 **E1030 Vehicular Equipment**
⊕ Not applicable.
- 9.1.4 **E1090 Other Equipment**
⊕ Not applicable.

9.2 E20 Furnishings

- 9.2.1 **E2010 Fixed Furnishings**
⊕ Not applicable.
- 9.2.2 **E2020 Movable Furnishings**
⊕ Not applicable.

10 F SPECIAL CONSTRUCTION & DEMOLITION

10.1 F10 Special Construction

- 10.1.1 **F1010 Special Structures**
⊕ Not applicable.
- 10.1.2 **F1020 Integrated Construction**
⊕ Not applicable.
- 10.1.3 **F1030 Special Construction Systems**
⊕ Not applicable.



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- 10.1.4 **F1040 Special Facilities**
 - ⊗ Not applicable.
- 10.1.5 **F1050 Special Controls and Instrumentation**
 - ⊗ Not applicable.

11 G BUILDING SITE WORK

11.1 G10 Site Preparation

- 11.1.1 **G1010 Site Cleaning**
 - ⊗ Not applicable.
- 11.1.2 **G1020 Site Demolition and Relocation**
 - ⊗ Not applicable.
- 11.1.3 **G1030 Site Earthwork**
 - ⊗ Not applicable.

11.2 G20 Site Improvements

- 11.2.1 **G2010 Roadways**
 - ⊗ Not applicable.
- 11.2.2 **G2020 Parking Lots**
 - ⊗ Not applicable.
- 11.2.3 **G2030 Pedestrian Walkways**
 - ⊗ Not applicable.
- 11.2.4 **G2040 Site Development (Fencing)**
 - ⊗ Not applicable.
- 11.2.5 **G2050 Landscaping**
 - Grass**
 - ⊗ Not applicable.

11.3 G40 Site Electrical Utilities

- 11.3.1 **G4010 Electrical Distribution**
 - ⊗ Not applicable.
- 11.3.2 **G4090 Other Site Electrical Utilities**
 - ⊗ Not applicable.

11.4 G90 Other Site Construction

- 11.4.1 **G9010 Service and Pedestrian Tunnels**
 - ⊗ Not applicable.
- 11.4.2 **G9090 Other Site Systems & Equipment**
 - ⊗ Not applicable.



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12 PLANNING

12.1 Barrier Free Design

- ⊕ As this facility is used for maintenance personnel requiring good physical mobility, barrier free design was not considered applicable, nor is it required by NBCC.

13 LIFE SAFETY CODE ANALYSIS

- ⊕ Facility meets current code for Life Safety.

14 FIRE AND LIFE SAFETY DEFICIENCIES

14.1 Structural Resistance to Fire

- ⊕ Not applicable.

14.2 Fire & Smoke Barriers

- ⊕ Fire and smoke separation appear in place around battery storage room.

14.3 Basic Detection and Alarm Application

- ⊕ See Electrical.

14.4 Automatic Fire Suppression

- ⊕ Not applicable.

14.5 Water Supplies

- ⊕ See Mechanical.

14.6 Fire Department

- ⊕ Not applicable.

14.7 Operation and Maintenance

- ⊕ Not applicable.

14.8 Emergency Lighting

- ⊕ See Electrical.

14.9 Egress

- ⊕ Adequate per NFPA and NBCC requirements.
- ⊕ Travel distances to exits meet current National Building Code of Canada requirements, which are more stringent than NFPA.



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15 TABLE OF PROBABLE COSTS

Recommendation / Deficiency	Priority 1 Opinion of Probable Cost	Priority 2 Opinion of Probable Cost	Priority 3 Opinion of Probable Cost	
Section 5.1.1.1	\$1,500			
Section 5.1.1.2		\$600		
Section 5.1.2.1	\$450			
Section 5.1.2.2		\$150		
Section 5.1.3.1	\$250			
Section 6.2.1.1	\$1,050			
Section 6.2.1.2	\$450			
Section 6.2.1.3			\$2,600	
Section 6.2.3.1	\$100			
Section 6.2.3.2	\$5,600			
Section 6.2.6.1	\$20,500			
Section 7.1.1.1	\$650			
Section 7.1.1.2	\$400			
Section 7.1.1.3	\$250			
Section 7.1.1.4	\$300			
Section 7.1.2.1		\$1,000		
Section 7.1.2.2	\$250			
Section 7.1.2.3	\$0			
Section 7.3.1.1		\$6,000		
Section 7.3.2.1	\$250			
Section 7.3.2.2	\$1,650			
Section 7.3.2.3	\$350			
Section 7.3.2.4		\$7,200		
Section 7.3.2.5		\$250		
Section 7.3.3.1		\$1,500		
Section 7.3.3.2		\$500		
Section 8.2.2.1			\$1,000	
Section 8.2.2.2			\$1,000	
Section 8.2.2.3			\$3,000	
Section 8.2.3.1			\$3,000	
Section 8.2.3.2			\$8,000	
Section 8.2.3.3			\$3,000	



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Section 8.2.3.4			\$3,000	
Section 8.2.4.1	\$500			
Section 8.3.2.1			\$2,000	
Section 8.3.2.2			\$2,000	
Section 8.3.2.3			\$2,000	
Section 8.3.3.1			\$500	
Section 8.3.3.2		\$10,000		
Section 8.3.5.1			\$3,000	
Section 8.3.5.2			\$3,000	
Section 8.3.5.3			\$2,000	
Section 8.3.5.4			\$2,000	
Section 8.3.5.5			\$2,000	
Section 8.4.1.1	\$500			
Section 8.5.1.1	\$10,000			
Section 8.5.1.2	\$50			
Section 8.5.1.3		\$15,000		
Section 8.5.1.4	\$350			
Section 8.5.1.5	\$750			
Section 8.5.1.6	\$500			
Section 8.5.1.7			\$100	
Section 8.5.1.8	\$200			
Section 8.5.1.9		\$250		
Section 8.5.1.10	\$350			
Section 8.5.1.11	\$250			
Section 8.5.1.12		\$300		
Section 8.5.1.13			\$1,000	
Section 8.5.1.14	\$500			
Section 8.5.1.15	\$250			
Section 8.5.1.16		\$50		
Section 8.5.1.17		\$150		
Section 8.5.1.18		\$100		
Section 8.5.2.1			\$3,000	
Section 8.5.2.2		\$100		
Section 8.5.2.3			\$150	
Section 8.5.2.4		\$750		
Section 8.5.2.5			\$650	



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Section 8.5.2.6	\$100			
Section 8.5.2.7	\$250			
Section 8.5.2.8	\$100			
Section 8.5.2.9			\$600	
Section 8.5.3.1			\$150	
Section 8.5.3.2		\$50		
Section 8.5.3.3		\$350		
Section 8.5.3.4		\$1,500		
TOTAL	\$48,650	\$45,800	\$48,750	\$143,200
Contingency 30%				\$42,960
Total				\$186,160

16 USE OF REPORT

This report is prepared for the exclusive use of Newfoundland and Labrador Hydro for the expressed purpose of preparing a summary condition report for the identified property. This report should not be considered transferable, and should not be relied upon for any other purpose.

The service provided for this project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time and similar locality. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. We reserve the right to revise or amend our opinion in this report in the event new information, documentation, or evidence becomes available.

Sincerely,



Coles Associates Ltd.
Per: Douglas A. Coles, P.Eng., P.E., F.E.C.
Vice President



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Appendix A

Photographs



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December 23, 2014



Photo: Section 5.1.1.1.a



Photo: Section 5.1.1.1.b



Photo: Section 5.1.1.2



Photo: Section 5.1.2.1



Photo: Section 5.1.2.2



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Photo: Section 7.3.3.1.c

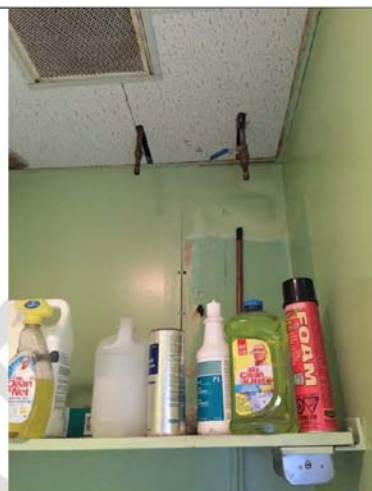


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Photo: Section 8.2.3.4



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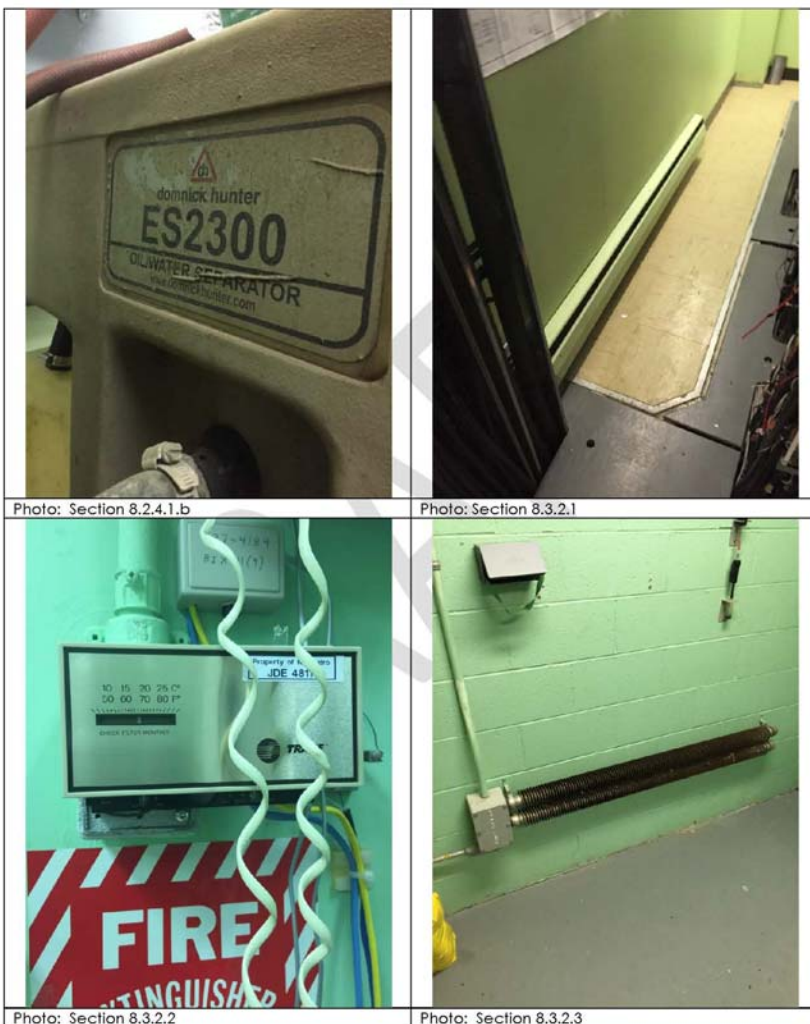


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Photo: Section 8.3.3.1 and 8.3.3.2.a



Photo: Section 8.3.3.2.b



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Photo: Section 8.3.5.3.a



Photo: Section 8.3.5.3.b



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Photo: Section 8.5.1.16



Photo: Section 8.5.1.17

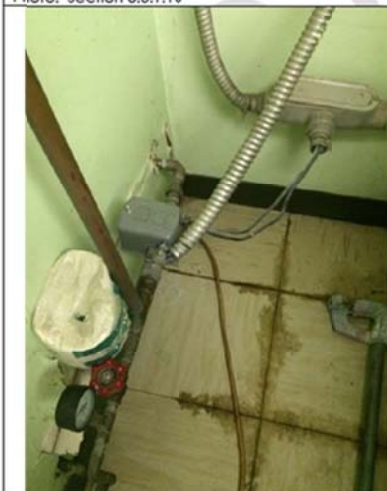


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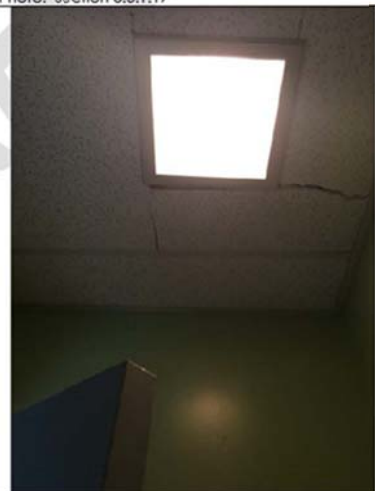


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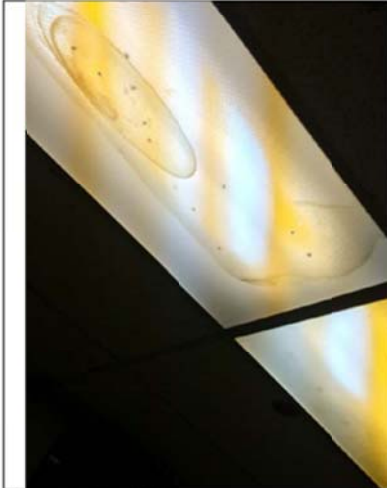


Photo: Section 8.5.2.3



Photo: Section 8.5.2.4.a



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Appendix B

Existing Floor Plans



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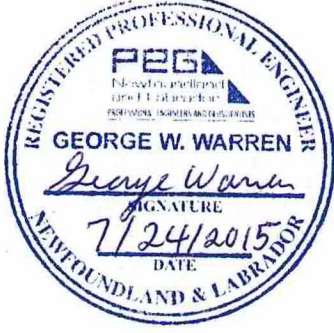
Schedules

Upgrade Office Facilities and Control Buildings - VAR - Schedule 2016

Priority List	Location	Assessment Complete	2016	2017	2018	2019	2020	2021	2022	2023	2024
Ranking*	Area/Regional Offices										
1	Bishop's Falls Service Bldg	Yes	Engl / Const.	Construction							
1	Port Saunders, NL	Yes	Engl / Const.	Construction							
2	Bishop Falls Facility	No	assessment	-	Engl / Const.	Construction					
2	Whitburn Facility	No	assessment	-	Engl / Const.	Construction					
3	Stephenville	No		assessment	-	Engl / Const.	Construction				
3	St. Anthony	No		assessment	-	Engl / Const.	Construction				
4	Deer Lake	No			assessment	-	Engl / Const.	Construction			
4	Baie Verte	No			assessment	-	Engl / Const.	Construction			
5	Happy Valley Goose-Bay	No				assessment	-	Engl / Const.	Construction		
5	Wabush	No				assessment	-	Engl / Const.	Construction		
6	Ramea	No					assessment	-	Engl / Const.	Construction	
Ranking*	230kV Control Building										
1	Sunnyside TS	Yes	Engl / Const.	Construction							
2	Oxen Pond TS	Yes		Engl / Const.	Construction						
3	Massey Drive	Yes			Engl / Const.	Construction					
3	Stephenville	Yes			Engl / Const.	Construction					
4	Holyrood TS	Yes				Engl / Const.	Construction				
4	Come by Chance TS	Yes				Engl / Const.	Construction				
5	Buchans TS	Yes					Engl / Const.	Construction			
5	Bay D'Espoir TS	Yes					Engl / Const.	Construction			
5	Stoney Brook TS	Yes					Engl / Const.	Construction			
6	Grand Falls TS	Yes						Engl / Const.	Construction		
7	Hardwoods TS	Yes							Engl / Const.	Construction	
7	Western Avalon TS	Yes							Engl / Const.	Construction	
7	Deer Lake TS	Yes							Engl / Const.	Construction	
Ranking*	138kV Building										
1	Bottom Waters	Yes									
1	Doyles	No	assessment	-	-	Engl / Const.	Construction				
1	Grandy Brook	No	assessment	-	-	Engl / Const.	Construction				
1	Howley	No	assessment	-	-	-	Engl / Const.	Construction			
1	Springdale	No	assessment	-	-	-	Engl / Const.	Construction			
2	Plum Point	No		assessment	-	-	-	Engl / Const.	Construction		
2	Bear Cove	No		assessment	-	-	-	Engl / Const.	Construction		
2	Peter's Barren	No		assessment	-	-	-	-	Engl / Const.	Construction	
2	Berry Hill	No		assessment	-	-	-	-	Engl / Const.	Construction	
2	Happy Valley	No			assessment	-	-	-	-	Engl / Const.	Construction
2	St. Anthony Airport	No			assessment	-	-	-	-	Engl / Const.	Construction
	Indian River	Not required									
Ranking*	69kV Building										
2	St. Anthony Diesel Plant	No			assessment	-	-	-	-	Engl / Const.	Construction

Assessment will be completed to include all buildings at each location
 - Assessments will not be back during the budget proposal process to estimate the budget required (Budgets between January-April)
 Engl / Const. Engineering will be completed where required and Construction will be completed for items NOT requiring engineering
 Construction Construction to continue all Engineering required should be completed in previous year
 * Throughout the life span of this programs priority to locations may change to accommodation the need of TRO and to correct areas which require immediate work

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

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

Automated Meter Reading - Labrador West

July 2015

SUMMARY

This proposal is for the installation of an Automated Meter Reading (AMR) system for the Labrador West service area to automatically collect and transfer revenue metering from each customer location. It is to replace a system based on travelling to each customer location and is part of an ongoing program to install AMR systems for all service areas. Other AMR systems have already been successfully installed and used for other Hydro service areas. This proposed system is of a current technology design by the same manufacturer and is fully compatible with the existing installed AMR systems.

AMR system installations are prioritized based on meter reader retirements and/or in order to maintain current meter reader workloads. As such, the meter reader working this area is retiring and this capital budget proposal is based on installing AMR in the service area of Labrador City West.

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1 INTRODUCTION

Hydro provides electrical service to 31 geographic service areas that are connected to the Island Interconnected System and to 21 isolated service areas served by diesel generation as well as Happy Valley/Goose Bay and Wabush/Lab City.

In 2003-2004, Hydro initiated a pilot program for automated customer meter reading (AMR) in St. Brendan's. This pilot program proved successful and Hydro extended the program to other service areas. To date, Hydro has implemented AMR in 17 service areas including the majority of the Wabush service area. An automated meter reading system provides the capability to report a customer's power usage without requiring a meter reader to visit the meter location to record the reading. Each customer's meter contains a transmitter that reports the meter reading. The meter readings are transmitted from each meter to a collector located at a local substation over the distribution power lines using power line carrier communications. These readings are then forwarded to a server in St. John's.

2 PROJECT DESCRIPTION

This project is required to implement AMR in the Labrador City area. This capital budget proposal is based on the service area of Labrador City. This project is a continuation in the deployment of AMR approved in Hydro's 2007, through to 2015 Capital Budget Applications.

In the Labrador City service area, AMR functionality is being implemented for a total of 2,600 customers. This total includes 2,300 residential and 300 commercial customers. There are a total of four feeders included on which this system will be implemented.

The work includes:

- (i) replacement of existing customer meters with AMR equipped meters;
- (ii) installation of data collectors and associated hardware in the substations;
- (iii) communications to the AMR server located in St. John's; and,
- (iv) configuring computer systems to receive the additional AMR meter readings and billing for each customer.

3 JUSTIFICATION

This project is justified on the results of a cost-benefit analysis which shows that the new AMR system has economic benefit over the existing system through a reduction in controllable costs.

The new system also provides improvements in customer service through the following:

- Improvements in meter reading accuracy;
- Estimated readings will be reduced or eliminated;
- More detailed energy usage information will be available to help customers track their consumption patterns; and
- More flexible billing options will be available to customers such as consolidated bills and customer selected billing dates.

In addition to the above, implementation of AMR will enhance safety by reducing employee risk exposure at customers premises¹ and will provide a benefit to the environment as a result of less vehicle usage.

Hydro requests that it be granted the right to change the location of the deployment of AMR to a different area, if the meter reader retirement does not occur at the expected time, and if the cost benefit analysis confirms it is the appropriate solution at this time. The new AMR location would be for a location where a meter reader is retiring.

3.1 Existing System

The current meter reading system used in the Labrador City service area is the Radix System. This system involves the following process for reading meters:

- Meter Route information is transferred from the Customer Information/Billing System to the Radix System and then loaded into a handheld device for use by the meter reader;

¹ Known risks are slips, trips and falls due to ice, snow, dog bites, etc.

- A Meter Reader visits each customer's meter and manually enters the meter reading into the handheld device;
- After the meter readings have been taken, the handheld device is connected to a local computer and the readings are transferred to the Radix System; and
- The meter readings are transferred from the Radix System to the Customer Information / billing System at head office in St. John's.

The AMR system proposed to be deployed is Landis + Gyr's Gridstream PLEX System. The PLEX System is a two-way power line carrier based communications system where data is transferred to and from a customer's meter to a data collector located in a terminal station using the existing distribution lines to carry the digital data signals. A two way system allows for remote updates and other advanced features.

Under previously approved capital projects, AMR has been implemented in the customer services areas of Bay d'Espoir, Change Islands, Conne River, Cow Head, Daniel's Harbour, Fogo, Gaultois, Hawke's Bay (excluding Port au Choix), Parsons Pond, St. Anthony and Wabush (excluding the industrial park), Rocky Harbour, Bear Cove, Glenburnie, Sallys Cove and Wiltondale, as well as the pilot project conducted in St. Brendan's in 2003-2004. The AMR systems installed at these sites were the Landis and Gyr TS1 system. The TS1 system is a one way communications, power line carrier system. The TS1 system has been discontinued and is no longer currently in production by the manufacturer. The TS1 system has been superseded by the manufacturer by the PLEX system. Under a currently approved 2015-2016 budget, the PLEX system shall be installed in the Barachoix and English Harbour West service areas.

3.2 Operating Experience

The AMR system will replace (i) manual handheld devices used to collect meter readings at each customer's site; (ii) supporting infrastructure (computers and modems) used to retrieve the data; and, (iii) a requirement for personnel to travel to each customer location

to read meters. Previous AMR projects have been completed by Hydro in a number of other the service areas. The AMR system being implemented is the current generation (PLEX) of the AMR product family from the same manufacturer, Landis and Gyr, which we have installed in all past projects. The AMR equipment has proven to be reliable and accurate.

3.2.1 Industry Experience

Landis and Gyr have been in the utility AMR business since the introduction of their TS1 System in 1995.

The PLEX AMR system was introduced January 2013 and is currently in use by over 35 North American utilities. The PLEX system builds upon Landis and Gyr industry experience and features a two way communications with many new and improved features. Some of the PLEX system improvements over the old TS1 system include fast 15 minute data packet transmit intervals, statistical data on power line quality at the end points, customer outage information, meter tampering notification and remote customer disconnect options among many other improvements.

There are currently over 400 utility customers using various models of Landis and Gyr AMR equipment with over four million endpoints deployed.

3.2.2 Vendor Recommendations

Landis + Gyr's estimated life expectancy for the data collectors used in the AMR system, which are located in terminal stations to capture meter readings, is 15 years. This time period has been used for completing the cost-benefit analysis (see Section 3.4.2).

For the Radix system, Radix's expectations are that the handheld models average about 18 months or 500 charges on a set of batteries before requiring return to the factory for replacement. The devices are supported for a period of seven to nine years.

3.2.3 Maintenance or Support Arrangements

Hydro has a maintenance agreement in place with Radix Micro Devices for the Radix system that covers software support, maintenance and repair services on equipment.

Hydro has a maintenance agreement in place with Landis + Gyr for the AMR System. The

annual cost of the support agreement for 2015 was \$13,704. The maintenance agreement includes software and hardware support, software updates from Landis + Gyr and full replacement of any defective endpoint integrated into the meters to provide AMR functionality.

3.2.4 Maintenance History

The five-year service agreement history for the installed *AMR* is shown in Table 1 below.

Table 1: Five-Year AMR Service Agreement History

Year	Total (\$000)
2015	13.7
2014	13.2
2013	12.4
2012	12.1
2011	10.0

There is no maintenance history for the AMR system as the first service areas became operational in 2008.

3.2.5 Historical Information

This is a recurring project started in 2007. A list of projects is provided in Table 2.

Table 2: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)	Comments	Number of Permanent Meter Reader Positions
2014-2015	697.1				In progress	
2013-2014	810.4	743.7	2064	0.36	Completed	13
2012-2013	578.1	593.7	1800	0.33	Completed	14
2011-2012	350.5	348.8	1400	0.25	Completed	15
2009-2010	490.5	390.7	1861	0.21	Completed	16
2008	606.0	598.0	1775	0.34	Completed	17

3.2.6 Anticipated Useful Life

The handheld units for the Radix system have an observed service life of five years.

Handheld units are not used with the AMR System. Endpoints do not change the useful life of the system and will last the life of the meter. The AMR collectors and associated support equipment have an anticipated life expectancy of 15 years.

3.3 Development of Alternatives

Two alternatives were considered:

- Alternative 1: Maintain the existing Radix system; and
- Alternative 2: Deploy Landis + Gyr's PLEX AMR System.

3.4 Evaluation of Alternatives

Alternative 1 is labour intensive and meter reading costs will continue to increase over time.

Alternative 2 has been selected by Hydro for the following reasons:

- The cost-benefit analysis shows that this alternative results in lower meter reading costs and a savings to Hydro as detailed in the Economic Analysis, Section 3.4.2 of this report.
- Improvements in meter reading accuracy.

- There is a future opportunity for Hydro's customers to have available more detailed energy usage statistics.
- There is a future opportunity for reporting of line quality and analytics from all endpoints.
- There is a future opportunity for Hydro for remote service disconnects and reconnects, avoiding the need for deploying an employee to complete a disconnect.

3.4.1 Energy Efficiency Benefits

There are no direct energy efficiency benefits that can be attributed to implementation of AMR. However, the capability to provide more detailed energy usage statistics enables customers to track consumption patterns. This helps promote energy efficiency.

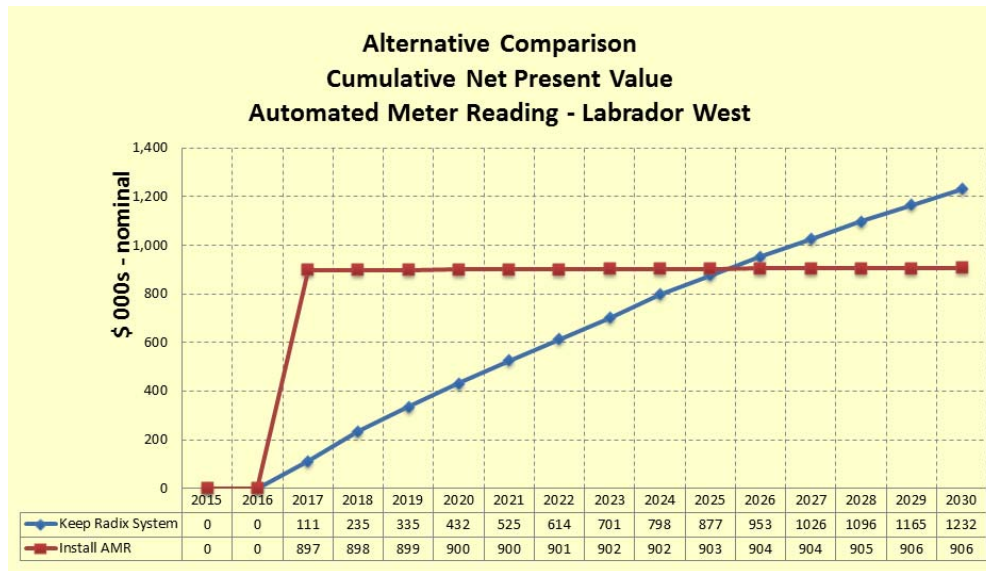
3.4.2 Economic Analysis

For the Labrador City service area, the cumulative net present worth analysis of AMR and the current system has a positive net present value starting in 2025 (9 years) and total savings of \$ 325,892 by 2030. The savings result primarily from the reduction in labour costs in not requiring meter readers to visit each customer's site to read their meter. The cumulative net present value comparison results between the two alternatives are shown in Table 3.

Table 3: Cumulative Net Present Value Comparison

Automated Meter Reading - Labrador West		
Alternative Comparison Cumulative Net Present Value To The Year 2015		
Alternatives	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
Install AMR	906,028	0
Keep Radix System	1,231,920	325,892

The cumulative net present value comparison between the two alternatives is shown in graphic form in Table 4.

Table 4: Cumulative Net Present Value Comparison Graphs

4 CONCLUSION

Implementation of Landis + Gyr's PLEX AMR System is the chosen alternative as determined from a cost benefit analysis.

4.1 Budget Estimate

The project budget estimate is shown in Table 5.

Table 5: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	272.8	225.0	0.0	497.8
Labour	87.4	87.4	0.0	174.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	36.2	0.0	0.0	36.2
Other Direct Costs	10.1	6.9	0.0	17.0
Interest and Escalation	27.4	68.9	0.0	96.3
Contingency	0.0	145.2	0.0	145.2
TOTAL	433.8	533.4	0.0	967.2

4.2 Project Schedule

The anticipated project schedule is shown in Table 6.

Table 6: Project Schedule

Activity		Start Date	End Date
Planning	Approval of Design Transmittal	January 2016	March 2016
Design	Meters Tendered	March 2016	April 2016
Procurement	AMR Equipment ordered	April 2016	April 2016
	Terminal Station Equipment Ordered	April 2016	April 2016
Construction	Install meter end points	May 2016	May 2016
	Terminal station Equipment Received	June 2016	June 2016
	Meters Received	June 2016	June 2016
Commissioning	Terminal station equipment installation	June 2016	August 2017
	Meter installation	Sept. 2016	June 2017
	In service	June 2017	December 2017
Closeout	Project completion and closeout	December 2017	December 2017

Line Depot Condition Assessment and Refurbishment Strategy

2016



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APPENDIX A A1

1 INTRODUCTION

This project is the second year of Line Depot Condition Assessment and Refurbishment Strategy, detailed in the report filed with the 2015 Capital Budget Application. Hydro is requesting approval for the year 2016 expenditures, as discussed in the following proposal.

This report outlines the 2016 year of a multiyear program to refurbish Hydro's aging line depot infrastructure out to the year 2023. This program includes continuing detailed assessment, engineering and construction of line depot upgrades and replacements as well as replacements of specific line depot storage ramps and storage sheds which have been identified previously as needing replacement.

1.1 Line Depot Refurbishment Strategy

Hydro has an array of depots and storage buildings used to facilitate transmission line work across all of the operating regions on the island and in Labrador. The scope of this initiative is to manage 25 sites out to the year 2023.

The Line Depot Refurbishment Program provides a structured and phased approach to performing detailed assessments, detailed engineering and refurbishment/rebuild of existing line depot facilities including office buildings, storage buildings and storage ramps. See Appendix A for the 2015 Line Depot Condition Assessment and Refurbishment Program Strategy Report that was filed with the 2015 Capital Budget Application.

The Line Depot refurbishment plan is reviewed annually. When updating the plan, assessment locations are chosen based on the condition of the infrastructure as well as improvements in efficiency by combining adjacent work areas. For example, the line depot and storage ramp in Ramea was originally scheduled for assessment, engineering and construction in 2018 through to 2020, however, it has been determined that the condition of this line depot as well as the ramp is in an advanced deteriorated condition and thus the

Ramea line depot refurbishment has been forwarded in the schedule to 2016 through to 2018.

The current schedule, including level 2 condition assessments, detailed engineering and refurbishments/construction, can be found in Appendix B. A summary of the cost estimate for the next 5 years in the program can be found in Table 1.

2 JUSTIFICATION

There are currently 27 existing sites that have been identified by operations as having aging infrastructure, between 25 and 40 years old, in need of improvement and many sites contain line depot offices as well as storage buildings and pole and transformer storage ramps.

Refurbishments of line depot office and storage buildings as well as storage ramps improve the safety and security of our Hydro employees.

The condition of the depots and storage buildings is such that continued use into the future requires refurbishment. As a result, this project is justified on the requirement to replace deteriorated infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service.

Table 1: Budget Estimate and Forecast for Next 5 Years of Program

Project Cost: (\$ x1,000)	2016	2017	2018	2019	2020
Material Supply	0.0	0.0	0.0	0.0	0.0
Labour	197.9	183.3	214.7	275.6	218.4
Consultant	0.0	0.0	0.0	0.0	0.0
Contract Work	440.0	975.0	1008.0	1040.0	1040.0
Other Direct Costs	35.9	0.0	0.0	0.0	0.0
Interest and Escalation	52.8	107.4	152.9	208.3	241.8
Contingency	134.8	231.7	244.5	263.1	251.7
TOTAL	861.4	1,497.4	1,620.1	1,787.0	1,751.9

2016 Line Depot Refurbishment Projects:

The 2016 Line Depot Refurbishment Project includes the following:

- Level 2 condition assessments for Ramea, Flowers Cove, Roddickton, Gaultois and Hermitage.
- Detailed engineering for Fogo, Change Islands and South East Bight, and
- Refurbishment/construction at Wabush.

Level 2 Condition Assessments

The line depot buildings are between 25 and 40 years old and these locations have been identified by staff as having infrastructure that is in a poor and deteriorated condition thus requiring further detailed assessment. A consultant report will detail code, structural and safety issues within the buildings that are best suited for refurbishment or component replacement. An effort has been made to group assessments together based on geographical region so as to increase the efficiency and lower the cost of the assessments. See Figures 1 below for 2016 assessment locations.

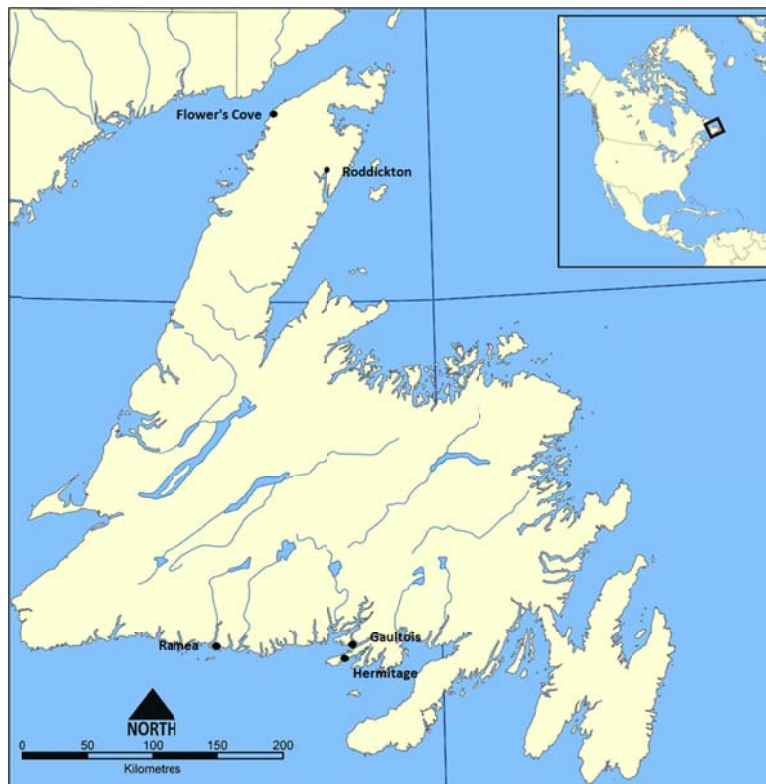


Figure 1: 2016 Assessment locations

Detailed Engineering

Detailed engineering will be completed in 2016 for Fogo, Change Islands and South East Bight line depot facilities. See Figure 2 for detailed engineering locations. Development of specifications and tender documents for these locations is planned for completion in 2016 based on the results of the level 2 condition assessments in 2015 (previously approved as part

of the 2015 Capital Budget Application). The tender specifications will include such items as roof, window and door replacements, heating unit upgrades, electrical code upgrades and safety related work.

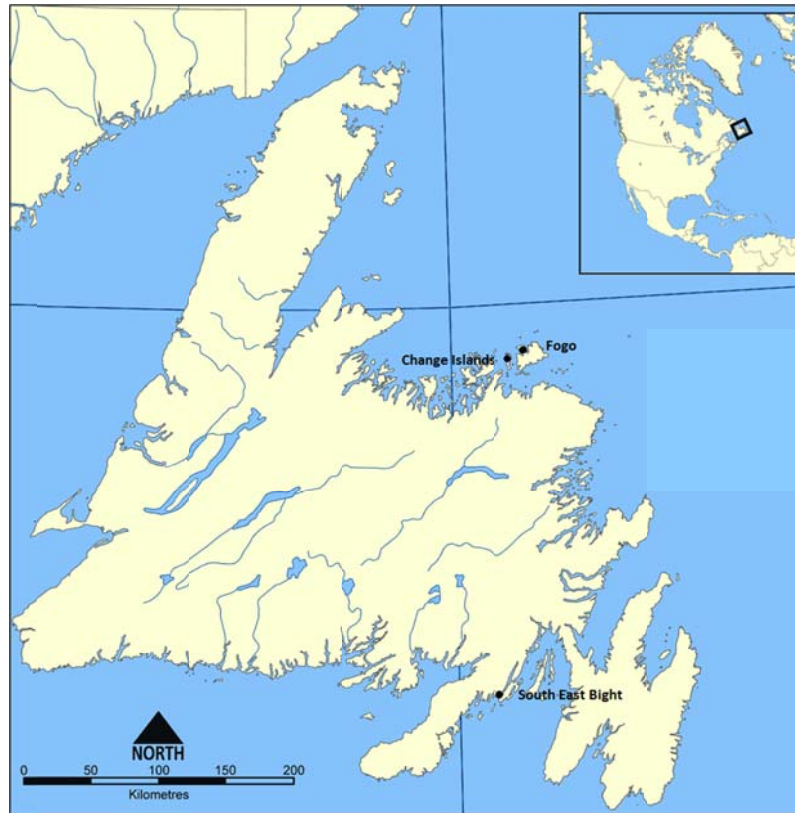


Figure 2: Line Depot locations requiring detailed engineering in 2016

Refurbishments at Wabush Line Depot

A condition assessment was completed in 2014 at the Wabush Line Depot building. See Appendix C for the condition assessment. The recommendations from this assessment include replacement of aluminum windows and doors, replacement of the water service line to the facility, installation of a humidification system as per code to prevent dry air sparking in the work shop, installation of exhaust ventilation in service garages as per code requirements and replacement of electrical panel boards and associated wiring due to age and deteriorated condition. Photos 1, 2, 3, and 4 below show examples of some of the issues outlined in the condition assessment.



Photo 1: New panelboard required



Photo 2: Welding shop heaters in poor condition



Photo 3: Mezzanine is structurally unsafe



Photo 4: Washroom exhaust fan to be properly ducted to outdoors

3 CONCLUSION

Hydro has determined a stepped, strategic approach will provide for continued use of the named facilities. These refurbishments, many of which are safety or code related, will help ensure the safety of Hydro work crews using this facility.

APPENDIX A

2015 Line Depot Condition Assessment and Refurbishment Program Strategy Report

A REPORT TO

THE BOARD OF COMMISSIONERS OF PUBLIC UTILITIES

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

**Line Depot Condition Assessment
and Refurbishment**

Asset Management Strategy Plan 2015

July 2014



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1 INTRODUCTION

This strategy report outlines a plan to refurbish Hydro's aging Transmission Rural Operations (TRO) line depot infrastructure over the next nine years. The program will include detailed assessments, engineering and refurbishment of aging infrastructure including line depot office and storage buildings as well as storage ramps at facilities associated with transmission and distribution line operations.

Having building and storage facilities that are sound, well maintained and functional is key in allowing employees to perform their work safely and efficiently. Hydro's local facilities also form the image of the corporation in many rural communities. Many of Hydro's line depots were constructed in the 1970's and 1980's and have not had detailed assessments or significant upgrades performed since that time.

2 BACKGROUND

2.1 Existing System

Hydro has an array of depots and storage buildings used to facilitate transmission line work across all operating regions on the island and in Labrador. Some buildings are integrated into regional offices, area offices or generation facility sites while others are stand-alone buildings. The scope of this initiative will be to manage the stand-alone sites.

There are currently 21 existing sites that have been identified by operations as having aging infrastructure in need of improvement and many sites contain line depot offices as well as storage buildings and pole and transformer storage ramps. In addition, there are facilities requiring refurbishment that are located in multipurpose yards; for example, a storage building could be located in diesel plant yard. These sites are also included in the list of facilities requiring refurbishment so that the entire line depot infrastructure is captured in this program.

Facilities maintenance crews perform general maintenance work on the buildings in order to keep them operational, however, some of the buildings are in excess of forty years old and many of them have not had significant upgrades since they were built.

The depot office and storage buildings are generally timber construction on either concrete or timber foundations. These depot buildings are in the range of 25-40 years old.

Recommendations from the condition assessments completed for Springdale, Cow Head and Rocky Harbour indicate that many of the windows and doors, as well as heating and cooling units are at the end of their expected life cycle and need replacement (see Figure 1). In addition, the Heating Ventilation Recovery (HRV) systems do not meet code requirements for ventilation and require a new HRV system installed at each depot office. There have been a number of items identified in the assessments as safety issues relating to the electrical system such as incorrectly wired exterior plugs, code deficient panel barriers, overloaded circuits for identified use and lack of Ground fault circuits in wet areas (see Figure 2). There have also been a number of fire safety deficiencies identified including missing fire detectors, illuminated exits signs and emergency light wall packs. These condition assessments have also

Line Depot Condition Assessment and Refurbishment

recommended the replacement of a storage shed (see Figure 3) and storage ramp (see Figure 4) at Springdale since both are dilapidated and unsafe for workers to use. In general, operations personnel have identified that the infrastructure at these three line depots is indicative of other line depot infrastructure of similar age, suggesting a program to refurbish these facilities is in order.



Figure 1: Window has Separated from Frame



Figure 2: Canvas Wire is a Code Violation



Figure 3: Rotten Storage Ramp Deck



Figure 4: Rotten Sill and Siding – Storage Building

Line Depot Condition Assessment and Refurbishment

2.2 Operating Experience

The line depot buildings are used by Hydro personnel as office space, storage space and workshops. These buildings and ramps also provide line workers with a safe and protected area to store, load and prepare materials and equipment used to maintain the integrity of Hydro's transmission lines. During emergency repairs in winter, under adverse weather conditions, working with frozen transmission line materials is difficult for the workers and many times, the weather conditions can be too adverse to assemble materials on site. As such, the line depots provide a sheltered location to repair equipment and keep materials protected from the weather so they do not freeze together. These depots also provide a safe reprieve from the adverse weather that workers are required to be in during emergencies, sometimes for exceptionally long hours. The buildings and ramps need to be structurally sound, secure and safe for Hydro employees.

Line Depot Condition Assessment and Refurbishment

3 IMPLEMENTATION PLAN

This program will introduce a structured and phased approach to performing detailed assessments, detailed engineering and refurbishment/rebuild of existing line depot facilities including office buildings, storage buildings and storage ramps.

Assessments will investigate the condition of electrical, plumbing and HVAC systems, structural condition of buildings (including roofs), compliance with National Building (NBC) and Occupational Health and Safety (OHS) codes, health and safety concerns (including mold and mildew), environmental concerns, energy usage, suitability of washroom and kitchen facilities, storage capacity of buildings and yards as well as the suitability of buildings to accommodate the number of staff and type of work being performed at each location. Assessments will also provide cost estimates that will be used for capital budgeting of refurbishment work to be carried out in subsequent years.

*Line Depot Condition Assessment and Refurbishment***4 APPROACH**

The refurbishments are based on two types of assessments; one is based on planned detailed assessments by a consultant and the other is based on already completed in-house assessments. Typically, the replacements based on in-house assessments relate to storage ramps and storage buildings that are in such a deteriorated state that replacement is the only viable option. In this case, specific ramps and storage buildings have been identified as requiring replacement and no further assessment is required.

Refurbishments based on planned detailed assessments by a consultant generally include line depot offices with a variety of functions where full building replacement is not considered cost effective. Operations has already identified line depots that have components in poor condition and a consultant detailed report will identify code, structural and safety issues within the buildings that are best suited for refurbishment or component replacement.

For each site planned for consultant assessment, the work will be implemented as follows:

- Year 1 – Detailed Consultant Assessment
- Year 2 – Detailed Engineering
- Year 3 – Construction

For each site with an in-house assessment completed, the work will be implemented as follows:

- Year 1- Detailed Engineering
- Year 2 - Construction

Assessments of three line depot yards were completed in 2013 by operations and the reports can be found in Appendix A. Refurbishment work was identified in these assessments, including items such as roof, window and door replacements, heating unit upgrades, electrical code upgrades, septic system upgrades and safety work. Refurbishment is planned for completion in 2015 with the engineering work to be completed in 2014. The capital program is

Line Depot Condition Assessment and Refurbishment

planned to begin in 2015 and will consist of concurrent detailed assessments, engineering and refurbishment work with all sites being covered within nine years as outlined in the schedule in Appendix B. Full replacements of storage buildings and ramps based on in-house assessments are included in this program with the schedule as outlined in Appendix C and D respectively.

Line Depot Condition Assessment and Refurbishment

5 BUDGET

Budget estimate for 2015 is presented in Table 1 below.

Table 1: 2015 Budget Estimate				
Project Cost: (\$ x1,000)	2015	2016	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	264.9	0.0	0.0	264.9
Consultant	0.0	0.0	0.0	0.0
Contract Work	427.5	0.0	0.0	427.5
Other Direct Costs	51.7	0.0	0.0	51.7
Interest and Escalation	60.3	0.0	0.0	60.3
Contingency	148.9	0.0	0.0	148.9
TOTAL	953.3	0.0	0.0	953.3

The outlined budget detailed work planned for 2015. It is estimated that the budget each year during the nine year program will be of similar magnitude as the budget for 2015

APPENDIX A
CONDITION ASSESSMENT REPORTS FOR SPRINGDALE, COW HEAD
AND ROCKY HARBOUR LINE DEPOTS

APPENDIX B
NINE YEAR PLAN FOR LINE DEPOTS REFURBISHMENT

LINE DEPOT REFURBISHMENT									
Location	2015	2016	2017	2018	2019	2020	2021	2022	2023
TRO CENTRAL									
Springdale	construction								
Fogo	assessment	engineering	construction						
Change Islands	assessment	engineering	construction						
South East Blight	assessment	engineering	construction						
Bay D'Espoir			assessment	engineering	construction				
Harbour Breton			assessment	engineering	construction				
Hermitage			assessment	engineering	construction				
Ramea			assessment	engineering	construction				
Burgeo			assessment	engineering	construction				
Lapointe			assessment	engineering	construction				
English Harbour West						assessment	engineering	construction	
Rencontre East						assessment	engineering	construction	
Gaultois						assessment	engineering	construction	
Base Verte							assessment	engineering	construction
Sop's Arm							assessment	engineering	construction
TRO NORTHERN									
Rocky Harbour	construction								
Cow Head	construction								
Flowers Cove		assessment	engineering	construction					
Roddickton		assessment	engineering	construction					
Larise Au Loup		assessment	engineering	construction					
Mary's Harbour					assessment	engineering	construction		
Woody Point							assessment	engineering	construction
TRO LABRADOR									
Wabush	engineering	construction							
Cartwright					assessment	engineering	construction		
Happy Valley					assessment	engineering	construction		

APPENDIX C
STORAGE BUILDINGS REPLACEMENT PLAN

CONSTRUCTION OF REPLACEMENT STORAGE BUILDINGS								
TRO CENTRAL	2015	2016	2017	2018	2019	2020	2021	2022
Springdale	construction							
Change Islands		engineering	construction					
South East Blight		engineering	construction					
Ramea					engineering	construction		
TRO NORTHERN								
St. Anthony			engineering	construction				
Charlottetown			engineering	construction				
Mary's Harbour						engineering	construction	
TRO LABRADOR								
Hopedale	engineering	construction						
Makkovik	engineering	construction						

**APPENDIX D
STORAGE RAMPS REPLACEMENT PLAN**

CONSTRUCTION OF REPLACEMENT STORAGE RAMPS									
TRO CENTRAL	2015	2016	2017	2018	2019	2020	2021	2022	2023
Springdale	construction								
Fogo		engineering	construction						
Bay D'Espoir				engineering	construction				
Harbour Breton				engineering					
Ramea					engineering	construction			
TRO NORTHERN									
Roddickton			engineering	construction					
Mary's Harbour						engineering	construction		
Norman Bay						engineering	construction		
TRO LABRADOR									
Wabush	engineering	construction							
Hopedale	engineering	construction							
Makkovik	engineering	construction							
Postville			engineering	construction					
Rigolet			engineering	construction					
Cartwright						engineering	construction		
Black Tickle						engineering	construction		

APPENDIX B

Program Schedule

LINE DEPOT REFURBISHMENT							
Location	2016	2017	2018	2019	2020	2021	2022
TRO CENTRAL							
Springdale							
Fogo	engineering	construction					
Change Islands	engineering	construction					
South East Bight	engineering	construction					
Ramea	assessment	engineering	construction				
Burgeo			assessment	engineering	construction		
Lapointe			assessment	engineering	construction		
Bay D'Espoir		assessment	engineering	construction			
Harbour Breton		assessment	engineering	construction			
Hermitage	assessment	engineering	construction				
English Harbour West					assessment	engineering	construction
Rencontre East					assessment	engineering	construction
Gaultois	assessment	engineering	construction				
Baie Verte				assessment	engineering	construction	
Sop's Arm				assessment	engineering	construction	
TRO NORTHERN							
Rocky Harbour							
Cow Head							
Flowers Cove	assessment	engineering	construction				
Roddickton	assessment	engineering	construction				
Woody Point			assessment	engineering	construction		
Lanse Au Loup				assessment	engineering	construction	
Mary's Harbour				assessment	engineering	construction	
TRO LABRADOR							
Wabush	construction						
Cartwright					assessment	engineering	construction
Happy Valley					assessment	engineering	construction
CONSTRUCTION OF REPLACEMENT STORAGE RAMPS							
TRO CENTRAL	2016	2017	2018	2019	2020	2021	2022
Springdale							
Fogo	engineering	construction					
Ramea		engineering	construction				
Bay D'Espoir			engineering	construction			
Harbour Breton			engineering	construction			
TRO NORTHERN							
Roddickton	assessment	engineering	construction				

APPENDIX C

Wabush Line Depot Level 2 Condition Assessment

Site Condition Assessment
Wabush, NL

December 22, 2014

Site Condition Assessment Wabush, NL

Prepared For:

Newfoundland and Labrador Hydro

Prepared By:



© December 22, 2014

Site Condition Assessment
Wabush, NL

December 22, 2014

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Wabush, NL

December 22, 2014

1 INTRODUCTION

The normal design life of a typical building is in the range of 25 to 30 years. The Office Building at Wabush Line Depot was built in the mid to late 1960's and Newfoundland and Labrador Hydro is looking to determine and evaluate the immediate, short, and long term capital renewal/extension/upgrade requirements that can be expected for this facility over the next 25 years. The intention is to bring all of the support facilities up to the Newfoundland and Labrador Hydro standard. It is anticipated that this site will continue with similar occupancies, staffing levels and activities for the foreseeable future.

The scope of this evaluation was restricted to the facility as illustrated within Appendix A.

Coles Associates was retained to undertake an audit and prepare a report to:

- # Assess the building envelope and systems to identify Priority 1, 2 and 3 (immediate, short and long term) areas where problems are occurring within the building and/or may occur.
- # Make note of any possible Life Safety and/or Code compliant issues that were visible. (Note: a thorough Life Safety, Building and Fire Code analysis was not performed as part of this Building Condition Audit.)
- # Investigate the need for expansion and/or relocation of the facilities in addition to the rehabilitation priorities, and
- # Provide estimates on the costs of all recommendations.

2 EXECUTIVE SUMMARY

In October 2014 a team of consultants reviewed the Office Building at the Wabush Line Depot, located in Wabush, NL. The objective was to undertake a Building Condition/ Rehabilitation/ Relocation/ Expansion Assessment Audit.

In summary, it is the purpose of this study to undertake the following tasks:

- # Establish the current condition of the architectural, structural, mechanical and electrical building components and systems;
- # Assess deficiencies of the building relative to current code and/or indicated usage;
- # Determine the need for either rehabilitation, relocation and/or expansion; and
- # Provide a cost estimate of all recommendations.

There is no mechanism within the National Building Code (NBC) that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change.

While there may be opportunities to increase the energy efficiency and/or functionality of this facility through such changes as internal/external renovation and/or increased insulation in the roof and walls, as well as the windows, given its age, it is anticipated that this decision point will be based upon a financial payback model as is undertaken for most private clients.



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Founders' Hall, 6 Prince Street, Charlottetown, PEI, Canada, Voice (902) 368-2300, Fax (902) 566-3768, www.colesassociates.com
Y:\Projects\2014\142004 Building Assessments, Nalcor\Western NL\Wabush\Reports\Wabush Site Condition Assessment #2.docx

Site Condition Assessment
Wabush, NL

December 22, 2014

Following review there are approximately:

\$ 52,450 of Priority Level #1 work to be undertaken.
\$131,190 of Priority Level #2 work to be undertaken.
\$163,100 of Priority Level #3 work to be undertaken.

All as defined below. To these amounts and as shown in Section 15, a 30% contingency has been added in the amount of \$104,022.

3 METHODOLOGY

3.1 Building Audit

The method of study was by site visit by a team of consultants from Coles Associates. Audit work included tasks to familiarize, visually review, and document the condition of the building.

One visit was made to the facility to conduct interviews with the building management and a walk-through investigation. The building audits were completed by:

Architectural/Structural Robert Haggis, RAIC, AIA, NCARB

Mechanical Sean Wheeler, P.Eng.

Electrical Elliott Coles, P.Eng.

The report was reviewed by Douglas A. Coles, P.Eng., P.E., F.E.C.

3.2 Drawings

Floor plans of the facility were available for the Audit. Floor plans were confirmed, where warranted, from rough measurements taken on site. Site documentation was unavailable.

3.3 Prioritization

The deficiencies/recommendations falling out of these reports and/or walkthrough will be identified indicating three priority levels:

1. **Priority One:** Where immediate attention is required in order to maintain or to re-establish the integrity of a strategic system, process, weather envelope, etc., in order to comply with life safety, Building Code violations and/or those resulting from Orders delivered by the Authority having Jurisdiction (AHJ) to prevent further on-going exposure, damage or deterioration or to remove or lessen a threat to life safety.
2. **Priority Two:** Where systems require attention but present no immediate risk to system integrity or to life safety. The short to intermediate nature of these issues (one to three years) is such as to allow some orderly planning and financial resource development to occur.
3. **Priority Three:** This category identifies intermediate to longer-term issues. In the context of this report and at the heart of the Priority Three issues is the long-term disposition of this facility in total; given the condition of the envelope, the issues of non-compliance with current codes for items such as wall insulation levels; and the implications and costs of its repair.



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3.4 Quality Assessment

Throughout the report references are made to the quality of materials and systems. The following provides a guide to the intent of the grading.

- # Good Suitable for continued use.
- # Serviceable Is able to remain in service with regular maintenance.
- # Marginal Is able to remain in service with heavy maintenance.
- # Suspect Requires further investigation, is not visible though possibly problematic.
- # Poor Requires significant maintenance, repair or replacement.
- # End of useful life Requires replacement. In practical terms, systems tend not to fail all at once. In this instance "outlived its useful life" means that it is time to seriously look at putting a financial plan in place to replace the identified system in the short term.

3.5 National Building Code

The National Building Code (NBC) is a document prepared by the National Research Council of Canada, which historically has been updated every 5 years. It is the purpose of the NBC to establish standards for building construction and systems, the focus of which is occupant safety. It is the underlying intent of the NBC to provide a level of systems and environment within a building, which provide for adequate life safety, environmental conditions (i.e. light levels and air ventilation levels) and mobility (i.e. barrier-free access). While all regulations do not necessarily get more stringent, regulations very often change. In fact, buildings never "catch up" to the state of the current-day Codes.

There is no mechanism in place that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change. At the same time, Authorities Having Jurisdiction have the right to make inspections at their discretion and direct improvements to components and/or systems where they feel life safety is at risk.

In upgrading older buildings, which were not originally designed to incorporate fire ratings or sometimes bulky and space consuming systems, it can be difficult to achieve the letter of the regulation. More often it is the intent to reasonably protect life safety, which is more readily achievable.

Therefore the purpose of the review of the salient requirements of the NBC is to provide a basis of comparison against the current Code requirements and to estimate the capital cost to upgrade the building to these standards.

Specific areas of this report deal with issues that should be undertaken in the short term for reasons of life safety, regardless of the ultimate disposition of the building.

3.6 Standard Classification for Building Elements and Related Site Work – UNIFORMAT II

- # This standard establishes a classification of building elements and related site work,
- # The classification serves as a consistent reference for analysis, evaluation, and monitoring,
- # Referenced documents, E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems,
- # The classification is hierarchical to allow different levels of aggregation and summarization.



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4 BUILDING SUMMARY

The building was originally constructed in the mid to late 1960's. It has undergone multiple renovations and upgrades since, major renovations in 2000 and minor as recent as 2012. The building had originally been constructed for multiple tenants but has since been fully occupied by Nalcor. It is a non-combustible structure composed of lead-bearing block and steel; steel roof trusses, metal siding and roofing. The building appears in good to serviceable condition.

Age	Mid to late 1960's
Location	Wabush, NL
Ownership	Newfoundland and Labrador Hydro

5 A SUBSTRUCTURE

5.1 A10 Foundations

5.1.1 A1010 Standard Foundations

- ✦ Existing drawings provided suggests typical reinforced frost wall construction with concrete spread footings at perimeter of building; good to serviceable condition.
- ✦ Minimal cracking and pitting evident at exposed north east corner. Foam insulation has also been damaged; possible area for frost penetration.
- ✦ Minor cracking evident at garage and man door sills.
- ✦ Major cracking with exposed rebar mesh at garage door sill onto line shop.

IT IS RECOMMENDED THAT:

1. Patch and repair pitted concrete at northeast corner, fix insulation and backfill area – **Priority 2**
2. Patch and repair major cracking with exposed rebar at garage door sill – **Priority 1**

5.1.2 A1020 Special Foundations

- ✦ Minor cracking at concrete entry slabs at garage doors.

5.1.3 A1030 Slab on Grade

- ✦ Existing drawings suggest typical 4" concrete slab.
- ✦ Minor cracking evident in garage slabs.
- ✦ Slab in Area Supervisors office is sloped; evidence of possible shift in foundation from frost or gravel/dirt under slab compromised.
- ✦ Yard Garage: Slab on grade in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Monitor minor cracking in garage slab – **Priority 1**
2. Monitor and investigate sloped interior slab on south side of building; most evident in Area supervisors office – **Priority 1**

5.2 A20 Basement Construction

5.2.1 A2010 Basement Excavation

- ✦ Not applicable.

5.2.2 A2020 Basement Walls

- ✦ Not applicable.

5.2.3 A2030 Basement Columns

- ✦ Not applicable.



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6 B SHELL

6.1 B10 Superstructure

6.1.1 B1010 Floor Construction

- ✦ Mezzanine levels in all garages are of wood construction and are in good to serviceable condition.
- ✦ Some structural framing concerns at mezzanine level in sheet metal shop. Post should be installed at transition around corner.

IT IS RECOMMENDED THAT:

1. Correct structural issues at mezzanine level in sheet metal area with additional support - **Priority 1**

6.1.2 B1020 Roof Construction

- ✦ Steel trusses in good condition.
- ✦ Leaks in some areas where mentioned by Gerald (onsite maintenance person), area of note is directly outside Area supervisors office
- ✦ Some water staining evident below attic space vents.
- ✦ Yard Garage: insulated wood trusses in good condition.

IT IS RECOMMENDED THAT:

1. Investigate source of leaks and correct - **Priority 1**
2. Investigate water stains in attic further; possible infiltration through roof vents; modify roof vents as needed to correct condition - **Priority 1**

6.2 B20 Exterior Enclosure

6.2.1 B2010 Exterior Walls

- ✦ Metal siding in fair to serviceable condition; various spots of minor rusting, chipping and fading.
- ✦ Some siding bolts are heavily rusted in areas.
- ✦ Some minor holes and dents evident on east and north wall siding.
- ✦ Metal sill along north side of building in disrepair (adjacent to line shop O/H doors).
- ✦ Reasonable amount of rusting, chipping and fading on west end of building.
- ✦ Yard Garage: wood frames insulated walls with vinyl siding. Siding coming off on west end.

Insulation

- ✦ Based on existing drawings provided, assumed R20 batt insulation exists. Unable to verify state of insulation.
- ✦ Insulation in roof space is minimal; combination of fiberglass and cellulose. Metal ceiling from below is exposed in many areas and may be contributing to water condensation, mold and water spots.

IT IS RECOMMENDED THAT:

1. Monitor rusting bolt fasteners and replace all nearing end fastening strength - **Priority 2**
2. Replace metal sill at north side - **Priority 2**
3. Re-paint and seal all exterior siding - **Priority 2**
4. Increase insulation in roof space with additional 3" of blown-in cellulose - **Priority 3**
5. Yard Garage: repair and reattach vinyl siding on west end - **Priority 1**

6.2.2 B2020 Exterior Windows

- ✦ Aluminum windows are in fair to serviceable condition; showing heavy signs of fading on south side.



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- ✦ Weather caulking is cracking in areas.
- ✦ Some window screws are in disrepair.
- ✦ Some rubber gasketing is falling away from thermal pane.
- ✦ Single pane vinyl windows at mezzanine level above office space have reached end of life span.

IT IS RECOMMENDED THAT:

1. Repaint and seal aluminum windows – **Priority 2**
2. Re-caulk and replace gasketing where in disrepair – **Priority 1**
3. Replace screens – **Priority 2**
4. Replace all aluminum windows with new aluminum units – **Priority 3**
5. Replace vinyl windows at mezzanine level with new aluminum units – **Priority 1**

6.2.3 B2030 Exterior Doors

- ✦ Steel man doors are in good to serviceable condition.
- ✦ Hinges on some man doors showing signs of heavy rust.
- ✦ Man door at east of building heavily chipping with metal frame exposed.
- ✦ Door at west end onto sheet metal shop is only 6' to u/s of closer creating a potential hazard
- ✦ Yard Garage: Insulated man door in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Monitor rusted hinges and replace as required – **Priority 2**
2. Prime and paint east man door and frame – **Priority 2**
3. Move closing device to the exterior at west-end door in sheet metal shop – **Priority 1**
4. Replace west-end door in sheet metal shop to a 6'-8" (min) tall insulated door – **Priority 2**

6.2.4 B2035 Exterior Overhead Doors

- ✦ Pressure treated jamb at north side garage doors require new primer and paint.
- ✦ O/H insulated steel doors are in good to serviceable condition.
- ✦ Weather stripping in disrepair on west side garage door.
- ✦ Some minor rust evident at base of O/H door jambs.
- ✦ Yard Garage: O/H steel door in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Prime and paint pressure treated O/H door jambs – **Priority 1**
2. Replace pressure treated wood jambs with steel painted (similar to west door at line shop) – **Priority 2**
3. Replace weather stripping as required – **Priority 2**
4. Sand, prime and paint base of steel door jambs and headers – **Priority 2**

6.2.5 B2040 Exterior Stairs/Roof Access Ladders

- ✦ Not applicable.

6.2.6 B3010 Roof Coverings

- ✦ Corrugated galvalume steel roof. Minor rust stains evident in some areas.
- ✦ Gutters and downspouts leaking in areas of patch work.
- ✦ Asphalt roof entry canopies on south side are in good to serviceable condition.
- ✦ Yard Garage: Asphalt roofing in fair to serviceable condition. Shingles nearing end of typical life expectancy.

IT IS RECOMMENDED THAT:

1. Monitor roof for continued rust and seal with new paint finish – **Priority 3**
2. Patch gutters – **Priority 1**



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3. Replace gutters and downspouts – **Priority 2**

6.2.7 **B3020 Roof Openings**

- ✦ Not applicable.

7 C INTERIORS

7.1 C10 Interior Construction

7.1.1 C1010 Partitions

- ✦ Office Areas & Mezzanine: GWB stud walls in good to serviceable condition; recently painted.
- ✦ Garage Areas: Combination of block, metal and some painted plywood. All in good to serviceable condition.

7.1.2 C1020 Interior Doors

- ✦ Office Areas: Hollow core wood painted doors in good condition.
- ✦ Office Areas: Painted wood trims in good to serviceable condition.
- ✦ Office Areas: Door jamb and trim broken at storage room on mezzanine level; looks like forced entry.
- ✦ Mezzanine Office: majority of hollow core wood painted doors are in good condition. Door frame broken into storage room at end of hall.
- ✦ Garage Area: Metal frames and doors in good to serviceable condition.
- ✦ Garage Area: Doors onto areas below mezzanine are wood in fair to serviceable condition.
- ✦ Door into battery storage room requires a 45min rated door and frame complete with a closing device.

Hardware

- ✦ In good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Fix door frame, adjust hardware and repaint – **Priority 1**
2. Verify door into battery storage room carries a 45min rated door and closing device. Replace as required – **Priority 1**

7.1.3 C1030 Interior Windows

- ✦ Not applicable.

7.1.4 C1040 Fittings

Washroom Accessories

- ✦ Office (women's washroom): Good to serviceable condition.
- ✦ Mezzanine (men's washroom): Good to serviceable condition.
- ✦ Garage washroom: Good to serviceable condition.

Vanities

- ✦ Office (women's washroom): Good to serviceable condition.
- ✦ Office (women's washroom): Shower requires service; caulking at base falling away from shower pan. Cased opening not painted.
- ✦ Mezzanine (men's washroom): Good to serviceable condition.
- ✦ Garage washroom: Good to serviceable condition.

Millwork

- ✦ Office Areas: In good to serviceable condition.

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- ✦ Kitchen: In good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Re-caulk shower base in women's washroom – **Priority 1**

7.2 C20 Stairs

7.2.1 C2010 Stair Construction

- ✦ Office Area: Stairs to mezzanine level from office area are wood with rubber treads and are in good to serviceable condition.
- ✦ Garage Area: Painted wood stairs to all mezzanine levels in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Re-paint stair to mezzanine at Motion and Canada bay – **Priority 2**

7.2.2 C2020 Stair Finishes

- ✦ Office Stair: Rubber treads in good to serviceable condition.

7.3 C30 Interior Finishes

7.3.1 C3010 Wall Finishes

- ✦ Office Area: GWB (painted) in good to serviceable condition.
- ✦ Garage Areas: Painted walls in fair condition.
- ✦ Yard Garage: Painted plywood walls and ceiling in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. Re-paint all walls in Garage Areas – **Priority 2**

7.3.2 C3020 Floor Finishes

- ✦ In general all VCT flooring throughout building is in good to serviceable condition.
- ✦ VCT flooring at mezzanine level in sheet metal shop is in complete disrepair
- ✦ In general, ceramic tile flooring throughout offices and welfare spaces are in fair to serviceable condition.
- ✦ Ceramic tiles chipping at main entry door to office.
- ✦ Ceramic tiles have been replaced and/or are sloping towards the south wall from Area Supervisor to Line Crew Office space (See 5.1.3).
- ✦ Rubber base throughout is in good to serviceable condition.
- ✦ Carpet tile in office storage rooms are in fair to serviceable condition.
- ✦ Painted concrete floors in line shop is in good to serviceable condition. All other painted concrete floors are in fair condition and requiring a new paint finish.

IT IS RECOMMENDED THAT:

1. Replace VCT flooring and rubber base in mezz level office in sheet metal shop – **Priority 1**
2. Repair and replace broken ceramic tiles at main entry in office – **Priority 2**
3. Monitor area where tile has been replaced and slab is sloping to the south for continued settlement and investigate potential cause of issue – **Priority 1**
4. Monitor area where tile has been replaced and slab is sloping to the south for continued settlement and investigate potential cause of issue – **Priority 1**
5. Re-paint all concrete floor, with exception of the line shop area – **Priority 2**

7.3.3 C3030 Ceiling Finishes

- ✦ Office Area: Acoustic tile ceiling in good to serviceable condition. Some tiles with minor cracks/chips.

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- ⊕ Mezzanine Office Area: Tiles stained in storage room area; evidence of leak from roof or condensation from lack of insulation.

IT IS RECOMMENDED THAT:

1. Investigate leaks, monitor and correct at mezzanine level – **Priority 1**
2. Replace damaged tiles – **Priority 2**

8 D SERVICES

8.1 D10 Conveying

8.1.1 D1010 Elevators & Lifts, D1020 Escalators & Moving Walks

- ⊕ Not applicable.

8.1.2 D1090 Other Conveying Systems

- ⊕ Not applicable.

8.2 D20 Plumbing

8.2.1 D2010 Plumbing Fixtures and Trim

- ⊕ The water closets throughout are white vitreous china. Water closets are floor mounted 6 litre and 12 litre tank type with regular and elongated rim bowls with insulated and non-insulated tanks. The flush valve in the south washroom is leaking and requires adjustment. The water closets throughout the facilities are in good to serviceable condition.
- ⊕ Lavatories throughout are vitreous china. Lavatories are built in counter mount type. Lavatory trim is a mixture of blade and single lever type handles. The lavatory in the south is having drainage issues requiring maintenance. Trim is in serviceable condition, requiring adjustment and maintenance.
- ⊕ Kitchen sink is a single bowl stainless steel sink, with lever handled trim. Sink and trim are in serviceable to marginal condition, with trim requiring adjustment and maintenance.
- ⊕ Shower is a PVC panel molded stone base with plastic round handle trim and standard shower head. The shower is no longer used. It was indicated that it had been removed previously. After experiencing issues with sewage gases it was re-installed.
- ⊕ A molded stone laundry tub with round handle trim and a hose is located near the south washroom. There is no vacuum breaker or backflow prevention on the hose. Sink and trim are in serviceable condition, with trim requiring adjustment and maintenance.
- ⊕ There is a washer and dryer located on the platform on the south of the building appear in good condition.
- ⊕ Unitary eyewash station is located near the south washroom. It appears to be inspected on a regular basis. Water level is below the 15 minute mark. Water should be replaced every 6 months. There are batteries below the eyewash which could limit access. Appears to be in serviceable condition.
- ⊕ Hot and cold water hose station is located in the south bay. Hot water valve had a tag indicating do not operate. No check valves are installed on the hot or cold water.
- ⊕ The hot water, cold water and sanitary piping servicing these fixtures appears to be in good to serviceable condition and consistent with the date of construction.
- ⊕ The fixtures and associated trim in the facility are not required to meet accessibility requirements for persons with disabilities.



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IT IS RECOMMENDED THAT:

1. Repair toilet flush valve (south washroom) – **Priority 3**
2. Repair lavatory drainage (south washroom) – **Priority 3**
3. Provide vacuum breaker on laundry tub trim – **Priority 3**
4. Remove / provide trap primer for un-used shower. – **Priority 3**
5. Replace water in eyewash every 6 months in accordance with manufacturers recommendations – **Priority 1**
6. Clean area around eyewash – **Priority 1**
7. Install check valves on hot and cold water to hose station – **Priority 3**

8.2.2 D2020 Domestic Water Distribution

Domestic Cold Water

- ✦ The facility receives domestic cold water from the municipal system. The service entrance is ¾ inches. The entrance is located near the first floor office washroom. Site personnel indicated there are issues freezing during the winter. Entrance appears in suspect condition.
- ✦ There is a temporary service entrance located in the north service bay. It is connected to the nearby H&H enterprises building 10 meters north of the Nalcor building. A 5/8" 100 ft x-pert black rubber hose running from a double valve at the former location of the washroom in the south west corner of the bay to the north east corner of the building. The hose then transitions to insulated PEX with heat trace into a PVC casement pipe underground to the nearby building hose bib. Consideration should be given to draining and disconnecting the system – reconnecting only if required.
- ✦ Near the south washroom – there is a direct water connection to the laundry sink waste. There is no backflow preventer. Water valve is fixed open continuously flowing water into the sewer. Site personnel indicated this was installed to prevent freezing at the water service entrance.
- ✦ The piping for the domestic cold water and domestic hot water is a mixture of PEX and copper piping. There are signs of light surface rust around the pipes. It is expected that the solder used for the copper pipe is a 50/50 lead-tin mix, which would be typical of the solder used in that time period. Sections of piping through the garage area have been isolated and removed. Remaining unused piping should be removed and ends of existing system capped. Water quality test should be completed on a regular basis to verify that water is within current national guidelines. Condition is marginal to suspect.
- ✦ There is no insulation on the domestic water lines.
- ✦ There are no backflow preventers on the service entrance.
- ✦ No check valves and vacuum breakers were noted to provide backflow prevention.
- ✦ A full backflow prevention audit should be performed.

Domestic Hot Water

- ✦ The domestic hot water system supplies hot water for the building including washrooms, showers and sinks.
- ✦ The domestic hot water is provided from 2 electric hot water heaters. The heaters appear in good condition.
 - The tank in the center of the building near the offices is a Rheem Model RR410T 40 imp gallon 3000 W 208 volt heater located under the stairwell.
 - The tank in the south of the building near the laundry sinks is a Rheem Model PRO410T 40 imp gallon 3000 W 208V heater



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- ✦ The heaters are located near fixtures served. No recirculation system is provided in the buildings. Most fixtures tested appeared to have hot water available on demand. Fixtures in the south washroom have an extended wait for hot water.

IT IS RECOMMENDED THAT:

1. Replace existing water service entrance to the municipal water main. Install waterline below frost line or provide insulation and or heat tracing to prevent freezing. Remove temporary water service entrance and water valve continuously flowing to sewer system. – **Priority 1**
2. Remove old domestic water piping no longer used. Provide permanent cap on ends of piping – **Priority 3**
3. Perform backflow contamination evaluation around the facility – **Priority 3**
4. Continue to test drinking water for inclusion of treatment systems – **Priority 3**
5. Insulate domestic cold water lines to prevent condensation – **Priority 3**

8.2.3 D2030 Sanitary Waste and Storm Drainage Systems

- ✦ The storm, sanitary and drain, waste and vent lines appear to be a mixture of ABS and Cast Iron. System appears to be in serviceable condition.
- ✦ Floor drains throughout are in relatively marginal to serviceable condition. Drawings indicate presence of trap primer on one drain near the south washroom. No trap primers appeared to be on the drains through the remainder of the building.
- ✦ Sewage lines for old washrooms were capped using a Gripper. Floor was beginning to cave around former washroom in north garage bay.
- ✦ End of line 1-1/2" Vent line at former north bay washroom is damaged and should be repaired / replaced.
- ✦ During the site inspection no oily water separation was noted.
- ✦ A hazard assessment should be completed concerning storage of petroleum products, specifically spill containment. Make sure procedures are followed.
- ✦ Sanitary service is located in a hatch on the east wall near the offices. No back water valve is installed.
- ✦ Drain line for air handling unit intake has been disconnected and should be repaired.
- ✦ Staff have indicated sewage gas issues in different sections of the building near the office area. Vent pipe appears to have a gooseneck – 2" diameter. Current codes would recommend 3" minimum diameter above the roof with no gooseneck. Based on the installation location, we would recommend the section above the roof is 4 inch and extended a minimum of 3 ft below roof and 3 ft above the roof to prevent icing / snow infiltration.

IT IS RECOMMENDED THAT:

1. Add trap primers on all floor drains – **Priority 3**
2. Repair vent line in north service bay – **Priority 3**
3. Perform Hazard Assessment to determine if current operations / material storage require oily water separator – **Priority 3**
4. Install backwater valve at service entrance to prevent sewage backup – **Priority 3**
5. Replace top portion of all vent lines, extend to 3 foot above roof line, expand to 4 inch diameter and remove gooseneck – **Priority 2**
6. Repair drain line from air handling unit intake – **Priority 2**

8.2.4 D2090 Other Plumbing Systems Accessories

- ✦ Not applicable.



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8.3 D30 HVAC

8.3.1 D3010 Energy Supply

- ⊗ Not applicable.

8.3.2 D3020 Heating Systems

- ⊗ The facility is heated using Stelpro / Chromalox / Play Ford/ baseboard electric heaters as well as electric horizontal unit heaters. The condition of these units appears to be serviceable. The Play Ford heaters appear to be older models which visually appear in suspect condition.
- ⊗ Heating is controlled by a dial line voltage thermostat, an internal controls in the garage areas. System appears in marginal condition.
- ⊗ Welding shop heaters appear in poor condition.

IT IS RECOMMENDED THAT:

1. Continue to upgrade thermostats to digital programmable – **Priority 3**
2. Condition of fins and guards are checked on a regular basis – **Priority 3**
3. Replace old unit heaters in south garage and welding shop – **Priority 3**

8.3.3 D3030 Cooling Systems

- ⊗ There is one Koolking Model MPN1-08CRN1-BI-19 ¼ ton Portable air conditioning unit which had been disconnected for the winter season located in the corridor. Condition of the unit appears serviceable.
- ⊗ Staff indicated the office area was warm during the summer.

IT IS RECOMMENDED THAT:

1. Evaluate the need to add a cooling coil to the existing air handling unit – **Priority 3**

8.3.4 D3040 HVAC Distribution Systems

- ⊗ Ductwork and air handling unit are assumed to have been installed in 1996 per the date of the ventilation drawings serving the office area.
- ⊗ Return air is ducted from one return grille per floor located near the doors accessing the garage.
- ⊗ There are no records indicating an air balance has been completed on the system.
- ⊗ Supply ductwork appears to be installed per the drawings, including supply air diverted into the washrooms.
- ⊗ Washroom exhausts are ducted to attic and storage areas.
- ⊗ Rangehood in the kitchenette area is ducted directly to the outdoors. There is no louver/gravity damper on the opening.
- ⊗ Dryer vent uses plastic flexible duct. The duct is disconnected from the dryer.

IT IS RECOMMENDED THAT:

1. Extend return ductwork into office area. Provide new return air grille – **Priority 3**
2. Remove supply air ductwork from washroom – **Priority 2**
3. Perform air balance on system. Install balancing dampers as required – **Priority 3**
4. Duct all washroom exhausts to outdoors – **Priority 2**
5. Provide exterior louver / backdraft damper on exterior duct openings – **Priority 2**
6. Replace flexible dryer duct with semi-rigid metal flexible duct or rigid – **Priority 1**

8.3.5 D3050 Ventilation Systems

- ⊗ Ventilation system consists of a supply fan, return fan, heating coil and economizer dampers. The supply fan was not in operation. Return fan was operating. Economizer appeared to be operational, fixed in the return position.
- ⊗ Filters for the system are located on the end of the return duct.



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- ✦ The system has no cooling system or humidification system.
- ✦ Staff indicated issues with ventilation system intaking exhaust fumes from trucks parked at nearby businesses during the winter.
- ✦ Washrooms all appear to have 50 CFM Broan exhaust fans installed.
- ✦ There is no ventilation through any of the garage bays.
- ✦ There is an exhaust hood located in the welding shop and appears in very poor condition.
- ✦ Two vehicle exhaust extraction system are located in the south bay. System does not appear to be operational.

IT IS RECOMMENDED THAT:

1. Repair supply fan – **Priority 1**
2. Install carbon filter on outdoor air duct – **Priority 2**
3. Schedule operation of ventilation system to operate during working hours – **Priority 3**
4. Install humidification system in ventilation system – **Priority 3**
5. Balance and set outdoor air and exhaust air dampers to meet minimum indoor air requirements – **Priority 3**
6. Provide exhaust ventilation and CO sensor/alarm for each of the garage bays to meet minimum ventilation requirements – **Priority 3**
7. Repair vehicle exhaust extraction system if required, else remove – **Priority 3**

8.3.6 D3090 HVAC Systems & Equipment

- ✦ Two flammable safety storage cabinets are located in the facility. One is located in the workshop area and one is located in the maintenance shed. Both cabinets are Williams Brothers model 16882 WB45.
- ✦ Both cabinets are naturally vented through a wall vent using galvanized sheet metal. The cabinet in the workshop area is located near an exit door.

IT IS RECOMMENDED THAT:

1. Cabinet should not be vented – **Priority 2**
2. If cabinet is vented, should be above the roof using mechanical ventilation – **Priority 2**
3. Venting ductwork should be constructed of minimum welded 18 ga. sheet steel – **Priority 2**
4. Cabinet should be located away from exit door – **Priority 1**

8.4 D40 Fire Protection

8.4.1 D4010 Fire Extinguishers

- ✦ A significant number of ABC type fire extinguishers were located around the facility. Sizes, age and condition of extinguishers varied.
- ✦ All fire extinguishers were fully charged and had valid monthly inspection tags.
- ✦ There were some fire extinguishers noted on site to have elapsed 6 year re-certifications.

IT IS RECOMMENDED THAT:

1. Inspect fire extinguishers on an annual basis – **Priority 1**
2. Perform 6 year maintenance of fire extinguishers – **Priority 1**

8.4.2 D4020 Automatic Sprinklers

- ✦ Not applicable.

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8.5 D50 Electrical

8.5.1 D5010 Electrical Service & Distribution

Main Service Equipment

- ✦ Main service is overhead 347/600V, 3 phase, 4 wire, 400A service fed from a hydro pole and service mast located at the south east end of the building to the main distribution equipment located within the workshop. The main service is fed into a 600V, 400A splitter trough which then branches off to a 600V, 200A, 3 phase, 4 wire Federal Pioneer disconnect switch which is connected to the line shop electrical distribution system. The 600V splitter trough is also connected through a 600V, 200A meter and a 600V, 200A, 3 phase, 4 wire, 200A Federal Pioneer disconnect switch to a 600V, 200A MLO, 3 phase, 4 wire Federal Pioneer distribution panelboard PP2 which is connected to heating loads and the separate electrical distribution systems for each of the bays within the building. Panelboard PP2 is then wired to a Delta 45kVA stepdown, 3 phase, 4 wire 600-120/208V stepdown transformer and branch circuit panelboard PP1 which is connected to the administrative area electrical branch circuits. Electrical distribution equipment has a typical service life of approximately forty years, and it is expected that some of the equipment is nearing the end of its design life. Periodic testing and maintenance should be conducted on the older equipment to ensure safe and proper operation of the equipment is maintained until it is replaced.
- ✦ In the Motion Ind. Canada bay, the vacant bay, the line shop, as well as the sheet metal shop there is a Marcus 15kVA, 1 phase, 3 wire, 600-120/208V stepdown transformer which is covered by equipment and other materials. A clear working space of 1m is to be provided in front of electrical equipment in accordance with CSA 22.1-12 article 2-308.
- ✦ There is only 710mm clear working space in front of the electrical service equipment in the workshop. Given the location and workable clearance, this equipment should be reviewed and deemed acceptable by the local authority having jurisdiction (AHJ), or the equipment be relocated to provide the required 1m of clear working space in front of electrical equipment in accordance with CSA 22.1-12 article 2-308.
- ✦ In the sheet metal shop there appeared to be some electrical disconnect switches and splitter boxes located on the north west and north east wall which are obsolete. If the equipment is deemed to be obsolete it should be removed c/w all associated conduit and wiring back to source.

Panelboards

- ✦ Panelboard PP1 is a Square-D 120/208V, 225A MB, 3 phase, 4 wire, 42 circuit panelboard located adjacent to the station service entrance in the workshop. Panelboard should have circuit breaker filler plates installed to conceal exposed bus.
- ✦ Panelboard PP2 is a General Electric 347/600V, 200A MLO, 3 phase, 4 wire, 30 circuit distribution panelboard located adjacent to the station service entrance in the workshop. Panelboard should have circuit breaker filler plates installed to conceal exposed bus.
- ✦ Panelboard located in the Motion Ind. Canada bay is a Federal Pioneer, 120/208V, 100A MLO, 1 phase, 3 wire, 24 circuit panelboard.
- ✦ Panelboard located in the vacant bay is does not have a certified panelboard enclosure and there is not a name plate to provide the panelboard characteristic. Uncertified cover should be removed, and the panelboard interior should be determined so that an appropriate cover can be provided.



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- ✦ Panelboard located on the north east wall of the workshop is a Federal Pioneer, 120/208V, 100A MLO, 1 phase, 3 wire, 24 circuit panelboard.
- ✦ Distribution panelboard located on the north east wall of the line shop is a Square-D 347/600V, 225A MLO, 3 phase, 4 wire, 42 circuit distribution panelboard. The panelboard appeared to be in reasonable condition; however, there were various materials stacked in front of the panelboard. A clear working space of 1m is to be provided in front of electrical equipment in accordance with CSA 22.1-12 article 2-308.
- ✦ Panelboard located on the north east wall of the line shop is a Federal Pioneer, 120/208V, 100A MLO, 1 phase, 3 wire, 24 circuit panelboard.
- ✦ There is a small recessed pony panel located in the file room of the administration area which is a Commander, 120/208V, 60A MB, 1 phase, 3 wire, 12 circuit panelboard which appeared to be in reasonable condition.
- ✦ There is a Siemens 120/208V, 100A MB, 1 phase, 3 wire, 24 circuit loadcenter located on the south east wall of the lunch room. Loadcenter appeared to be in good condition.
- ✦ Panelboard located in the sheet metal shop is a Square-D, 120/208V, 100A MLO, 1 phase, 3 wire, 24 circuit panelboard which appears to be in poor condition. Recommend that the panel cover be taken off by a qualified electrician and the panelboard interior and associated terminations be verified. Further, there are several knockouts missing on the side of the panelboard enclosure which should be plugged.
- ✦ Pony panel located on the south west wall of the sheet metal shop as inaccessible due to the amount material and equipment stacked in front of the panel.
- ✦ The panelboard located in the outdoor garage is a Square-D, 120/208V, 200A MB, 1 phase, 3 wire, 30 circuit panelboard which appeared to be in good condition.
- ✦ Federal Pioneer panel boards are becoming increasingly difficult to source replacement parts and circuit breakers for. Replacement of this panel board should be considered in an effort to avoid potential maintenance issues in the future.
- ✦ Branch circuit breakers connected to the 120VDC systems, exit signs, and CCTV systems should be painted red and provided with lock on devices so they are not inadvertently turned off.

Wiring Devices

- ✦ There appeared to be a sufficient quantity of receptacles throughout the building, although several faceplates and receptacles were broken or damaged and should be replaced with new. Stainless steel faceplates should be considered for durability.
- ✦ All exterior receptacle covers should be replaced with waterproof, gasketed while in use covers, and all existing exterior receptacles should be replaced with GFCI protected receptacles in accordance with CSA 22.1-12 article 26-702. This is inclusive of all exterior receptacles used for block heaters located on the south east facade of the building.
- ✦ In several locations throughout the main building, electrical junction boxes are missing covers.
- ✦ It was noted that some of the receptacles along the kitchen counters in the lunch room and the receptacle located in the upstairs washroom should be replaced with ground fault circuit interrupting (GFCI) receptacles as they are within 1500mm from sinks (Reference CSA C22.112, Article 26-700 (11)).

Wiring Systems

- ✦ Wiring is a RW90 copper conductor in electrical metallic tubing (EMT), PVC, and flexible interlocked armor (AC90) and in some places Teck 90 cabling was used for



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- branch circuit wiring. NMD wiring was also used in some locations for concealed branch circuit wiring. Communications cabling was in PVC conduit or free air. Low voltage cabling for network cameras is run in conduit.
- ✦ In the vacant bay, wiring to the ceiling mounted force flow heater is not properly spliced in an electrical junction box.
 - ✦ In the north west corner of the vacant bay, there appeared to be conduit penetrating through the block wall which is not fire/smoke sealed.
 - ✦ There are several branch circuits extending from the panelboard in the vacant and Motion Ind. Canada bay which appear to be obsolete. If determined to be obsolete the circuits should be removed back to source.
 - ✦ In the sheet metal shop, there is a permanent receptacle located in the office with is wired with an extension cord.
 - ✦ In the line shop, the connection from the ground to the secondary of the transformer should be verified. Further, the bar cabling to ground rod located adjacent to the distribution panelboard should be protected with conduit to protect it from mechanical damage.
 - ✦ Heat trace located on the water line running to the adjacent H&H building should be spliced in an appropriate junction box and not connected with an extension cord.
 - ✦ Several electrical conduit and cabling penetrations through the exterior wall are not properly sealed.
 - ✦ Bond from the antenna on the south façade of the building was not connected/cut.
 - ✦ Heat trace located in the concrete slab on the west bay of the line shop was exposed.
 - ✦ Teck 90 spin-on connectors to several exterior branch were rusted out and should be replaced.
 - ✦ In several locations, exterior branch circuit Teck cabling was not securely fastened to the associated spin-on connector.
 - ✦ Obsolete AC90 wiring in the workshop mezzanine should be traced out removed back to source.
 - ✦ In several instances in the sheet metal shop, several junction boxes were installed such that they were inaccessible and unable to remove junction box covers. Electrical boxes are to be accessible in accordance with CSA C22.1-12 article 12-

IT IS RECOMMENDED THAT:

1. Clear working space is to be provided in front of all transformers in the vacant, Motion Ind. Canada, sheet metal shop and line shop bays - **Priority 1**
2. Electrical service entrance equipment should be relocated to provide adequate access and clearance or the location be approved by the AHJ - **Priority 1**
3. Removal of all obsolete electrical equipment in the sheet metal shop - **Priority 1**
4. Install circuit breaker filler plates in panelboards PP1 and PP2 - **Priority 1**
5. Install new panelboard enclosure on vacant bay panelboard - **Priority 1**
6. Verify internal terminations and condition of panelboard in sheet metal shop and install knockout plugs - **Priority 1**
7. Replace Federal Pioneer panelboard and all associated branch circuit breakers with new - **Priority 3**
8. Paint critical system circuit breakers red and provide lock on circuit breaker devices - **Priority 3**
9. Replace broken and damaged faceplates with new stainless steel faceplates - **Priority 2**
10. Waterproof while-in-use receptacle covers be installed on all exterior GFCI receptacles, and replace all damaged block heater receptacle with new - **Priority 1**
11. Replace missing electrical junction box covers - **Priority 1**



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12. Install GFCI protected receptacle around sink in lunch room and washroom - **Priority 1**
13. Properly splice wiring to force flow heater in an electrical junction box - **Priority 2**
14. Fire and smoke seal conduit and cabling penetrations between bays - **Priority 2**
15. Trace out and remove all obsolete wiring from the Motion Ind. Canada and vacant bays - **Priority 2**
16. Permanently wire receptacle in sheet metal shop - **Priority 2**
17. Verify and protect ground wire in line shop - **Priority 2**
18. Splice water line heat trace in an appropriate weatherproof junction box - **Priority 2**
19. Seal electrical conduit and cabling penetrations through the exterior façade of the building - **Priority 2**
20. Bury exposed heat trace in concrete slab - **Priority 1**
21. Securely fasten and support exterior Teck 90 cabling and replace rusted spin-on connectors - **Priority 2**
22. Trace out and remove all obsolete wiring in the sheet metal shop - **Priority 2**
23. Relocate electrical junction boxes so that they are accessible - **Priority 1**

8.5.2 D5020 Lighting

Interior Lighting

- ✦ Majority of interior lighting in the bay areas is 400W, 347V metal halide high bay luminaires. In the administrative areas, lunch room and offices, there are 120V, 2 lamp 1' x 4' and 2' x 4' T8 fluorescent lensed troffers. Average horizontal illuminance at the floor level in the bay areas was measured at 35 fc, and the average horizontal illuminance at the workplane in the administrative and office areas was measured at 40 fc.
- ✦ In the workshop area, several highbay luminaires had burnt out and as a result the stairway is no longer illuminated well. Burnt of lamps in highbay luminaires should be replaced.
- ✦ One-to-one replacement of the existing HPS highbay luminaires with 4 lamp T5HO fluorescent highbay luminaires should be considered to eliminate HPS warmup times, increase light levels and light quality, and reduce maintenance costs associated with re-lamping.
- ✦ In the sheet metal shop, the area under the mezzanine used for storage on the north wall, is dimly lit, and it appears that at one time there were luminaires installed here but they were removed at some point. Fluorescent luminaires c/e ire guards should be installed under this mezzanine to provide additional light.
- ✦ Some fluorescent wrap style luminaires in the outdoor garage were missing lenses.

Exterior Lighting

- ✦ Low Pressure Sodium (LPS) wall packs around the perimeter of the building appeared to be nearing the end of their designed life and should be replaced; further, the exterior wall packs located along the south wall were also on at the time of the audit (during the day) which is indicative that the photocell or contactor is not operating properly. These low pressure sodium wall packs are energy efficient, but provide poor quality and distribution of light when compared to LED sources. There appeared to be a significant amount of traffic around the building, so replacement of the existing LPS wall packs should be considered to increase visibility around the site.

Lighting Control

- ✦ Lighting is controlled by single pole or three-way toggle style switches. In an effort to increase efficiency and reduce maintenance costs, replacement of the existing



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single pole toggle switches with wall or ceiling mounted occupancy sensors should be considered in the washrooms, file room and storage rooms.

- ✦ Luminaires located in the upper office of the sheet metal shop are not switched locally as the corresponding switch is located at the bottom of the stairs.
- ✦ 8' fluorescent T8 luminaires located in the upper storage area of the sheet metal shop are not switched and are currently controlled by the staff by switching the circuit breaker on and off.

Emergency Lighting

- ✦ Emergency lighting units are halogen MR16 style units in good working condition. Periodic testing should be completed to ensure proper operation
- ✦ In the workshop and Motion Ind. Canada bay single remote head emergency lights should be installed above the stairway to provide illumination levels in accordance with NBC article 3.2.7.3 along paths of egress.
- ✦ There are currently no emergency lighting units installed in the sheet metal shop. Emergency lighting units should be installed illuminate paths of egress.
- ✦ Installation of backlit LED exit signs should be considered on exit doors from the sheet metal shop and the Motion Ind. Canada bay.
- ✦ Emergency lighting unit located in the upstairs corridor by the communications room should have heads positioned to illuminate the path of egress.

Exit Signs

- ✦ Existing exit signs are LED or incandescent backlit type, ceiling or wall mounted with red lettering. The age of the exit signs are unknown; however, they appear to be in good condition. Periodic testing of the exit signs should be completed to ensure proper operation.
- ✦ In the vacant bay, there is an exit sign on the south wall which is no longer considered to be an acceptable exit. Obsolete exit sign should be removed to avoid confusion.
- ✦ Three exit signs in the administrative area were tested and found to be not operational.
- ✦ Exit sign located in the upstairs corridor by the communications room should have chevron knocked out in the direction of egress.

IT IS RECOMMENDED THAT:

1. Replace burnt out high bay lamps – **Priority 2**
2. One-to-one replacement of all HPS high bay luminaires with suspended T5HO fluorescent highbay luminaires - **Priority 2**
3. Install two lamp fluorescent strip luminaires below mezzanine in sheet metal shop - **Priority 3**
4. Replace missing luminaire lenses - **Priority 2**
5. Replace exterior lighting wall packs with new LED to provided , old and poor light quality, although efficient, lots of traffic on site – **Priority 2**
6. Replace the existing single pole toggle switches with wall or ceiling mounted occupancy sensors in the washrooms and storage rooms - **Priority 3**
7. Periodic testing be conducted on the exit signs and emergency lighting units to ensure proper operation - **Priority 1**
8. Provide proper switching for the lighting circuits in the sheet metal shop - **Priority 1**
9. Provide additional emergency lighting units in the Motion Ind. Canada bay – **Priority 1**
10. Provide emergency lighting units in the sheet metal shop - **Priority 1**
11. Installation of backlit exit signs - **Priority 2**



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12. Remove obsolete exit sign including all associated conduit and wiring back to source in the vacant bay - **Priority 1**
13. Repair exit signs in the administrative area - **Priority 1**
14. Knock-out exit sign chevron - **Priority 2**

8.5.3 D5030 Communications & Security

Telephone/Data

- ✦ The communications service is fed to a set of BIX blocks and a data rack located on the upper floor communications room above the administrative area. The telephone service is wired through a rack mounted Nortel PBX system which is then distributed out to the associated telephone drops. The data system is fed through a rack mounted switch and associated patch panels to the data drops. There are also several Eaton Powerware rack mounted UPS units which provide uninterruptible power to the buildings communications systems. Telephone and data outlets are wired with Cat 5e CMR run free air. The communications systems all appeared to be in good condition.
- ✦ In the workshop, a PVC communications conduit located on the north west wall is not properly supported and is putting pressure on the BIX terminations.
- ✦ In the line shop, obsolete communications wiring on the north west wall should be removed back to source.
- ✦ In the workshop mezzanine area, obsolete communication wiring on the south east wall should be removed back to source.

Door Intercom System

- ✦ Not applicable

Security Systems

- ✦ Not applicable

Paging/Sound System

- ✦ There is a building paging system that has several interior horns located throughout the building. Paging horns and associated wiring appeared to be in good condition.

Card Access System

- ✦ There is a proximity card access control system which is located adjacent to the latch on both the interior and exterior sides of all exit doors. The proximity card readers are then wired to the access control system head end unit located in the communication room located on the upper level above the administrative. The proximity card access system appears to be in good to serviceable condition.
- ✦ Fault was present on access control door panels 5 and 6.

Closed Circuit Camera System

- ✦ Not applicable

Fire Alarm and Detection

- ✦ Only a few local smoke alarms were found through the facility. These smoke alarms should be tested periodically to ensure proper operation. Although not required by code, the installation of a full addressable fire alarm notification and initiation system should be considered.

IT IS RECOMMENDED THAT:

1. Properly support communication conduit in the workshop - **Priority 2**
2. Remove obsolete communications wiring in the line shop back to source - **Priority 2**



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3. Remove obsolete communications wiring in the workshop mezzanine area back to source - **Priority 2**
4. Address access control panel faults - **Priority 1**
5. Installation of a full addressable fire alarm notification and initiation system should be considered - **Priority 2**

Reference Review:

For the purpose of this investigation, the following building codes and standards were reviewed:

- ✦ NBCC; National Building Code of Canada (2010);
- ✦ CEC; Canadian Electrical Code; CSA C22.1-12;
- ✦ Inspection and Testing of Fire Alarm Systems; CSA/ULC-S536-04
- ✦ IES Lighting Handbook 10th Edition(2010)

The scope of this investigation did not cover a detailed analysis of concealed cabling, cabling terminations or fire alarm system verification.

9 E EQUIPMENT & FURNISHINGS

9.1 E10 Equipment

9.1.1 E1010 Commercial Equipment

- ✦ Not applicable.

9.1.2 E1020 Institutional Equipment

- ✦ Not applicable.

9.1.3 E1030 Vehicular Equipment

- ✦ Not applicable.

9.1.4 E1090 Other Equipment

- ✦ Not applicable.

9.2 E20 Furnishings

9.2.1 E2010 Fixed Furnishings

- ✦ Not applicable.

9.2.2 E2020 Movable Furnishings

- ✦ Not applicable.

10 F SPECIAL CONSTRUCTION & DEMOLITION

10.1 F10 Special Construction

10.1.1 F1010 Special Structures

- ✦ Not applicable.

10.1.2 F1020 Integrated Construction

- ✦ Not applicable.

10.1.3 F1030 Special Construction Systems

- ✦ Not applicable.

10.1.4 F1040 PCB Building in Storage Yard

- ✦ Metal clad steel storage shed in very good condition.

10.1.5 F1050 Special Controls and Instrumentation

- ✦ Not applicable.



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11 G BUILDING SITE WORK

11.1 G10 Site Preparation

11.1.1 G1010 Site Cleaning

⊗ Not applicable.

11.1.2 G1020 Site Demolition and Relocation

⊗ Not applicable.

11.1.3 G1030 Site Earthwork

⊗ Not applicable.

11.2 G20 Site Improvements

11.2.1 G2010 Roadways

⊗ Not applicable.

11.2.2 G2020 Parking Lots

⊗ Not applicable.

11.2.3 G2030 Pedestrian Walkways

⊗ Not applicable.

11.2.4 G2040 Site Development (Fencing)

⊗ Not applicable.

11.2.5 G2050 Landscaping Grass

⊗ Not applicable.

11.3 G40 Site Electrical Utilities

11.3.1 G4010 Electrical Distribution

⊗ Not applicable.

11.3.2 G4090 Other Site Electrical Utilities

⊗ Not applicable.

11.4 G90 Other Site Construction

11.4.1 G9010 Service and Pedestrian Tunnels

⊗ Not applicable.

11.4.2 G9090 Other Site Systems & Equipment

⊗ Not applicable.

12 PLANNING

12.1 Barrier Free Design

⊗ As this facility is used for maintenance personnel requiring good physical mobility, barrier free design was not considered applicable. However, a large portion of the building is occupied by administrative office spaces and there may be a future need for barrier free construction. This requirement should be reviewed against corporate standards as this area of the building does not presently meet all barrier-free requirements.



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- ✦ Washroom facilities and majority of access points did not meet accessible requirements as set out by the current National Building Code of Canada or current CSA standards.

13 LIFE SAFETY CODE ANALYSIS

- ✦ Facility meets current code for Life Safety.

14 FIRE AND LIFE SAFETY DEFICIENCIES

14.1 Structural Resistance to Fire

- ✦ Not applicable.

14.2 Fire & Smoke Barriers

- ✦ A conscious effort was put forward to create a 1hr. fire and smoke barrier between the maintenance garage/shop areas and the office space. This is a requirement of the NBCC per occupancy type separation. Most walls appeared to be properly sealed and up to the u/s of the roof deck. However, all doors and frames between these two occupancy types require a 45min. rating, have closing device and doors sweeps. As most doors were painted this will need to be investigated further. Any and all ductwork will need to be fire dampened and penetrations through these demising walls will need to be fire stopped.

14.3 Basic Detection and Alarm Application

- ✦ See Electrical.

14.4 Automatic Fire Suppression

- ✦ Not applicable.

14.5 Water Supplies

- ✦ See Mechanical.

14.6 Fire Department

- ✦ Not applicable.

14.7 Operation and Maintenance

- ✦ Not applicable.

14.8 Emergency Lighting

- ✦ See Electrical.

14.9 Egress

- ✦ Adequate per NFPA and NBCC requirements.
- ✦ Travel distances to exits meet current National Building Code of Canada requirements, which are more stringent than NFPA.

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15 TABLE OF PROBABLE COSTS

Recommendation / Deficiency	Priority 1 Opinion of Probable Cost	Priority 2 Opinion of Probable Cost	Priority 3 Opinion of Probable Cost	
Section 5.1.1.1		\$900		
Section 5.1.1.2	\$650			
Section 5.1.3.1	\$0			
Section 5.1.3.2	\$0			
Section 6.1.1.1	\$600			
Section 6.1.2.1	\$0			
Section 6.1.2.2	\$0			
Section 6.2.1.1		\$600		
Section 6.2.1.2		\$450		
Section 6.2.1.3		\$20,790		
Section 6.2.1.4			\$14,000	
Section 6.2.1.5	\$250			
Section 6.2.2.1		\$2,100		
Section 6.2.2.2	\$900			
Section 6.2.2.3		\$150		
Section 6.2.2.4			\$11,500	
Section 6.2.2.5	\$3,000			
Section 6.2.3.1		\$500		
Section 6.2.3.2		\$150		
Section 6.2.3.3	\$150			
Section 6.2.3.4		\$1,300		
Section 6.2.4.1	\$400			
Section 6.2.4.2		\$1,200		
Section 6.2.4.3		\$350		
Section 6.2.4.4		\$600		
Section 6.2.6.1			\$14,500	
Section 6.2.6.2	\$350			
Section 6.2.6.3		\$2,200		
Section 7.1.2.1	\$200			
Section 7.1.2.2	\$0			
Section 7.1.4.1	\$100			
Section 7.2.1.1		\$800		
Section 7.3.1.1		\$10,500		

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Section 7.3.2.1	\$550			
Section 7.3.2.2		\$250		
Section 7.3.2.3	\$0			
Section 7.3.2.4	\$0			
Section 7.3.2.5		\$6,700		
Section 7.3.3.1	\$0			
Section 7.3.3.2		\$200		
Section 8.2.1.1			\$500	
Section 8.2.1.2			\$1,000	
Section 8.2.1.3			\$500	
Section 8.2.1.4			\$2,000	
Section 8.2.1.5	\$500			
Section 8.2.1.6	\$500			
Section 8.2.1.7			\$1,000	
Section 8.2.2.1	\$30,000			
Section 8.2.2.2			\$3,000	
Section 8.2.2.3			\$2,000	
Section 8.2.2.4			\$500	
Section 8.2.2.5			\$7,000	
Section 8.2.3.1			\$15,000	
Section 8.2.3.2			\$3,000	
Section 8.2.3.3			\$1,000	
Section 8.2.3.4			\$4,000	
Section 8.2.3.5		\$4,000		
Section 8.2.3.6		\$500		
Section 8.3.2.1			\$3,000	
Section 8.3.2.2			\$500	
Section 8.3.2.3			\$4,000	
Section 8.3.3.1			\$10,000	
Section 8.3.4.1			\$7,000	
Section 8.3.4.2		\$1,000		
Section 8.3.4.3			\$5,000	
Section 8.3.4.4		\$3,000		
Section 8.3.4.5		\$3,000		
Section 8.3.4.6	\$2,000			
Section 8.3.5.1	\$1,000			
Section 8.3.5.2		\$5,000		

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Section 8.3.5.3			\$5,000	
Section 8.3.5.4			\$10,000	
Section 8.3.5.5			\$500	
Section 8.3.5.6			\$30,000	
Section 8.3.5.7			\$2,000	
Section 8.3.6.1		\$500		
Section 8.3.6.2		\$5,000		
Section 8.3.6.3		\$5,000		
Section 8.3.6.4	\$500			
Section 8.4.1.1	\$500			
Section 8.4.1.2	\$1,000			
Section 8.5.1.1	\$400			
Section 8.5.1.2	\$2,000			
Section 8.5.1.3	\$300			
Section 8.5.1.4	\$150			
Section 8.5.1.5	\$300			
Section 8.5.1.6	\$150			
Section 8.5.1.7			\$4,500	
Section 8.5.1.8			\$200	
Section 8.5.1.9		\$250		
Section 8.5.1.10	\$750			
Section 8.5.1.11	\$500			
Section 8.5.1.12	\$150			
Section 8.5.1.13		\$150		
Section 8.5.1.14		\$1,000		
Section 8.5.1.15		\$300		
Section 8.5.1.16		\$350		
Section 8.5.1.17		\$150		
Section 8.5.1.18		\$500		
Section 8.5.1.19		\$500		
Section 8.5.1.20	\$750			
Section 8.5.1.21		\$500		
Section 8.5.1.22		\$300		
Section 8.5.1.23	\$250			
Section 8.5.2.1		\$250		
Section 8.5.2.2		\$17,500		
Section 8.5.2.3			\$400	

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Section 8.5.2.4		\$100		
Section 8.5.2.5		\$6,400		
Section 8.5.2.6			\$500	
Section 8.5.2.7	\$100			
Section 8.5.2.8	\$750			
Section 8.5.2.9	\$350			
Section 8.5.2.10	\$1,250			
Section 8.5.2.11		\$750		
Section 8.5.2.12	\$150			
Section 8.5.2.13	\$500			
Section 8.5.2.14		\$0		
Section 8.5.3.1		\$100		
Section 8.5.3.2		\$250		
Section 8.5.3.3		\$100		
Section 8.5.3.4	\$500			
Section 8.5.3.5		\$25,000		
TOTAL	\$52,450	\$131,190	\$163,100	\$346,740
			Contingency 30%	\$104,022
			Total	\$450,762

Site Condition Assessment
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16 USE OF REPORT

This report is prepared for the exclusive use of Newfoundland and Labrador Hydro for the expressed purpose of preparing a summary condition report for the identified property. This report should not be considered transferable, and should not be relied upon for any other purpose.

The service provided for this project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time and similar locality. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. We reserve the right to revise or amend our opinion in this report in the event new information, documentation, or evidence becomes available.

Sincerely,



Coles Associates Ltd.
Per: Douglas A. Coles, P.Eng., P.E., F.E.C.
Vice President



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Appendix A

Photographs



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Photo: Section 5.1.1.1



Photo: Section 5.1.1.2



Photo: Section 5.1.3.1



Photo: Section 5.1.3.2

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Site Condition Assessment
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Photo: Section 6.2.1.5



Photo: Section 6.2.2.1



Photo: Section 6.2.2.2



Photo: Section 6.2.2.3



Photographs - Page 4

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Photo: Section 6.2.2.4



Photo: Section 6.2.2.5



Photo: Section 6.2.3.1



Photo: Section 6.2.3.2



Photographs - Page 5

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December 22, 2014



Photo: Section 6.2.3.3



Photo: Section 6.2.4.1



Photo: Section 6.2.4.2



Photo: Section 6.2.4.3

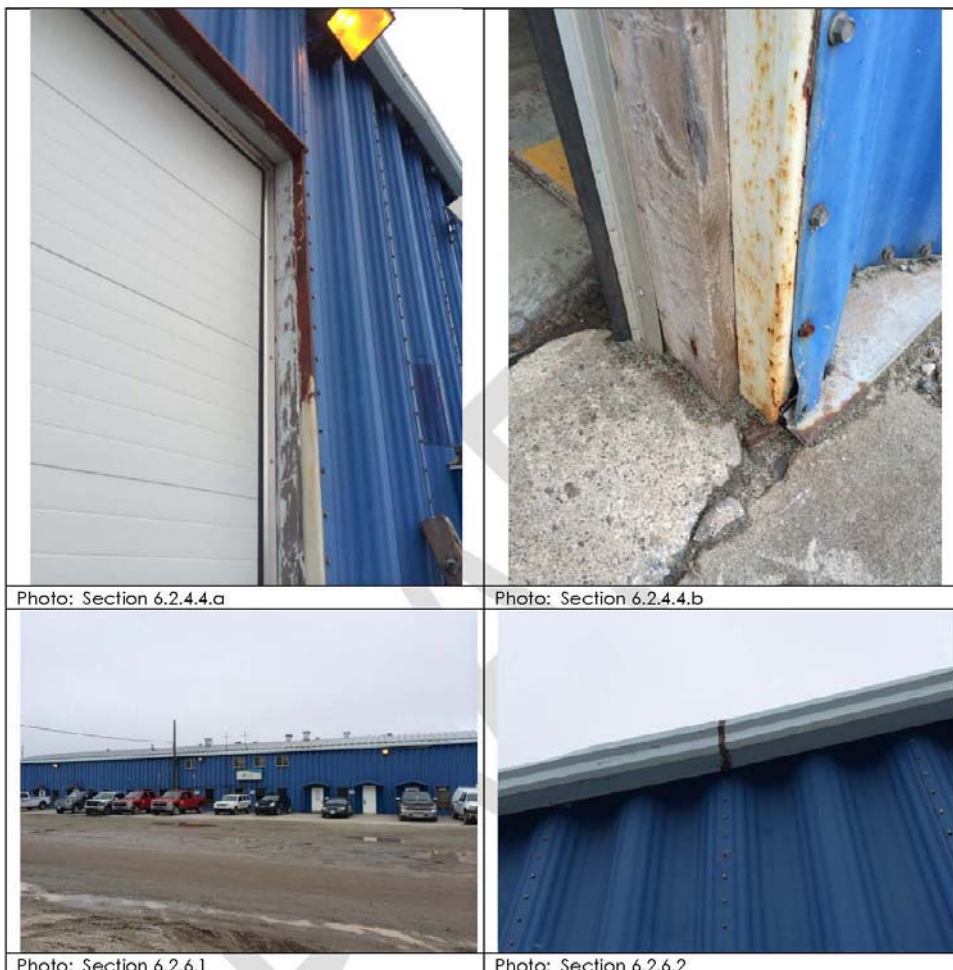


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Site Condition Assessment
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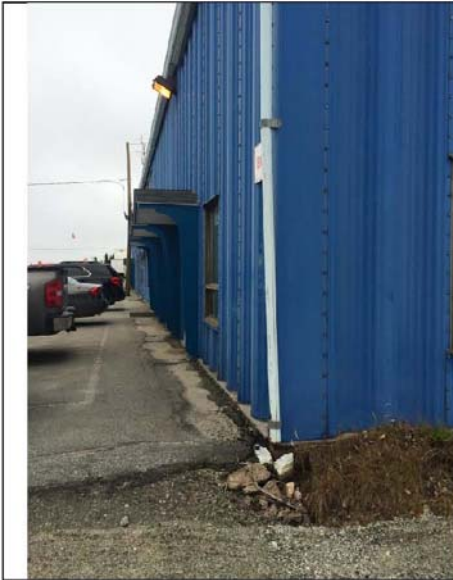


Photo: Section 6.2.6.3

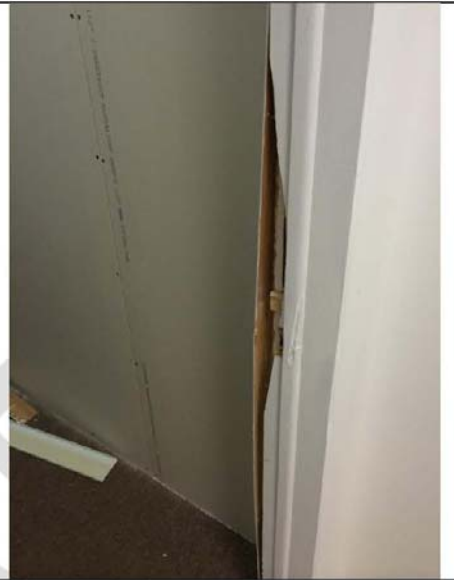


Photo: Section 7.1.2.1



Photo: Section 7.1.4.1



Photo: Section 7.2.1.1



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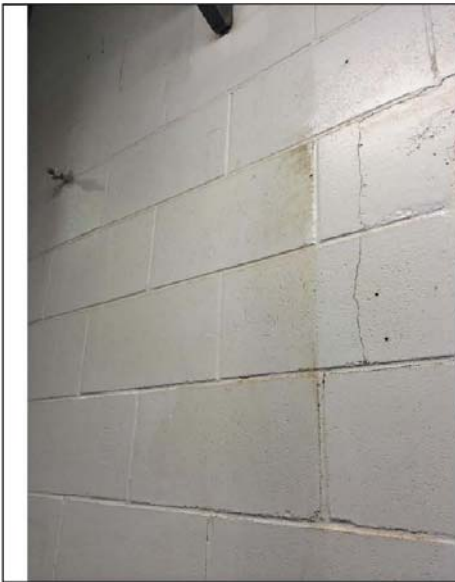


Photo: Section 7.3.1.1



Photo: Section 7.3.2.1



Photo: Section 7.3.2.2

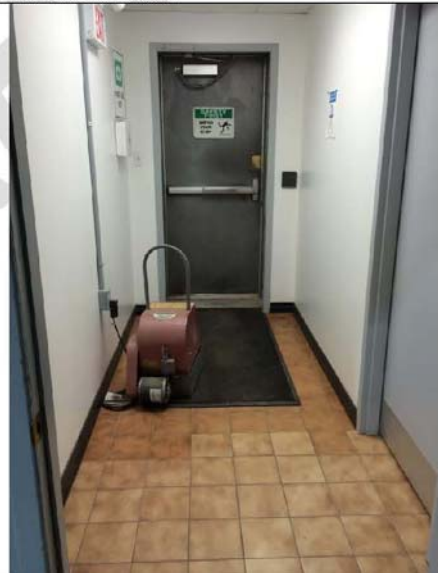


Photo: Section 7.3.2.3 and 7.3.2.4



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Photo: Section 7.3.2.5.a



Photo: Section 7.3.2.5.b



Photo: Section 7.3.2.5.c



Photo: Section 7.3.3.1

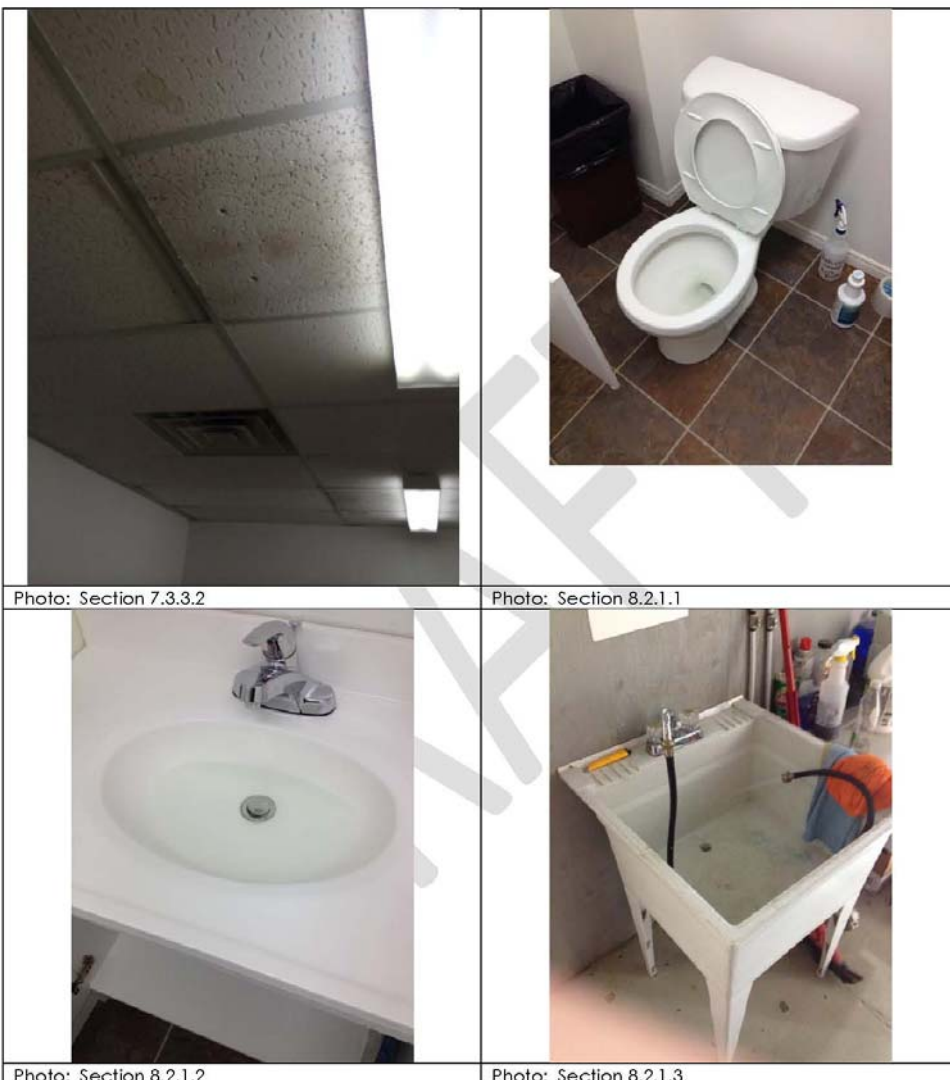


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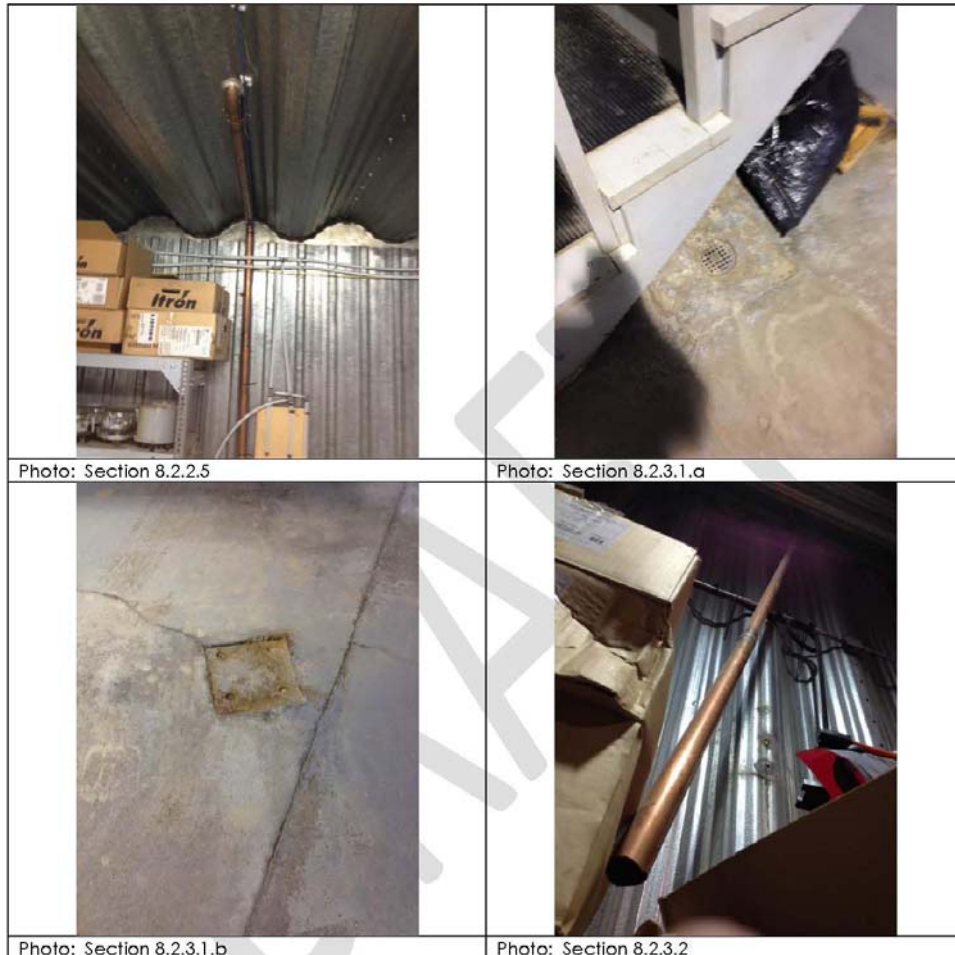
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Site Condition Assessment
Wabush, NL

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Photo: Section 8.2.3.3.a



Photo: Section 8.2.3.3.b



Photo: Section 8.2.3.4



Photo: Section 8.2.3.5

Site Condition Assessment
Wabush, NL

December 22, 2014



Photo: Section 8.2.3.6



Photo: Section 8.3.2.1



Photo: Section 8.3.2.2



Photo: Section 8.3.2.3

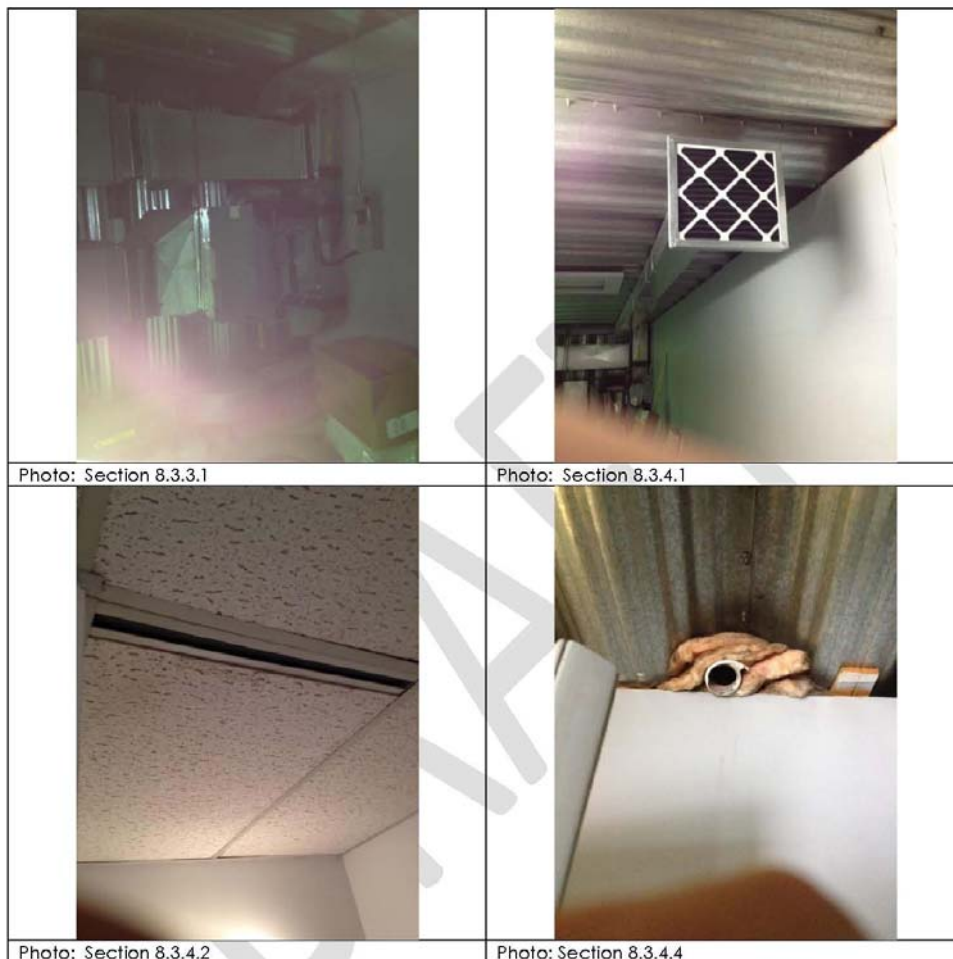


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Site Condition Assessment
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Photo: Section 8.3.5.6



Photo: Section 8.3.5.7



Photo: Section 8.3.6.1



Photo: Section 8.3.6.2

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Photo: Section 8.4.1.1



Photo: Section 8.5.1.1



Photo: Section 8.5.1.2



Photo: Section 8.5.1.3.a



Photo: Section 8.5.1.3.b



Photo: Section 8.5.1.4.a



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Site Condition Assessment
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Photo: Section 8.5.1.10.b



Photo: Section 8.5.1.10.c



Photo: Section 8.5.1.11.a



Photo: Section 8.5.1.11.b



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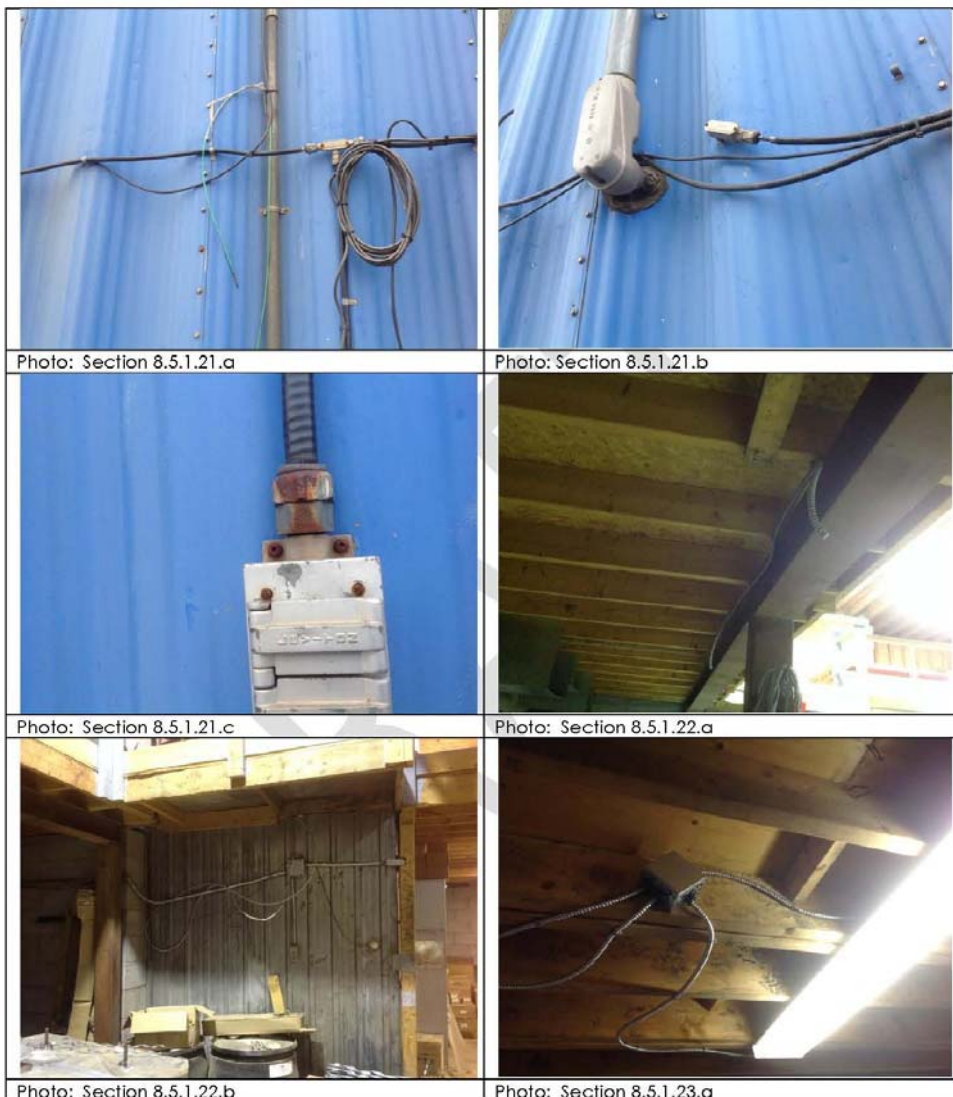


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Site Condition Assessment
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Photo: Section 8.5.1.23.b



Photo: Section 8.5.2.2



Photo: Section 8.5.2.3



Photo: Section 8.5.2.5



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Photo: Section 8.5.2.12



Photo: Section 8.5.2.14



Photo: Section 8.5.3.1

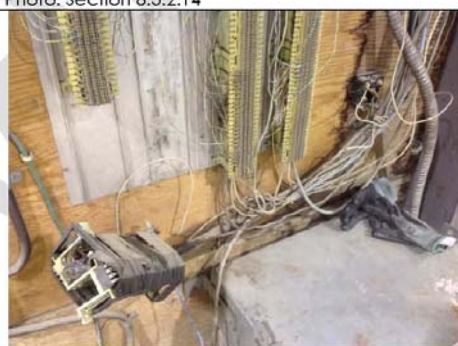


Photo: Section 8.5.3.2

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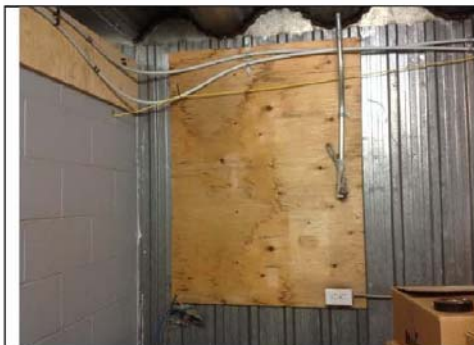


Photo: Section 8.5.3.3



Photo: Section 8.5.3.4

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

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

**Install Fire Protection
Bay d’Espoir**

July 2015

SUMMARY

This report details a proposal to design and install a fire protection system for the Bay d'Espoir Terminal Station. Currently there is no fire protection system at this location, putting the power generated at Bay d'Espoir at risk to fire. It has been proposed to install a fire protection system by use of a gaseous extinguishing system using the clean agent - Inergen. As part of the design air leak testing is required to ensure the terminal station is properly sealed for the Inergen to effectively extinguish the fire.

To limit risk of fire and to ensure the distribution of the vital power generated at Bay d'Espoir, this project is required.

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4.2 Project Schedule	9
Appendix A	A1

1 INTRODUCTION

In 2011, it was identified in the Stephenville Gas Turbine that the control room of the terminal station did not have fire protection. It was recommended to install a gaseous fire suppression system at this location. The control room houses the control cabinets, a combustible false floor, and a significant combustion load under the floor due to the concentration of the control cables.

The terminal station located in Bay d’Espoir has a similar control room with similar components. This terminal station also requires a gaseous fire suppression system to decrease the risk of a prolonged fire that can cause extensive damage to the terminal station. If this terminal station is damaged due to a fire it could be many months before the generation from Bay d’Espoir is reestablished.

In 2015, a Capital Proposal was approved by the board to install a gaseous fire suppression system in the Holyrood Terminal Station. This project is under development and is anticipated to be completed in 2016. There has been a review of other terminal stations and a list has been developed for the addition of this equipment to reduce the risk of fire at these locations. Below is the tentative schedule, subject to approval, for the terminal stations fire suppression upgrades:

- 2016-2017: Bay d’Espoir Terminal Station;
- 2017-2018: Hardwoods and Western Avalon Terminal Stations;
- 2018-2019: Oxen Pond, Sunnyside, and Stoney Brook Terminal Stations;
- 2019-2020: Massey Drive, Buchans, and Voisey’s Bay Nickel Terminal Stations; and
- 2020-2021: Deer Lake, Come By Chance, and Bottom Brook Terminal Stations.

2 PROJECT DESCRIPTION

This project will include the detailed design and installation of a fire suppression system in the control building at the Bay d’Espoir 230 kV and 69 kV Terminal Station. The system will be designed to protect the control cabinets and cables and any other critical equipment from being destroyed by a fire through the use of a gaseous extinguishing system using the clean agent - Inergen. Design and installation of the system will be completed by a contractor, including the air leak testing of the building. Management of the project will be completed by Hydro’s internal engineering, and a Hydro On Site Representative.

3 JUSTIFICATION

Presently, Hydro's terminal stations are not equipped with a fire suppression system. This poses a risk to the system and this risk has been identified by our risk and insurance agent, FM Global, at a similar terminal station in Stephenville (See Appendix A). A project started in 2015 at the terminal station at Holyrood to install a gaseous extinguishing system using the clean agent, Inergen, and this project will be completed in 2016.

The Bay d'Espoir terminal station building includes the switchyard control and protection equipment for 230 kV and 69 kV transmission lines and supply from the generating units in Bay d'Espoir. Terminal stations control power flow on the grid transmission lines and reduce the grid voltage to sub transmission voltage. The control room in the terminal station building contains control cabinets with a significant combustible loading due to the number of cables. As the facility is unattended, a fire in the cable trenches or cabinets could quickly spread, causing severe damage to the equipment in the building. Loss of this building or severe damage to the equipment from fire would reduce power from Bay d'Espoir for an extensive period of time. Powerhouse 1 and 2 in Bay d'Espoir house seven generating units that have a capacity of approximately 600 MW, this is approximately 40% of the winter peak demand.

Further, the addition of any protection, suppression and/or detection system within our facilities will, in the long term, ensure property insurance rates remain competitive.

3.1 Existing System

The terminal station control room has a smoke detector with a fire alarm tied into the Bay d'Espoir plant but no fire suppression system. The control panels, cable trays above the panels and the cable trenches contain control, communications and power cables as shown in Figures 1, and 2.

The current Terminal Station has had no major work or upgrades since it was constructed in

1982. During the time of construction a fire suppression system was not installed.



Figure 1: Bay d'Espoir Terminal Station – Control Panels and Cable Trays



Figure 2: Bay d'Espoir Terminal Station – Inside Control Panels and Cable Trench

3.2 Operating Experience

Inergen fire suppression systems were installed throughout Hydro in the 1990s to replace Halon fire suppression systems due to the fact that Halon was determined to be an ozone depleting substance. Installation of the Inergen systems mainly included Hydro's telecontrol and communication rooms, control rooms in unattended power plants and in the gas turbine plants. There have not been any operational issues with these systems and maintenance requirements are completed to meet NFPA and ULC code requirements.

3.2.1. Outage Statistics

In 2002, at the frequency convertor in Corner Brook, which does not have a fire suppression system, a fire caused some major damage to cables and placed that system out of service for a period of six weeks.

3.2.2 Safety Performance

Any fire has the potential of serious health and safety issues especially for those who must extinguish the fire if it is not extinguished automatically.

3.2.3 Industry Experience

It is recommended by FM Global to install these systems where major loss due to fire is critical. For example, at Manitoba Hydro, where equipment criticality, equipment value, life safety, or access restrictions warrant, they now install automatic fire suppression systems.

3.2.4 Vendor Recommendations

The vendor, KD Pratt, along with FM global, has recommended the use of this type of system.

3.2.5 Maintenance or Support Arrangements

Maintenance of a new fire suppression system would be completed by a certified contractor on an annual basis or as required by code.

3.2.6 Historical Information

A proposal was approved last year by the Board of Commissioners of Public Utilities (Board Order No. P.U. 50(2014)) for the installation of a fire protection system at the terminal station in Holyrood in 2015-16.

3.2.7 Anticipated Useful Life

Every 20 years the Inergen cylinders must be discharged, inspected and pressure tested in a shop.

3.3 Development of Alternatives

There are no viable alternatives to installing this fire suppression system in a terminal station. The only alternative here was to keep the status quo of no fire suppression system but this option was deemed not viable due to the potential of losing 40% of peak demand capacity from Bay d’Espoir.

Other terminal stations have been proposed to be upgraded with a fire protection system. The tentative schedule for the other locations is as follows:

- 2017-2018: Hardwoods and Western Avalon Terminal Stations;
- 2018-2019: Oxen Pond, Sunnyside, and Stoney Brook Terminal Stations;
- 2019-2020: Massey Drive, Buchans, and Voisey’s Bay Nickel Terminal Stations; and
- 2020-2021: Deer Lake, Come By Chance, and Bottom Brook Terminal Stations.

These other terminal stations will have separate proposals developed in the appropriate year.

4 CONCLUSION

None of Hydro's 230 kV terminal stations are equipped with fire suppression systems in the control room buildings. The control room at the terminal station in Bay d'Espoir contains control cabinets with high concentration of control, communications and power cables that are combustible. A fire could result in major damages to the protection, communications and control equipment which would result in a significant portion of the island to be without power for an extended period of time. Installation of a fire suppression system at the Bay d'Espoir terminal station and all other 230 kV terminal stations in future years is planned to protect Hydro's critical assets from major loss and to prevent the loss of supply of power to our customers in the event of a fire. Also, the suppression system would reduce the risk to firefighters.

4.1 Budget Estimate

Table 1: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	2.5	0.0	2.5
Labour	36.2	81.1	0.0	117.3
Consultant	0.0	0.0	0.0	0.0
Contract Work	150.0	310.0	0.0	460.0
Other Direct Costs	1.6	7.8	0.0	9.4
Interest and Escalation	12.2	46.8	0.0	59.0
Contingency	0.0	117.8	0.0	117.8
TOTAL	200.0	566.0	0.0	766.0

4.2 Project Schedule

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Open work order, develop detailed schedules.	March 2016	March 2016
Procurement	Procurement of contractor and materials	April 2016	May 2016
Design/Options	Detailed design of system by contractor	June 2016	August 2016
Final Design	Approved design with drawings	October 2016	October 2016
Construction	Installation of system	May 2017	May 2017
Commissioning	Commissioning of system	June 2017	June 2017
Closeout	Lessons learned, as built drawings, lessons learned	July 2017	September 2017

APPENDIX A

FM GLOBAL RISK REPORT

Stephenville Gas Turbine

2011

FM Global Risk Report

Nalcor Energy

10-05-001 continued

Technical Detail	- all components are capable of withstanding a 2-hour fire exposure by an ASTM E-119 test from either side with no flame penetration to the unexposed side; and - barriers are capable of withstanding not less than 25% of full design wind loads at maximum fire-exposed material temperatures. Use design wind speeds (3-second gust) per <i>FM Global Property Loss Prevention Data Sheet 1-28, Design Wind Loads</i>, or similar, acting concurrently with the worst-case fire exposure. For the Stephenville area, this speed is estimated at 117 mph. Barriers should extend 1 ft. vertically and 2 ft. horizontally beyond transformer components. As per <i>FM Global Property Loss Prevention Data Sheet 5-4 on Transformers</i>, a distance of 50 ft. would be needed between the transformer and the gas turbine building.
RiskMark Points	Completion of <u>only</u> this recommendation will result in a RiskMark score increase of 2.03 Points.
Status	This will need to be further considered at the corporate level.

06-03-001

Install an Inergen system to protect the control equipment of the power station.

The control cabinets and the concealed space located under the floor of the control room located in the Main Building (No.2 on the insurance sketch) should be protected with a gaseous extinguishing system using a clean agent.

General guidelines for the selection, plan submittal, design and installation, testing and maintenance of special protection systems should be followed in accordance with *FM Global Property Loss Prevention Data Sheets*.

FM Global Risk Report

Nalcor Energy

06-03-001 continued

The Hazard	This facility is attended only on Mondays to Fridays during the day, however, it is unattended on weekends. A fire involving the control cabinets or combustible false floor could grow undetected for a long period of time, causing severe physical damages which would most likely lead to the total destruction of control equipment. Such an incident would impair the power station for many months.
	 Cables under False Floor of Control Room
Technical Detail	The control room features control cabinets, a combustible false floor, and a significant combustible loading underneath due to a concentration of cables.
RiskMark Points	Completion of <u>only</u> this recommendation will result in a RiskMark score increase of 1.95 Points.
Status	Mr. James Wheeler stated that there are currently no plans to install an Inergen system in the recommended area. Such an installation needs to be approved at the corporate level due to the costs involved.

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

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

**Replace Roof on Services Building
Bishop's Falls**

July 2015

SUMMARY

Constructed in 1989, the Bishop's Falls Services building has a total floor area of approximately 1,100m². The facility provides maintenance, storage and administrative space. It is strategically located in Central Newfoundland and serves as the hub for Hydro's central and northern operating groups.

The facility's roofing system is original to the building and has not undergone any major upgrades since its installation. A condition assessment, completed by Coles Associates in 2013, noted that the roof was nearing the end of its service life and its replacement was recommended. Given the roofing system's age and noted condition, the completion of repairs is not a viable alternative.

The Bishop's Falls Services building is a critical asset to Hydro's operations group. The proposed roof replacement must be completed to mitigate risks associated with the formation of leaks and to provide a new roofing system capable of providing maintenance free protection for the next 25 years.

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1 INTRODUCTION

Constructed in 1989, the Bishop's Falls Service building has a total floor area of approximately 1,100m². The facility provides maintenance, storage and administrative space. It is strategically located in Central Newfoundland and serves as the hub for Hydro's central and northern operating groups.

The facility's roofing system is original to the building and has not undergone any major upgrades since its installation. A condition assessment, completed by Coles Associates in 2013, noted that the roof was nearing the end of its service life and its replacement was recommended.

The replacement of the roof must be completed to mitigate risks associated with the formation of leaks and to provide a new roofing system capable of providing maintenance free protection for the next 25 years.

This project is driven by Hydro's requirement to replace an asset which has reached the end of its service life.

2 PROJECT DESCRIPTION

This project comprises the replacement of the roofing system for the Bishop's Falls Services building with a new mechanically fastened roofing system.

The project scope includes:

- replacement of deteriorated wood blocking;
- reinforcement of all perimeters, projections, and roof/wall junctions;
- supply and installation of new projection sleeves and insert drains;
- supply and installation of new vapour barrier and composite insulation;
- supply and installation of a new cold-applied roofing system; and
- installation of new flashing.

3 JUSTIFICATION

The Bishop's Falls Services building's roof has reached the end of its service life. Given the roofing systems age and noted condition, the occurrence of leaks is imminent and the probability of a "blow-off", whereby the roofing system could become completely detached from the structure during periods of high wind, is greatly increased. While spot repairs can be enacted to address the occurrence of leaks, any repairs completed on the roof would be topical in nature and will not address the risk associated with the complete failure of the membrane. Detachment of the roofing membrane could prove disastrous, leaving the building contents fully exposed and/or resulting in significant damage to persons and/or equipment. A proactive approach is required to ensure that the roof replacement can be completed prior to the failure of the roofing membrane system.

3.1 Existing System

The Bishop's Falls Services building roof measures, approximately, 1,100 m² (see Figure 1). The facility was constructed with a built-up roofing system, consisting of two layers of insulation, separated by a layer of air/vapour barrier, and topped with a modified bituminous membrane.

The roof is original to the facility and has not received any major upgrades since its installation in 1989.

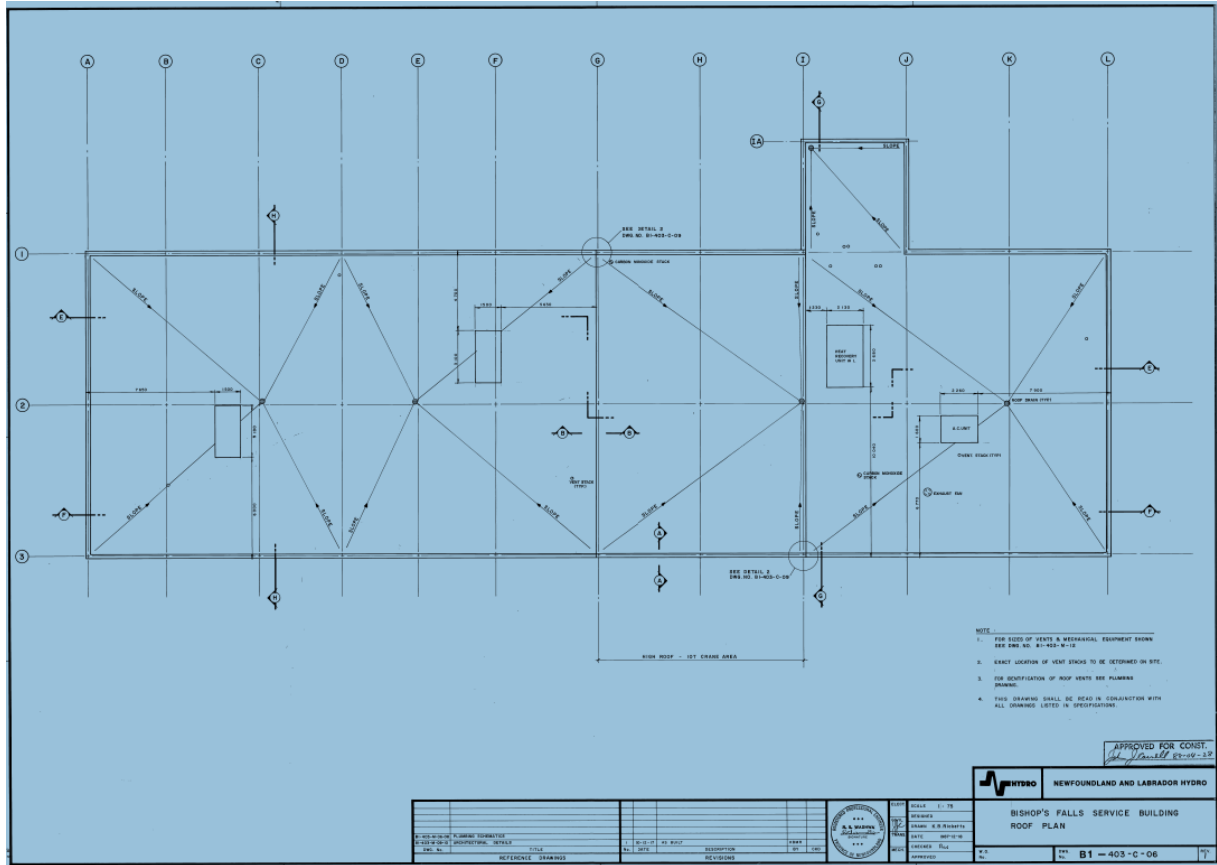


Figure 1: BFL Service Building Roof Plan

3.2 Operating Experience

The Services building's roof has reached the end of its service life and has started to show signs of deterioration, typical of its age. Noteworthy items include: considerable organic growth, visible membrane settlement, evidence of leakage within transition flashing, and evidence of previous membrane repairs.

3.2.1 Reliability Performance

While the service building's roof has performed well, it has reached the end of its service life and is starting to show signs of deterioration. Given the age and condition of the roof, its integrity has been compromised. Failure to adopt a proactive replacement strategy could result in the failure of the roofing system, potentially resulting in increased upgrade costs.

3.2.2 Industry Experience

Developed in the early 1980s, cold-applied roofing systems¹ are becoming increasingly common in today's industry. Typical roofing applications contain a 15 year service warranty and have a life expectancy ranging from 25 to 30 years.

Aside from its superior weatherproofing ability, cold-applied systems are widely preferred as they reduce fumes and pollution and eliminate the danger of fire during installation - making them the ideal choice for use in occupied buildings.

3.2.3 Vendor Recommendations

In 2013, Hydro engaged Coles Associates to conduct a condition assessment of the Bishop's Falls Services building. The assessment findings noted that the existing roofing system was nearing the end of its service life and its replacement was recommended.

3.2.4 Maintenance or Support Arrangements

Maintenance for this asset is typically completed by external contractors. Replacement of the existing roofing system will essentially eliminate maintenance requirements for the next 25 years.

¹ Cold-applied bituminous roofing systems include the same basic components as traditional asphalt-based systems: multiple reinforcement plies combined with a waterproofing agent. However, in cold-applied systems, a solvent-based adhesive replaces hot asphalt between the multiple reinforcement layers.

3.2.5 Maintenance History

The five-year maintenance history for the Bishop's Falls Services building is shown in Table 1.

Table 1: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	0.0	0.0	0.0
2013	0.0	0.0	0.0
2012	0.0	0.4	0.4
2011	0.0	0.0	0.0
2010	0.0	0.2	0.2

3.2.6 Historical Information

Recent roof replacements, completed by Hydro, consist solely of the Hydro Place mechanical penthouse roof replacement.

Additional roof upgrades at Hydro Place and upgrades to the Holyrood Thermal Generating Station's powerhouse roof will be completed in 2015.

Table 2 details the costs associated with roof upgrades within the past five years. All of the noted roof replacements involved cold-applied roofing systems.

Table 2: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units(sq. ft.)	Cost per Unit (\$000)	Comments
2015B	1,047.8	-	20,650	50.7	Holyrood powerhouse roof upgrades (Year 1)
2015B	671.9	-	15,000	44.8	Hydro Place Level 6, Level 5, and ECC
2013	199.7	162.9	5,450	36.6	Hydro Place Mechanical Penthouse

3.2.7 Anticipated Useful Life

The existing roofing systems have an anticipated useful life of 25 years.

3.3 Development of Alternatives

The roofing system, designated to be replaced under this proposal, has reached the end of its service life. Given its age, the completion of repairs or upgrades would not be feasible.

While isolated repairs can be completed to address the occurrence of leaks, any such repairs are topical in nature and will not address concerns pertaining to the membranes adherence to the roofing structure. Replacement is the only viable alternative to ensure that the roof's integrity is restored.

While there are a number of types of roofing systems available in today's market, the elimination of the open flame heat source, required for the installation of traditional hot-applied systems, provides for the safety of both persons and property. The added safety benefit provided by cold-applied systems make it the clear cut choice for Hydro.

4 CONCLUSION

The roofing system of the Bishop's Falls Services building has reached the end of its useful service life. It is starting to show signs of deterioration, typical for roofs of this age, and will continue to deteriorate over the next few years. If left unaddressed, the roofing system will inevitably form leaks and is at risk of failing completely.

A proactive approach is required to restore the integrity of the Services building's roof.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 3.

Table 3: Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	79.0	0.0	0.0	79.0
Consultant	45.0	0.0	0.0	45.0
Contract Work	359.3	0.0	0.0	359.3
Other Direct Costs	2.3	0.0	0.0	2.3
Interest and Escalation	30.1	0.0	0.0	30.1
Contingency	97.1	0.0	0.0	97.1
TOTAL	612.8	0.0	0.0	612.8

4.2 Project Schedule

The anticipated project schedule for this work is provided in Table 4.

Table 4: Project Schedule

Activity	Start Date	End Date
Planning	February 2016	March 2016
Consultant Engagement	March 2016	April 2016
Design	April 2016	May 2016
Procurement	May 2016	June 2016
Construction	July 2016	August 2016
Commissioning	-	August 2016
Closeout	-	October 2016

APPENDIX A

Building Condition Assessment and Rehabilitation/Relocation/Expansion Assessment

Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL

December 20, 2013

**Building Conditions Assessment and
Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL**

Prepared For:

Newfoundland and Labrador Hydro

Prepared By:



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1 INTRODUCTION

The normal design life of a typical building is in the range of 25 to 30 years. The Bishop's Falls Service Facility is intended for maintenance, operations, and administration purposes for line workers. This facility was built during the construction period within this era and Newfoundland and Labrador Hydro is looking to determine and evaluate the immediate, short, and long term capital renewal/extension/upgrade requirements that can be expected over the next 25 years. The intention is to bring all of the support facilities up to the Newfoundland and Labrador Hydro standard. It is anticipated that this site will continue with similar occupancies, staffing levels and activities for the foreseeable future.

The scope of this evaluation was restricted to the service facility as illustrated within Appendix A.

Coles Associates was retained to undertake an audit and prepare a report to:

- ✦ Assess the building envelope and systems to identify Priority 1, 2 and 3 (immediate, short and long term) areas where problems are occurring within the building and/or may occur.
- ✦ Make note of any possible Life Safety and/or Code compliant issues that were visible. (Note: a thorough Life Safety, Building and Fire Code analysis was not performed as part of this Building Condition Audit.)
- ✦ Investigate the need for expansion and/or relocation of the facilities in addition to the rehabilitation priorities, and
- ✦ Provide estimates on the costs of all recommendations.

2 EXECUTIVE SUMMARY

In early December of 2013 a team of consultants reviewed the Bishop's Falls facility. The objective was to undertake a Building Condition/Rehabilitation/Relocation/Expansion Assessment Audit.

In summary, it is the purpose of this study to undertake the following tasks:

- ✦ Establish the current condition of the architectural, structural, mechanical and electrical building components and systems;
- ✦ Assess deficiencies of the building relative to current code and/or indicated usage;
- ✦ Determine the need for either rehabilitation, relocation and/or expansion; and
- ✦ Provide a cost estimate of all recommendations.

The Bishop's Falls Facility is located on the Botwood Highway in Bishop's Falls, NL.

There is no mechanism within the National Building Code (NBC) that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change.

While there may be opportunities to increase the energy efficiency and/or functionality of this facility through such changes as internal/external renovation and/or increased insulation in the roof and walls, as well as the windows, given its age, it is anticipated that this decision point will be based upon a financial payback model as is undertaken for most private clients. There was also no indication that these existing elements were deteriorating into a priority 1 or 2 status.

Following review there are approximately:



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\$212,000 of Priority Level #1 work to be undertaken.
\$194,250 of Priority Level #2 work to be undertaken.
\$161,000 of Priority Level #3 work to be undertaken.

All as defined below. To these amounts and as shown in Section 6, a 30 % contingency has been added in the amount of \$170,175.

3 METHODOLOGY

3.1 Building Audit

The method of study was by site visit by a team of consultants from Coles Associates. Audit Work included tasks to familiarize, visually review, and document the condition of the building.

One visit was made to the facility to conduct interviews with the building manager and a walk-through investigation. The building audits were completed by:

Architectural/	Robert Haggis, RAIC, AIA, NCARB
Structural	
Mechanical	Sean Wheeler, P.Eng.
Electrical	Elliott Coles, E.I.T.

The report was reviewed by Douglas A. Coles, P.Eng., P.E., F.E.C.

3.2 Drawings

Floor plans of the facility were available for the Audit. Floor plans were confirmed, where warranted, from rough measurements taken on site. Site documentation was unavailable.

3.3 Prioritization

The deficiencies/recommendations falling out of these reports and/or walkthrough will be identified indicating three priority levels:

1. **Priority One:** Where immediate attention is required in order to maintain or to re-establish the integrity of a strategic system, process, weather envelope, etc., in order to comply with life safety, Building Code violations and/or those resulting from Orders delivered by the Authority having Jurisdiction (AHJ) to prevent further on-going exposure, damage or deterioration or to remove or lessen a threat to life safety.
2. **Priority Two:** Where systems require attention but present no immediate risk to system integrity or to life safety. The short to intermediate nature of these issues (one to three years) is such as to allow some orderly planning and financial resource development to occur.
3. **Priority Three:** This category identifies intermediate to longer-term issues. In the context of this report and at the heart of the Priority Three issues is the long-term disposition of this facility in total; given the condition of the envelope, the issues of non-compliance with current codes for items such as wall insulation levels; and the implications and costs of its repair.

3.4 Quality Assessment

Throughout the report references are made to the quality of materials and systems. The following provides a guide to the intent of the grading.



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⊕ Good	Suitable for continued use.
⊕ Serviceable	Is able to remain in service with regular maintenance.
⊕ Marginal	Is able to remain in service with heavy maintenance.
⊕ Suspect	Requires further investigation, is not visible though possibly problematic.
⊕ Poor	Requires significant maintenance, repair or replacement.
⊕ End of useful life	Requires replacement. In practical terms, systems tend not to fail all at once. In this instance "outlived its useful life" means that it is time to seriously look at putting a financial plan in place to replace the identified system in the short term.

3.5 National Building Code

The National Building Code (NBC) is a document prepared by the National Research Council of Canada, which historically has been updated every 5 years. It is the purpose of the NBC to establish standards for building construction and systems, the focus of which is occupant safety. It is the underlying intent of the NBC to provide a level of systems and environment within a building, which provide for adequate life safety, environmental conditions (i.e. light levels and air ventilation levels) and mobility (i.e. barrier-free access). While all regulations do not necessarily get more stringent, regulations very often change. In fact, buildings never "catch up" to the state of the current-day Codes.

There is no mechanism in place that requires a building owner to maintain the building current with the NBC as long as the functional use/classification of the facility does not change. At the same time, Authorities Having Jurisdiction have the right to make inspections at their discretion and direct improvements to components and/or systems where they feel life safety is at risk.

In upgrading older buildings, which were not originally designed to incorporate fire ratings or sometimes bulky and space consuming systems, it can be difficult to achieve the letter of the regulation. More often it is the intent to reasonably protect life safety, which is more readily achievable.

Therefore the purpose of the review of the salient requirements of the NBC is to provide a basis of comparison against the current Code requirements and to estimate the capital cost to upgrade the building to these standards.

Specific areas of this report deal with issues that should be undertaken in the short term for reasons of life safety, regardless of the ultimate disposition of the building.

3.6 Standard Classification for Building Elements and Related Site Work – UNIFORMAT II

- ⊕ This standard establishes a classification of building elements and related site work.
- ⊕ The classification serves as a consistent reference for analysis, evaluation, and monitoring.
- ⊕ Referenced documents, E917 Practice for Measuring Life-Cycle Costs of Buildings and Building Systems,
- ⊕ The classification is hierarchical to allow different levels of aggregation and summarization.

4 BUILDING SUMMARY

In general, the Bishop's Falls facility is a steel frame and CMU block structure on concrete foundations.

Age Approximately (Building Original) 25 years



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Location Bishop's Falls, NL
Ownership Newfoundland and Labrador Hydro

5 BISHOP'S FALLS SERVICE FACILITY

5.1 A SubStructure

5.1.1 A10 Foundations

.1 A1010 STANDARD FOUNDATIONS

- ⊕ The foundations were described as standard frost walls with footings.

IT IS RECOMMENDED THAT:

1. None at this time.

.2 A1020 SPECIAL FOUNDATIONS

- ⊕ Not applicable.

.3 A1030 SLAB ON GRADE

- ⊕ Generally, the majority of the concrete slab is in good to serviceable condition with minor cracking.
- ⊕ The slab has settled slightly near the foundation wall on the north side area encompassing the steam cleaning room, battery room, and electrical room. Although the settlement had occurred, it was not visually evident that this was a continuing issue.

IT IS RECOMMENDED THAT:

1. None at this time.

5.1.2 A20 Basement Construction

.1 A2010 BASEMENT EXCAVATION

- ⊕ Not applicable.

.2 A2020 BASEMENT WALLS

- ⊕ Not applicable.

.3 A2030 BASEMENT COLUMNS

- ⊕ Not applicable.

5.2 B Shell

5.2.1 B10 Superstructure

.1 B1010 FLOOR CONSTRUCTION

- ⊕ See 5.1.1.3 see A1030.

.2 B1020 ROOF CONSTRUCTION

- ⊕ The roof was original to the building.
- ⊕ It consisted of a flat built up membrane roof.
- ⊕ There was evidence of past/current leakage. This evidence was in the form of minor repairs of the West portion of the roof and major modified bitumen and tar patch work around the air handling units of the east portion of the roof. As well there was evidence of stained Acoustic Ceiling Tiles (ACT) throughout the upper floors.
- ⊕ The word "DAMP" was spray painted on the roof membrane. This was unable to be explained by the local personnel; however, anecdotally this area was considered to be restrictive by personnel.



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- ✦ There is visual evidence of organic growth on the roof membrane. This growth would not be considered to be minor.
- ✦ There is evidence of ponding deemed around all of the air handling units (AHU).
- ✦ Also, although the top sheet appeared in serviceable condition the roof itself was considered to be in marginal to poor condition.
- ✦ The level of insulation was not readily visible but given the age of the building should be considered for increasing with any roof replacement.
- ✦ Evidence of leaking in some transition flashing.
- ✦ Evidence of minor rust spots on vertical flutes of metal siding.
- ✦ Cap flashing was dented and misshapen in various areas which may have been corrected. It is presumed that the flashing was damaged by the wind.
- ✦ All caulking at transition and cap flashing has reached the end of its lifespan; cracking and uncaulked joints were evident.

IT IS RECOMMENDED THAT:

1. Remove all caulking and replace with new. Installation may be more suitable at the time of roof and flashing replacement - **Priority 2**
2. Replace roof – **Priority 2**

5.2.2 B20 Exterior Enclosure

.1 B2010 EXTERIOR WALLS

- ✦ The exterior wall was a combination of metal siding and brick veneer, against a CMU block structure.
- ✦ The level of wall insulation was presumed to be consistent with a building of this age but was not determined from the site visit.
- ✦ Exterior wall system was considered to be good to serviceable.
- ✦ Obvious brickwork was undertaken on the south side of the building.
- ✦ Brick re-pointing may be required in some areas.
- ✦ Some minor rusting is visible at window lintels.
- ✦ Additional remedial caulking was evident.
- ✦ Evidence of minor rust spots on vertical flutes of metal siding which was presumed to be from exterior piping; notably below sprinkler discharge pipes.

Insulation

- ✦ Presumed to be typical installation for a building of this vintage.

IT IS RECOMMENDED THAT:

1. Monitor and repoint brick as required - **Priority 3**
2. Provide leaders to grade at sprinkler discharge pipes - **Priority 3**
3. Clean and monitor condition of metal siding where rusting has occurred - **Priority 3**

.2 B2020 EXTERIOR WINDOWS

- ✦ The majority of the exterior windows are aluminum operable double pane.
- ✦ Some windows are anodized.
- ✦ Some major caulking has been applied to deteriorating window gasket at the south window off of heavy vehicle and maintenance shop.

IT IS RECOMMENDED THAT:

1. Monitor and replace south window off of the heavy vehicle and maintenance shop – **Priority 2**

.3 B2030 EXTERIOR DOORS

- ✦ Entrances and exits are insulated hollow metal doors.



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- ⊕ Doors and jambs have begun to deteriorate noticeably.
- ⊕ Otherwise the hardware is in good condition.

IT IS RECOMMENDED THAT:

1. Replace metal doors and jambs; repair and replace mortar as needed – **Priority 1**
2. Replace hardware as warranted by addition study when doors are replaced – **Priority 2**

.4 B2035 EXTERIOR OVERHEAD DOORS

- ⊕ Overhead doors are insulated hollow metal doors, electrically operated and in both accordion and regular high lift style.
- ⊕ The doors are in fair to poor condition.
- ⊕ The hardware is in serviceable condition.
- ⊕ Doors are nearing to the end of their service life.

IT IS RECOMMENDED THAT:

1. Replacement of all accordion style overhead doors - **Priority 1**
2. Replacement of all sectional overhead doors - **Priority 1**

.5 B2040 EXTERIOR STAIRS/ROOF ACCESS LADDERS

- ⊕ The exterior stairs/access were constructed of painted steel members.
- ⊕ Components of the roof access are in need of immediate remediation.
- ⊕ Components of the external stairways are in need of immediate remediation.
- ⊕ Visual rust on the stairs and access ladders was evident.
- ⊕ Anchor points could be improved. Base connection would be a candidate for redesign and modification under any stair replacement program.
- ⊕ Handrails on the roof accesses were less than sturdy.
- ⊕ Roof access systems would be considered to be serviceable.

IT IS RECOMMENDED THAT:

1. Sand-blast/replace and recoat stairways/roof access ways - **Priority 1**
2. Complete preventative maintenance on external stairways and roof access – **Priority 3**
3. Consider manner in which the stairways are attached to the ground – **Priority 2**

.6 B3010 ROOF COVERINGS

- ⊕ See 5.2.1.2 B1020.

IT IS RECOMMENDED THAT:

1. None at this time.

.7 B3020 ROOF OPENINGS

- ⊕ Not applicable.

5.3 C Interiors

5.3.1 C10 Interior Construction

.1 C1010 PARTITIONS

- ⊕ The interior partitions in the building are block wall with no applied surface in the more industrial areas while the office and welfare area tended to be of wood stud and ceramic or drywall. Generally, they are in good to serviceable condition.
- ⊕ Lack of interior partitions is jeopardizing the electrical distribution and transformer units in the heavy equipment and vehicle maintenance shop area and providing for a hazardous condition. It has been suggested that a waterproof protective enclosure around the 600V equipment is required. See electrical section for further information.

IT IS RECOMMENDED THAT:



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1. Construct waterproof enclosure around distribution panels - **Priority 1**

.2 **C1020 INTERIOR DOORS**

- # Metal doors and metal frames are generally present throughout the industrial part of the facility.
- # Wood doors and metal frames are generally present throughout the office and welfare areas of the building.
- # Doors and frames are in good to serviceable condition.

Hardware

- # In general, the hardware throughout the building, closures, kick plates, door knob, lock and key sets/ privacy sets are in good to serviceable condition.
- # Some surface rust is evident on some of the hardware.

IT IS RECOMMENDED THAT:

1. None at this time.

.3 **C1030 INTERIOR WINDOWS**

- # Not applicable.

.4 **C1040 FITTINGS**

Washroom Accessories

- # Generally washroom accessories are in good condition.

Vanities

- # The vanities are sound and in good condition.

Millwork

- # The millwork is sound and in good condition.

IT IS RECOMMENDED THAT:

1. None at this time.

5.3.2 **C20 Stairs**

.1 **C2010 STAIR CONSTRUCTION**

- # Interior stairs are constructed of metal stringers, checkerplate treads and metal risers in good condition.
- # Handrails are metal tubing in good condition.

IT IS RECOMMENDED THAT:

1. None at this time.

.2 **C2020 STAIR FINISHES**

- # Painted metal in good condition.

IT IS RECOMMENDED THAT:

1. None at this time.

5.3.3 **C30 Interior Finishes**

.1 **C3010 WALL FINISHES**

- # Walls where paint is applied are in good to serviceable condition.
- # Ceramic walls are in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. None at this time.



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.2 C3020 FLOOR FINISHES

- # Painted concrete in the industrial areas generally is in good to serviceable condition.
- # Vinyl composite tile with rubber base generally in welfare and office areas generally is in good to serviceable condition.
- # Some base missing and should be replaced.
- # Tile in Tool Room 103 is in poor condition and requires replacement.
- # Tile in Corridor 124 is in poor condition and requires replacement.
- # The concrete flooring in the shops area are unpainted.

IT IS RECOMMENDED THAT:

1. Replace tile in Room 124 and 103 – **Priority 2**
2. Repair/replace base – **Priority 2**

.3 C3030 CEILING FINISHES

- # Generally Acoustical Ceiling Tile (ACT) was present in the office and welfare areas and is for the most part in good condition with some staining and cracked tiles noted.

IT IS RECOMMENDED THAT:

1. Replace ceiling tiles which are cracked/stained – **Priority 2**

5.4 D Services

5.4.1 D10 Conveying

.1 D1010 ELEVATORS & LIFTS, D1020 ESCALATORS & MOVING WALKS

- # Not applicable.

.2 D1090 OTHER CONVEYING SYSTEMS

- # Not applicable.

5.4.2 D20 Plumbing

.1 D2010 PLUMBING FIXTURES AND TRIM

- # The water closets throughout are white vitreous china. Water closets are floor mounted 12 litre tank type with regular rim bowls. The water closets throughout the facilities are in serviceable condition.
- # Lavatories throughout are vitreous china. Lavatories are counter mount type. Lavatory trim is a mixture of blade and round type handles. Trim is in serviceable condition, requiring adjustment and maintenance.
- # The urinals are standard wall hung units which are fed from a flush tank mounted high on the wall which in turn fills and siphons into the urinals. It is expected that the water flows continuously through the urinals resulting in the high water consumption. This could reduce the life expectancy on the tile field.
- # Kitchen sink is a double bowl stainless steel sink, with round handled trim. Sink and trim are in serviceable condition, with trim requiring adjustment and maintenance.
- # Stand-up shower is two piece molded composite with curtain enclosure. Trim is single lever valve with regular shower head. Shower, enclosure trim and shower head are in marginal condition.
- # The hot water, cold water and sanitary piping servicing these fixtures appears to be in good condition and consistent with late 1980's construction.
- # The fixtures and associated trim in the facility are not required to meet accessibility requirements for persons with disabilities.

IT IS RECOMMENDED THAT:

1. Replacement of the urinals with ultralow flow flush type urinals – **Priority 2**



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.2 D2020 DOMESTIC WATER DISTRIBUTION

Domestic Cold Water

- # The facility receives domestic cold water from the municipal system. The service entrance is shared with the sprinkler system and appears to be 1 ½ half inches. There is a pressure reducing valve which drops the building pressure to 50 PSI.
- # The piping for the domestic cold water and domestic hot water is generally copper pipe throughout. There are signs of light surface rust around the pipes. It is expected that the solder used for the copper pipe is a 50/50 lead-tin mix, which would be typical of the solder used in that time period. A water quality test should be conducted to verify that water is within current national guidelines.
- # There are no backflow preventers on the service entrance.
- # Check valves and vacuum breakers were used in limited locations to provide limited backflow prevention.
- # A full backflow prevention audit should be performed.

Domestic Hot Water

- # The domestic hot water system supplies hot water for the building including washrooms, showers and sinks.
- # The domestic hot water is provided from 3 electric hot water heaters. The heaters appear in good condition.
 - o The tank in the south of the building is a GSW model SS125EB 10 gallon 1500 W heater located under the lunch room sink.
 - o The tank in the center section of the building is a GSW series 6 model 6ETF-1-175, 60 gallon 3000 W heater located in the janitorial room under the stairs.
 - o The tank in the North end of the building is a John's Wood Pro model JW50SDEN1 60 gallon 3000 W heater located in the second floor janitorial room.
- # The heaters are located near fixtures served. No recirculation system is provided in the buildings. All fixtures tested appeared to have hot water available on demand.

IT IS RECOMMENDED THAT:

1. Perform backflow contamination evaluation around the facility – **Priority 3**
2. Test drinking water for inclusion of treatment systems – **Priority 3**

.3 D2030 SANITARY WASTE AND STORM DRAINAGE SYSTEMS

- # The storm, sanitary and drain, waste and vent lines appear for the most part to be cast-iron.
- # There was evidence of general leaks. These may contribute to the staining identified in the architectural portion of the report. These leaks were largely attributed to the roof however, we would recommend a further complete visual investigation and remediation (as necessary) of the drainage system be undertaken.
- # Floor drains and keynotes throughout are in relatively fair to good condition.
- # Conversations with maintenance staff indicated that all sanitary passed through an oily water sump pit prior to being discharged to a 20,000 L septic tank and tile field located on the far east portion of the site.
- # A site plan indicating domestic water, storm and sanitary services does not show any connections from the building to the sanitary services. The plan shows one connection to storm services exiting the Northeast corner of the building. Further investigation and updating of the site plan.
- # Given the above information an investigation to confirm all sanitary fixtures, floor drains and oily water sumps are connected to the sanitary system is warranted.

- ⊕ The roof of the building is a modified type with roof drains centrally located. There were areas of the roof where water was pulling away from roof drains. Whenever a major roofing project is undertaken consideration should be given to ensure the roof is re-sloped and additional roof drains are added as required.

IT IS RECOMMENDED THAT:

1. A complete visual investigation and remediation (as necessary) of the drainage system be undertaken – **Priority 2**
2. Investigation and updating of the site plan insofar as waste and water lines are concerned – **Priority 3**
3. Investigation to confirm all sanitary fixtures, floor drains and oily water sumps are connected to the sanitary system – **Priority 3**
4. Roof is re-sloped and add additional roof drains as required whenever major roof work is undertaken – **Priority 3**

.4 D2090 OTHER PLUMBING SYSTEMS ACCESSORIES

- ⊕ The oil water sump has a duplex hydromatic pump system and controller installed. The pumps are currently manually operated with the controller disabled.
- ⊕ The sump has Zurn electronic oil/grease alert which is currently switched off. Operators currently dip the sump on a daily basis to check for hydrocarbon contamination.
- ⊕ A 2300 L underground waste lube oil tank is installed near the steam cleaning room. There is no evidence of a containment sump, double wall piping or access for inspection. It is anticipated that the installation is original to the facility. Consideration should be given to upgrading to meet the latest standards and codes.
- ⊕ Maintenance personnel indicated that drainage from the vehicle service pit was not operational. This pit required manual pumping on a regular basis. It was indicated that this was related to the oily water sump issues. Consideration should be given to installing a new oily water separator and monitoring system meeting current standards and environmental regulations.

IT IS RECOMMENDED THAT:

1. Upgrade underground waste lube oil tank and piping system - **Priority 3**
2. Upgrade the oily water separator and monitoring system - **Priority 3**

5.4.3 D30 HVAC

.1 D3010 ENERGY SUPPLY

- ⊕ Not applicable.

.2 D3020 HEATING SYSTEMS

- ⊕ The accommodations facility is heated using Stelpro/Chromalox baseboard electric heaters as well as electric horizontal and vertical unit heaters. The condition of these units appears to be serviceable.
- ⊕ Heating is controlled by line voltage thermostats, with a significant number of thermostats having been switched to low voltage programmable thermostats. The system is functional and should be maintained on a regular basis.
- ⊕ One piece of baseboard in the South Lunch room is beyond useful life.

IT IS RECOMMENDED THAT:

1. Replace baseboard in South Lunch room – **Priority 1**
2. Condition of fins and guards are checked on a regular basis – **Priority 3**

.3 D3030 COOLING SYSTEMS

- # Air conditioning is provided to the facility using two wall-mounted built-in air-conditioning units and one roof mounted Trane air-conditioning unit.
- # The air conditioner in the south office is an Electrolux model HW905800 Reykjavik 9000 BTUs/hour drawing 12 A on a 120 V circuit. Air conditioner was plugged into a wall receptacle. This unit appeared in serviceable condition.
- # The air conditioner in the center office is a three-quarter ton electronic home unit and appeared in serviceable condition.
- # Air conditioner controls were integral to the units.
- # For the roof top Trane unit see section 5.4.3.5 D3050 Ventilation Systems.

IT IS RECOMMENDED THAT:

1. Provide separate electrical circuit for air-conditioning units – **Priority 2**
2. Wall-mounted built-in air-conditioning units to be evaluated for replacement – **Priority 2**
3. Condition of fins to be checked on a regular basis - **Priority 3**

.4 D3040 HVAC DISTRIBUTION SYSTEMS

- # The ductwork was presumed to be original to the building.
- # It can be expected to be dirty considering its age.

IT IS RECOMMENDED THAT:

1. Duct cleaning to be undertaken – **Priority 3**

.5 D3050 VENTILATION SYSTEMS

- # One (1) Penn Fumex model XR94, 4 hp fan is located on the north portion of the building and was off during the site visit. It appears to service the washrooms.
- # One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the steam cleaning room. The fan appeared to be operational.
- # One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the machine shop. The fan appeared to be operational.
- # One (1) Penn Fumex horizontal exhaust fan is located on the wall outside of the equipment testing room. The fan appeared to be operational.
- # One (1) Kramer Tool & Manufacturing stationary rectangular shaker type dust collector is located in a room attached to the south face of the building. It has four (4) 24 inch drums. Air is circulated using a 19 1/8" Dayton 8 hp blower. An under slab 12 inch duct collects dust from:
 - o one skill saw,
 - o two planers,
 - o one large bandsaw,
 - o one bandsaw,
 - o one table saw,
 - o one sander.

The unit returns are directed to the building. The current system does not meet code and should be replaced or removed.

- # The machine shop has an in-line cabinet fan and heating coil making up air to the room. It appeared to be functional.
- # The machine shop has one welding fume extraction arm connected to a centrifugal exhaust fan and discharged through the outside wall.
- # The vehicle maintenance shop has 2 centrifugal exhaust fans which are connected to multiple vehicle exhaust extraction ducts. The operation of the fan is controlled by 2 CO sensors and manual switches. It is unknown when the CO sensors were last calibrated.

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- ⊕ Washrooms are served primarily by ceiling mount wash and exhaust fans, sidewall vented. The main washroom/locker room in the building is served by an in-line exhaust fan mounted above the ceiling. Conversations with staff indicated that the fan may be undersized. Washroom fans are operated by the light switch.
- ⊕ There are four (4) rooftop air handling units. Three (3) Engineered Air units and one (1) Trane unit.
- ⊕ The 3 Engineered Air units were located south, center and north. Each unit is a recirculation unit with electric heat and power exhaust complete with pleated filters. The Trane unit is located on the north portion of the building. All units appear to be original to the building.
- ⊕ The South unit (model LM-3-K, 3000 CFM) was in operation during the site visit. The filters required replacement. The filter showed signs of damage. The unit is in marginal condition and should be considered for replacement.
- ⊕ The central unit is approximately the same size as the South unit although the name tag could not be read. The central unit was not in operation during the site visit. Filters appeared to be in good condition. Occupants in the central portion of the building noted poor air quality. This in part could be due to this system not being operational at this time. Visually, the unit appeared to be in marginal condition and should be considered for replacement.
- ⊕ The North Engineered Air Unit is model LM 6K, 6000 CFM and is the larger of the two units. It was in operation during the site visit. Filters appeared in poor condition. Belts and the fans were loose, a latch was broken on the return air filter access and one blade on the outside air damper was broken. Ducting around the unit appeared to be modified recently. The unit was in marginal condition and should be considered for replacement.
- ⊕ The North Trane unit serves the northernmost section of the building which is primarily offices and storage. The unit has the ability to provide air-conditioning. It was not in operation during the site visit. The disconnect on the roof was switched off suggesting terminal problems. Occupants in the north portion of the building noted poor building air quality. This in part could be due to this system not being operational at this time. Visually, the unit appeared to be in marginal condition and should be considered for replacement.
- ⊕ Fumes from the maintenance garage were noted to be an issue during the inspection. Consideration should be given to adding a small continuously operated exhaust fan to this area to help improve relative building pressures.

IT IS RECOMMENDED THAT:

1. Calibrate carbon monoxide sensors – **Priority 1**
2. Plan for adjusting dust collection system - **Priority 3**
3. Replace filters on a preventive maintenance basis - **Priority 1**
4. Replace all four roof mounted air handling units - **Priority 2**
5. Replace broken outside air damper - **Priority 1**
6. Investigate why the Central Engineered Air unit was nonoperational - **Priority 1**
7. Add a maintenance garage continuous exhaust fan - **Priority 2**
8. Investigate why the North Trane unit was nonoperational - **Priority 1**

.6 D3090 HVAC SYSTEMS & EQUIPMENT

- ⊕ Not applicable.



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5.4.4 D40 Fire Protection

.1 D4010 FIRE EXTINGUISHERS

- ✦ A significant number of ABC type fire extinguishers were located around the Facility. Sizes, age and condition of extinguishers varied.
- ✦ All fire extinguishers were fully charged and had valid inspection tags.

IT IS RECOMMENDED THAT:

1. Inspect fire extinguishers on an annual basis – **Priority 1**

.2 D4020 AUTOMATIC SPRINKLERS

- ✦ The automatic sprinkler system service entrance is located in the mechanical storage room.
- ✦ The system has four (4) zones from south to north; civil works, terminals, garage and transmission.
- ✦ The incoming line is pressurized 90 PSI.
- ✦ The sprinkler verification certificate by Viking is dated June 2009.
- ✦ There are rust stains on the east face of the building where zone test connection pipes exit the building suggesting the system is leaking.
- ✦ The system appears in good condition.
- ✦ Discussions with maintenance personnel indicated the system was connected to municipal system which may have flow restrictions.
- ✦ There are no backflow prevention on the service entrance.

IT IS RECOMMENDED THAT:

1. Verify automatic sprinkler system on an annual basis - **Priority 1**
2. Confirm the adequacy of the incoming fire water line from the municipality and replace if required – **Priority 1**

5.4.5 D50 Electrical

.1 D5010 ELECTRICAL SERVICE & DISTRIBUTION

Main Service Equipment

- ✦ The Bishop Falls Service Building is fed by an aerial utility line to hydro pole which is then fed underground to a padmount utility transformer located at the north-east corner of the building.
- ✦ The utility service is then fed underground to the main electrical room and a 1200 A, 600 V, 3-phase, 4-wire, Federal Pioneer two (2) section switchboard c/w 1200 A main breaker, utility meter and distribution cells.
- ✦ The distribution section of the switchboard contains one (1) 300A/3P breaker feeding distribution panel 'DB' (Carpentry Shop), one (1) 450A/3P breaker feeding distribution panel 'DC' (Terminals and Machine Shop), one (1) 600A/3P breaker feeding distribution panel 'DE' (Maintenance Garage), one (1) and 30A/3P breaker feeding transformer 'NT4' for the Fire Alarm System.
- ✦ The Communications service is fed in a similar manner underground from hydro pole located at the northeast corner of the building to the communications backboard located in the main electrical room.
- ✦ The PVC conduit for the main power and communications services currently do not have the weather heads installed and are filled with water. This results in a hazardous condition.

Wiring System



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- ✦ The age of the existing wiring is presumed to be original to the building with the normal number of adjustments typical of a building of this function and age.
- ✦ All exposed teck cabling to Roof units and interior AC 90 feeders appear to be in good condition.
- ✦ 30A, 600V unfused disconnect switches for three (3) rooftop air handling units were rusting at joints and appeared to be losing their weather resistance/integrity.
- ✦ The 600V distribution panel and transformer in the carpentry shop and heavy vehicle maintenance shop area are directly exposed to water spray and ambient contamination from wood shop and metal working functions which can be considered a fire hazard.
- ✦ High voltage bus for gantry crane has been exposed to water as a result of roof leaks.
- ✦ In various locations, existing nylon faceplates for wiring devices were cracked or damaged.
- ✦ The majority of wiring devices throughout the facility appeared in reasonable to serviceable condition.
- ✦ It was noted that a large number of offices were outfitted with power bars and extension cords for supplying power to equipment.

IT IS RECOMMENDED THAT:

1. Install weather heads on the incoming services - **Priority 1**
2. Install a proper enclosure around the 600V distribution panels and transformers in the shops area and provide NEMA Type 3S sprinkler proof enclosures for all exposed electrical distribution equipment - **Priority 1**
3. Provide protection from the roof leaking onto the gantry crane high voltage bus until roof replacement is completed - **Priority 1**
4. Rusting disconnect switches at rooftop air handling units to be replaced with NEMA Type 4X disconnect switches - **Priority 2**
5. Replace all damaged nylon faceplates with stainless steel faceplates - **Priority 3**
6. To avoid tripping and fire hazards, duplex receptacles in offices should be replaced with quadruplex receptacles to eliminate the use of power bars and extension cords - **Priority 3**

.2 D5020 LIGHTING AND BRANCH WIRING

Interior Lighting

- ✦ Lighting in the buildings is accomplished through a combination of incandescent and fluorescent ceiling mounted and task luminaires and metal halide high bay luminaires for general lighting in workshop and garage areas.
- ✦ Lighting levels were measured and were found to be in accordance with the Illuminating Engineering Society (IES) recommended lighting levels throughout most of the building.
- ✦ Building personnel noted that continuing maintenance and lamp changes for the metal halide luminaires was becoming an issue.

Exterior Light Fixtures

- ✦ There are approximately twenty (20) existing wall mounted low pressure sodium (LPS) wall packs complete with integral button type photocell located around the perimeter of the building. Most of these wall packs were damaged, rusted and had flaking paint.



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Emergency Lighting

- # Emergency lighting were wall mounted plug-in type with incandescent lamps.
- # It was noted that there is inadequate emergency lighting with the corridor outside offices 213 and 214.

Exit Lights

- # The majority of exit lights were illuminated incandescent types complete with test switch and battery backup, however, several photo luminescent types remain installed.
- # Exit lights outside Kitchen 203, Corridor 206 and Boardroom 224 were not operational when tested.

Telephone/Data

- # The telephone/data system demarcation point is in the main electrical room in the northeast corner of the building.
- # There is existing data and telephone in all the main offices, kitchen and workshop areas.
- # A wire basket spans the length of the building to provide distribution of communication cables.

Door Intercom System

- # Not applicable.

Security Systems

- # Not applicable.

Card Access System

- # The existing proximity card readers were located at exterior doors and the access control system is fed to several access control panels located in Room 206.

Closed Circuit Camera System

- # The existing CCTV system is located at various exterior doors and fed to head and equipment located in Room 206.

IT IS RECOMMENDED THAT:

1. All exterior LPS wall packs be replaced with LED exterior wall pack complete with integral button type photocell to improve efficiency and reduce maintenance - **Priority 2**
2. New dual head emergency lighting unit be installed in the corridor outside offices 213 and 214 to achieve required emergency lighting levels - **Priority 1**
3. Single remote heads should be installed in the cold room adjacent to the carpentry shop and all electrical and mechanical rooms - **Priority 3.**
4. Exit lights outside Kitchen 203, Corridor 206 and Boardroom 223 be replaced with illuminated LED exit lights complete with test switch and battery backup - **Priority 1**
5. All existing metal halide high bay fixtures be replaced with LED or TSHO high bays to improve efficiency and reduce maintenance - **Priority 3**
6. All existing photo luminescent type exit lights to be replaced with illuminated LED exit lights complete with test switch and battery backup - **Priority 1**

.3 D5090 OTHER ELECTRICAL SYSTEMS

Fire Alarm and Detection

- # Existing conventional initiation and notification fire alarm system fed to an Edwards 6616 fire alarm control panel located adjacent to the Southeast building entrance.



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IT IS RECOMMENDED THAT:

1. None at this time

Reference Review:

For the purpose of this investigation, the following building codes and standards were reviewed:

- # NBCC – National Building Code of Canada
- # CEC – Canadian Electric Code
- # IES – Illuminating Engineering Society
- # NFPA – National Fire Protection Association

5.5 E Equipment & Furnishings

5.5.1 E10 Equipment

- .1 **E1010 COMMERCIAL EQUIPMENT**
Not applicable.

IT IS RECOMMENDED THAT:

1. None at this time.

- .2 **E1020 INSTITUTIONAL EQUIPMENT**
Not applicable.
- .3 **E1030 VEHICULAR EQUIPMENT**
Not applicable.
- .4 **E1090 OTHER EQUIPMENT**
Not applicable.

5.5.2 E20 Furnishings

- .1 **E2010 FIXED FURNISHINGS**
Fixed cabinetry and showing looked to be in good to serviceable condition.

IT IS RECOMMENDED THAT:

1. None at this time.

- .2 **E2020 MOVABLE FURNISHINGS**
Not applicable.

5.6 F Special Construction & Demolition

5.6.1 F10 Special Construction

- .1 **F1010 SPECIAL STRUCTURES**
Not applicable.
- .2 **F1020 INTEGRATED CONSTRUCTION**
Not applicable.
- .3 **F1030 SPECIAL CONSTRUCTION SYSTEMS**
Not applicable.
- .4 **F1040 SPECIAL FACILITIES**
Not applicable.
- .5 **F1050 SPECIAL CONTROLS AND INSTRUMENTATION**
Not applicable.



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5.7 G Building Site Work

5.7.1 G10 Site Preparation

- .1 G1010 SITE CLEANING
⊗ Not applicable.
- .2 G1020 SITE DEMOLITION AND RELOCATION
⊗ Not applicable.
- .3 G1030 SITE EARTHWORK
⊗ Not applicable.

5.7.2 G20 Site Improvements

- .1 G2010 ROADWAYS
⊗ Driveway appears adequate.

IT IS RECOMMENDED THAT:

- 1. None at this time.

- .2 G2020 PARKING LOTS
⊗ The parking lot and site is asphalt.
⊗ Adequate parking space for the number of occupants.
⊗ Some minor cracking evident throughout the asphalt parking lot abutting the structure.

IT IS RECOMMENDED THAT:

- 1. None at this time.

- .3 G2030 PEDESTRIAN WALKWAYS
⊗ Not applicable.
- .4 G2040 SITE DEVELOPMENT (FENCING)
⊗ Not applicable.

IT IS RECOMMENDED THAT:

- 1. None at this time.

- .5 G2050 LANDSCAPING
Grass
⊗ Not applicable.

5.7.3 G40 Site Electrical Utilities

- .1 G4010 ELECTRICAL DISTRIBUTION
⊗ Not applicable.
- .2 G4090 OTHER SITE ELECTRICAL UTILITIES
⊗ Not applicable.

5.7.4 G90 Other Site Construction

- .1 G9010 SERVICE AND PEDESTRIAN TUNNELS
⊗ Not applicable.
- .2 G9090 OTHER SITE SYSTEMS & EQUIPMENT
⊗ Not applicable.



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5.8 Planning

5.8.1 BARRIER FREE DESIGN

- ⊗ As this facility is used for maintenance personnel requiring good physical mobility, barrier free design was not considered applicable.
- ⊗ Washroom facilities and majority of access points did not meet accessible requirements as set out by the current National Building Code of Canada or current CSA standards.

5.9 Life Safety Code Analysis

- ⊗ Facility meets current code for Life Safety.

5.10 Fire and Life Safety Deficiencies

5.10.1 Structural Resistance to Fire

- ⊗ Not applicable.

5.10.2 Fire & Smoke Barriers

- ⊗ Missing fire stopping at internal firewalls where walls meet roof structure and at a variety of Mechanical and Electrical penetrations.

IT IS RECOMMENDED THAT:

1. Undertake a full Fire Barrier report and repair as required – **Priority 1**

5.10.3 Basic Detection and Alarm Application

- ⊗ Not applicable.

5.10.4 Automatic Fire Suppression

- ⊗ Not applicable.

5.10.5 Water Supplies

- ⊗ See Mechanical.

5.10.6 Fire Department

- ⊗ Not applicable.

5.10.7 Operation and Maintenance

- ⊗ Not applicable.

5.10.8 Emergency Lighting

- ⊗ See Electrical.

5.10.9 Egress

- ⊗ Adequate per NFPA requirements.
- ⊗ Travel distances to exits may not meet current National Building Code of Canada requirements, which are more stringent than NFPA.

6 TABLE OF PROBABLE COSTS

Recommendation /Deficiency	Priority 1 Opinion of Probable Cost	Priority 2 Opinion of Probable Cost	Priority 3 Opinion of Probable Cost	
Section 5.2.1.2.1		\$5,000		
Section 5.2.1.2.2		\$45,000		



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Section 5.2.2.1.1			\$22,500	
Section 5.2.2.1.2			\$7,000	
Section 5.2.2.1.3			\$13,500	
Section 5.2.2.2.1		\$2,500		
Section 5.2.2.3.1	\$41,000			
Section 5.2.2.3.2		\$11,000		
Section 5.2.2.4.1	\$75,000			
Section 5.2.2.4.2	\$35,000			
Section 5.2.2.5.1	\$25,000			
Section 5.2.2.5.2			\$5,000	
Section 5.2.2.5.3		\$3,500		
Section 5.3.1.1.1	\$12,500			
Section 5.3.3.2.1		\$2,500		
Section 5.3.3.2.2		\$250		
Section 5.3.3.3.1		\$500		
Section 5.4.2.1.1		\$4,000		
Section 5.4.2.2.1			\$2,500	
Section 5.4.2.2.2			\$1,000	
Section 5.4.2.3.1		\$5,000		
Section 5.4.2.3.2			\$2,500	
Section 5.4.2.3.3			\$5,000	
Section 5.4.2.3.4			\$5,000	
Section 5.4.2.4.1			\$25,000	
Section 5.4.2.4.2			\$5,000	
Section 5.4.3.2.1	\$500			
Section 5.4.3.2.2			\$500	
Section 5.4.3.3.1		\$2,500		
Section 5.4.3.3.2		\$2,500		
Section 5.4.3.3.3			\$500	
Section 5.4.3.4.1			\$10,000	
Section 5.4.3.5.1	\$1,000			
Section 5.4.3.5.2			\$2,000	
Section 5.4.3.5.3	\$1,000			
Section 5.4.3.5.4		\$90,000		
Section 5.4.3.5.5	\$1,000			
Section 5.4.3.5.6	\$500			



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Rehabilitation/Relocation/Expansion Assessment
Bishop's Falls, NL

December 20, 2013

Section 5.4.3.5.7		\$5,000		
Section 5.4.3.5.8	\$500			
Section 5.4.4.1.1	\$500			
Section 5.4.4.2.1	\$1,000			
Section 5.4.4.2.2	\$1,000			
Section 5.4.5.1.1	\$2,000			
Section 5.4.5.1.2		\$12,000		See 5.3.1.1.1
Section 5.4.5.1.3	\$2,000			
Section 5.4.5.1.4				See 5.4.3.5.4
Section 5.4.5.1.5			\$3,000	
Section 5.4.5.1.6			\$20,000	
Section 5.4.5.2.1		\$15,000		
Section 5.4.5.2.2	\$1,000			
Section 5.4.5.2.3			\$1,000	
Section 5.4.5.2.4	\$500			
Section 5.4.5.2.5			\$30,000	
Section 5.4.5.2.6	\$5,000			
Section 5.10.2.1	\$5,000			
TOTAL	\$211,000	\$194,250	\$161,000	\$566,250
Contingency 30%				\$169,875
Total				\$736,125

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7 USE OF REPORT

This report is prepared for the exclusive use of Newfoundland and Labrador Hydro for the expressed purpose of preparing a summary condition report for the identified property. This report should not be considered transferable, and should not be relied upon for any other purpose.

The service provided for this project was performed with the care and skill ordinarily exercised by reputable members of the profession practicing under similar conditions at the same time and similar locality. No warranty, expressed or implied, is made or intended by rendition of these consulting services or by furnishing oral or written reports of the findings made. We reserve the right to revise or amend our opinion in this report in the event new information, documentation, or evidence becomes available.

Sincerely,

Coles Associates Ltd.
Per: Douglas A. Coles, P.Eng., P.E., F.E.C.
Vice President



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Appendix A

Photographs



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Photo #7: repointing done



Photo #8: Rusting from Leaking test head



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Photo #9: Exterior Door



Photo #10: Exterior Door Jamb



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Photo #11: Overhead Accordion Door



Photo #12: Overhead Sectional Door



Photo #13: Rusting Stair Stringer



Photo #14: Roof Access



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Photo #15: Ground Connection on Stair



Photo #16: 600V equipment Exposed tdirectly to Shop

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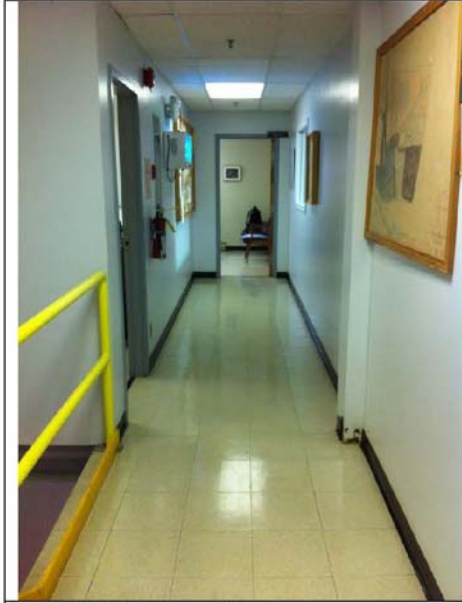


Photo #17: Worn Floor Tile



Photo #18: Base requiring replacement



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Photo #19: Stained Ceiling tile



Photo #20: Urinal tank



Photo #21: Office A/C



Photo #22: Zurn Alert



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Photo #23: Duplex Oily Water system



Photo #24: Roof top units



Photo #25: No weatherheads



Photo #26: Rusting Disconnect



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Photo #27: Wall Pack



Photo #28: Exit Light with Faulty Test Switch



Photo #29: Metal Halide High Bays

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Appendix B

Existing Floor Plans



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

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

Additions for Load Growth
Happy Valley – Goose Bay

July 2015

SUMMARY

This report details a proposal to upgrade the Happy Valley – Goose Bay distribution system to accommodate load growth in the region. If the status quo is maintained, some customers in Happy Valley – Goose Bay will experience reduced reliability due to overload equipment on the feeder. In certain areas of the Happy Valley – Goose Bay distribution system, recent load growth has caused the overloading of a section of conductor and a substation transformer during peak demand periods.

According to Hydro's most recent Operating Load Forecast and construction activity in the area this condition will only worsen as time progresses since the load growth in Happy Valley – Goose Bay is expected to continue for the foreseeable future.

The scope of this project will involve converting the voltage of a portion the feeder North Side Line 11 (NS11) from 4.16 kV to 25 kV and transferring the load to the feeder Happy Valley Line 7 (HV7).

This project will cost an estimated \$593,700, and to avoid further conductor and transformer overloads during peak demand, it must be completed by the winter of 2016/2017.

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1 INTRODUCTION

Hydro provides service to residents in select rural communities within the province through the use of electrical distribution systems. The distribution systems typically consist of a substation coupled with a wood pole distribution line that directs power from the substation to customers throughout the community. The electrical infrastructure in Happy Valley – Goose Bay is owned, operated and maintained by Hydro and is comprised of one terminal station, two substations, one diesel plant, one gas turbine and 14 distribution feeders consisting of approximately 186 kilometers of single and three-phase distribution line. The Town of Happy Valley – Goose Bay is located in central Labrador and has a population of approximately 7,500¹ people. Figure 1 is a map of Labrador showing the geographical location of Happy Valley – Goose Bay.



Figure 1: Labrador System

¹ According to a 2012 Census

Over time, new customers are added to the distribution system and existing customers can increase their load. The cumulative effect is that the load on the distribution system can grow, and this load growth can have negative effects on voltage levels along the feeders and produce overloads on system equipment and/or conductors. Hydro's System Planning Department is responsible for determining the requirements for all new generation, transmission and distribution facility additions and upgrades that are required to supply the forecasted growth in power and energy requirements within the company's service area. Hydro reviews the capacity of its distribution systems annually to verify the ability to meet forecasted loads. When abnormal conditions are identified, projects are developed to ensure the affected distribution system(s) can continue to meet future demands of the normally growing load before the abnormal condition occurs.

Concentrated load growth in one area between November 2014 and January 2015 led to the determination that a portion of the Happy Valley – Goose Bay distribution system (North Side Line 11 (NS11)) cannot support existing and expected future load growth under the status quo. Due to the timing of the new loads, it was too late to include a proposal in Hydro's 2015 Capital Budget submission, so after some analysis, Hydro determined that the severity of these criteria violations was not great enough to warrant a supplementary Capital Budget Application and that a Capital Budget proposal would be submitted with Hydro's 2016 Capital Budget submission. See Section 3.3.5 for more information.

This additional demand has increased the load to exceed Hydro's acceptable equipment loading limits under peak conditions (See Section 3.1).

This report will propose a solution that will mitigate this issue in Happy Valley – Goose Bay and accommodate projected future growth on feeder NS11 for the foreseeable future.

2 PROJECT DESCRIPTION

This project will require less than one year to complete, and will involve converting a portion of the feeder NS11 from 4.16 kV to 25 kV and transferring the load to the feeder HVY7. The portion of line that will be converted to 25 kV runs along Toronto Ave as shown below in Figure 2 (dark blue).

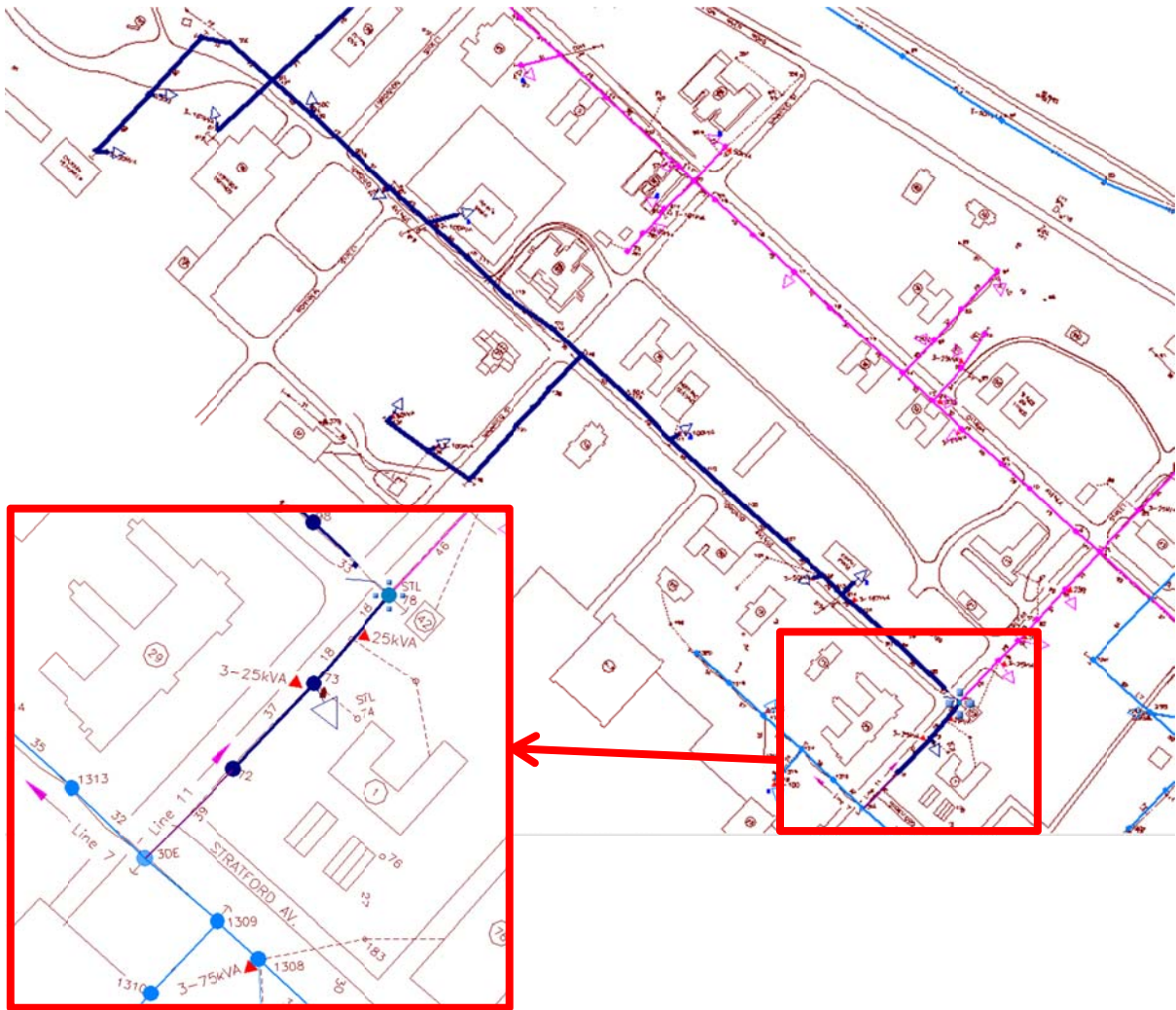


Figure 2: HVY NS11 Partial Voltage Conversion – Toronto Ave

This load will be transferred to HV7 by disconnecting a three phase tap along Toronto Ave from NS11 (pink) and connecting it to HV7 (light blue). This project will include reinsulating NS11 to 34.5 kV standards, replacing all distribution transformers along this section with 25 kV transformers, installing any fused disconnects as required and replacing poles as

required.

This project will cost an estimated \$593,700 and take approximately 10 months to complete. See Section 4.2 for a detailed schedule.

3 JUSTIFICATION

This project is justified on the requirement to meet the growing electricity needs of Hydro's customers on the Happy Valley – Goose Bay distribution system. According to load flow analysis and recent load studies, it has been determined that under peak conditions there is overloaded equipment near and in the Happy Valley – Goose Bay North Side substation (HNS)

These overloads are based on Hydro's planning criteria which are used to determine when capital work must be complete for loading or low voltage reasons. Different criteria are used when determining if supplemental capital or emergency work is required. The amount of overload on the equipment in Happy Valley – Goose Bay did not warrant a supplemental capital application for this project. See section 3.1 for more information on planning criteria.

Due to the existing overloaded equipment and additional load growth expected in this area these overloads must be addressed by the winter season.

This increase in load can be attributed to the connection of four new large customers on the feeder NS11 in 2014. As a result, these additional loads have caused an increase in loading on the feeder.

The voltage conversion and load transfer will not only prevent the overloads but will reduce the losses² on the electrical distribution system.

3.1 Planning Criteria

Hydro's distribution planning criteria was established to ensure an adequate supply of power to customers served on Hydro's distribution systems. As a general rule to guide Hydro's planning activities the following criteria have been adopted:

² The losses on NS11 are minimal and are not included in the cost benefit analysis

Voltage Levels

- A) The range of normal operating voltage is based on the Canadian Standard CSA CAN3-C235-83 ("Preferred Voltage Levels...") and the CEA "Distribution Planner's Guide".
- B) Voltage balance – maximum 2% voltage unbalance.
- C) Voltage Flicker Limit – maximum of 5% voltage flicker.

Hydro uses the CSA standard *CAN3–C235–83 – Preferred Voltage Levels for AC Systems 0 – 50,000 V* as the guide for determining acceptable steady-state voltage limits at customers' service entrances. This is a National Standard of Canada that establishes a guideline for voltage standards for AC Systems in Canada. It was adopted by Hydro as its standard for the range of acceptable voltages that will be provided to customers and is used by utilities across Canada. A standard for voltage levels is necessary because the devices connected to the electrical system are designed to operate within a certain range of voltages. When voltages supplied to the device deviate from this acceptable range, the device can be damaged or fail to function properly. The standard is meant to ensure that the devices connected to the electrical system will receive voltage within their normal operating range so that they function normally and damage does not occur.

The standard refers to two separate operating conditions, normal and extreme. The normal operating condition is applied when the distribution system is operating as designed and not experiencing continuous operation outside design limits. The extreme operating condition is applied during continuous operation of a power system outside of design limits and planned capital or operating work is scheduled to be carried out to correct the issue. In this situation, the system is operating within Normal Operating Conditions most of the time and only operates within Extreme Operating Conditions at times of peak demand. These conditions do not include voltage levels experienced during fault conditions or heavy starting loads.

Under normal operating conditions where there are no operational anomalies and the feeder is performing as designed, the customer service entrance voltage must be held between a minimum of 110 V for single-phase customers and 112 V for three-phase

customers and a maximum of 125 V for a nominal 120 V service.

Table 1 displays the normal and extreme operating condition nominal voltage ranges for many types of electrical services.

Table 1: Recommended Voltage Variation Limits for Circuits up to 1000V, at Service Entrances³

Nominal System Voltages	Voltage Variation Limits Applicable at Service Entrances			
	Extreme Operating Conditions			
	Normal Operating Conditions			
Single-phase (V)	Lower Limit		Upper Limit	
120/240	106/212	110/220	125/250	127/254
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635
Three-phase 4-Conductor (V)				
120/208Y	110/190	112/194	125/216	127/220
240/416Y	220/380	224/338	250/432	254/440
277/480Y	245/424	254/440	288/500	293/508
347/600Y	306/530	318/550	360/625	367/635
Three-Phase 3-Conductor (V)				
240	212	220	250	254
480	424	440	500	508
600	530	550	625	635

The standard also states that primary service voltages are to be supplied within six percent of the nominal system voltage.

Under extreme operating conditions the distribution system is operating outside of the normal operating voltage limits and an operational anomaly has been identified on the system. In this case, work must be planned to correct the deficiency so that voltages remain within the normal operating condition limits. During extreme operating conditions, the customer service entrance nominal voltage must range from a minimum of 106 V for single-phase customers and 110 V for three-phase customers to a maximum of 127 V for a nominal 120 V service (single- phase and three-phase).

³ Taken from CSA standard CAN3–C235–83 (R2006) – Preferred Voltage Levels for AC Systems 0 – 50,000 V, Table 3 - Recommended Voltage Variation Limits for Circuits up to 1000 V, at Service Entrances.

If the customer service entrance nominal voltage falls outside of the extreme voltage range as outlined in the CSA standard, emergency work must be completed as soon as possible to rectify the issue. If not, damage to customer equipment is likely. Hydro is responsible for ensuring voltage levels up to the service entrance, i.e. the weatherhead, are within stated limits.

The above CSA standard has been adopted by Hydro to ensure customer service entrance voltages remain within the stated limits. However, planning engineers complete system design and analysis using nominal voltages on primary distribution feeders. To relate the two, the System Planning Department references the CEA Distribution Planners Manual. The manual provides estimates of the average voltage drop that can be anticipated between the primary and the service entrance to define a minimum and maximum planning voltage on a 120 V base for the primary distribution line.

Table 2 and Table 3 outline the Hydro standard voltage drop for each line section and transformer between the primary conductor and the service entrance for single-phase and three-phase customers respectively.

Table 2: Preferred Voltage at the Primary for Single-phase Customers

		Voltage (120 V Base)	
		Heavy Load	Light Load
Service Entrance Voltage*		110	125
Voltage Drop at	Service Drop Wire	1	0.375
	Secondary Conductor	2	-
	Distribution Transformer	3	1.125
Total Voltage Drop from Primary to Service Entrance		6	1.5
Voltage at Primary		116	126.5
Note: Some customers are supplied from express service drops. Therefore, no secondary voltage drop occurs under the light load condition. * Hydro is responsible for voltage up to the service entrance.			

Table 3: Preferred Voltage at the Primary for Three-phase Customers

		Voltage (120 V Base)	
		Heavy Load	Light Load
Service Entrance Voltage*		112	125
Voltage Drop at	Service Drop Wire	1	0.375
	Secondary Conductor	-	-
	Distribution Transformer	3	1.125
Total Voltage Drop from Primary to Service Entrance		4	1.5
Voltage at Primary		116	126.5

Note: 3Φ General Service Customers are normally supplied from express drops off their own transformer bank. Therefore, no secondary voltage drop occurs.

* **Hydro is responsible for voltage up to the service entrance.**

Therefore, Hydro uses a planning voltage range of 116 V to 126.5 V on distribution primary lines, assuming a 120 V base.

Voltage unbalance occurs when loads are not equally distributed across all three-phases of a distribution feeder. The percentage voltage unbalance is calculated as the maximum phase voltage deviation from the average voltage, divided by the average voltage, multiplied by 100%. It is common on many Hydro distribution systems to have long single-phase lines with large end of line loads which can increase voltage unbalance. A feeder experiencing a high percentage of voltage unbalance can cause excessive motor heating, increasing the likelihood of failure.

Voltage flicker is a transient phenomenon that occurs when large loads are switched on the system causing an instantaneous change in voltage. Usually this is experienced during motor starting or pick-up of a large customer load. In these cases, a dip in voltage is experienced due to the increase in current flow, causing lights to flicker. This can dim lighting and interrupt motor operation. Hydro will allow a maximum of 5% voltage flicker before work must be initiated to correct the problem. If voltage flicker worsens, the problem becomes much more noticeable and pronounced. Hydro addresses flicker at the operational level by setting limitations on the amount of current the system can supply to a customer without causing disturbances to other customers on the system.

Loading

- A) Equipment loading is no greater than 100% of its continuous rating
 - i. Conductor ampacity is seasonally adjusted for appropriate temperature during the peak.
 - ii. Short term overloading on transformers is permitted.
- B) Load Unbalance – maximum 10% deviation of load on any phase from the average phase loading.

Loading of equipment should not exceed nameplate ratings and the conductor ampacity must be adjusted for the ambient temperature during periods of peak loading. Distribution power transformers, however, are permitted to be loaded to 110% of nameplate rating for short durations. This is due to the cooling effect of the oil surrounding the transformer core and windings during short periods of overloading.

Increases in customer load on distribution feeders can lead to overloading of overhead conductor and/or related equipment. A detailed load flow analysis will indicate areas which are experiencing current overloads during periods of peak loading. Equipment affected by overloads includes transformers, circuit breakers, reclosers, voltage regulators and switches.

Overloads on bare overhead conductor are identified during load flow analysis for the particular distribution feeder. Hydro has adopted the IEEE738⁴ method for calculating the ampacity of overhead conductor based on ambient temperatures and uses a 100% ampacity rating for all planning related design and analysis.

Hydro has two standard types of switches, group operated switches and single-phase cutouts. Group operated switches are rated for load breaking and are operated by a single handle to break all phases at the same time. These switches do not use any fuses for line protection. Single-phase cutouts are used for isolating sections of line once they have been

⁴ IEEE738 - IEEE Standard for Calculating the Current-Temperature of Bare Overhead Conductors

de-energized, as they are not rated to break load. Cutouts, however, can be fused to a number of ratings depending on the protection requirements. For planning and analysis purposes, the System Planning Department uses 100% of the continuous current rating for switches. Gang switches are rated for 600A per phase, where solid blade (no fuse) cutouts are rated for 300A. If the cutout is fused, the rating then becomes the rating of the installed fuse.

The planning rating for reclosers is 100% of the rated continuous and interrupting current of the unit. Circuit breaker planning ratings are the same for reclosers; 100% of the rated continuous and interrupting current rating of the unit.

Overloads on power transformers in distribution substations are identified during the feeder load flow analysis. Hydro uses a planning rating of 110% of the nameplate rating of the transformer. Voltage regulators on the Hydro system are analyzed using a planning rating of 100% of the continuous current rating of the series winding of the device. Table 4 contains a list of the planning loading limits for all distribution system equipment.

Table 4: Planning Limits for Loading of Distribution System Equipment

Equipment Type	Nominal %	Planning %	Comments
Breaker	100	100	
Recloser	100	100	
Fuse	100	100	
Sectionalizer	100	100	
Switch	100	100	
Aerial Conductor	100	100	Seasonally adjusted for temperature.
Insulated Cable	100	100	Adjusted for installation location and type.
Regulator	100	100	
Transformer	100	110	Where overload is short term.

Load imbalance occurs when customer loads are not equally distributed across all three-phases of a distribution feeder. The percentage of load imbalance is calculated as the maximum phase load deviation from the average load, divided by the average load, multiplied by 100%. A highly unbalanced load on a feeder can lead to a high degree of voltage unbalance along the feeder due to varying voltage drop on the phase conductors.

An unbalanced feeder will experience higher losses due to currents flowing in the neutral circuit.

By comparing the planning ratings to the forecast load, Hydro determines the required timing of capacity additions.

3.1.2 Assumptions

To maintain a consistent approach to all distribution system design and analysis, Hydro has developed a set of assumptions for all systems. No equipment, including transformers, regulators, reclosers, circuit breakers or switches is de-rated. Therefore all equipment is assumed to be capable of operating within design limits.

A number of assumptions are made to obtain the ampere rating of a particular sized conductor depending on its construction and geographic location. Generally, the rated capacity of the lines is based on the maximum allowable operating temperature, which is affected by climate. Hydro has adopted the *IEEE738 - IEEE Standard for Calculating the Current-Temperature of Bare Overhead Conductors*, which outlines the method used to determine the current-temperature of a particular cable. Hydro assumes a maximum conductor rating of 75°C, a temperature rise of 45°C and a 30°C ambient temperature. The operating temperature of an overhead conductor is affected by the heating effects of solar radiation and the cooling effects of wind as well as geographic location. A new overhead conductor is shiny, which reflects solar radiation and is less susceptible to additional heating to that of a weathered conductor which is dull and absorbs more solar energy. Hydro assumes all conductors to have 50% emissivity and 50% solar absorption which reflects a weathered (greyed) conductor in full sunshine and a clear atmosphere, located at 50° north latitude at sea level. Cooling of the conductors during normal operation due to light cross winds is assumed. All conductors are assumed to be orientated east to west.

Distribution line ampere ratings are further based on the time of the year in which the peak load occurs on that particular feeder and its location; whether it is located on the Island or in Labrador. For a winter peaking system in Labrador, the ambient temperature is assumed

to be -20°C, where the same system on the Island is assumed to experience an ambient temperature of 0°C. A summer peaking system is assumed to experience an ambient temperature of 30°C across all distribution systems. For emergency and temporary situations conductors may be rated based on lower temperatures than indicated above. This depends on the specific location and expected weather during peak conditions.

During load flow analysis, unless all the loads are known, all loads are scaled and power factor adjusted so that the substation bus sending power and power factor matches the peak loading EMS data. Furthermore, loads are modelled, unless known, to have a power factor of 0.90 lag if it is primarily a motor load and a power factor closer to unity if the load is primarily electrical resistance heating. The voltage on the substation bus is assumed to be set at its lowest EMS value (if available) during peak loading as a worst case scenario.

3.2 Existing System

The Happy Valley – Goose Bay distribution system provides electricity to the communities of Happy Valley – Goose Bay, North West River and Mud Lake. The system is supplied with power from both transmission lines and combustion turbines. It contains one terminal station, two substations and 14 distribution feeders. Figure 3 shows the layout of the Happy Valley – Goose Bay distribution system.

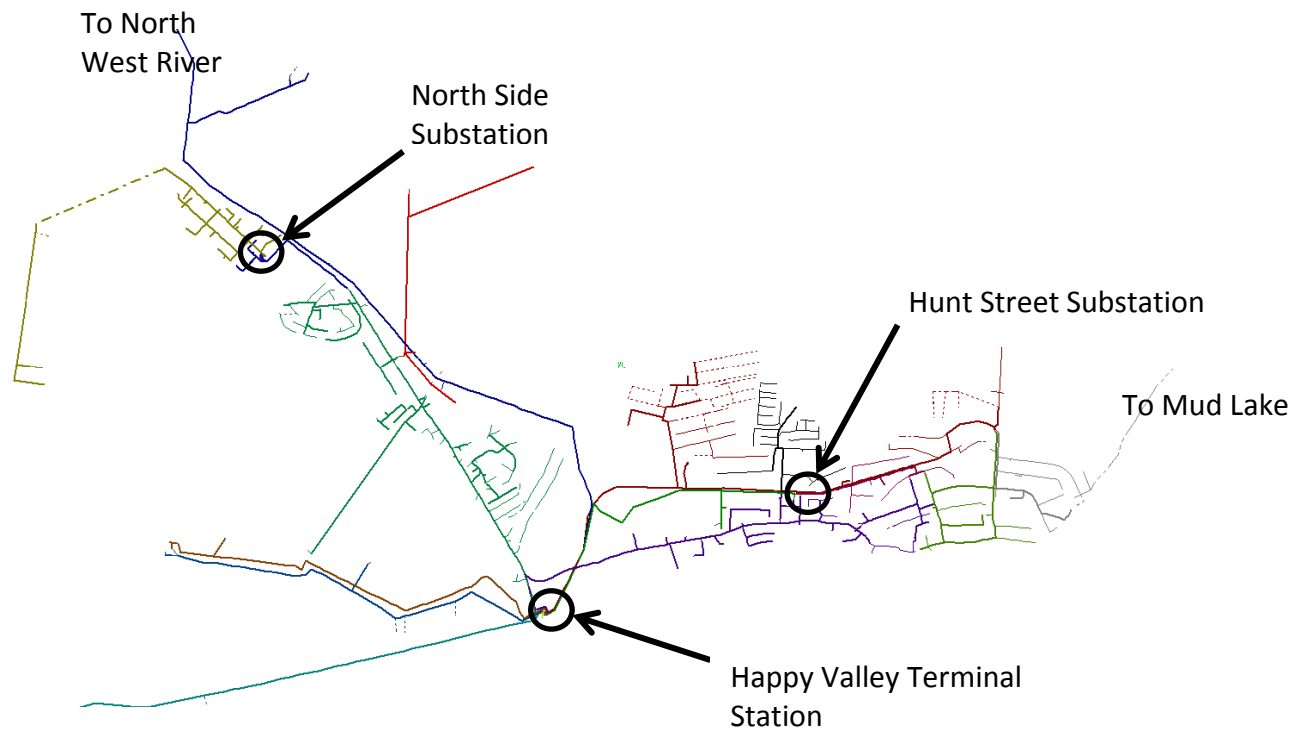


Figure 3: Happy Valley - Goose Bay Distribution System

The focus of this project and report is on the feeder HV7 originating at the Happy Valley – Goose Bay terminal station, and the feeder NS11 originating at the North Side substation.

The HV7 feeder operates at 25 kV and serves approximately 879 customers and the Happy Valley – Goose Bay North Side substation. The main trunk portion of this feeder is approximately 9.1 km of 477 ASC primary conductor and 30 km of 4/0 AASC primary conductor. The feeder runs north from the Happy Valley – Goose Bay terminal station along route 520 to North West River. There is a tap off the main line near the north side of the airport that feeds the Happy Valley – Goose Bay North Side substation

The Happy Valley - Goose Bay - North Side (HNS) substation is located near the intersection of Ottawa Avenue and London Street. In the substation there are four transformers: HNS-T1, HNS-T2, HNS-T3 and HNS-T4. HNS-T1, T2 and T3 are 3.75 MVA, 4.16/25 kV, Delta/Ygnd transformers that convert the voltage from HNS-G6, G7 and G8 to 25 kV distribution level voltage. HNS-T4 is a 3 MVA, 4.16/25 kV, Ygnd/Ygnd transformer that connects generators: HNS-G1 through G5 and feeder NS11 to the 25 kV distribution system.

The NS11 feeder operates at 4.16 kV and serves approximately 60 customers. The main trunk portion is approximately 5.3 km of 1/0 cu primary heading northwest along Ottawa and Toronto Ave. There is also 1.2 km of underground cable passing underneath a runway.

Table 5 and Table 6 summarize some of the major work or upgrades completed on the feeders HV7 over the past 10 years.

Table 5: Major Work or Upgrades on HV7

Year	Major Work/Upgrade
2014	North West River Line Upgrades
2012	Trunk Feeder Conductor Upgrade
2010	Installed Voltage Regulator HV7-VR3
2007-2009	Pole Replacement
2007	Replace Porcelain Insulators
2006	Install Voltage Regulator HV7-VR2

Table 6: Major Work or Upgrades on NS11

Year	Major Work/Upgrade
2015	Reconductor along Toronto Ave

3.3 Operating Experience

The following sections present current and past experiences pertaining to the feeders HV7 and NS11 in Happy Valley – Goose Bay. These sections will focus on reliability, maintenance and historical load growth.

3.3.1 Reliability Performance

Hydro first notes that the justification for this project rests squarely with application of Hydro's distribution planning criteria, and the existing criteria violations. This project is not being justified on the basis of improvements in reliability performance. However, having said that, it is prudent to review the reliability of the respective distribution feeders to assess their performance and give consideration for reliability improvements (if necessary) within the capital project.

The reliability of the distribution systems is tracked using the industry standard service continuity indexes; System Average Interruption Frequency Index (SAIFI)⁵, and System Average Interruption Duration Index (SAIDI).⁶

Table 7 provides the 2010 to 2014 average SAIFI and SAIDI reliability data for all causes and all causes exclusive of Loss of Supply outages. For comparison, the regional indices, corporate indices and the latest CEA four-year average indices (2010 to 2013) are also presented. By presenting the reliability statistics of the distribution systems with the loss of supply outages removed, the reliability specific to that system or feeder is shown.

Table 7: Five Year Average Outage Statistics (2010 to 2014)

SYSTEM	All Causes		All Causes (Excluding Loss of Supply)	
	SAIFI	SAIDI	SAIFI	SAIDI
Labrador Interconnected	7.27	16.75	4.35	12.25
NS11 Distribution Feeder	0.07	0.07	0.04	0.04
Hydro Corporate	5.25	13.78	2.98	9.76
CEA Region 2 (2010-2013)	2.94	9.83	2.27	9.12

According to Table 7, the Happy Valley North Side NS11 distribution feeder is relatively reliable compared to its counterparts. On average, the North Side distribution system has less outages and at shorter durations compared to all of Hydro's distribution systems and the CEA Region statistics.

3.3.2 Maintenance or Support Arrangements

The maintenance of the Distribution System in Happy Valley – Goose Bay is performed by Hydro operations personnel stationed in Happy Valley - Goose Bay. A visual inspection of distribution feeders is performed every eight years to evaluate the condition of the line. This inspection is completed by Hydro personnel and any corrective maintenance required is reported, scheduled and completed. The inspection schedule is determined through a Reliability Centered Maintenance Program initiated by Hydro and is dependent on a variety

⁵ SAIFI - Indicates the average number of power outages a customer has experienced in the respective distribution system per year.

⁶ SAIDI - Indicates the average length of time a customer is without power in the respective distribution system per year.

of factors including geographical location, line age, and customer usage. Inspection schedules may vary between lines depending on the existing circumstances.

3.3.3 Maintenance History

The five-year maintenance history for the HV7 and NS11 distribution feeders is shown in the following tables:

Table 8: Five-Year Maintenance History- HV7

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	4.0	31.7	35.7
2013	0.1	3.4	33.5
2012	5.2	87.3	92.5
2011	7.3	66.1	73.4
2010	1.2	51.0	52.2

Table 9: Five-Year Maintenance History – NS11

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	0.5	9.9	10.4
2013	0.0	2.2	2.2
2012	1.2	9.0	10.2
2011	0.0	9.3	9.3
2010	3.2	0.5	3.7

3.3.4 Historical Information

A distribution line upgrade consists of one or more of the following: Pole replacements, insulator replacements, conductor replacements, structure framing, transformer replacements, and service attachment transfers. A line could cover several kilometers or only a few. Because of the variety in line lengths and equipment, unit costs for jobs are not available.

Table 10 lists budgeted and actual costs for distribution system additions in the 2014 calendar year.

Table 10: Historical Information

Year	Capital Budget (\$000)]	Actual Expenditures (\$000)	Comments
2014	1052.1	927.4	South Brook - Upgrade System
2014	692.6	634.2	Bay D'Espoir - Upgrade System
2014	494.2	443.2	Conne River - Upgrade System
2014	583.7	530.9	Barachoix - Upgrade System
2014	519.6	521.6	Grey River - Upgrade System
2014	359.1	320.1	McCallum - Upgrade System
2014	392.80	292.00	Charlottetown - Upgrade L1 / L2
2014	985.00	758.70	St. Lewis - Upgrade L1
2014	1357.9	1464.2	Roddickton - Upgrade L1 / L3

3.3.5 Historical Load Growth

The Happy Valley - Goose Bay System has historically experienced steady growth in peak load and electricity sales for the past five years.

The system normally experiences its annual peak demand during the winter months. This is due to cold temperatures driving increased demand from heating related loads (primarily water heating, electric heating, and furnace usage).

The annual historical net peak and energy consumption of the Happy Valley – Goose Bay distribution system and the net peak of the HV7 feeder for the past five years are shown in Figure 4 below.

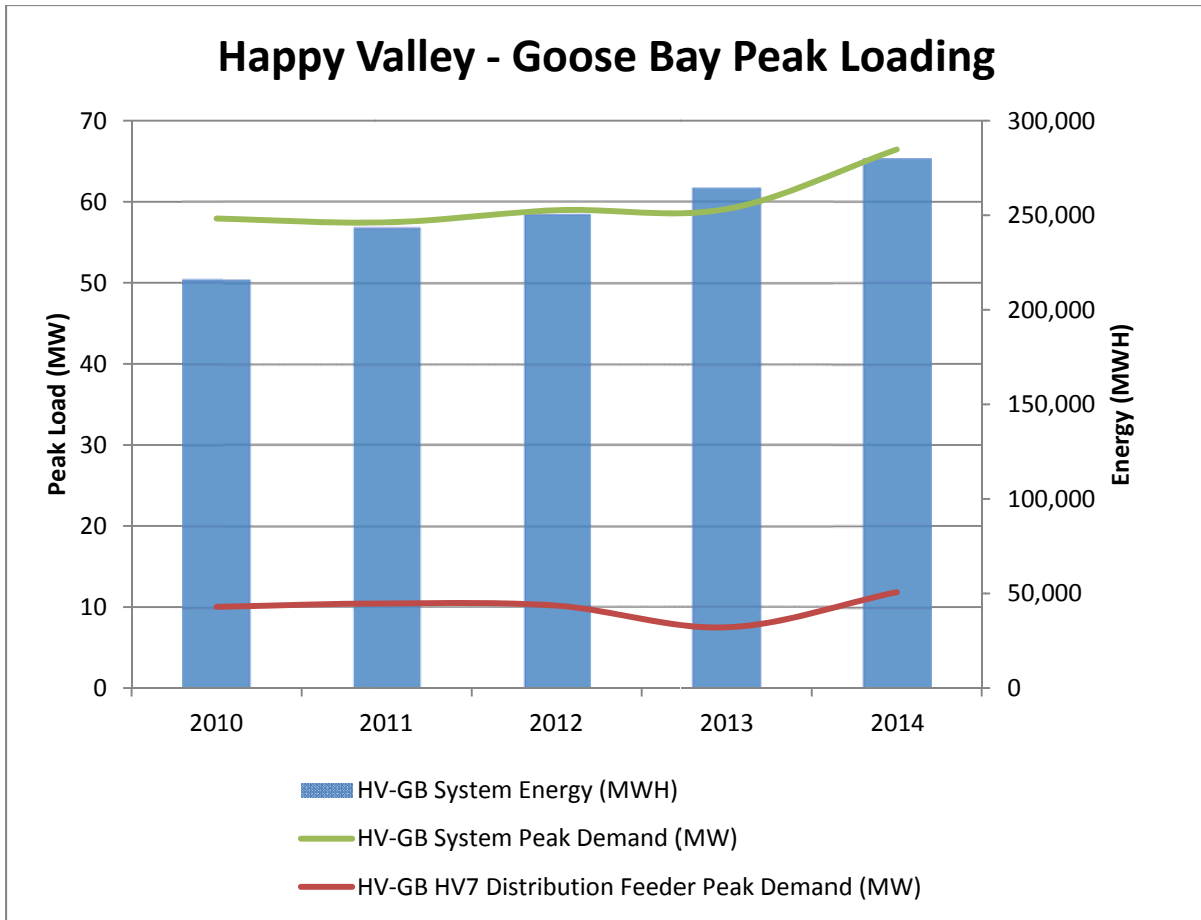


Figure 4: Happy Valley – Goose Bay System Load History 2010-2014

Historical Peak Loading on NS11 is not available on an annual basis. Instead, peak load information is collected by installing temporary meters when required. Meters were installed in 2010, 2014, and 2015 and the results are shown in Table 11

Table 11: NS11 Load Study Data

Year	Peak During Load study	Scaled to Match Yearly Peak ⁷
2010	1.03 MW	1.29 MW
2014	1.98 MW	2.32 MW
2015	2.32 MW	3.28 MW

In late 2014 and early 2015, four new large customers were installed on NS11 with a total connected load of 1.6 MVA.

⁷ 2010 Load Study is scaled to match the 2010 feeder non-coincident peak. 2014 Load Study is scaled to match the 2014 feeder coincident peak because the non-coincident peak recorded contains additional load on HV7 due to temporary switching.

Based on load flow simulations, this additional load has caused conductors that are rated for 415 A to be loaded at 444 A and the 3.0 MVA substation transformers will be loaded at 3.3 MVA.

3.4 Forecast Customer Growth

Hydro prepares a forecast of the anticipated loads on all Hydro's distribution systems on an annual basis including Happy Valley – Goose Bay. The forecast projects the peak demands for each system for a six year period. The peak demand forecast is used to determine the required amount of capacity that a distribution system or piece of equipment within the system must have in order to meet that demand.

The justification for this project is not based on the forecasted load growth for Happy Valley – Goose Bay, instead it is based on the recently installed loads on NS11. The load growth is considered in the evaluation of alternatives.

The forecast includes new customers from both Domestic Service Customers (new homes) and General Service Customers (new businesses, and institutional facilities). The new residential customers (domestic services) added to the system are assumed to have the same annual energy consumption as the average of the existing customers in that system. A winter season spreads over two separate calendar years and therefore the winter peak of a system could occur in one of those two years. For a winter peaking system like Happy Valley – Goose Bay, the 2016 peak includes the winter of 2016/2017 which ranges between November 2016 and March 2017. Therefore, to meet the 2016 peak, it is necessary that work be completed before November 2016.

The 2014 operating load forecast for the Happy Valley – Goose Bay distribution systems is presented in Table 12.

Table 12: 2014 Operating Load Forecast – Happy Valley – Goose Bay

Year	Gross Peak (kW)	Gross Energy (MWh)	Total Sales (MWh)	Company Use (MWh)
2014	67,381	273,477	259,506	1,455
2015	68,464	277,872	263,700	1,455
2016	69,187	280,807	266,500	1,455
2017	69,763	283,147	268,733	1,455
2018 ⁸	79,090	308,667	293,086	1,455

As mentioned in section 3.2, the Happy Valley – Goose Bay system contains a large number of distribution feeders which all peak at different times. This diversity causes the system peak to be lower than the sum of feeder peaks and must be accounted for when planning the distribution system. To compensate for this System Planning creates a feeder forecast which is based on the average percent of system load that each feeder provides, the typical growth on each feeder and a coincident factor which helps scale the load at the time of the system peak to the actual peak experienced by the feeder. The Feeder peak forecast for HV7 is shown in Table 13.

Table 13: 2014 Feeder Forecast - Happy Valley – Goose Bay Feeder HV7

Year	Feeder Gross Peak (kW)
2014	12,345
2015	12,585
2016	12,745
2017	12,873
2018	13,043

As seen in Table 12, the forecast predicted 1083 kW of load growth on the entire Happy Valley – Goose Bay system between 2014 and 2015. The feeder forecast assigns a portion of the total system load growth to each feeder based on the historical load growth on each feeder. This provides an idea on where the load growth may occur over the forecasted year.

The amount of load that was added to the system on NS11 is atypical due to the fact that all new customers are located very close to each other. As a result, the effect on the

⁸ In 2018 it is expected that a large customer with a secondary supply contract will switch to a firm supply contract

distribution system was concentrated all in one area and the consequences were not forecasted.

Hydro expects more customers to request service in the area of NS11 over the next couple years. There is currently two new buildings being constructed along Toronto Ave whose demand is not yet known and another customer on Ottawa Avenue requesting a service expansion.

3.5 Development of Alternatives

Following the identification of abnormal conditions during the annual review on Hydro's distribution systems, a number of alternatives are considered to correct the problem(s). Hydro considers the following alternatives to address abnormal operating voltages and overloads to overhead conductor and/or equipment:

- Transfer Load;
- Single-phase to Three-phase Line Conversion;
- Install Voltage Regulators;
- Replace Existing Equipment with Equipment with Higher Ratings;
- Increase Conductor Size (Reconductor);
- Voltage Conversion;
- Relocate Equipment; and
- Construct New Distribution Feeder.

Typically, minor work to adjust voltages to within the Hydro standard normal operating range can be covered through the operational measures such as settings adjustment or rebalancing the load on the feeder. If the voltages cannot be brought to within the normal operating range by changing equipment settings, equipment upgrades and distribution system reconfigurations must be executed, which are budgeted as capital projects.

Transfer Load

A load transfer improves voltage regulation and alleviates overloads by reducing the load on

the feeder. This is achieved by transferring a portion of the load on the feeder to an adjacent feeder which has less load or greater capacity. A reduction in load reduces the current through the feeder and associated equipment, thereby reducing voltage drop and improving customer voltage levels. Load can also be transferred from one phase to another to relieve overloads on a single-phase. This procedure is referred to as load balancing. Usually distribution systems with a high degree of load unbalance can overload a single-phase of a piece of equipment. A load transfer is not an option for radial feeders because there are no nearby feeders for transferring extra load.

Single-Phase to Three-Phase Line Conversion

Hydro's distribution system employs long single-phase sections of feeder for supplying power to smaller loads. As loads increase, converting to three-phases may become necessary. Conversion of a single-phase line to a three-phase equivalent can significantly reduce losses, improve load balancing on the system and improve voltage regulation.

Install Voltage Regulators

Depending on the existing configuration of the distribution system, a number of voltage regulator banks can be installed along the feeder to boost end-user voltage to within the Hydro Standard Limits. In practice, up to three stages of voltage regulation can be installed from the terminal station to the end of a feeder. The installation of voltage regulators does not address equipment overloads.

Replace Existing Equipment with Equipment with Higher Ratings

An equipment overload can be addressed by replacing the existing equipment with new equipment having a higher rating to handle the extra load. In some cases, additional equipment is installed in parallel, such as substation transformers to share the load. In some cases replacing an item such as a power transformer with a larger unit can also improve voltage on the feeder because the voltage drop through the transformer may be reduced (depending on transformer impedance).

Reconductor

A specific subset of the above is to replace the existing conductor on a line with a larger conductor. The installation of a larger conductor can greatly increase the power transfer capability of a feeder, and can address both abnormal voltages and overload on the conductor itself. A larger conductor has lower resistance and can transfer more power. The lower the resistance of the conductor, the more current it can carry at the same temperature rise. Due to the lower resistance, the conductor will have better voltage regulation (less voltage drop) and less power loss than a smaller conductor.

Voltage Conversion

Another alternative to improve voltage regulation and overloads is to increase the nominal voltage of the feeder. This is known as a voltage conversion and can be completed on distribution lines which are operating at nominal voltages less than Hydro's maximum distribution voltage of 25 kV. Power is the multiple of current and voltage. Then, for the same demand, an increase in the feeder voltage will correspondingly reduce the current on the line by the same proportion as the increase in voltage. Since current is reduced, voltage regulation is improved and losses are reduced. The line will have increased the power transfer capability because it is operating at higher voltage. Typically, a voltage conversion is achieved by replacing the existing distribution transformers along the feeder with new distribution transformers with a higher rated primary winding voltage. Pole line insulation or other distribution system equipment, if not rated for the new voltage, must also be replaced with suitable insulation or equipment. Depending on the distribution system supply voltage, the project may facilitate the removal or relocation of a substation on a feeder. However, if there is no supply available at the required distribution voltage then extensive upgrades may also be required to the terminal station which can significantly increase cost.

Relocate Equipment

Relocating the overloaded equipment to a location where the load is sufficient for the capacity of the equipment can be used to alleviate an overload condition. In addition to

addressing the overload, the project must also ensure that system protection is not compromised. If the overloaded equipment is a substation, then a voltage conversion will also be required for the customers and equipment upstream of the new substation location. Sometimes the relocation of equipment such as voltage regulators can improve the voltage profile of a feeder.

Construct New Distribution Feeder

Another viable alternative depending on the distribution system configuration is to run an additional feeder from the substation to the load center. This alternative may require an extension to a substation bus to make a spare feeder / breaker bay if one is not already available, and will require appropriate circuit breakers, reclosers and protection equipment to be installed.

The above alternatives are first evaluated technically to determine which can meet the needs of the system. Some alternatives will use a combination of the above. The alternatives meeting the technical requirements to address the abnormal conditions are then economically evaluated to determine the least cost alternative. The evaluation of the alternatives is presented in the following section.

3.6 Evaluation of Alternatives

The following discussion examines the technical viability of the options for this potential project. Overloading conditions were identified on NS11 during the annual distribution review. In response, a number of alternatives were considered to alleviate the overload conditions.

3.6.1 High Level Technical Evaluation

Transfer Load and Voltage Conversion

A load transfer is a technically viable alternative to eliminate the conductor overloads, and transformer overload on the NS11 feeder. The feeder NS11 is fed from and surrounded by the feeder HV7 which operates at 25 kV. Currently there is a span of conductor that is a part

of the NS11 feeder that terminates on the same structure as HV7. A section of line along Toronto Ave is next to this shared structure and can be easily separated from the rest of NS11 and connected to HV7. A voltage conversion is necessary to complete the load transfer because NS11 operates at 4.16 kV and HV7 operates at 25 kV.

There are three possible voltage conversion/load transfer alternatives considered for this project. They are: a partial voltage conversion including Toronto Ave, a partial voltage conversion including Toronto Ave and Ottawa Ave, and a full voltage including Toronto Ave, Ottawa Ave, and the section of line feeding the airport runway.

Refer to the Single Line Diagrams in Appendix A for more details, specifically “*Alternative 1*” through “*Alternative 3*”.

Single-Phase to Three-Phase Line Conversion

The area of interest is already a three-phase line; therefore this alternative is not applicable.

Reconductor and Transformer Upgrade

Increasing size of conductor (reconductoring) along feeder NS11 is a viable alternative that would prevent existing conductor overloads for the foreseeable future. This alternative will not prevent the transformer overload so it would have to be combined with a transformer upgrade. Hydro has two standard sizes of main line conductor, 4/0 AASC and 477 ASC that can be utilized to resolve the abnormal condition.

The proposed scope for this alternative is to replace approximately 230m of 1/0 Cu conductor with 477 ASC conductor. Replacing the existing primary conductor with 477 ASC conductor, would increase the power transfer capability of the line to acceptable levels. Then increasing the size of the transformer NS-T4 is a viable alternative that would relieve the existing NS-T4 from being overloaded.

Refer to the Single Line Diagrams in Appendix A for more details, specifically “*Alternative 4*”.

Install Voltage Regulators

A voltage regulator is used to eliminate the low voltage issues. There are no low voltage issues present on L11 at this time and this is not considered a viable alternative.

Relocate Equipment

This alternative is not applicable. There is no piece of equipment that can be relocated to improve the existing overload conditions on the NS11 distribution feeder.

Construct New Distribution Feeder

This alternative is not applicable. The construction of a new distribution feeder, either from Happy Valley – Goose Bay terminal station or the North Side substation will not improve the existing equipment overload condition enough to prevent planning criteria violations on the NS11 feeder.

Technically Viable Alternatives

Table 14 summarizes the alternatives considered to address the abnormal conditions on the Happy Valley – Goose Bay - North Side distribution system.

Table 14: Technically Viable Alternatives

Alternative	Description
Alternative #1	Partial Voltage Conversion Along Toronto Ave
Alternative #2	Voltage Conversion of the entire NS11 feeder excluding underground cable
Alternative #3	Voltage Conversion of the entire NS11 feeder
Alternative #4	Reconductor NS11 from the HNS substation to Halifax Avenue and Upgrade Transformer Capacity HNS-T4.

3.6.2 Economic Analysis

Each of the above alternatives requires an economic analysis to effectively choose the most economically viable alternative. The economic analysis for this project did not consider costs associated with the operation and maintenance of the distribution system because the cost is relatively common for all alternatives. The upfront costs of the various alternatives are as follows:

Table 15: Alternative Cost Estimates

Alternative	Description	Project Estimate (Dollars)
Alternative #1	Partial Voltage Conversion (Toronto Ave)	\$594,000
Alternative #2	Partial Voltage Conversion (Ottawa and Toronto Ave)	\$1,181,000
Alternative #3	Full Voltage Conversion	\$1,595,000
Alternative #4	Reconductor and Transformer Upgrade	\$588,000

Future Considerations

With regards to future possible load growth, Alternative #1 provides more benefits than Alternative #4 under all load growth scenarios.

If Alternative #1 is completed then the feeder is only half the size as it would be if Alternative #4 is completed. This means that if load growth occurs on Toronto Ave it would have no effect on NS11 as Toronto Ave will now be on HV7. This allows for an additional 10 MW of growth at the end of Toronto Ave. If an additional 1,100 kW of load growth occurred at the end of Ottawa Ave, then NS11 will be in a similar state as it is now, violating the planning criteria and conductor and transformer loading near their rated capacity. At this load level the same alternatives will be available, either a voltage conversion (~\$600,000) or reconductoring along Ottawa Ave (~\$600,000).

If Alternative #4 is complete, NS11 could only handle either an additional 500 kW at the end of Toronto Avenue or 700 kW at the end of Ottawa Avenue before low voltages start to appear and the recloser at the substation overloads. At this point the only alternatives that could eliminate the low voltages would be a voltage conversion (~\$600,000 – same as alternative #1) or the replacement of the recloser and installation of a voltage regulator (>\$300,000).

Alternative #1 allows for more future load growth than Alternative #4. Considering future load growth possibilities and the cost associated with configuring the system to be able to supply this future load growth, the load growth would have to be under 500kW for 70 years for Alternative #4 to be the lowest cost alternative. Based on the load growth over the past

two years and ongoing construction activity, this is considered very unlikely. Therefore, Alternative #1 is the lowest cost alternative and was chosen to prevent the overload conditions in Happy Valley – Goose Bay by the winter of 2016/2017.

4 CONCLUSION

This project is justified on the requirement to meet the growing electricity needs of Hydro's customers in Happy Valley – Goose Bay. In 2014, four new large customers were connected to NS11 feeder causing conductor and transformer overloads on the distribution system. Further load growth is expected to continue over the next few years due to ongoing construction in the area. Therefore, the status quo is not acceptable. Of the considered alternatives, Alternative #1, the voltage conversion and transfer of load along Toronto Avenue to HV7, is considered the optimum alternative and must be completed by the winter of 2016/2017, or sections of the distribution system will remain overloaded at peak demand times. The overloaded conductor and transformer increase the chances of equipment failure which would result in an outage to some customers in Happy Valley – Goose Bay.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 16.

Table 16: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	230.0	0.0	0.0	230.0
Labour	135.0	0.0	0.0	135.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	100.0	0.0	0.0	100.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	35.7	0.0	0.0	35.7
Contingency	93.0	0.0	0.0	93.0
TOTAL	593.7	0.0	0.0	593.7

4.2 Project Schedule

The anticipated project schedule is shown in Table 17.

Table 17: Project Schedule

Activity		Start Date	End Date
Planning	Resource Planning	January 2016	January 2016
Design	Assessment Completed	September 2014	November 2014
Procurement	Materials Ordered	January 2016	March 2016
Construction	Monitor Construction Activities	June 2016	August 2016
Commissioning	Inspection Performed by Local Operations Crews	August 2016	September 2016
Closeout	Project Closeout	September 2016	October 2016

Appendix A
Single Line Diagrams

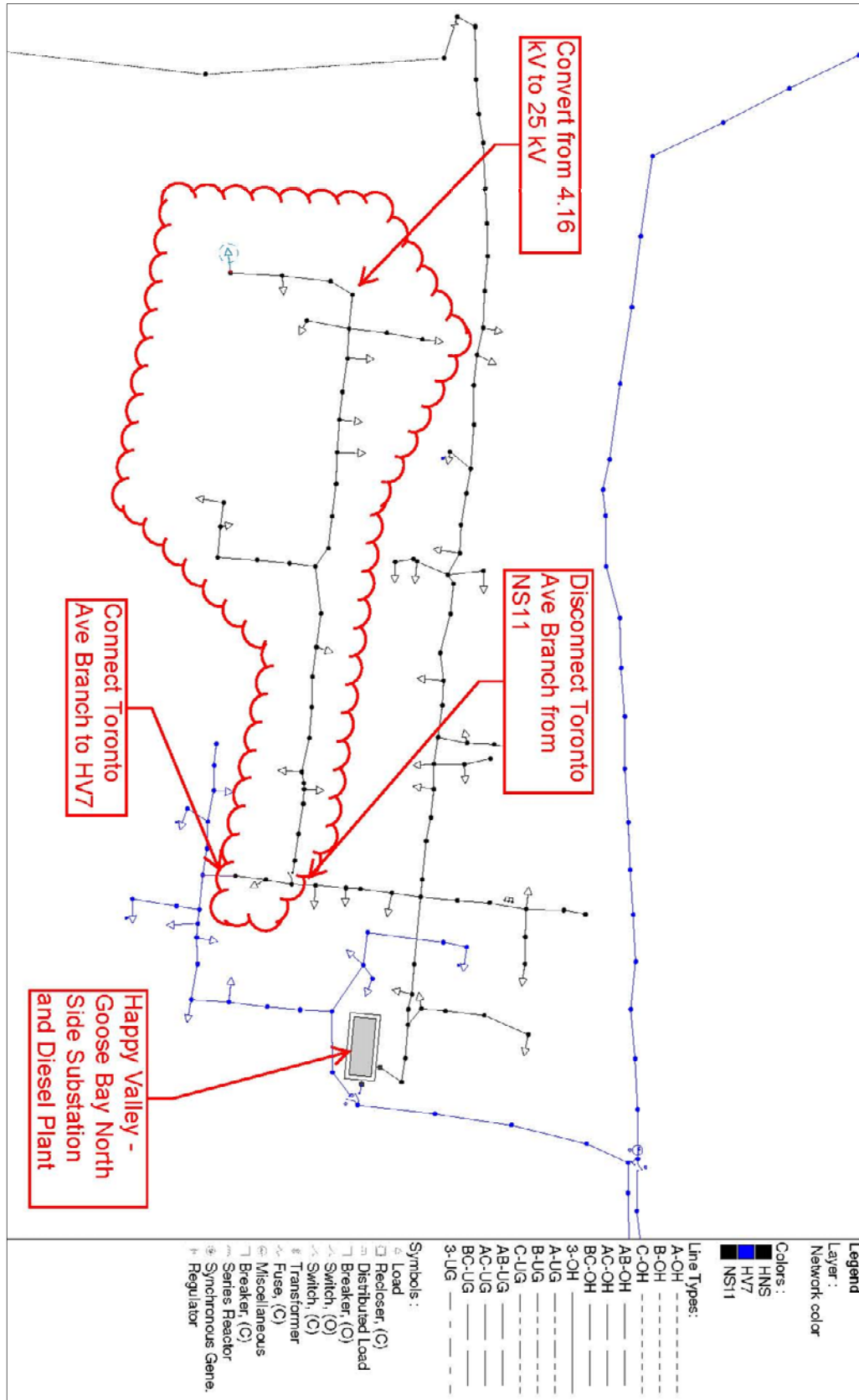


Figure 5: Alternative 1 Single Line Diagram

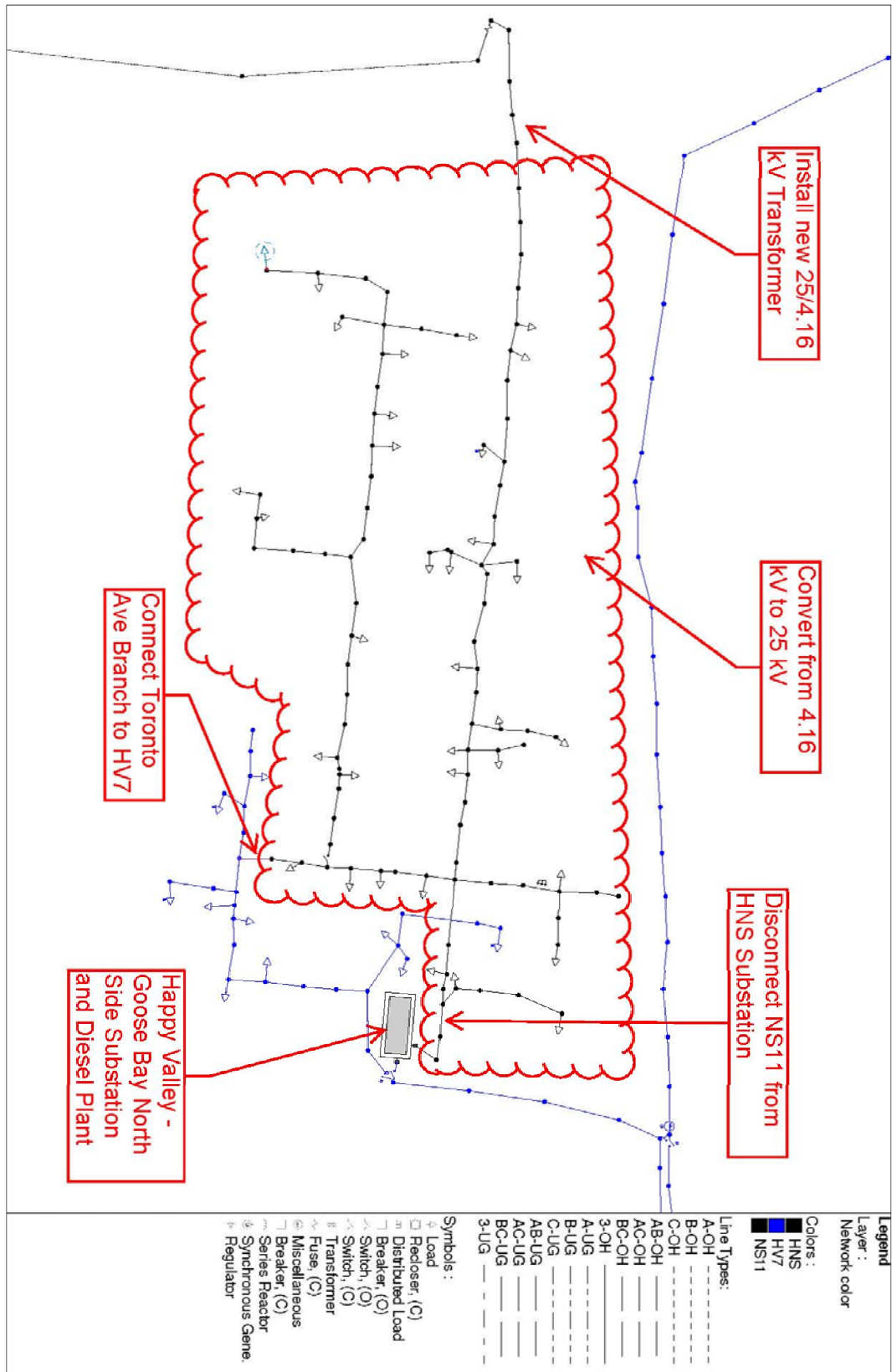


Figure 6: Alternative 2 Single Line Diagram

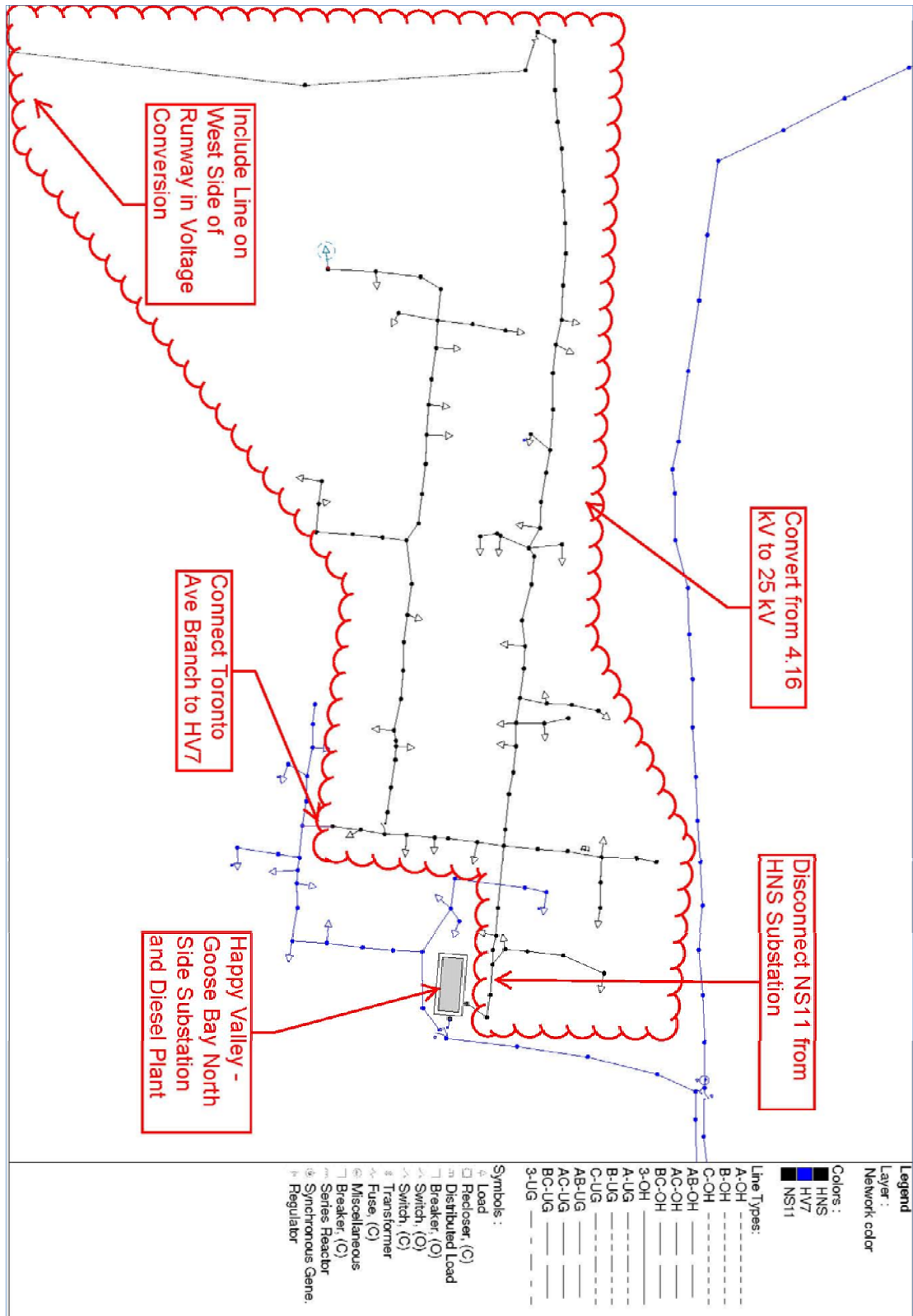


Figure 7: Alternative 3 Single Line Diagram

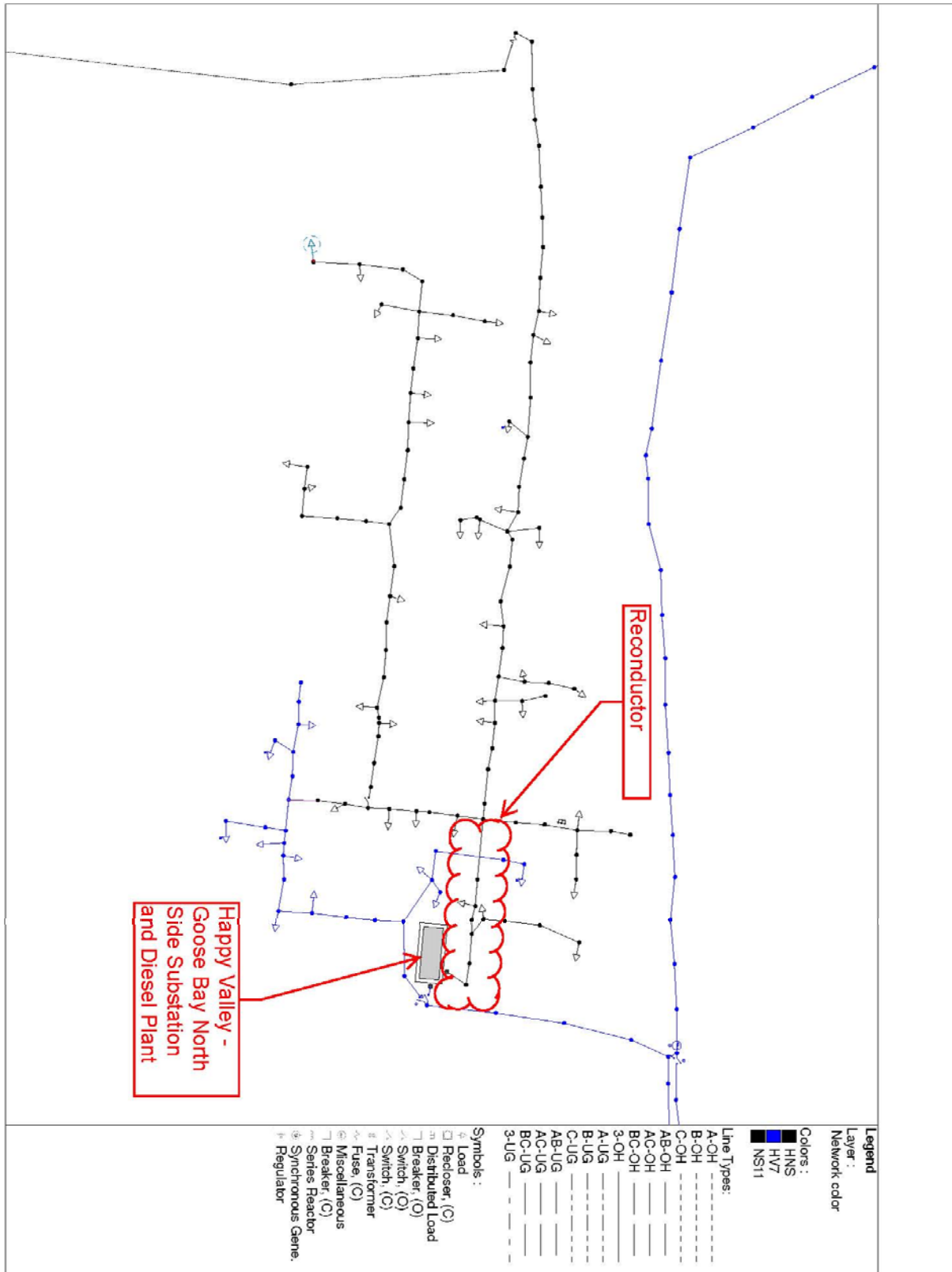
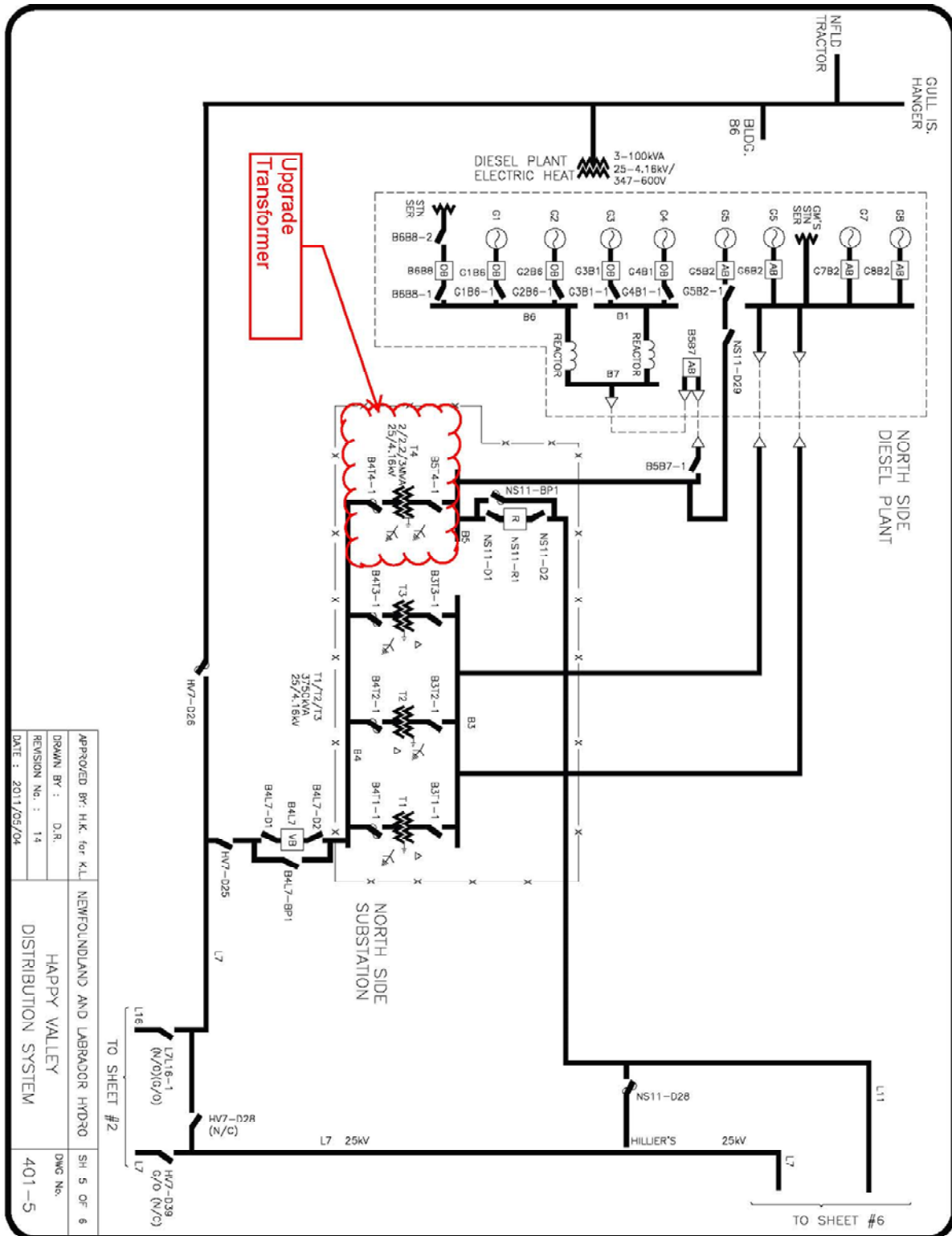


Figure 8: Alternative 4 Single Line Diagram



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

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

**Upgrade Digital Fault Recorders
Various Sites**

July 2015

SUMMARY

Digital Fault Recorders (DFRs) record voltages and currents in stations which can be used to analyze system disturbance events, such as short circuits or failure of elements, which result in abnormal voltages and/or currents. These recordings can give a good indication of what has happened during a disturbance. Hydro has DFRs in use throughout the Island Interconnected System to capture information from waveforms for this purpose.

In total, there are 17 stations on the island equipped with standalone Mehta Tech Inc. DFRs. Mehta Tech Inc. completed a full review of all existing fault recorders on October 20, 2014, and determined there are eight stations requiring extensive hardware upgrades, due to electronic components which have become obsolete. The eight digital fault recorders requiring upgrades are located at Hardwoods, Plum Point, Western Avalon, Sunnyside, Cat Arm, Stony Brook, Upper Salmon and Holyrood. Upgrading the eight stations which require extensive upgrades is necessary to ensure the reliability of the DFRs used by Hydro.

Only specific obsolete components of the electronic chassis will require replacement. The existing cabling to the DFR cabinets, the internal wiring of the cabinets and the blocking and testing switches will not be replaced. The master station software will also not require replacement. The scope of work will also include increasing the number of analog channels from 32 to 48 at five of these stations to provide more information for Systems Operations and Protection and Control Engineering in analyzing system disturbance events.

The total cost of the project to upgrade all obsolete components on the Mehta Tech DFRs and to expand the analog channels from 32 to 48 at five stations is estimated at \$502,500 and will be scheduled over a two year period from 2016 - 2017. Materials will be sole-sourced from Mehta Tech Inc.

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1 INTRODUCTION

Following the power interruptions which occurred on the Island Interconnected System in January 2014, Hydro's internal review identified opportunities for improvement related to existing system disturbance event recording devices and procedures. In the 'Report to the Board of Commissioners of Public Utilities related to Alarms, Event Recording Devices and Digital Relays' dated August 1 2014, Section 2.1.1 "Review of Existing Digital Fault Recorders", it was stated that Hydro would 'Develop a multi-year replacement plan and capital budget proposal for obsolete Digital Fault Recorders (DFRs) with a priority on 230 kV stations, and then followed by 138 kV and 69 kV stations'. This proposal will outline the scope of work to be completed for upgrading existing DFRs, the schedule and the cost.

This proposal covers only stations with existing DFRs. It is expected that during the course of this project a review of stations without fault recorders will be completed to determine which, if any, would benefit from having a digital fault recorder installed. If necessary, additional DFR projects will be proposed in future capital budget applications.

When a system disturbance event occurs on the system, DFRs are an important aspect in helping to determine the cause(s) and/or effect(s) of the event such that corrective action can be taken. DFRs record and store voltages and currents in stations that are used to analyze system disturbances. These recordings give a good indication of what has happened during a disturbance. Hydro has DFRs in use throughout the Island Interconnected System to capture information for this purpose.

In total, there are 17 stations on the island equipped with standalone Mehta Tech Inc. DFRs. In late 2014, Hydro authored a report surveying the 17 stations and providing recommendations for their upgrades. Of the 17 stations surveyed, it was found that nine stations require minor software upgrades and eight stations require extensive upgrades.

The minor software upgrades include upgrading the processor operating system and the processor BIOS (Basic Input/Output System). The extensive upgrades involve replacing

obsolete electronic hardware components. It was also recommended to increase the number of analog channels at five of these stations to provide more information for Systems Operations and Protection and Control Engineering in analyzing system disturbance events.

The nine stations requiring minor upgrades will be covered under the 2015 operating budget. This proposal covers only the eight stations requiring extensive upgrades, five of which require additional analog channels.

2 PROJECT DESCRIPTION

The scope of the work is to upgrade the eight existing standalone Mehta Tech Inc. DFRs identified as requiring extensive upgrades.

The extensive upgrades include the replacement of obsolete electronic components in the electronic chassis of the DFR, including the hard drive, host processor, RAM memory, internal modem and the Ethernet interface module. The electronic chassis can be seen in Figures 1 and 2 below of the front and rear of the DFR cabinet.

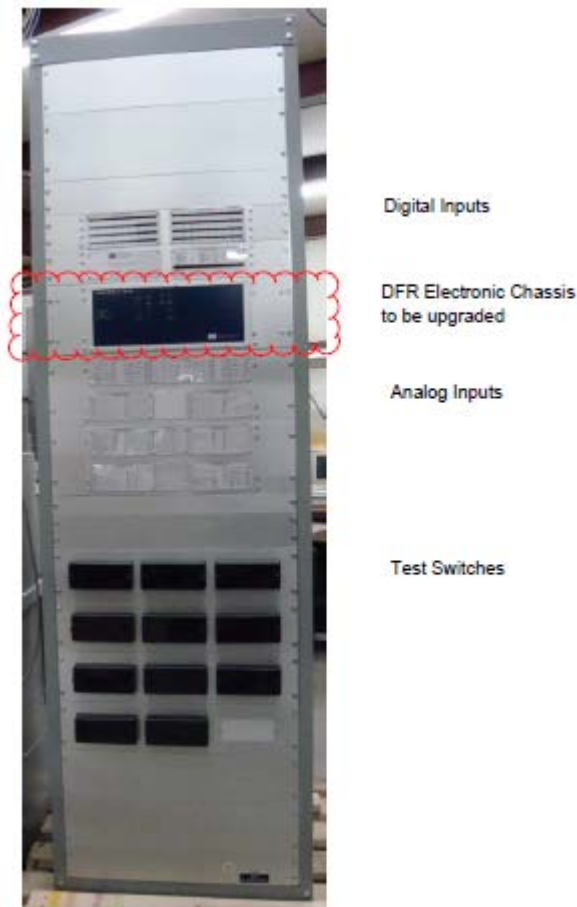


Figure 1: Mehta Tech DFR Cabinet Layout – Front View



Figure 2: Mehta Tech DFR Cabinet Layout – Rear View

Only specific obsolete components of the electronic chassis will require replacement. The existing cabling to the DFR cabinets, the internal wiring of the cabinets and the blocking and testing switches will not be replaced. The master station software will also not require replacement.

The eight digital fault recorders requiring upgrades are located at Hardwoods, Plum Point, Western Avalon, Sunnyside, Cat Arm, Stony Brook, Upper Salmon and Holyrood. The scope of work will also include increasing the number of analog channels from 32 to 48 at five of these stations (Hardwoods, Western Avalon, Sunnyside, Stony Brook and Holyrood) to provide more information for Systems Operations and Protection and Control Engineering in analyzing system disturbance events.

The upgrades to the eight stations will be implemented over the two year period from 2016-2017. Materials will be sole-sourced from Mehta Tech Inc., as they are the original supplier.

3 JUSTIFICATION

This project proposal outlines the requirements to perform extensive upgrades on eight existing digital fault recorders on the island. This project is necessary to upgrade the older DFRs in Hydro's system by replacing the obsolete components, as determined by the original manufacturer Mehta Tech Inc.

DFRs are an important aspect in determining the cause(s) and/or effect(s) of a system disturbance event on the system. Hydro has DFRs in use throughout the Island Interconnected System to capture information from recordings of voltages and currents for this purpose. Data collected from DFRs is analyzed by personnel from both Protection and Control Engineering and Systems Operations such that corrective action on the system can be taken.

Most utilities use fault recording devices and they are required for all North American utilities in some capacity that follow NERC standards.

3.1 Existing System

There are 17 stations on the island which are equipped with standalone Mehta Tech Inc. DFRs. This proposal describes the eight that require extensive upgrades. These can be seen below in Table 1. A detailed description can be found in Appendix A.

Table 1: Hydro DFR Inventory

Location	Year Installed	Age (Years)
Holyrood	2003	12
Stony Brook	2002	13
Upper Salmon	2002	13
Cat Arm	2000	15
Sunnyside	1999	16
Plum Point	1996	19
Western Avalon	1996	19
Hardwoods	1995	20

A summary of all major work and upgrades completed on the existing DFRs requiring extensive upgrades can be seen below in Table 2. There have been no other upgrades or maintenance performed on any of the DFRs, other than what is listed below, since installation.

Table 2: Major Work or Upgrades

Year	Location	Major Work/Upgrade	Comments
2014	Hardwoods	Replaced Hard drive	Remote communications currently not operational.
2014	Western Avalon	Replaced Hard drive	
2013	Plum Point	Replaced modem	Local/Remote communications currently not operational.
2010	Plum Point	Replaced Hard drive	
2008	Plum Point	Replaced Hard drive	
2003	Holyrood	Replaced DFR	

Many of the DFRs were installed many years ago, but none of the existing DFRs are considered entirely obsolete. A detailed description of the vendor recommended upgrade plan can be found in Section 3.2.3.

3.2 Operating Experience

The information stored in the DFRs is regularly monitored by personnel in Protection and Control Engineering and Systems Operations and generally the DFRs perform their intended function. However, during the power outages of January 2014, some system events could not be analyzed and re-constructed due to a DFR which had failed. It was discovered after the power outages that the hard drive at Western Avalon had failed and as a result did not capture any data during the system disturbance events. Having a functioning DFR at Western Avalon could have aided in analyzing and providing solutions for the power outages of January 2014. Upgrading the obsolete components of the DFRs will help to avoid this issue in the future.

Another issue which has been identified is that some important information is not being monitored by all DFRs. For example, at Hardwoods Terminal Station, the DFR monitors the three phase currents on TL201, TL236 and TL242. However, the neutral current is not being

monitored. On Transformers T1, T2 and T3, only the neutral current is being monitored, but not the phase currents. This is due to a lack of available analog channels on the existing DFRs.

The report authored by Hydro in late 2014 completed a review of all analog channels on the existing DFRs and identified stations which would benefit from an increase in the number of analog channels from 32 to 48 (see Appendix B). Of the eight stations which will be undergoing extensive upgrades, five of these stations would benefit from an expansion of analog channels to capture additional data for analyzing system events. These stations are Hardwoods, Western Avalon, Sunnyside, Stony Brook and Holyrood.

3.2.1 Reliability Performance

During the power outages of January 2014, system events could not be analyzed and reconstructed due to DFRs which had failed.

3.2.2 Industry Experience

Hydro One in Ontario uses standalone Mehta Tech DFRs. They recently completed an upgrade of 80 DFRs in their system by using an exchange program which was proposed by Mehta Tech Inc. See 3.2.6 below for further information on the proposed program.

3.2.3 Vendor Recommendations

An analysis of existing DFRs was completed by Mehta Tech Inc. on October 20, 2014. Each electronic component was evaluated against the recommended time frame for replacement. A detailed listing of recommended upgrades for each of the eight proposed DFRs was provided by Mehta Tech Inc. and can be found in Appendix C.

Of the 17 stations surveyed by Mehta Tech Inc., it was found that eight stations require extensive upgrades and nine stations require minor upgrades. The nine stations requiring minor upgrades will be covered under the 2015 operating budget. This proposal covers only the eight stations requiring extensive upgrades.

Mehta Tech Inc. has proposed an exchange program for upgrading the existing digital fault recorders which require extensive upgrades.

The proposed plan involves purchasing a new electronic chassis for \$18,500 and installing it at a station. That station's chassis would then be sent to the Mehta Tech Inc. factory and have the required upgrades completed which would cost approximately \$2,460 in addition to the cost of the upgrade parts. This procedure minimizes cost and downtime and was recommended to Hydro by Mehta Tech Inc., as Hydro One has recently completed upgrades on 80 DFRs using this exchange concept with great success.

Sending each electronic chassis back to the manufacturer allows Mehta Tech Inc. to perform heat testing on the refurbished units, which would aid in discovering any other issues which may be present in the existing units. Additionally, if a problem does arise, it is much more convenient and efficient for the Mehta Tech representatives to remediate the issue in their factory with their tools and equipment readily available, rather than doing unscheduled repairs in the field. This would also minimize overall downtime, as an existing unit would not be removed from a station until the replacement unit had arrived and was ready to be installed.

A two-year replacement plan beginning in 2016 has been proposed and is shown in the tables below. This plan would begin by purchasing a new electronic chassis and having it installed at Hardwoods. From there, the electronic chassis at Hardwoods would be removed and sent to the factory for refurbishment. This would continue from the older stations to the newer stations until all upgrades were completed. The existing analog channels will not have to be recalibrated, if they are presently within calibration. However, it has been proposed that after the upgrade Hydro will check to see if the original analog channels are within calibration.

The cost for replacement parts for each site can be found in Table 3 below. The costs below represent only the Mehta Tech Inc. costs, and not the Hydro costs involved with personnel

removing and installing the DFRs at each station and any other required commissioning tasks. The costs below are estimated in Canadian dollars based on a conversion rate of 1.23 (obtained online on April 22, 2015).

Table 3: Mehta Tech Cost: Extensive Upgrades

Location	Year Installed	Price in \$CAD for Material
Buy New Chassis		\$18,500
Upper Salmon	2008	\$8,000
Holyrood	2003	\$8,000
Stony Brook	2002	\$8,000
Cat Arm	2000	\$17,000
Sunnyside	1999	\$17,000
Plum Point	1996	\$14,000
Western Avalon	1996	\$8,000
Hardwoods	1995	\$11,000
Miscellaneous		\$5,000
Total		\$114,500

Mehta Tech Inc. was also consulted for a cost estimate for the five stations which have been identified as benefitting from an upgrade in the number of analog channels. Mehta Tech Inc. reviewed the layout drawings for the stations and confirmed there was sufficient space for an expansion from 32 to 48 analog channels for each DFR. The estimated cost per station to upgrade from 32 to 48 analog channels is \$13,000 per station. The additional cost for materials to upgrade the analog channels at five stations can be seen below in Table 4.

Table 4: Mehta Tech Cost: Analog Upgrade

Location	Year Installed	Price in \$CAD for Material
Holyrood	2003	\$13,000
Stony Brook	2002	\$13,000
Sunnyside	1999	\$13,000
Western Avalon	1996	\$13,000
Hardwoods	1995	\$13,000
Cable		\$10,000
Miscellaneous		\$5,000
Total		\$80,000

3.2.4 Maintenance or Support Arrangements

There are no maintenance or support arrangements in place for any of the existing DFRs on the island. Mehta Tech Inc. is contacted for assistance if the need arises.

3.2.5 Maintenance History

Routine maintenance is not performed on any of the 17 digital fault recorders in Hydro's system.

3.2.6 Anticipated Useful Life

Each individual component of the DFR has a different anticipated useful life which varies between 4 – 25 years. A description of Mehta Tech Inc. electronics upgrade information can be found in Appendix D. A summary of the service life of the electronic components can be found below in Table 5.

Table 5: Useful Life of DFR Components

Electronic Component	Service Life
Host Processor	12 years
Power Supply	10-12 years
Synchronized Clock Module	15 years
System Support Module	12 years
16MB RAM Memory Module	15 years
Data Collection / Data Processing Modules	15-18 years
Internal Modem	10-12 years
Battery Replacement	4-6 years
Digital Isolator Module	18-20 years
Relay Output Module	20-25 years
Ethernet Interface Module	12 years
DC Analog Isolation Module	18-20 years
Electronic Chassis	25 years

3.3 Forecast Customer Growth

This project is not needed for customer growth.

3.4 Development of Alternatives

All DFRs owned by Hydro are manufactured by Mehta Tech Inc. This proposal is based on recommendations received directly from Mehta Tech Inc. upon performing a thorough review of all existing DFRs on the island. The manufacturer recommended a replacement plan based on the obsolescence of parts, as determined by the estimated useful service life of each individual electronic component.

Mehta Tech Inc. DFRs are modular in design, allowing for easy expansion and upgrading of specific electronic components which are obsolete. As seen in Section 2, the electronic chassis on Shelf 6 is one component in the DFR cabinet. Since only specific obsolete components of the electronic chassis require replacement, it is not viable to consider purchasing an entirely new DFR from another manufacturer. For example, at Hardwoods Terminal Station only four hardware components within the electronic chassis require replacement.

The existing cabling to the DFR cabinets, the internal wiring of the cabinets and the blocking and testing switches will not be replaced. The master station software will also not require replacement.

3.5 Evaluation of Alternatives

The manufacturer has recommended replacing obsolete electronic components based on a thorough review of the existing DFRs. There are no other viable alternatives.

3.5.1 Energy Efficiency Benefits

There are no energy efficiency benefits related to this proposal.

3.5.2 Economic Analysis

The replacement of electronic components within the DFRs is based on the recommendations from Mehta Tech Inc. The components requiring replacement are at the end of their useful service life and can no longer be relied upon to capture data during system disturbance events.

4 CONCLUSION

There are eight DFRs owned by Hydro which require extensive upgrades based on the manufacturer's recommendations, due to electronic components which have become obsolete. Upgrading the eight stations which require extensive upgrades is necessary to ensure the reliability of the DFRs used by Hydro. The scope of work will also include increasing the number of analog channels from 32 to 48 at five of these stations to provide more information for Protection and Control Engineering and Systems Operations in analyzing system disturbance events.

The total cost of the exchange program to upgrade all obsolete components on the Mehta Tech DFRs and to expand the analog channels from 32 to 48 at five stations is estimated at \$502,500 CAD and will be scheduled over a two year period from 2016 - 2017.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 6.

Table 6: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	105	89.5	0.0	194.5
Labour	69.1	92.3	0.0	161.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	10.5	7.6	0.0	18.1
Interest and Escalation	13.3	40.4	0.0	53.7
Contingency	0.0	74.8	0.0	74.8
TOTAL	197.9	304.6	0.0	502.5

4.2 Project Schedule

The anticipated project schedule is shown in Table 7.

Table 7: Project Schedule

Activity		Start Date	End Date
Planning	Prepare Scope Statement	January 2016	February 2016
	Gather technical information for contract	January 2016	February 2016
	Prepare contract for supply	January 2016	February 2016
Design	Prepare and update drawings	March 2016	June 2016
Procurement	Issue Contract	March 2016	March 2016
	Purchase miscellaneous material	May 2016	May 2016
Construction	Install eight refurbished DFRs including five with extra analog channels	June 2016	September 2017
Commissioning	Commission eight refurbished DFRs	June 2016	October 2017
Closeout	Project closeout information	November 2017	December 2017

APPENDIX A
Hydro Digital Fault Recorder Inventory

Hydro Digital Fault Recorder Inventory

Item	Location	Manufacturer	Model	No. of Analog Inputs	No. of Digital Inputs	Year Installed	Working	Issue / Notes
1	Cat Arm	Mehta Tech Inc.	Transcan	32	64	2000	YES	
2	Holyrood	Mehta Tech Inc.	Transcan	32	64	2003	YES	Replaced in 2003. Original was RIS DFR.
3	Hardwoods	Mehta Tech Inc.	Transcan	32	64	1995	NO	Hard drive replaced in 2014. Remote Comm. Is not working.
4	Plum Point	Mehta Tech Inc.	Transcan	24	48	1996	NO	Modem (2013) and Hard drive (2010, 2008) replaced. Local/Remote Comm. not working.
5	Sunnyside	Mehta Tech Inc.	Transcan	32	64	1999	YES	
6	Stony Brook	Mehta Tech Inc.	Transcan	32	64	2002	YES	
7	Upper Salmon	Mehta Tech Inc.	Transcan	32	64	2002	YES	
8	Western Avalon	Mehta Tech Inc.	Transcan	32	64	1996	YES	Hard drive replaced in 2014.

APPENDIX B

Review of Analog Inputs

Hardwoods Terminal Station							
	Actual		Per Standard		Recommended to add		
Electrical Element	PT	CT	PT	CT	PT	CT	Comments
Buses							
Bus B1 (230 kV)	-	-	3	-	-	-	PT from TL201
Bus B2 (230 kV)	-	-	3	-	-	-	PT from TL242
Bus B7 (66 kV)	3	-	3	-	-	-	
Bus B8 (66 kV)	3	-	3	-	-	-	
Bus B6 (66 kV)	-	1 (B)	3	-	-	-	NL Power
Bus B9 (66 kV)	-	1 (B)	3	-	-	-	NL Power
Transmission Lines							
TL 201 (Western Avalon)	3	3 (no N)	-	4	-	1	Bus B1 (230 kV)
TL 236 (Oxen Pond)	-	3 (no N)	-	4	-	1	"
TL 242 (Holyrood)	3	3 (no N)	-	4	-	1	Bus B2 (230 kV)
Transformers							
T1 (230 kV / 66 kV)	-	1 (N)	-	4	-	3	
T2 (230 kV / 66 kV)	-	1 (N)	-	4	-	3	
T3 (230 kV / 66 kV)	-	1 (N)	-	4	-	3	
T4 (230 kV / 66 kV)	-	2 (N HS & LS)	-	4	-	3	
T5 (66 kV / 13.8kV)	-	3 (no N)	-	-	-	-	
GT1 (66 kV / 600V)	-	1 (N)	-	-	-	-	
		32	46		15		

Bus B1 & B2 only have B-phase PTs, PTs from TL201 and TL242
 Bus B6 & B9 are NL Power so not required if there is not enough space
 Use 15 added analog inputs
 Total of 47 analog inputs required at Hardwoods
Add 16 analog inputs at Hardwoods

Plum Point Terminal Station							
Electrical Element	Actual		Per Standard		Recommended to add		Comments
	PT	CT	PT	CT	PT	CT	
Buses							
Bus B1 (138 kV)	3	-	3	-	-	-	
Bus B2 (12.5 kV)	1 (A)	-	-	-	-	-	
Transmission Lines							
TL 241 (Peter's Barren)	1 (C)	4	-	4	-		Bus B1 (138 kV)
TL 244 (Bear Cove)	1 (C)	4	-	4	-		"
Transformers							
T1 (138 kV / 12.5 kV)	-	1 (N)	-	-	-	-	
Other							
Reactor R1 (138 kV)	-	1 (B)	-	-	-	-	
Reactor R2 (138 kV)	-	1 (B)	-	-	-	-	

17

11

No recommendations

There are 7 spare analog channels on existing DFR

No Recommendations

Western Avalon Terminal Station							
	Actual		Per Standard		Recommended to add		
Electrical Element	PT	CT	PT	CT	PT	CT	Comments
Buses							
Bus B1 (230 kV)	3	-	3	-	-	-	
Bus B2 (66 kV)	3	-	3	-	-	-	
Bus B3 (230 kV)	-	-	3	-	-	-	no TL on this bus
Bus B4 (138 kV)	3	-	3	-	-	-	
Transmission Lines							
TL 208 (Long Harbour)	-	1 (N)	-	4	-	3	Bus B1 (230 kV)
TL 237 (Come by Chance)	-	4	-	4	-	-	"
TL 201 (Hardwoods)	-	4		4	-	-	"
TL 203 (Sunnyside)	-	4		4	-	-	"
TL 217 (Holyrood)	-	4		4	-	-	"
86L (Blaketown)	-	-		4	-	-	Bus B2 (66 kV) - NL Power
64L (Blaketown)	-	-	-	4	-	4	Bus B4 (138 kV) - NL Power
Transformers							
T1 (230 kV / 66 kV)	-	1 (N)	-	4	-	3	
T2 (230 kV / 66 kV)	-	1 (N)	-	4	-	3	
T3 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	Use CT readings on 64L (low side of T3, T4, T5)
T4 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	
T5 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	
GT1 (66 kV / 6.9kV)	-	1 (N)	-	-	-	-	
		32	60		13		

No TL from Bus B3 so do not need PT reading

86L is NL Power owned so we don't need if there is not enough space

64L is NL Power owned, but take these 4 CT readings, as that is enough information so that CT readings from T3, T4 and T5 are not required

Use 13 added analog inputs at Western Avalon

Total of 45 analog inputs required at Western Avalon

Add 16 analog inputs at Western Avalon

Sunnyside Terminal Station							
Electrical Element	Actual		Per Standard		Recommended to add		Comments
	PT	CT	PT	CT	PT	CT	
Buses							
Bus B1 (230 kV)	-	-	3	-	-	-	Have PT readings
Bus B2 (138 kV)	3	-	3	-	-	-	
Bus B3 (138 kV)	-	-	3	-	-	-	
Transmission Lines							
TL 206 (Bay d'Espoir)	3	4	-	4	-	-	Bus B1 (230 kV)
TL 203 (Western Avalon)	3	4	-	4	-	-	"
TL 207 (Come by Chance)	3	3 (no N)	-	4	-	1	"
TL 202 (Bay d'Espoir)	3	4	-	4	-	-	"
TL212 (Linton Lake)	-	-	-	4	-	4	Bus B2 (138 kV)
TL219 (Salt Pond)	-	-	-	4	-	4	Bus B3 (138 kV)
109L (Gander)	-	-	-	4	-	-	Bus B3 (138 kV) - NL Power
100L (Clareville)	-	-	-	4	-	-	Bus B3 (138 kV) - NL Power
Transformers							
T1 (230 kV / 138 kV)	-	1 (N)	-	4	-	3	
T4 (230 kV / 138 kV)	-	1 (N)	-	4	-	3	
T5 (138 kV / 12.5kV)	-	-	-	-	-	-	
		32			46	15	

Bus B1 - Have PT readings from 4 TLs off of Bus B1

109L & 100L - NL Power owned so can be left out if not enough space

Use 15 added analog inputs to Sunnyside

Add 16 analog inputs at Sunnyside

Cat Arm Generating Station

Electrical Element	Actual		Per Standard		Recommended to add		Comments
	PT	CT	PT	CT	PT	CT	
Buses							
230 kV Bus			3	-			
Transmission Lines							
TL 247 (Deer Lake)			-	4			230 kV Bus
Transformers							
T1 (230 kV / 13.8kV)			-	4			
T2 (230 kV / 13.8kV)			-	4			

15

T1 & T2 - include as they are upstream from generators G1 & G2
No DFR drawings available for Cat Arm to determine actual inputs

Stony Brook Terminal Station							
	Actual		Per Standard		Recommended to add		
Electrical Element	PT	CT	PT	CT	PT	CT	Comments
Buses							
Bus B1 (230 kV)	3	-	3	-	-	-	
Bus B2 (230 kV)	-	-	3	-	1	-	Only phase B PT on B2.
Bus B3 (138 kV)	3	-	3	-	-	-	
Transmission Lines							
TL232 (Buchans)	-	4	-	4	-	-	Bus B1 (230 kV)
TL231 (Bay d’Espoir)	-	4	-	4	-	-	"
TL205 (Buchans)	-	4	-	4	-	-	"
TL235 (Grand Falls Freq.)	-	4	-	4	-	-	"
TL204 (Bay d’Espoir)	-	4	-	4	3	-	Bus B2 (230 kV)
TL222 (Springdale)	-	4	-	4	-	-	Bus B3 (138 kV)
130L (Grand Falls)	-	-	-	4	-		"
133L (Bishops Falls)	-	-	-	4	-		"
TL210 (Gander)	-	-	-	4	-	4	"
Transformers							
T1 (230 kV / 138 kV)	-	1 (N)	-	4	-	3	
T2 (230 kV / 138 kV)	-	1 (N)	-	4	-	3	
		32	53		14		

Bus B2 - only phase B PT available. Take phase B and take PT readings from TL204 which is on B2

130L & 133L - not included because of lack of space

Use additional 14 channels at Stony Brook

Add 16 analog inputs at Stony Brook

Upper Salmon Generating Station

Electrical Element	Actual		Per Standard		Recommended to add		Comments
	PT	CT	PT	CT	PT	CT	
Buses							
230 kV Bus			3	-			
Transmission Lines							
TL 234 (Bay d'Espoir)			-	4			230 kV Bus
TL 263 (Granite Canal)				4			230 kV Bus
Transformers							
T1 (230 kV / 13.8kV)			-	4			

15

T1 - include as it is upstream from generator G1

No DFR drawings available for Upper Salmon to determine actual inputs

Holyrood Terminal Station

	Actual		Per Standard		Recommended to add		
Electrical Element	PT	CT	PT	CT	PT	CT	Comments
Buses							
Bus B15 (230 kV)	-	-	3	-	-	-	no TL on this bus
Bus B8 (138 kV)	3	-	3	-	-	-	
Bus B11 (230 kV)	-	-	3	-	1	-	Only phase B PT on B11 & B12. TL217 & TL242 PTs used.
Bus B12 (230 kV)	-	-	3	-	1	-	
Bus B13 (230 kV)	-	-	3	-	-	-	No PTs on B13. Use TL218 PT.
Bus B6 (69 kV)	-	-	3	-	3	-	
Bus B7 (69 kV)	3	-	3	-	-	-	
Transmission Lines							
39L	-	-	-	-	-	4	Bus B8 (138 kV) - NL Power
TL217 (Western Avalon)	3	3 (no C)	-	4	-	1	B11/B12 (230 kV)
TL242 (Hardwoods)	3	3 (no B)	-	4	-	1	B11/B12 (230 kV)
TL218 (Oxen Pond)	-	3 (no A)	-	4	3	1	B12/B13 (230 kV)
38L	-	-	-	-	-	-	Bus B7 (69 kV) - NL Power
Transformers							
T6 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	Use CT readings on 39L (low side of T6, T7, T8)
T7 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	
T8 (230 kV / 138 kV)	-	1 (N)	-	4	-	-	
T10 (230 kV / 69 kV)	-	1 (N)	-	4	-	3	
T5 (230 kV / 69 kV)	-	1 (N)	-	4	-	3	
T1 (230 kV / 16kV)	-	2 (B,N)	-	4	-	2	
T2 (230 kV / 16kV)	-	2 (B,N)	-	4	-	2	
T3 (230 kV / 16kV)	-	2 (B,N)	-	4	-	2	

32

65

27

Bus B15 - No TL from this bus so do not need PT reading

Bus B13 - no PTs available. Take PT reading from TL218. Ideally, B11/B12/B12 should all have PTs.

39L - take CT readings here and use for T6, T7, T8

T1, T2, T3 - include as they are upstream from generators G1, G2, G3

Could use 27 added analog inputs at Holyrood

Can only add 16 analog inputs to existing DFR

Add 16 analog inputs at Holyrood

APPENDIX C

Mehta Tech Inc. DFR Review and Budgetary Quote

October 20, 2014

Mehta Tech Budgetary Quotation 14-278
to Newfoundland Labrador Hydro
TRANSCAN DFR Upgrade / Chassis Replacement Recommendations

List of DFRs requiring extensive upgrades.

Job Site	Project #	Number of Analog & Digital Channels	Replace End-of-Life Host Processor	Upgrade to Host Processor INLINK Operating System	Upgrade Host Processor BIOS	Replace End-of-Life DCM/DPMs	Replace End-of-Life Power Supply & Wiring Harness	Replace End-of-Life System Support Module	Replace End-of-Life Memory with SRAM	Replace End-of-Life Modem	Replace End-of-Life Real Time Clock with Synch. Clock Module	Replace End-of-Life Hard Drive with Flash Drive	Price for Upgrade Parts	OPTION 1: Price for New Replacement DFR Electronics Chassis *
Hardwoods	93-390	32/64	No	No	No	Yes	Yes	Yes	No	Yes	No	No	US\$5,750	US\$15,000
Plum Point Terminal Station	95-555	24/48	Yes	No	No	Yes	Yes	Yes	Yes	No	Yes	No	US\$8,900	US\$15,000
Western Avalon Terminal Station	95-623	32/64	No	No	No	Yes	No	No	No	Yes	No	No	US\$3,950	US\$15,000
Sunnyside Terminal Station	99-993	32/64	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	US\$10,750	US\$15,000
Cat Arm Generating Station	00-1050	32/64	Yes	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	US\$10,750	US\$15,000
Stony Brook Terminal	02-1214	32/64	Yes	No	No	No	Yes	Yes	No	Yes	No	No	US\$3,950	US\$15,000
Upper Salmon Generating Station	02-1219	32/32	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes	US\$3,850	US\$15,000
Holyrood Terminal Station	03-1265	32/64	Yes	No	No	No	Yes	Yes	No	Yes	No	No	US\$3,950	US\$15,000

Yes - Upgrade is recommended

No - No upgrade is recommended at this time

Option 1: Replaces the existing DFR electronics chassis with one of the current design. The replacement chassis will be pre-configured and tested using the DFR's existing configuration files. This option results in a DFR "down-time" of one day or less. The price includes one copy of the Standard TRANSCAN DFR Master Station software (single user license).

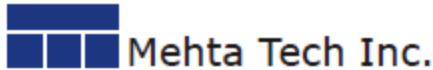
*** Note:** Electronics chassis includes an Ethernet Interface and an internal modem with surge suppressor.

Warranty - There is a 5-year warranty on new electronics chassis. There is a 2-year warranty on replacement parts installed in an existing electronics chassis.

Quotation Validity - This quotation is valid for 60 days.

Terms & Conditions - All prices are US Dollars, FOB factory, Eldridge Iowa. Customer is responsible for packaging, handling, shipping (prepaid and billed at actual), national, provincial or local user and/or sales taxes and duties that may be charged are excluded from the quoted prices. Not included in the quoted prices: Goods and Service Tax, Provincial Sales Tax, HST and any Import Duty, if levied that may be applicable. Prices are based on NET 30 payment. Late charges in the amount of 1.5 percent per month will be applied after 30 days.

APPENDIX D
Mehta Tech Inc. Spare Parts Description



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www.mehtatech.com
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Mehta Tech DFR Electronics Upgrade Information

Flash Drive

The original hard drive is end-of-life and is no longer available. It is superseded in our design by the TRANSCAN Flash Drive with the following attributes:

- Supports up to 255 records
- Non-volatile solid-state storage, no moving parts
- The Flash Drive is physically compatible with the SCSI hard drive used in the TRANSCAN DFR and does not require or support the front panel LED on the DFR electronics chassis
- Includes and requires, no-charge upgrade to the DFR's BIOS and INLINK
- Requires V40II Host Processor

V-40II Host Processor

Replaces existing end-of-life Host Processor. We recommend replacing the V40 Host Processor after 12 years of service. The V40II host processor and INLINK 5 operating system supports IPCU, continuous recording, Flash Drive, Ethernet Interface, PMU functionality, etc. The V40II also provides two additional on-board communication ports for up to 115.2Kbit.

Power Supply for Recorder (100 watts AC/DC)

We recommend replacing the original power supply after 10 to 12 years of service. The power supply life can vary based on environmental conditions and loading.

Synchronized Clock Module (SCM)

We recommend replacing the original Real Time Clock (RTC) Module after 15 years of service. The SCM is a "plug compatible" replacement for the RTC module. It does not require batteries. It also decodes the year information from the IRIG-B signal, if the GPS satellite clock has the IEEE 1344 feature enabled. The SCM does not require manual configuration for use with modulated or un-modulated IRIG-B. The SCM supports PMU functionality. The SCM is not compatible with long obsolete JRAM memory modules.

System Support Module (SSM)

We recommend replacing the original SSM after 12 years of service.

16MB RAM Memory (SRAM) Module

Replaces existing end-of-life XT memory modules (8MB maximum) and JRAM memory modules (long obsolete). We recommend replacing these modules after 15 years of service. The SRAM module has 16MB of RAM and supports PMU functionality.

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Data Collection / Data Processing Modules (DCMs / DPMs)

Replaces existing end-of-life DCMs / DPMs. We recommend replacing the original 12 bit DCMs / DPMs after 15 to 18 years of service. The replacement DCMs / DPMs are 16 bit and support PMU functionality.

Internal V.92 Modem (includes External Surge Suppressor)

We recommend replacing the original modem (external or internal) after 10 to 12 years of service. This upgrade allows communications with higher speed modem modems at the Master Stations. The modem supports up to 56Kbps but the actual data transfer rates vary depending on the communication line quality.

Battery Replacement Kit for Real Time Clock (RTC) Module

For existing RTC modules which are not end-of-life, we recommended that the rechargeable NiCad batteries be changed-out every 4 to 6 years.

Digital Isolator Module (DIM)

We recommend replacing the original DIMs after 18 to 20 years of service. The DIMs are mounted in a Card Termination Interface Module (CTIM).

Relay Output Module

We recommend replacing the original Relay Output Module after 20 to 25 years of service. The Relay Output Module is mounted in a CTIM.

Ethernet Interface Module

We recommend replacing the current Ethernet Interface Module (PN 9879) after 12 years of service. The original Ethernet Interface Module (PN 9858) is obsolete and no longer supported.

DC Analog Isolation Module (DCAIM)

We recommend replacing the original DCAIM after 18 to 20 years of service. The DCAIM is mounted in a CTIM.

Electronics Chassis

We recommend replacing the original "Roll-out" Electronics Chassis (not including the electronic modules) after 25 years of service. The associated ribbon cable harnesses eventually become brittle.

Replace Vehicles and Aerial Devices

Various Sites

July 2015

SUMMARY

This project provides for the replacement of light-duty and heavy-duty vehicles that meet the established replacement criteria.

Hydro operates in many diverse locations across the Province and it is critical to the ability to provide economical and reliable electricity that employees are provided with safe and reliable equipment.

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INTRODUCTION

Hydro operates a fleet of vehicles comprised of approximately 200 light-duty vehicles (cars, pick-ups and vans) and 65 heavy-duty trucks (aerial devices, material handlers and boom trucks).

The vehicle fleet is strategically distributed across Hydro's operating areas throughout the Province and is utilized on a daily basis to support staff engaged in the maintenance and repair of the electrical system.

The Transportation section of Hydro maintains a close liaison with other Canadian Utilities through participation on the Canadian Utility Fleet Council and has established vehicle replacement guidelines, which consider the operating regime for the vehicles, as well as average replacement criteria used by other Canadian utilities.

2 PROJECT DESCRIPTION

This project proposes the replacement of 37 light-duty vehicles and three heavy-duty vehicles in accordance with the established replacement criteria for vehicle age and kilometers (km) as follows in Table 1. Also indicated below are the replacement criteria of three other Atlantic electric utilities as surveyed by Hydro in 2014 (see Table 2).

Table 1: Replacement Criteria - Hydro

Hydro	
Light-duty vehicles	5-7 years or > 150,000 km and Condition/Maintenance Cost
Heavy-duty vehicles:	
- Class 4, 5 and 6	6-8 years or > 200,000 km and Condition/Maintenance Cost
- Class 7 and 8	7-9 years or > 200,000 km and Condition/Maintenance Cost

Table 2: Replacement Criteria - Other Atlantic Electric Utilities

Utility #1	
Light-duty vehicles	5 years or 200,000 km
Heavy-duty vehicles:	8 years or 300,000 km
Utility #2	
Light-duty vehicles	5-6 years or 200,000 km
Heavy-duty vehicles:	
- Class 3, 4, 5 and 6	8 years or 300,000 km
- Class 7 and 8	10 years or 300,000 km
Utility #3	
Light-duty vehicles	5 years or 150,000 km
Heavy-duty vehicles	10 years or 250,000 km

3 JUSTIFICATION

Hydro operates in many diverse locations across the Province and it is critical to the provision of economical and reliable electricity that employees are provided with safe and reliable vehicles.

3.1 Existing System

This project proposes the replacement of 37 light-duty vehicles and three heavy-duty vehicles in accordance with the established replacement criteria for vehicle age and kilometers. All vehicles that meet the criteria are being replaced.

Operating Regime

As this project relates to the replacement of vehicles and aerial devices, there is no relevant data related to operating regime. Typically, the units do not move from region to region so that they can provide reliable service in the assigned areas. However, a unit may be relocated to another area if operational commitments demand it.

Age of System or Equipment

Please see Appendix A for a detailed listing of the vehicles being replaced under this proposal, which includes the age at retirement, projected kilometers and maintenance costs as of January 2015.

Major Work and/or Upgrades

There have been no major upgrades since purchase.

3.2 Operating Experience

Failure to replace units in accordance with the replacement policy will lead to increasing maintenance costs and less reliable vehicles. Hydro employees maintain the electrical system 24 hours a day, 7 days a week and require dependable and safe vehicles for their work. As vehicles age, they experience increasing downtime, which could negatively affect response times for emergency outages or planned maintenance.

3.2.1 Reliability Performance

Due to the age of these machines, they are considered unreliable.

3.2.1.1 Outage Statistics

As this project relates to the replacement of light-duty vehicles and aerial devices, there is no relevant data related to outage statistics. Hydro does not maintain outage statistics for vehicles.

3.2.2 Legislative or Regulatory Requirements

Hydro complies with requirements stipulated in the following:

- Occupational and Health Safety Regulations;
- Canadian Motor Vehicle Safety Standards;
- Environmental Protection Act ; and
- Air Pollution Control Regulations.

3.2.3 Safety Performance

There is no relevant data related to safety performance.

3.2.4 Environmental Performance

Hydro ensures that the operation of its motorized vehicles is in compliance with the NLR 39/04 Air Pollution Control Regulations, Section 16 Motorized vehicles and has an emission limit not in excess of the standards prescribed in the regulations. The regulations state NLR

39/04 Air Pollution Control Regulations:

Motorized Vehicles

16. (1) A person shall not operate or permit the operation of a light-duty motorized vehicle having an emission in excess of the standards prescribed in Schedule F.
- (2) The opacity of a visible emission from a diesel fuelled heavy duty motorized vehicle, as determined by procedure SAE J1667 entitled *Snap Acceleration Smoke Test Procedure for Heavy-Duty Diesel Vehicles*, shall not exceed:
- (a) 40 percent for 1991 model vehicles and newer; and
 - (b) 55 percent for 1990 model vehicles and older.
- (3) For the purpose of ensuring that the standards prescribed in Schedule F and subsection (2) are met, according to paragraph 111(1)(p) of the Act, the minister may, by regulation, establish an emission inspection and maintenance program as a means of reducing exhaust and evaporative air contaminants.

A fuel consumption analysis is completed on all light-duty vehicles that have a fuel consumption rating to ensure that Hydro purchases fuel efficient vehicles. The fuel cost is calculated on a 55 percent Highway/45 percent city fuel rating for 150,000 kms. The total cost is factored into the upfront cost of the vehicle and the tender is awarded to the lowest total cost bid.

3.2.5 Industry Experience

Vehicle replacement criteria across the Canadian Utility Industry varies dependent on location, exposure to harsh environmental conditions and the severity of the service hours

for the vehicle. While some variances exist, vehicle replacement criteria in other utilities are generally consistent with the replacement criteria utilized by Hydro (see Section 2).

Hydro's Transportation section maintains a database of the vehicle fleet which tracks individual unit history including acquisition date, kilometers and maintenance history. The Fleet Specialist updates this information on an ongoing basis and uses current data to determine annual vehicle replacements.

Prior to the preparation of the capital budget proposal, a review of the latest version of the database is performed to select the units which meet the replacement criteria for age or kilometers, and to verify those which should be included in the capital budget proposal based on their maintenance history or ongoing maintenance issues.

3.2.6 Vendor Recommendations

There are no vendor recommendations in regards to this project.

3.2.7 Maintenance or Support Arrangements

The Hydro fleet of vehicles is primarily maintained by external service garages. In-house mechanical maintenance personnel are used to maintain the specialized utility equipment such as our aerial devices, booms and heavy off-road tracked equipment.

Warranty on Hydro's on-road vehicles is generally the standard warranty (often 3 years/ 60,000kms). Warranty for off-road and aerial devices/booms is usually 1 year from in service date.

3.2.8 Maintenance History

Please see Appendix A for the life to date maintenance costs for vehicles being replaced under this proposal.

3.2.9 Historical Information

Hydro has, in the past, applied a rust proofing to the heavy fleet upon purchase and then annually applied. Hydro's experience was that there was no significant decrease in corrosion as a result. The light duty vehicles have not had a corrosion protection applied as Hydro's experience is rust is not a significant issue in this fleet class.

Rust is a major factor in replacing the units in the heavy fleet, especially with the attachments on these trucks such as the booms, cargo boxes, decks, rear steps/hitches, etc. Hydro is in the process of testing a new electronic rust prevention system. This system is currently installed on three units. The test project is ongoing with results to be determined over the next two to three years.

Table 3 provides the five-year purchase history for vehicle and aerial device purchases, as well as the budgets for 2014 and 2015.

Table 3: Vehicle and Aerial Device Purchases

Vehicle and Aerial Device Purchases 2011 – 2015				
Year	Units Purchased		Budget (\$000)	Actuals (\$000)
	Vehicles	Aerial Devices		
2015 - 2016B	40	4	2,602	
2014 - 2015B	32	9	2,900	
2013	17	8	1,982	2,049
2012	30	8	2,930	2,878
2011	25	5	2,989	2,011

3.2.10 Anticipated Useful Life

The anticipated useful life for light-duty vehicles is six years and for heavy-duty vehicles it is eight years.

3.3 Forecast Customer Growth

As this project relates to the replacement of vehicle and aerial devices, there is no relevant data related to forecast customer growth.

3.4 Development of Alternatives

Replacement of these vehicles and aerial devices is the only viable option.

4 CONCLUSION

This project provides for the replacement of light-duty and heavy-duty vehicles which are at the end of their useful lives and are no longer dependable.

4.1 Budget Estimate

This budget estimate for this project is shown in Table 4.

Table 4: Project Budget Estimate

Project Cost: (\$ x1,000)	2016	2017	Beyond	Total
Material Supply	1,378.8	411.1	0.0	1,789.9
Labour	8.0	2.0	0.0	10.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	3.0	3.0	0.0	6.0
Interest and Escalation	53.5	27.8	0.0	81.3
Contingency	0.0	90.3	0.0	90.3
TOTAL	1,443.3	534.2	0.0	1,977.5

4.2 Project Schedule

This project is scheduled to be completed by December 31, 2017.

APPENDIX A
Replace Vehicles and Aerial Devices Hydro System 2016

Type	Unit	Age at retire	Projected kms	AGE	KMS	Condition	LTD \$ Maint
Car	V1335	5.9	161907	X	X		\$9,250
Car	V1336	5.9	166949	X	X		\$8,862
Mini Van	V1333	6.3	180287	X	X		\$12,723
Pick Up	V2712	6.0	232636	X	X		\$13,111
Pick Up	V2758	4.9	198882		X	Body	\$19,316
Pick Up	V2648	7.8	169839	X	X		\$14,088
Pick Up	V2649	7.8	109016	X		RUST	\$13,376
Pick Up	V2652	7.8	187452	X	X		\$28,960
Pick Up	V2674	7.1	200007	X	X		\$19,393
Pick Up	V2698	6.2	159617	X	X		\$11,115
Pick Up	V2704	6.0	170455	X	X		\$10,658
Pick Up	V2705	6.0	155455	X	X		\$23,604
Pick Up	V2708	6.0	178001	X	X		\$9,171
Pick Up	V2709	6.0	173864	X	X		\$7,588
Pick Up	V2717	6.0	163636	X	X		\$12,418
Pick Up	V2729	6.0	196364	X	X		\$7,407
Pick Up	V2714	6.0	193879	X	X		\$15,078
Pick Up	V2737	5.2	179892		X		\$9,461
Pick Up	V2680	7.1	153618	X	X		\$9,033
Pick Up	V2702	6.0	171187	X	X		\$9,816
Pick Up	V2703	6.0	170320	X	X		\$12,985
Pick Up	V2739	5.2	223459	X	X		\$24,811
Pick Up	V2752	4.9	237794		X		\$8,862
Pick Up	V2763	4.9	230588		X		\$13,279
Pick Up	V2740	5.2	162465	X	X		\$13,984
Pick Up	V2693	6.9	161000	X	X	Body	\$26,501
Pick Up	V2724	6.0	155827	X	X	Body	\$29,824
Pick Up	V2746	4.9	194559		X		\$12,300
Pick Up	V2747	4.9	200455		X		\$9,875
Pick Up	V2748	4.9	187091		X		\$10,691
Pick Up	V2749	4.9	187091		X		\$12,966
Pick Up	V2750	4.9	181152		X		\$11,813
Pick Up	V2751	4.9	164818		X		\$10,313
SUV	V2165	12.0	130113	X		Hi idle hrs	\$14,469
Van	V2687	7.0	167222	X	X		\$9,942
Van	V2725	5.9	171636	X	X		\$9,103
Van	V2767	4.8	247760	X	X		\$10,000
Boom Truck	V4483	12.1	83348	X		RUST	\$61,853
Dump truck	V4485	12.7	119535	X		RUST	\$82,807
Boom Truck	V4486	12.1	68438	X		RUST	\$73,797

Upgrade Microsoft Office Software

Information Systems

July 2015

SUMMARY

Hydro currently deploys a standard desktop that includes the Microsoft (MS) Office Suite of products and the Windows 7 Desktop Operating System on corporate desktops and laptops. The laptop/desktop environment and server infrastructure is based on the MS Windows Operating System. Within the timeframe of the project, Hydro will also begin to transition its fleet of desktops and laptops to a new Windows operating system to replace Windows 7 on new deployments.

Within the corporate and energy management environments Hydro uses a collection of Microsoft operating systems, servers and productivity applications. This project will enable Hydro to continue its Enterprise Agreement (EA) with Microsoft such that all of the products currently in use will remain available to be upgraded to the latest versions. Hydro will also maintain access to reduced rates on new products for the life of the agreement. Other benefits of the EA include ability to upgrade to the latest version of products for the life of the agreement, use the software from multiple devices, and access technical support and training resources.

The EA is a three year agreement allowing the costs to be distributed over three equal payments to be spread over the three years of the agreement. The current agreement will expire after May 2016 if not renewed. This project would renew the agreement for a further three years beginning in June 2016 and to end in 2019.

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1 INTRODUCTION

The scope of the proposed Microsoft Enterprise Agreement budget includes:

- Renewal of the Enterprise Agreement with Microsoft (MS) Corporation. The Enterprise Agreement covers a three year period with equal payments in each year, commencing in June 2016.
- Design, testing and implementation of new Windows operating system images and related software will commence in 2017. Transition of desktops and laptops to the new operating system will be rolled out on new machines as they are replaced.

2 PROJECT DESCRIPTION

Hydro currently deploys a standard desktop that includes the Microsoft (MS) Office Suite of products and the Windows 7 Desktop Operating System. The laptop/desktop environment and server infrastructure runs on current versions of Microsoft Windows Operating System. Hydro uses a number of Microsoft applications to ensure efficient operation.

This project will see Hydro continue its Enterprise Agreement (EA) with Microsoft such that all of the products currently in use will remain available to be upgraded to the latest versions. Hydro will also maintain access to reduced rates on any new products it implements for the life of the agreement. Other benefits of the EA include ability to upgrade to the latest version of products for the life of the agreement.

The EA is a three year agreement and is proposed to be paid for in three equal payments to be spread over the three years of the agreement. This agreement, upon budget approval, will renew in 2016 and end in 2019.

3 JUSTIFICATION

This project is a part of the Corporation's ongoing effort to ensure that users are able to meet ongoing productivity requirements and to effectively collaborate with outside resources as required. This is achieved by ensuring that the desktop application base is maintained to the appropriate version levels to limit incompatibilities.

The cadence of security threats has steadily risen over the past few years, and running on a supported operating system is necessary to avoid unplanned downtime in the user community. The enterprise agreement permits Hydro to use the latest version of Windows on a user desktop or laptop. Without an agreement such as this, Hydro would have to repurchase the Windows operating system licensing to migrate to the next version of Windows on a desktop, laptop or server. This license features reduces budget impact of maintaining the latest version of Windows in use.

Hydro currently supports a standard desktop that includes the Microsoft (MS) Office Suite of products and the MS Windows 7. The laptop/desktop environment and server infrastructure is based on the MS Windows Operating System. Within the environment, Hydro also uses a number of Microsoft technologies to ensure efficient operation, including but not limited to MS SQL server for databases, MS System Center Configuration Manager for device and software management, and MS Remote Desktop Services (RDS) with Citrix technology for application delivery to users.

As a result of the investment made in the existing Enterprise Agreement, Hydro's desktop and server software is maintained at current and supported versions which enable more effective collaboration both internally and externally, and ability to maintain the latest required version of software under one common windows license fee. Software used to manage the desktop and server environments as well as database servers many key systems depend on are also maintained under this agreement. The cost to acquire and maintain business software from Microsoft is reduced under the Enterprise Agreement.

3.1 Existing System

This project is a part of the Corporation's ongoing effort to ensure that users are able to meet ongoing productivity requirements and to effectively collaborate with outside resources as required. This is achieved by ensuring that the desktop application base is maintained to the appropriate version levels to limit incompatibilities. See Table 1 for existing software installed.

Table 1: Existing Software

Product	Installed Version	Future Version
Microsoft Desktop Operating System	Windows 7	Windows 10 (or later)
Microsoft Access	MS Access 2010	Office 2016
Microsoft Word	MS Word 2010	Office 2016
Microsoft Excel	MS Excel 2010	Office 2016
Microsoft Power Point	MS Power PT 2010	Office 2016
Visio Pro	Visio 2010	Visio 2016
Visio Pro	Visio 2010	Visio 2016
SQL Enterprise Edition Per proc	MS SQL 2008 / 2012	SQL Ent. 2012 (or later)
SQL Standard Edition Per Proc	MS SQL 2008 / 2012	SQL Std. 2012 (or later)
System Management Server (SMS)	SCCM 2012	Systems Centre 2012
SMS Server CAL's	SCCM 2012 Cal's	Systems Centre 2012
SharePoint Ent CAL	Sharepoint 2010 Ent CAL	Sharepoint 2012 Ent. CAL's
Sharepoint Server	Sharepoint 2010 Server	Sharepoint Server 2012
Windows Server	Server 2008 R2	Server 2012 R2
Terminal Services with Citrix	Windows Remote Desktop	Windows Remote Desktop

Hydro currently supports a standard desktop that includes the Microsoft (MS) Office Suite of products and the MS Windows 7 Desktop Operating Systems. The laptop/desktop environment and server infrastructure is based on the MS Windows Operating System. Within the operating environment, Hydro also uses a number of Microsoft technologies to ensure efficient operation, including but not limited to MS SQL server for databases, MS System Center for server and PC management, and MS Terminal Services with Citrix technology for application delivery to users.

3.2 Age of Equipment or System

As a result of the investment already made in the existing Enterprise Agreement the company's desktop and server software is maintained at current, supported versions. Desktop, laptop and server operating systems are replaced on average every five years, the Microsoft operating system and software purchased under Enterprise Agreement permits system upgrade to the latest version at the lifecycle date without requiring Hydro to repurchase the licensing.

3.2.1 Major Work/or Upgrades

The current software and operating systems include Office 2010 Professional, Windows 7, and Windows 2008 R2 which are all currently supported, industry standard products. The Enterprise Agreement allows Hydro to upgrade to the current server, desktop and application versions over the life of the agreement. The work to deploy and maintain these packages is an ongoing part of the of desktop, laptop and server lifecycles.

3.2.1.1 Outage Statistics

There are no outage statistics related to this project.

3.2.2 Legislative or Regulatory Requirements

There are no legislative or regulatory requirements for this project.

3.2.3 Safety Performance

There is no specific safety issue related to this project.

3.2.4 Environmental Performance

Environmental non-compliance is not an issue for this project.

3.2.5 Industry Experience

There is no known industry experience available with regards to Application version,

although as a result of being behind the mainstream in versioning, collaboration would be affected. Security and stability is improved by maintaining current, supported operating systems and applications.

3.2.6 Vendor Recommendations

There are no relevant vendor recommendations with respect to this project.

3.2.7 Maintenance or Support Arrangements

There is no Maintenance agreement for those products included in the agreement.

3.2.8 Maintenance History

There is no maintenance history associated with Microsoft Applications with the exception of monthly security patches being applied to the Server Operating Systems.

3.2.9 Historical Information

This is not a recurring project, historical information is not available.

3.2.10 Anticipated Useful Life

The anticipated useful life of an application is approximately -five to seven years or until the next major release of the product that is widely accepted by the corporate community. The Enterprise Agreement permits Hydro to proceed with upgrades to these software packages based on business need and lifecycle planning. This agreement renewal is for a three year period.

3.3 Forecast Customer Growth

Customer load growth does not affect this project.

3.4 Development of Alternatives

The only alternative to this project is to upgrade the individual applications without an

Enterprise Agreement. This would be more costly and it would only allow upgrade to the current version of the application at the time of its purchase. The Enterprise Agreement allows Hydro to upgrade to the current application version over the life of the agreement, a three year period.

3.5 Evaluation of Alternatives

The applications and operating systems purchased under the Enterprise Agreement generally carry perpetual rights for use only at the current version available when the Enterprise Agreement ends. By maintaining the enterprise agreement on these software purchases for a further three years, the ability to use enterprise management features and upgrade to the latest versions is protected, as is the reduced price to acquire additional licenses for existing and new software.

There are additional benefits to the agreement which further reduce cost, including the ability to license only one copy (versus two copies) of software such as MS Office products to a user who may then access it from their local PC/laptop and from the Microsoft Remote Desktop Services (RDS) with Citrix environment, a key delivery mechanism for corporate applications. This cost savings is maintained by renewing the maintenance on these products under the Enterprise Agreement.

4 CONCLUSION

This project is necessary to maintain Microsoft Application environment at the most current level. By doing so, Hydro will ensure that its collaboration efforts with outside agencies, security and software accessibility are not adversely affected and that its employees are able to avail of the functionality and productivity benefits of the latest versions of the applications.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 2.

Table 2: Project Budget Estimate

Project Cost: (\$ x1,000)	2016	2017	2018	Total
Material Supply	633.1	633.1	633.1	1899.3
Labour	28.8	108.0	28.8	165.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	162.8	0.0	162.8
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	21.8	49.5	72.6	143.9
Contingency	0.0	0.0	222.8	222.8
Sub-Total	683.7	953.4	957.3	2,594.4
Cost Recoveries	(317.1)	(442.2)	(444.0)	(1,203.3)
TOTAL	366.6	511.2	513.3	1,391.1

4.2 Project Schedule

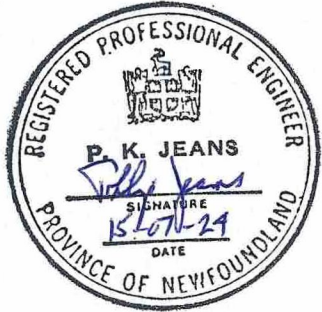
The Enterprise Agreement renewal will commence June 1, 2016 and expire May 31, 2019.

Application and operating system upgrades will be done on an as needed basis.

Table 3: Project Schedule

Activity		Start Date	End Date
Year 1			
Planning	Review products, license counts for the new agreement.	April 2016	April 2016
Design	Generate tender materials for procurement	April 2016	April 2016
Procurement	Purchasing process	May 2016	May 2016
Construction	Award and setup contract details, key contacts, purchasing details	May 2016	June 2016
Commissioning	EA in place; Projects and departments able to purchase additional licenses under agreement.	June 2016	June 2019
Year 2			
Planning	Review products, license counts for the year 2 true up	April 2017	April 2017
Design	Finalize requirements	April 2017	April 2017
Procurement	Purchasing process to adjust licenses for second year payment	May 2017	May 2017
Construction	Windows 7 replacement program begins; Sub project to identify, design and implement required processes and materials to enable new deployments of desktop and laptops to use new version of Windows and applications.	January 2017	June 2017
Commissioning	EA in place; Projects and departments able to purchase additional licenses under agreement; New deployments use new Windows client operating system and applications.	June 2017	June 2019
Year 3			
Planning	Review products, license counts for the new agreement.	April 2018	April 2018
Design	Generate tender materials for procurement	April 2018	April 2018
Procurement	Purchasing process	May 2018	May 2018
Construction	Prepare for extension of EA for 2019 to 2022.	May 2018	June 2018
Commissioning	EA in place until end of May 2019; Projects and departments able to purchase additional licenses under current agreement.	June 2018	June 2019
Closeout	Closeout	June 2019	

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

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

Replace MDR-4000 Microwave Radio (East)
Various Locations

July 2015

SUMMARY

This proposal is for the replacement of the microwave radios on four major communications links connecting the Energy Control Center in Hydro Place with the Bull Arm Hill Microwave Repeater Site along with the associated multiplexing equipment. This equipment has reached the end of its service life and can no longer be supported. The reliable transmission of communications over this equipment is necessary for the reliable remote control and monitoring of a significant portion of the power grid. This includes teleprotection, SCADA (Supervisory Control and Data Acquisition), voice and administrative data.

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1 INTRODUCTION

Hydro currently maintains an island wide communications system for the support of the power generation, transmission and distribution facilities.

This project will replace the remaining high-capacity Alcatel MDR-4000 microwave radios that were installed in 2001 between the Energy Control Center in Hydro Place and the Bull Arm Hill Microwave Repeater Site. This radio system provides teleprotection, supervisory control, departmental and administrative voice and administrative data between Hydro Place and all major terminal stations and generating stations. High speed and highly reliable telecommunication facilities are required to ensure the stability and reliability of the provincial power grid.

As part of this project, five Telmar 1603 multiplexers will be replaced by the built-in multiplexing capability of the proposed later model microwave radios. Multiplexers are data conversion units used extensively in communication networks to multiplex (combine and/or break out) multiple lower speed circuits for different equipment and purposes, into higher speed data circuits. These higher speed circuits are then suitable for transmission by the microwave radio. The multiplexer considered for replacement in this report is a SONET multiplexer which has 155 Mbps connections to the radio and primarily DS1 (1.544 Mbps) connections for the lower speed connections.

This proposal is to replace radios in the East portion of the Hydro microwave system. A separate project to replace radios in the West portion of the Hydro microwave system was completed in 2014.

2 PROJECT DESCRIPTION

The radios to be replaced are listed in Table 1. It is proposed to replace the existing Alcatel MDR-4000 microwave radios with Alcatel MDR-8000 radios with the same data capacity using the same frequencies.

Table 1: MDR-4000 Radio to be Replaced

#	Radio Location	Toward
1	Energy Control Center (Hydro Place)	Petty Harbour Hill Microwave/Repeater
2	Petty Harbour Hill Microwave/Repeater	Energy Control Center (Hydro Place)
3	Petty Harbour Hill Microwave/Repeater	Four Mile Hill Microwave/Repeater
4	Four Mile Hill Microwave/Repeater	Petty Harbour Hill Microwave/Repeater
5	Four Mile Hill Microwave/Repeater	Chapel Arm Hill Microwave/Repeater
6	Chapel Arm Hill Microwave/Repeater	Four Mile Hill Microwave/Repeater
7	Chapel Arm Hill Microwave/Repeater	Bull Arm Hill Microwave/Repeater
8	Bull Arm Hill Microwave/Repeater	Chapel Arm Hill Microwave/Repeater

The Telmar 1603 multiplexers to be removed are listed in Table 2.

Table 2: 1603 Multiplexers to be Removed

#	Multiplexer Location	Toward
1	Energy Control Center (Hydro Place)	Petty Harbour Hill Microwave/Repeater
2	Petty Harbour Hill Microwave/Repeater	Energy Control Center (Hydro Place) and the Four Mile Hill Microwave/Repeater
3	Four Mile Hill Microwave/Repeater	Petty Harbour Hill Microwave/Repeater and the Chapel Arm Hill Microwave/Repeater
4	Chapel Arm Hill Microwave/Repeater	Four Mile Hill Microwave/Repeater and the Bull Arm Hill Microwave/Repeater
5	Bull Arm Hill Microwave/Repeater	Chapel Arm Hill Microwave/Repeater and the Shoal Harbour Hill Microwave/Repeater

The Alcatel MDR-8000 microwave radio is the currently utilized elsewhere in the Hydro microwave radio system. A map of the system is shown in Figure 1. This allows Hydro to utilize the existing spares, training and mock-ups currently available.

Note that while the microwave radios and multiplexers are critical components of the microwave facilities, they are part of the overall infrastructure which includes equipment shelters, large stationary batteries, backup generators, high towers, waveguide, antennas and many other support items. None of this equipment is proposed for replacement by this proposal.

3 JUSTIFICATION

The project is justified on the need to replace obsolete equipment. The Alcatel MDR-4000 radio has been discontinued by the manufacturer since 2004. The manufacturer has also discontinued the guaranteed return and repair of failed modules since 2009 due to the obsolescence of the components within the modules. Failed modules have been returned as un-repairable in 2011 as a result.

Hydro has obtained some components from the used market, however this supply is unreliable. Some components were also obtained from the microwave links decommissioned in 2010 and 2014 to extend the life of the radios to this time.

The replacement of the radio system is required to ensure a reliable and safe provincial power system.

3.1 Existing System

Hydro has a network of 7 GHz (gigahertz) frequency microwave radio, by which corporate communications and system data are transmitted. The microwave radio system provides the backbone for corporate voice and data communications.

Traffic carried over the microwave system includes:

- Teleprotection signals for the provincial transmission system;
- Data pertaining to Hydro's Supervisory Control and Data Acquisition (SCADA) system;
- Data pertaining to the corporate administrative system; and
- Operational and administrative voice systems.

The existing microwave network is composed of the main backbone of a series of SONET (Synchronous Optical Network) radios from the Energy Control Center (ECC) in St. John's to the Sandy Brook Hill Microwave Repeater Site and from the Stoney Brook Terminal Station to the Bay d'Espoir Hydro Plant. The SONET capacity is 155 Mbps (OC-3). Secondary, lower capacity microwave links and other communications methods are fed from the main microwave backbone as shown in Figure 1.

The site locations and links affected are shown in Figure 1 with the specific equipment at each site detailed in Table 1 and Table 2. The string of microwave links affected is from the Energy Control Center (ECC) in Hydro Place in St. John's to the Bull Arm Hill Microwave/Repeater Site on the West side of the Avalon Peninsula. A list of station abbreviations used in Figure 1 is provided in Appendix A.

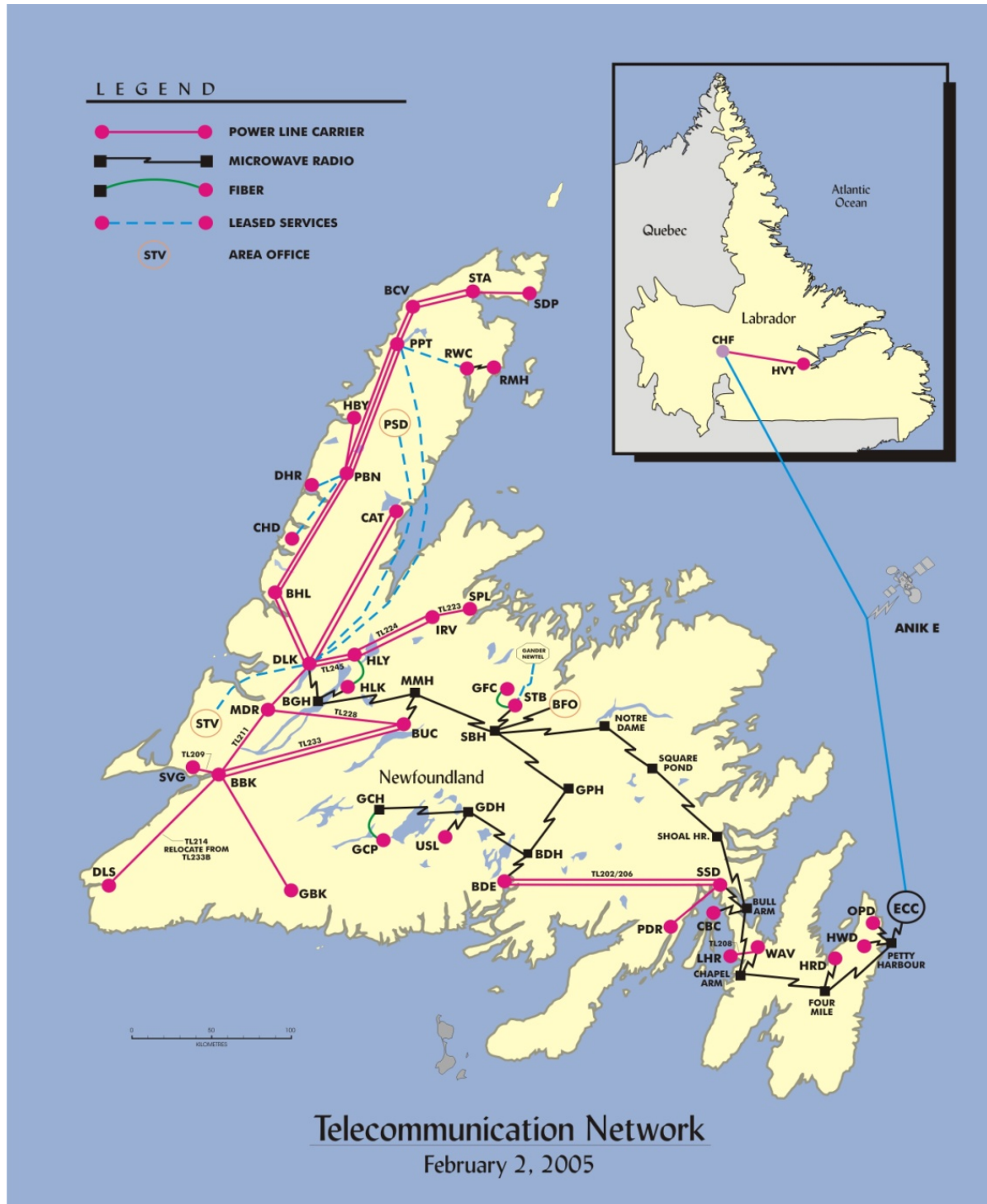


Figure 1: Hydro Telecommunications Network showing the Microwave Radios

3.2 Operating Experience

The original Alcatel MDR-4000 radio and 1603 multiplexers were installed in 2001 and have proved to be a valuable asset in the remote control and monitoring of the provincial power system. However, the equipment has been discontinued by Alcatel.

3.2.1 Reliability Performance

The communications equipment proposed for replacement is an integral part of the communications used for monitoring and control of the power grid requiring a very high reliability in order to provide the continuous support. The path design parameter used is 99.9999 % availability. Redundant hardware and multiple frequencies are used to achieve this design.

3.2.1.1 Outage Statistics

The following are the communications outage summary since January 2014.

Table 3: Outage Statistics	
ECC - BAH Microwave Outage Statistics	
Period of Outage Statistics	Cumulative Outage Duration
January 2014 to June 2015	521 seconds

Detailed outage statistics have not been kept on this equipment prior to January 2014.

3.2.2 Industry Experience

Power utilities throughout North America use dedicated microwave systems in support of its operations in exactly the same way that Hydro uses its system and use the type of equipment listed for replacement in this proposal. All of the major power utilities in Canada have similar systems. Special permission and frequencies are allocated by Industry Canada for this requirement. It is a common practice for utilities to replace this equipment in a planned proactive method to avoid communications outages.

3.2.3 Vendor Recommendations

The vender has discontinued the MDR-4000 microwave being replaced and has recommended the MDR-8000 microwave as a replacement, as proposed in this report.

3.2.4 Maintenance or Support Arrangements

Corrective and preventative maintenance of the equipment is provided by internal forces. There is also an existing technical support agreement with Alcatel to provide detailed hardware and software support. The replacement equipment be maintained using the same arrangement.

3.2.5 Maintenance History

A total of \$14,415 has been recorded in the period from January 2014 to June 2015. Detailed preventative and corrective maintenance costs have not been kept on this equipment prior to January 2015.

3.2.6 Historical Information

There have been two similar projects completed in the last five years.

The first project was for the replacement of the microwave radio between the Bay d’Espoir Hydro Plant and the Bay d’Espoir Hill microwave site completed in 2010. There were no multiplexer replacements.

The second project was for the replacement of the microwave radios between the Bay d’Espoir Hill microwave site and the Stoney Brook Terminal Station completed in 2014. Three multiplexers were removed.

Table 4: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)
2013-2014	1,245.9	620.0	6 radios	103.3
2010	488.7	375.0	2 radios	187.0

3.2.7 Anticipated Useful Life

Hydro microwave radio equipment is depreciated over 15 years. However, the useful service life can vary depending on the vendor support, and the availability of spare parts.

3.3 Development of Alternatives

There are no viable alternatives to replacing the microwave radios. The existing microwave infrastructure is the only available facilities for providing the required communications to the eastern part of the island.

4 CONCLUSION

The replacement of this microwave equipment is necessary in order to prevent outages caused by the anticipated failure of older equipment that can no longer be supported for the high reliability required for critical, high speed, low latency communications.

This replacement proposed by Hydro is based on operational experience and manufacturer's recommendations.

Due to operational risks associated with the failure of corporate microwave equipment, this project is a proactive approach to ensuring that the likelihood of failure of these microwave radios does not impact the operational power grid.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 5.

Table 5: Project Budget Estimate				
Project Cost: (\$ x1,000)	2016	2017	Beyond	Total
Material Supply	13.0	680.5	0.0	693.5
Labour	44.0	131.7	0.0	175.7
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	16.0	2.2	0.0	18.2
Interest and Escalation	4.4	101.2	0.0	105.6
Contingency	0.0	177.5	0.0	177.5
TOTAL	77.4	1,093.1	0.0	1,170.5

4.2 Project Schedule

The anticipated project schedule is shown in Table 6.

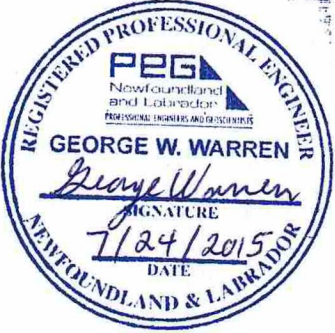
Table 6: Proposed Project Schedule

Activity		Start Date	End Date
Planning	Complete a detailed schedule and budget with resource assignments.	January 2016	March 2016
Design	Complete site visits. Complete a detailed design with all items and outages identified.	April 2016	November 2016
Procurement	Complete all ordering and detailed schedules for delivery.	October 2016	February 2017
Construction	Complete all outage requests and install and test all equipment at site.	May 2017	June 2017
Commissioning	Cutover new equipment during staged communications outages.	July 2017	August 2017
Closeout	Complete all drawings and project management closeout procedures.	November 2017	December 2017

APPENDIX A
Site Abbreviations

Abv	Site Name
BAH	Bull Arm Hill Microwave/Repeater
BDE	Bay d'Espoir Hydro Plant
BDH	Bay d'Espoir Hill Microwave/Repeater
BFI	Bishop Falls Office
BGH	Blue Grass Hill Microwave/Repeater
BUC	Buchans Terminal Station
CAH	Chapel Arm Hill Microwave/Repeater
CBC	Come By Chance Terminal Station
DLK	Deer Lake Terminal Station
DLP	Deer Lake Passive Repeater
ECC	Energy Control Center
FMH	Four Mile Hill Microwave/Repeater
GCH	Granite Canal Hill Microwave
GDH	Godaleich Hill Microwave/Repeater
GPH	Gull Pond Hill Microwave
HRP	Holyrood Plant
HWD	Hardwoods Terminal Station
MMH	Mary March Hill Microwave
NDH	Notre Dame Hill
OPD	Oxen Pond Terminal Station
PHH	Petty Harbour Hill Microwave/Repeater
SBH	Sandy Brook Hill Microwave
SHH	Shoal Harbour Hill
SPH	Square Pond Hill
SSD	Sunnyside Terminal Station
STB	Stony Brook Terminal Station
USL	Upper Salmon Plant
WAP	Western Avalon Passive Repeater
WAV	Western Avalon Terminal Station

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

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

Replace UPS Systems
Hydro Place

June 2015

SUMMARY

This proposal is for the replacement of the Uninterruptable Power Supply (UPS) systems at Hydro Place. The purpose of the Hydro Place UPS systems is to provide temporary backup power to the critical equipment used by the Energy Management Systems (EMS) and Information Systems (IS). This includes supplying backup power to the Energy Control Center and other critical networks used within Hydro Place. This is necessary for operation and maintaining control of the island electrical grid and generation sources in the event of a local power interruption to Hydro Place. During a power interruption the UPS will continue to supply power to critical equipment until either the onsite diesel generators have started or the restoration of normal power is achieved. The electrical power to operate critical systems during the time period between the loss of normal grid supplied electricity and the diesel generators starting and coming on line is maintained by the UPS. Thus the ECC retains control of the grid, generation assets, and communications. Without the UPS there would be at a minimum a brief period of complete loss of Grid control and at worst an extended loss of control. This could result in a cascade failure of the island electrical grid. The restoration of the grid is dependent upon the ECC remaining operational and maintaining control of the grid.

The existing UPS equipment will be at the end of vendor support as of January 2017. At this time the manufacturer will no longer provide replacement parts or support for this model. It has also been noted that the existing capacity of the current system has been determined to be insufficient for the load requirements.

The proposed UPS system replacement is a recently introduced design that is redundant, modular and energy efficient with full support from the manufacturer. It will be equipped with a battery sized to provide a minimum of three hour backup power.

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1 INTRODUCTION

The Energy Control Center (ECC) is located in St. John's within the Hydro Place building. The ECC is a critical facility necessary for the monitoring and control of the provincial power grid and generation plants. Control as well as restoration of the grid in the case of a power interruption is the responsibility of the ECC.

Maintaining proper operation of the ECC in the event of a power interruption is of paramount importance. The ECC requires its equipment to operate regardless of any local power interruptions. To ensure this uninterrupted power, Hydro Place has installed diesel generators which operate if a power outage is detected. During the starting of the diesel generators the operation of the ECC equipment is maintained by the UPS system. The installed UPS has served its purpose well since it was installed, but will enter the end of vendor support beginning in January 2017. The result is that all service and replacement parts shall be unavailable from the manufacturer after this time.

During the blackout of the 2013-2014, the current UPS provided twenty minutes of reserve power as it was designed to supply. Events during the blackout were such that there was an extended power interruption. The UPS maintained ECC power as designed, but the diesel generators failed to start after the grid interruption. Diesel repair personnel were dispatched to get the generators on line but there was a lead time of several hours before the generators were able to be brought on line. During this period the UPS and the ECC were maintained for the initial 20 minutes after which the UPS exhausted its batteries and the ECC was nonoperational until the diesels were started. During this time the ECC had no control of the island electrical grid and was unable to work toward power restoration.

This project proposes to replace the five existing UPS systems with two new current production models. An additional goal is to increase the reserve time of the UPS to a minimum of three hours of reserve capacity. This will be achieved through installation of a higher capacity battery bank.

2 PROJECT DESCRIPTION

The scope of this project is the replacement of the existing end of life UPS devices with new units of a current and supported manufacturer design. The new UPS units will offer increased run time and enhanced reliability. The system will supply clean reliable power to the critical EMS and IT and communications equipment.

The new units will be supplied, installed and commissioned by a contractor.

The new systems will be installed in the Hydro Place electrical room in place of the existing UPS units. The battery banks will be installed in the adjacent dedicated battery room. The two new UPS systems will be fully redundant in design.

It is not anticipated that this project will result in any outages or interruption of services.

3 JUSTIFICATION

This project is justified due to the following:

- The UPS is approaching end of life equipment status as per manufacturer. Starting January 2017 repair parts and service will no longer be available.
- The batteries in the system are also nearing their end of life rating. By January 2017, they will be scheduled for replacement.
- The current 20 minute run time of the installed UPS has been found to be insufficient. During the blackout of 2013-2014 the UPS operated as designed for the first 20 minutes of the outage. However, the diesels experienced several issues when they were attempted to be started. One of the two diesel generators had been recently locked out for repair by the maintenance people due to a frequency synchronization issue and the second diesel had failed to start. It took several hours for the maintenance vendor to arrive on site and bring one generator on line. Meanwhile once the UPS reserve batteries had been exhausted after the 20 minutes, the UPS shut down leaving the ECC without control of the grid until the diesel generators were brought on line.

3.1 Existing System

The existing UPS arrangement at Hydro Place consists of five UPS systems. Three of the systems are located in the electrical room adjacent to the diesel generators with one system providing redundancy. The other two systems are located in the Information Services server room located on the first floor at Hydro place, with one system providing redundancy.

The UPS system was designed to maintain the critical systems for a period of about 20 minutes in the event of a power outage. The system works such that the UPS will maintain power during the time between the local grid interruption and the building diesel generation coming online. The battery banks of the existing systems are contained with the UPS unit themselves and are of the sealed lead acid variety.

The existing systems were installed in 2005 and have served their designed purpose. There have been no major issues with the UPS controllers. There have been batteries identified as defective over the years that were replaced on a case by case basis. The existing systems operated as designed during the 2013-2014 blackout, but the designed hold time of 20 minutes was found to be insufficient.

3.2 Operating Experience

The existing UPS system has served its intended purpose and experienced no major malfunctions or failures since installation other than some battery cell failures. Its performance was as expected during the 2013-2014 outages, but was limited to a 20 minute run time.

The UPS controllers will soon be classified as end of life by the manufacturer. As such, replacement parts and service shall be non-available as of the start of 2017. In the event of a component failure, the UPS controllers would not be able to be repaired. There are no other known sources of repair parts.

The battery banks contained in the units will have reached their end of life, as well. It is known that the rate of failure increases exponentially if kept in service past their rated life. The batteries cannot be considered reliable past their rated life span.

If this project is not completed, the risk is that the ECC may not be able to manage the power system as required in the event of an outage to the feeder supplying Hydro's ECC.

3.2.1 Outage Statistics

The existing UPS systems have operated without any major outage since installation. During the power outages in 2014, the UPS system depleted its batteries within 20 minutes without grid power, leaving the ECC without power and, thus, control of the power system not possible. The operational reserve time was determined to be insufficient.

3.2.2 Industry Experience

It has been observed and is generally accepted in the industry that the failure of equipment such as UPS units increases greatly when the units have exceeded their rated service life as these units shall by the start of 2017. It is accepted good practice to replace such critical equipment before failure once they have reached the end of the manufacturer rated life before being forced to complete emergency replacement when a failure occurs.

The batteries used in these UPS units have a limited lifespan. Once the rated life has been exceeded, it has been observed and documented that the failure rate exponentially increases, this fact is stated by all battery manufacturers. Batteries that have passed their rated life are not to be considered reliable, and should be replaced to ensure reliability.

3.2.3 Vendor Recommendations

Eaton power systems (the manufacturer) has indicated the equipment will soon be reaching end of life and that they will not be able offer support or repair parts as of January 2017. They have strongly advised that for continued reliability the units should be replaced with a current model.

3.2.4 Maintenance or Support Arrangements

Manufacturer maintenance and support of this model shall be completely discontinued as of January 2017.

3.2.5 Maintenance History

Regular annual PM was conducted on the equipment. Annual maintenance included visual inspection and reviewing internal diagnostics along with voltage testing of the battery cells. Several cells were replaced within the last two years due to failure.

3.2.6 Anticipated Useful Life

The UPS is anticipated to have a useful life of 15 years and the Battery Banks have a useful life of 10 years.

3.3 Development of Alternatives

The existing UPS system was designed to have a hold up time of up to 20 minutes. Due to issues the diesel generator in 2014, and therefore a delay in providing power to the building, the UPS capacity of 20 minutes was found to be inadequate. Alternatives were investigated such as greater and less than the proposed three hour UPS holdup up time. It was determined that three hours reserve power would be the best solution to maintain uninterrupted emergency ECC operation.

In the event of the loss of both the grid power supply as well as loss of the emergency generators, the UPS will provide three hours of uninterrupted ECC operation. This three hour window will provide ample time to attempt to bring the emergency diesel generators on line. In the event that the diesel generators were unable to be started, this three hour window would allow the operators time to travel to and staff the emergency control center located in the Holyrood plant.

It was found that the three hour window met Hydro's requirements. To increase this capacity beyond the stated three hours would result in larger battery sizes and larger UPS units. This would also require major building renovations, equipment replacement and would significantly increase the overall cost.

There are no viable alternatives to this project.

4 CONCLUSION

Maintaining reliable power to Energy Control Center and Information Services equipment is a critical requirement to providing safe, reliable and dependable power to our customers. Ensuring the uninterrupted operation of the ECC in the event of an emergency such as a power failure is crucial to maintaining the Island grid.

Maintaining the current UPS systems has been shown to be unacceptable, both due to end of rated service life as well as providing insufficient reserve hold time for emergency situations.

The suggested replacement of the existing UPS equipment will increase the reliability of the system. The end result shall be an overall increase in the electrical system dependability.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 1.

Table 1: Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	608.6	0.0	0.0	608.6
Labour	48.2	0.0	0.0	48.2
Consultant	0.0	0.0	0.0	0.0
Contract Work	45.0	0.0	0.0	45.0
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	47.6	0.0	0.0	47.6
Contingency	140.4	0.0	0.0	140.4
TOTAL	889.8	0.0	0.0	889.8

4.2 Project Schedule

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

	Activity	Start Date	End Date
Planning	Planning Activity	January 2016	February 2016
Design	Tender, Work packages and Drawings	February 2016	March 2016
Procurement	Tender issue – supply and install	April 2016	April 2016
	Contract award	May 2016	May 2016
	Purchase of battery banks	May 2016	June 2016
Construction	Contractor orientation and planning	July 2016	August 2016
	Construction start	July 2016	
Commissioning	Load testing of battery banks	August 2016	August 2016
	Testing / configure UPS proper operation	August 2016	
Closeout	Final reports, lesson learned, financial.	December 2016	December 2016

**A REPORT TO
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	Electrical
	Mechanical
	Civil
	Protection & Control
	Transmission & Distribution
	Telecontrol
	System Planning

**Replace Battery Banks and Chargers
Various Sites**

July 2015

SUMMARY

This proposal provides for the replacement of large stationary batteries and chargers at various locations in the Hydro power system, used to supply temporary power on loss of the prime power to critical sites. These systems are used to maintain local and remote control, monitoring and communications necessary for reliable operation of the power system.

The battery and charger replacement program is an ongoing effort to maintain the reliability of the electrical grid. The batteries have a limited rated service life and experience reduced capacity as they age due to chemical processes that occur internally. Towards their end of life the battery capacity begins to rapidly decline and they also experience an increased quantity of failures. Similarly with the chargers, as with all electrical equipment, once the rated service life has been exceeded it has been shown that they experience increased failure rates. Thus, the replacement program is, and shall continue to be, an ongoing program.

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1 INTRODUCTION

Hydro's Battery and Charger Replacement Program is an ongoing program to replace battery banks and chargers which are required for equipment located in generating and terminal stations and at telecommunications sites throughout Hydro's operating area.

Hydro has 39 generation sites including hydraulic, thermal and diesel, 54 high-voltage (66kV and above) terminal stations and 14 telecommunications microwave sites. Stationary batteries are located in all of these sites, and are used to provide power to telecommunications, protection and control, and switching equipment during times of AC power loss, enabling Hydro to continue operating the stations, either locally or by remote control from the Energy Control Centre (ECC).

Two types of stationary batteries are in use today. The flooded-cell battery shown in Figure 1 is the most common type. It consists of a series of individual cells connected together to supply the required voltage, either 48V or 125V DC, depending on the application. Each cell has rectangular plates of lead-calcium alloy bathed in a sulfuric acid electrolyte. The battery is large, heavy, and unwieldy; however, it has the advantage of high reliability and a typical service life of 18-20 years. If an individual cell fails, the battery continues to operate, although at diminished capacity. This type of battery has three disadvantages: Flooded-cell batteries emit small amounts of hydrogen gas during charging, and therefore require battery room ventilation; the battery requires regular maintenance to ensure the battery electrolyte does not deplete during operation; and the Battery container may fail causing potentially dangerous spills of sulfuric acid. To date, Hydro has only experienced one very minor leak from a cell two years ago which was replaced with a new unit. Also, in one shipment of cells, there was a missing cap resulting in some leakage during shipping. The spilled acid was neutralized without incident.



Figure 1: Flooded-cell battery (Stephenville)

In an effort to develop a smaller battery with less maintenance and less exposure to dangerous chemicals, manufacturers introduced a type of battery, known as Valve Regulated Lead Acid (VRLA), shown in Figure 2. These batteries hold the electrolyte suspended in a gel or paste and utilize a sealed container which reduces the chance of spill and prevents hydrogen escaping to the atmosphere. Unfortunately, once in operation they soon demonstrated several significant disadvantages. In practice, VRLA batteries have only seven to ten years of service life, which is approximately half of the flooded-cell battery service life. The batteries can experience a condition known as “thermal runaway”, which is overheating that could lead to an explosion. Hydro has not experienced an explosion, but several sites (eg: St Anthony airport) with VRLA cells have experienced overheating and swelling which is a dangerous state. The cells were replaced before total failure. When a cell fails, it fails with an open circuit, meaning that the failure of one cell can cause the whole bank to fail. For these reasons, many users still use flooded-cell batteries.



Figure 2: VRLA battery (Hinds Lake)

There are two applications for stationary batteries – supporting Telecontrol systems; and supporting Protection and Control (P&C) systems. The voltage of Telecontrol batteries is usually 48V DC. These batteries typically have higher standby capacity (in terms of hours the battery can supply the load) than is required for P&C batteries for two reasons. First, they often support Telecontrol functions for not only the site itself, but other sites as well, so they have a higher standby time requirement. Second, P&C equipment operates intermittently, whereas Telecontrol equipment draws power continuously. P&C batteries operate protection, control and switching equipment in the station, and are typically 125V or 24V DC.

Because they operate at a different voltage and on direct rather than alternating current, batteries are equipped with a charging system or charger. The charger converts AC to DC for the battery and attached equipment. Chargers normally last longer than the batteries and, therefore, are not always replaced when the batteries are replaced.

2 PROJECT DESCRIPTION

This project is part of Hydro's ongoing program to replace stationary batteries and chargers at generating sites, terminal stations and telecommunications microwave sites. These batteries are the source of power for telecommunications and protection and control equipment during the loss of station service. The batteries are a DC power source and thus require a charging system that converts AC to DC.

The batteries and chargers listed in Table 1 are to be installed in 2016 and 2017 under this proposal. Due to labor availability, scheduling and with respect to the age of the units, half the batteries will be purchased and installed in each year based on outage schedules and other projects. All new batteries shall be of the same type as existing installed.

Table 1: 2016 and 2017 Battery and Charger Replacements

Batteries and Chargers to be Installed in 2016 and 2017				
No.	Location	Equipment	Proposed Size	Existing Installed
1	Snooks Arm Diesel Plant	120V VRLA Battery	90Ah	unknown
2	Black Tickle Diesel Plant	2 x 24V VRLA Battery	TBD	unknown
3	Charlestown Diesel Plant	24V VRLA Battery	41 Ah	2003
4	Hopedale Diesel Plant	4 x 24V VRLA Battery	TBD	1991
5	Makkovik Diesel Plant	2 x 24V VRLA Battery	TBD	unknown
6	Paradise River Diesel Plant (Lab.)	4 x 24V VRLA Battery	TBD	unknown
7	South Brook Terminal	125V VRLA Battery	100 Ah	2003
8	Black Tickle Diesel Plant	24V Charger	TBD	unknown
9	Mary's Harbour Diesel Plant	2 x 24V VRLA Battery	120 Ah	2003
10	South East Hill	24V VRLA Battery	30 Ah	2005
11	Hardwoods Terminal Station	125V VRLA Battery	600 Ah	2003
12	Buchan's Terminal Station	125V FLOODED Battery	170 Ah	1996
13	Postville Diesel Plant	3 x 24V VRLA Battery	TBD	2000
14	Williams Harbour Diesel	24V VRLA Battery	TBD	1997
15	Paradise River Diesel Plant (Lab.)	2 x 24V Charger	30 A	1971
16	Western Avalon Terminal station	48V Charger	70 A	1998
17	Plum Point Terminal Station	48V Charger	70 A	1990
18	Bear Cove Terminal Station	48V Charger	70 A	1995
19	Cartwright Diesel Plant	3 x 24V Charger	30 A	1987
20	Holyrood Plant (Bank #6)	125V FLOODED Battery	250 Ah	1995
21	Holyrood Plant (UPS #3)	480V VRLA Battery	100 Ah	2005
22	Holyrood Plant (UPS #4)	480V VRLA Battery	100 Ah	2005

3 JUSTIFICATION

Flooded-cell batteries have an average service life of 18-20 years. VRLA batteries have an average service life of seven to ten years. Replacement is based on a combination of age and condition. As batteries age, they rapidly deteriorate and will no longer provide sufficient power in the event of an outage. Institute of Electrical and Electronics Engineers (IEEE) Standards 450 and 1188 recommend replacement of a battery at the earliest possible opportunity if the capacity has fallen to 80% or less of its rated capacity.

This proposal includes 22 VRLA banks, 4 flooded banks and 9 chargers. Based on age alone, the batteries being replaced have either reached or are nearing the end of their useful lives. Testing of the batteries demonstrates the need for timely replacement.

Hydro's Battery Replacement Program ensures that batteries are replaced before they fail. Batteries are key components of the infrastructure that is required to support the reliable operation of the power grid. Hydro's battery replacement program ensures that battery life is maximized while at the same time ensuring that reliable operation is maintained.

3.1 Existing System

The battery banks throughout Hydro's system are inspected regularly, depending on age and condition, to determine if there is a need for replacement. Batteries are typically inspected annually and tested as required. More frequent monitoring and testing may be performed if deterioration is noticed.

Flooded-cell batteries have an average life of 18 to 20 years and VRLA batteries 7 to 10 years. Replacement is based on a combination of age and condition. As batteries age, they rapidly deteriorate and will no longer provide sufficient power in the event of an outage.

There has been no major work or upgrades on any of the batteries or chargers being replaced under this project.

3.2 Operating Experience

Battery banks and chargers are stand-by equipment and are used to provide power to telecommunications, protection and control, and switching equipment during times of AC power loss, enabling Hydro to still operate terminal stations and microwave sites, either locally or by remote control from the Energy Control Centre. These systems are the last line of defense during power outages, and therefore high reliability and sufficient backup time must be provided. These systems must be available 24 hours per day, every day.

Replacement after failure is unacceptable, since a power outage at the station will prolong customer outages.

3.2.1 Reliability Performance

Operating history has shown that the flooded lead acid cells are more reliable and have a longer life expectancy than the VRLA cells. As such where space allows it is our preference to use the flooded type where ever possible. In cases where there is limited installation space precluding the flooded cells, the use of VRLA cells will continue. It has also been noted, both within the company as well as generally in the industry, that for both the flooded type cells as well as VRLA that the reliability of the cells performance past the manufacturer rated life expectancy rapidly deteriorates. The chargers also experience reduced reliability and an accelerated failure rate once past their manufacturer rated life expectancy. As such the batteries and chargers noted on this proposal have reached their rated life expectancy and are being replaced to maintain system integrity.

3.2.1.1 Outage Statistics

Battery chargers are typically installed in a redundant configuration, in order to minimize outages. Batteries that fail must be replaced immediately. There are no recorded outages for any of the equipment being replaced under this program.

3.2.2 Legislative or Regulatory Requirements

IEEE Standards 450 and 1188 recommend replacement of a battery at the earliest possible opportunity if the capacity has fallen to 80% of its rated capacity. Note that these are

neither legislative nor regulatory requirements, but are industry accepted standards.

3.2.3 Safety Performance

Aging batteries can on occasion present a safety hazard since cells are more likely to rupture, especially if plate distortion is present. This phenomenon is often observed in aging batteries but rupture is not common. As well, aging cells occasionally develop cracks which may leak. Hydro personnel are equipped with personal protective equipment and spill remediation kits should electrolyte spillage occur.

3.2.4 Environmental Performance

Because of the presence of sulfuric acid and lead, precautions must be taken in the handling and disposal of batteries. Transportation of Dangerous Goods (TDG) regulations apply to the transport of batteries. Training is provided to Hydro personnel and contractors to ensure that the risk to the environment is minimized.

3.2.5 Industry Experience

Battery life is highly variable and can depend on many factors. High temperature, slightly elevated charging voltage, and the number, duration and depth of discharges can all affect the service life of a battery. Industry users have experienced battery life for VRLA batteries of as little as 24 months and as long as 25 years for flooded cell batteries that are rarely used and maintained under ideal conditions. Hydro has had to replace batteries with as little as five years of use and has kept batteries in service for well over 20 years in some cases. Testing and monitoring of batteries is critical to ensuring that they are available when required.

3.2.6 Vendor Recommendations

Most vendors refer to the standards published by the Institute of Electrical and Electronics Engineers (IEEE) for battery testing and replacement.

3.2.7 Maintenance or Support Arrangements

Most batteries and chargers are maintained by Hydro personnel. Depending on the location, the battery may be inspected and/or tested biannually or annually. The exception is the Uninterruptible Power Supply (UPS) batteries at Hydro Place and Holyrood. Because of the specialized application, these batteries are maintained by the manufacturer. Annual inspection and maintenance is performed on these batteries.

3.2.8 Maintenance History

Battery maintenance varies with the age, location and type of battery. Generally speaking, if batteries are in a location where they are being observed regularly, such as a staffed generating station, they may not be tested as regularly as those in locations that are not visited frequently. Visual observation of batteries can offer information regarding their condition.

Regular maintenance included visual inspection, measurement of cell voltage, measurement of electrolyte specific gravity, and replacement of evaporated electrolyte with distilled water.

Conductance testing is intended to supplement traditional capacity testing, which is the most accurate test of a battery's condition. In a capacity test, the battery is removed from service and connected to a load that is designed to discharge the battery over eight hours. This test of the so-called eight hour rate assesses the actual capacity of the battery. The battery cells are observed during the test for rapid loss of voltage to determine if they have deteriorated. The battery is deemed to have failed the test if it demonstrates less than 80% of rated capacity.

Because the capacity test takes a significant amount of time and requires a disruption of service, it is difficult to conduct regularly. A suitable proxy for discharge testing is conductance testing, during which the conductance or ability of the battery's individual cells to conduct current is measured. Hydro personnel periodically test batteries using a

conductance tester. By comparing results over time, deterioration of the battery can be tracked. Ideally, batteries are tested shortly after installation and this baseline is used to track changes in the battery's condition. However, many batteries currently being replaced have been in service longer than Hydro has been testing batteries, so baseline test results are not available. As well, some manufacturers publish reference values that are useful for comparing test results; however these results are not available for all batteries. As a result, some judgment must be used.

Chargers are not generally tested. They are replaced as they reach the end of their useful lives or when maintenance becomes an issue. Replacement is based on age, operating experience and failures.

3.2.9 Historical Information

Historical information for the Stationary Battery and Charger Replacement Program is shown in Table 2.

Table 2: Battery Chargers Capital Budget and Expenditures History

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Battery Bank Units	Charger Units
2014B ¹	497.0	ongoing	11	11
2013	782.0	553.2	14	8
2012	880.8	633.6	13	6
2011	978.4	813.3	18	11
2010	716.9	559.0	8	7

3.2.10 Anticipated Useful Life

Flooded-cell batteries have a typical service life of 18 to 20 years. VRLA batteries have a typical service life of seven to ten years.

3.3 Forecast Customer Growth

Batteries and chargers are not impacted by forecast customer growth.

¹ 2014B is a multiyear budget covering 2014 and 2015.

3.4 Development of Alternatives

Status quo or deferral are not alternatives to replacing the equipment as the equipment has demonstrated that it is past the end of life criteria and operation to failure is an unacceptable alternative. Stationary batteries are a critical component of, and are integral to, the design of station control and telecommunications equipment.

Because of their short life, when replacing VRLA batteries, flooded cell batteries are substituted whenever possible. Space limitations sometimes dictate that VRLA batteries must be used.

3.5 Evaluation of Alternatives

There are no viable alternatives to replacing batteries and chargers in a power system such as maintained by Hydro.

3.5.1 Energy Efficiency Benefits

There are no projected energy efficiency benefits related to the replacement of batteries and chargers.

3.5.2 Economic Analysis

As there are no viable alternatives, an economic analysis is not applicable.

4 CONCLUSION

Stationary batteries are a critical component of the equipment required to control the power grid. In order to ensure that the grid can be controlled during times of disruption, Hydro will replace aging batteries and chargers on a continual basis to ensure that reliability of the overall system is maintained.

4.1 Budget Estimate

The proposed budget estimate is provided in Table 3.

Table 3: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	190.8	112.0	0.0	302.8
Labour	166.9	116.7	0.0	283.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	38.1	30.9	0.0	69.0
Interest and Escalation	29.2	65.9	0.0	95.1
Contingency	0.0	131.1	0.0	131.1
TOTAL	425.0	456.6	0.0	881.6

4.2 Project Schedule

The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Open Project Complete Design Transmittal	January 2016	January 2016
Design 2016	Engineering Design	February 2016	March 2016
Procurement 2016	Purchase Battery and Chargers	April 2016	May 2016
Construction 2016	Install and Commission Battery, Chargers and UPS Systems	June 2016	September 2016
Closeout 2016	Update design drawings	November 2016	December 2016
Design 2017	Engineering Design	February 2017	March 2017
Procurement 2017	Purchase Battery and Chargers	April 2017	May 2017
Construction 2017	Install and Commission Battery, Chargers and UPS Systems	June 2017	September 2017
Closeout 2017	Update design drawings	November 2017	December 2017
Project Close	Close the project	December 2017	December 2017

Replace Personal Computers

Various Sites

July 2015

SUMMARY

This project is for the replacement program of personal computers and end user devices used by employees in Hydro.

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1 INTRODUCTION

The report details the personal computers replacement program required to replace Hydro employees' personal computers. The personal computers are replaced according to a replacement life cycle of four years for Laptops, five years for Desktops and six years for Thin Clients.

2 PROJECT DESCRIPTION

The Personal Computer (PC) Replacement program is an on-going program required to enhance the efficiency of Hydro's employees by replacing the PCs used for their day to day requirements.

This project will enable Hydro to replace 195 Thin Clients, Desktops, Workstations and laptops computers that were deployed up to, and including, 2012. There are 27 Thin Clients, 144 Laptops, 12 Desktops, and 12 Workstations to be replaced. A workstation is a more powerful desktop that is used for specialized applications that require more power and resources, such as AutoCAD for drafting.

The assignment of a particular device is determined by the employee's manager or supervisor. Generally, if an employee is expected to use their computer while away from the office, a laptop is assigned.

The projected costs of the units are as follows:

- Thin Client - \$750;
- Laptop - \$1,900;
- Desktop - \$1,000; and
- Workstation - \$2,050.

To streamline existing PC deployment processes, and improve operational efficiencies, Hydro will engage external consultants to:

- Analyze existing PC deployment process to identify gaps and deficiencies in existing processes; and
- Design, build and implement a PC deployment solution based on the results of the analysis.

Areas of focus for the engagement include:

- Improvement of delivery times;
- Reduction of deployment costs;
- Improvement in operational efficiency;
- Use of existing infrastructure and software; and
- Implementation of an efficient, streamlined and stable process for PC deployment.

Hydro will release a public tender for supply of PC equipment and procurement of professional consulting services.

3 JUSTIFICATION

Hydro must keep computers current in order to adequately support and protect the Information Technology applications and information required to operate its business. The replacement and addition of PC components to achieve this goal requires investment over the life cycle of the computers.

The computer replacement program makes it possible for computers to be replaced in a planned and consistent manner. This allows for even distribution of budgets and ensures that the computers are available and reliable to support user applications. Continued review of the computer life cycle allows Hydro to adjust plans based on performance, technology changes and new business requirements.

In addition, the computers to be replaced under this project are approaching the end of their useful lives and failures can be expected. The maintenance agreements for these computers will have expired and replacement parts can no longer be guaranteed.

The implementation of an improved PC deployment process will improve management and deployment of Hydro's PC assets while lower deployment costs through the introduction of process efficiencies and lower deployment times. Hydro's current process consists of multiple steps, resources and vendors to deploy PCs to users in over 40 sites.

3.1 Existing System

Hydro has approximately 900 end-user personal computers in service. It is important to refresh this equipment on a regular cycle to keep the technology current to maintain a reliable, efficient and productive workforce. Refreshing is the replacement of end user equipment, such as desktops, laptops and thin clients, on a life cycle depending on the type of device.

Minimum specifications for replacement of personal computers are reviewed on an annual basis to ensure that the PCs in service continue to remain effective. Industry best practices,

technology and application trends are taken into consideration when specifications for computer devices are decided for the current year. The annual review continues the replacement life cycle for laptops of every four years, desktops every five years and thin clients every six years.

As this budget proposal is for the routine replacement of computing hardware based on a corporate standard consistent with industry practice, the following items under the existing system section are not relevant to the proposal:

- Major Work and/or Upgrades; and
- Operating Regime.

Age of Equipment or System

The existing PCs that are to be replaced under this project will have been in service between four and six years depending on the hardware platform used.

Availability of Replacement Parts

Replacement parts are readily available for the duration of the maintenance agreements. Once the maintenance agreement has expired there is no guarantee that replacement parts can be obtained.

3.2 Operating Experience

Status Quo

If the end user infrastructure is not kept current the following scenarios could potentially occur:

- New applications may not run on the old hardware platform;
- Decreased speed may result in lost production;
- Failure rates will exceed 50%;
- Maintenance agreements will not be offered by vendor; and
- Operating systems may be unsupported.

3.2.1 Industry Experience

Hydro has a similar life cycle plan for computer equipment as other companies in the utility industry, including Newfoundland Power.

3.2.2 Maintenance or Support Arrangements

Hydro has purchased maintenance agreements with Lenovo Corporation, the manufacturer that covers laptops for four years and desktops for five years.

3.2.3 Historical Information

Historical information on computer replacement over the last five years as well as those budgeted for 2015 is presented in Table 1.

Table 1: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)
2015B	573.3		335	1.71
2014	463.9	529.1	271	1.95
2013	463.9	518.2	237	2.18
2012	490.6	499.0	183	2.73
2011	403.5	422.2	142	2.97
2010	406.6	403.6	215	1.87

3.2.4 Anticipated Useful Life

According to Gartner¹, the useful life for a laptop is three years while for a desktop and Workstations is four to five years. The North American industry standard life cycle for end-user devices is three years for laptops, five years for desktops and workstations and six years for thin clients. Hydro has adopted a four to five year life cycle and utilizes extended warranties to ensure reliable operation.

¹ Gartner Inc. provides research and analysis on the global Information Technology industry. They assist companies in making informed technology and business decisions by providing in-depth analysis and advice on virtually all aspects of technology.

3.3 Evaluation of Alternatives

The only alternative is to consider leasing the equipment. However, this has been done in the past and has proven to be more expensive and difficult to manage.

3.3.1 Economic Analysis

This project is subject to a lease or purchase cost benefit analysis to determine the lowest cost alternative. The cost benefit analysis is done in the year of replacement to ensure consideration of incentives or other benefits that may be offered by the providers.

4 CONCLUSION

The PC Replacement Program as proposed in this project is the preferred solution for the following reasons:

- It enables the end user equipment to remain current;
- It improves workforce efficiency by providing reliable hardware; and
- It allows for a predictable annual budget.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 2.

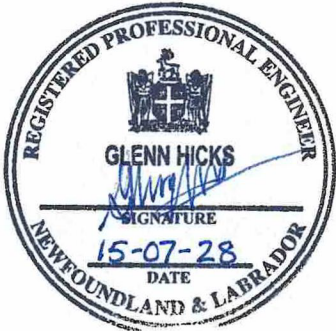
Table 2: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	535.1	0.0	0.0	535.1
Labour	33.6	0.0	0.0	33.6
Consultant	118.4	0.0	0.0	118.4
Contract Work	88.5	0.0	0.0	88.5
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	8.5	0.0	0.0	8.5
Contingency	77.6	0.0	0.0	77.6
TOTAL	861.7	0.0	0.0	861.7

4.2 Project Schedule

The project is scheduled to start in January 2016 and be completed before December 30, 2016.

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

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

Replace Powerline Carrier – TL214 and TL239

Bottom Brook, Doyles, Deer Lake and Berry Hill
Terminal Stations

July 2015

SUMMARY

This report proposes the replacement of powerline carrier systems servicing two (2) remote terminal stations in the western portion of Newfoundland. Due to the age of the PLC systems considered in this proposal, there are concerns regarding its continued reliable operation. Should failure occur, the loss of line protection and SCADA services may result in a loss of service to customers on the southwest coast and the Great Northern Peninsula. It is proposed to replace the existing powerline carrier equipment with the latest version of the same equipment. Although limited in the amount of bandwidth available for the various services, a powerline carrier system is more economically viable than either microwave radio or optical fibre alternatives for remote stations.

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1 INTRODUCTION

Powerline Carrier (PLC) equipment is utilized by electrical utilities to provide low bandwidth communications services between high voltage stations using the transmission line as the communications medium. A typical PLC system includes the powerline carrier, high-voltage coupling equipment, and typically the following services:

- Teleprotection - for high speed, automatic transmission line and breaker protection;
- SCADA (Supervisory Control and Data Acquisition) - for manual remote control of terminal/generation station equipment from the Energy Control Centre;
- Voice - for communications with the Energy Control Centre; and
- Network Management - for remote monitoring of communications equipment.

Each of these services is essential to the safe and reliable operation of the electrical power grid.

The scope of this project is to replace the PLC and associated coupling equipment providing communications services between the terminal stations at Doyles and Bottom Brook via TL214 as shown in **Figure** , and between the terminal stations at Berry Hill and Deer Lake via TL239 as shown in **Figure** . Both TL214 and TL239 are 138-kV transmission lines.

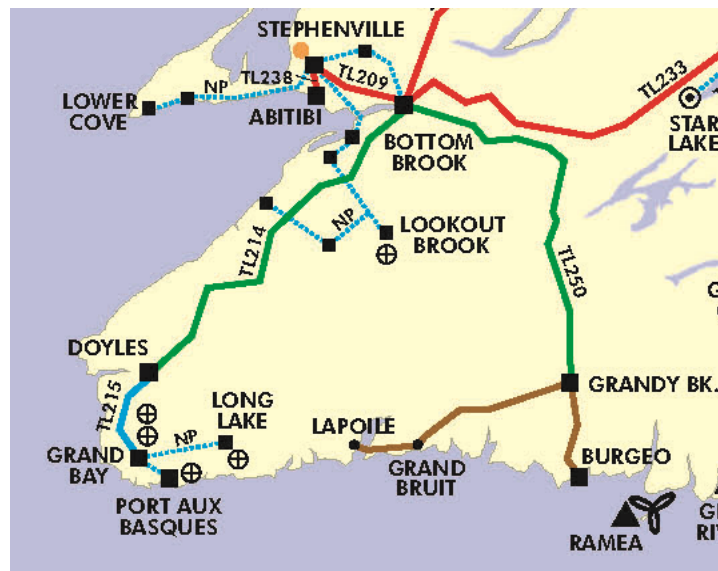


Figure 1: TL214 Doyles to Bottom Brook

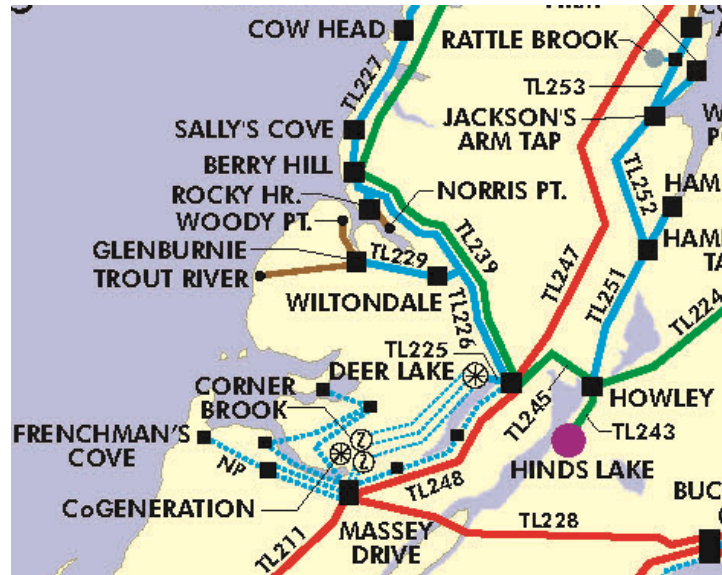


Figure 2: TL239 Berry Hill to Deer Lake

Newfoundland and Labrador Hydro utilizes powerline carrier (PLC) systems to provide communications services, including teleprotection and SCADA, to remote terminal and generating stations. Since the bandwidth requirements for these remote locations is typically low compared to more centrally located sites, other communications systems, such as microwave radio and optical fibre, are cost prohibitive.

The Project proposal is justified based on a lack of manufacturer support, the unavailability of spare parts, and an inability to repair faulty components. There are no environmental, safety, or regulatory/legislative drivers for the replacement of these PLC systems.

2 PROJECT DESCRIPTION

This is a two-year Project to replace the TL214 and TL239 powerline carrier systems with new powerline carriers and high voltage (HV) coupling equipment. The work will take place at the Doyles and Bottom Brook Terminals Stations for TL214, and the Berry Hill and Deer Lake Terminal Stations for TL239. The replacement process consists of the following major activities:

- Design powerline carrier systems, including HV coupling;
- Procuring the components;
- Replace powerline carrier;
- Replace coupling equipment;
- Commission powerline carrier system; and
- Reconnect and test communications services.

3 JUSTIFICATION

This project is justified on the requirement to replace failing or deteriorated infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service. The Powerline Carrier (PLC) equipment has been in service for over 24 years and is now obsolete. The currently installed model of PLC, the ETI21 with NSD60 teleprotection module, has been phased out by the manufacturer ABB since the mid-1990s. The manufacturer has indicated that, due to the unavailability of components, the discontinued products can rarely be repaired. As such, continued utilization of this equipment poses the risk of failure and hence loss of communications required for the protection and control of the power system. Replacement of the powerline carriers ensures communications to monitor and control power devices in order to provide uninterrupted service to our customers and protection of the transmission assets.

Note that there is occasionally some misunderstanding related to this type of equipment. In recent years, much publicity has been given to the benefits of high speed communications over powerlines, known as “Broadband Powerline Carrier” (BPL). BPL is quite different than the equipment being replaced here, and suitable only for very short distances, such as on distribution lines to households for Internet access. BPL cannot be used on high-voltage transmission lines to provide the types of service required by Hydro in this application.

3.1 Existing System

The TL214 and TL239 PLC systems provide both the Doyle's and Berry Hill Terminal Stations with the following communications services:

- Teleprotection – for the high speed, automatic transmission line protection on the 138-kV transmission lines to Bottom Brook and to Deer Lake;
- SCADA – for the Supervisory Control and Data Acquisition for manual remote control of terminal station equipment from the Energy Control Centre;
- Voice – for communications with the Energy Control Centre; and

- Network Management – for the remote monitoring of communications equipment at Doyles and Berry Hill.

The TL214 and TL239 PLC systems consist of the following major components:

- ETI21 Powerline Carrier;
- NSD60 Teleprotection Unit;
- Line Matching Units (LMU);
- Current Voltage Transformers (CVT); and
- Wavetraps (WT).

The existing TL214 ETI21 PLC was originally installed in 1990 on TL233 between the Buchans and Bottom Brook Terminal Stations. In 2000, the TL233 PLC system was replaced by the latest version of PLC and coupling equipment, and changed from phase-to-ground coupling to phase-to-phase coupling in order to increase reliability. After completion of the TL233 PLC replacement, the ETA/B PLC on TL214 was then replaced with the TL233 ETI21 PLC. To make ready for its use on TL214, the ETI21 PLC was upgraded to change the transmission line coupling from phase-to-ground to phase-to-phase. Since the TL214 PLC equipment was replaced in 2000, no major work or upgrades have been made to the PLC system.

The existing TL239 ETI21 PLC was installed in 1990 and no major work or upgrades have been completed.

3.2 Operating Experience

The following sections highlight the operating experience of the TL214 and TL239 PLC systems.

3.2.1 Outage Statistics

There are no recorded failures of this equipment since 2000. Records before 2000 are not available. Note that due to the very high reliability requirements of this equipment, the lack

of significant outage statistics should not be used to prevent an orderly replacement. Replacement for such equipment is required before significant outages are allowed to occur.

3.2.2 Industry Experience

There is no known industry experience available with regards to the failure rate of Powerline Carrier, suggested life spans or replacement schedules.

3.2.3 Vendor Recommendations

The existing Powerline Carrier ETI model has been phased out since the mid-1990s, spares are no longer available, and due to the unavailability of components, discontinued parts can rarely be repaired. The equipment manufacturer ABB classifies the ETI PLC model as being “obsolete” meaning the product and its pertinent components are no longer supported.

3.2.4 Maintenance or Support Arrangements

The equipment manufacturer ABB no longer provides maintenance support for the ETI PLC model.

3.2.5 Maintenance History

Since 2000, the average annual preventative maintenance costs associated with the PLC equipment at Doyles, Bottom Brook, Deer Lake and Berry Hill Terminal Stations is approximately \$1,000. No corrective maintenance has been required during this 15-year period.

3.2.6 Historical Information

The labour and materials estimate for this proposal is in alignment with past budget estimates for the replacement of PLC systems.

3.2.7 Anticipated Useful Life

Based on similar communications equipment, the Powerline Carrier is assumed to have a useful life of 15 years.

3.3 Development of Alternatives

Due to the limited availability of alternatives for communications to remote, end-of-the-line stations where bandwidth requirements are minimal, typically PLC systems are the most cost-effective solution for providing SCADA and teleprotection services to these remote sites. Other alternatives, such as optical fibre and microwave radio, have much higher upfront capital costs, and in the case of microwave radio, much higher operating costs as well. All three of these solutions have a useful life of about 15 years. When compared to the PLC system solution for TL214 and TL239, which has a capital cost per transmission line of about \$400,000, optical fibre and microwave radio solutions would be in excess of \$1,000,000 per transmission line.

4 CONCLUSION

This project is necessary in order to maintain reliable communications associated with the automatic and manual control of the electrical power grid. Alternative, equivalent performance, communications systems, such as optical fibre and microwave radio, are not economically viable. Failure to replace this aging PLC and coupling equipment may result in power system outages on the Northern Peninsula and Southwest coast, requiring the affected stations to be manned until remote control could be restored.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 1.

Table 1: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	405.2	0.0	405.2
Labour	59.9	140.7	0.0	200.6
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	8.7	24.0	0.0	32.7
Interest and Escalation	4.8	65.6	0.0	70.4
Contingency	0.0	127.8	0.0	127.8
TOTAL	73.4	763.4	0.0	836.8

4.2 Project Schedule

The anticipated project schedule is shown in Table 2.

Table 2: Project Schedule

Activity		Start Date	End Date
Planning	Project set-up and site visits	January 2016	May 2016
Design	PLC system design	May 2016	August 2016
Procurement	Public tendering for PLC system	August 2016	March 2017
Construction	Includes preparation of work packages, preliminary site work and procurement of miscellaneous installation materials	January 2017	August 2017
Installation/ Commissioning	Requires transmission line outage to complete installation and testing	September 2017	October 2017
Closeout	As-built drawings, lessons learned and Project completion	November 2017	December 2017

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

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

Replace Roof
Hydro Place

July 2015

SUMMARY

Constructed in 1988, Hydro Place is a six-story office building with a mechanical penthouse at the seventh level. The building measures approximately 88 feet tall, generating a total floor area of approximately 20,054 m². The facility currently houses nearly 500 employees and serves as the headquarters for Hydro.

A condition assessment, completed by BAE-Newplan Group Limited in 2009, noted that the existing roofing system was nearing the end of its service life and its replacement was recommended. In an effort to prolong the requirement for a complete roof replacement, Hydro has closely monitored the roof's condition, particularly during the spring thaw when snow melt and rainfall combine to generate an influx of water. Numerous repairs have been enacted to remedy any leaks, however, the repairs are often short lived and in some instances the leaks have reoccurred and/or new leaks form at different locations.

Given the roofing system's age, the formation leaks will continue to pose a problem to building maintenance personnel and occupants alike. If left unaddressed these leaks may impact the use of the building and result in deterioration and mold growth.

Failure to replace the roof will result in the continued infiltration of rain water leading to further interior damage and the potential failure of the electrical equipment contained in the Energy Control Center. The replacement of the roof must be completed to mitigate this risk and to provide a new roofing system capable of providing maintenance free protection for the next 20 years.

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1 INTRODUCTION

Constructed in 1988, Hydro Place is a six-story office building with a penthouse at the seventh level. The building measures approximately 88 feet tall, generating a total floor area of approximately 20,054 m². The facility currently houses nearly 500 employees and serves as the headquarters for Hydro.

A 2009 condition assessment, completed by BAE Newplan, noted that the facilities roofing system was nearing the end of its service life and its replacement was recommended (See Appendix A). Since the completion of the assessment, the roof has formed numerous leaks and has been the subject of numerous repair efforts.

The occurrence of these leaks solidifies the assessment recommendations and reinforces the need to complete the proposed upgrades. Completion of the upgrades is required to restore the integrity of the roof, thus, enabling it to function as per its design intent for the next 20 years.

This project is driven by Hydro's requirement to replace an asset which has exceeded its service life.

2 PROJECT DESCRIPTION

This project comprises the second year of a three year program for the completion of roof upgrades at Hydro Place. Upgrades include supply and installation of a new, mechanically fastened roofing system; and the completion of interior repairs to various areas damaged as a result of water infiltration. The roof areas to receive upgrades in 2016 include levels 3 and 4.

3 JUSTIFICATION

A condition assessment, completed by BAE-Newplan Group Limited in 2009, noted that the existing roofing system was nearing the end of its service life and its replacement was recommended. In an effort to prolong the requirement for a complete roof replacement, Hydro has closely monitored the roof's condition, particularly during the spring thaw when snow melt and rainfall combine to generate an influx of water. Numerous repairs have been enacted to remedy noted leaks, however, the repairs are often short lived and in some instances the leaks have reoccurred and/or new leaks have formed at different locations.

Given the roofing system's age, the formation leaks will continue to pose a problem to building maintenance personnel and occupants alike. If left unaddressed these leaks may impact the use of the building and result in deterioration and mold growth.

The replacement of the roof must be completed to mitigate this risk and to provide a new roofing system capable of providing maintenance free protection for the next 20 years.

3.1 Existing System

The existing roofing system is commonly referred to as a "Protected Membrane Roof". This type of system is comprised of a layered assembly consisting of: stone ballast¹ (concrete pavers at the perimeters), filter fabric, 75 mm rigid insulation, single-ply roofing membrane², 25 mm rigid insulation, and vapour barrier. The system has been in place for 26 years and is nearing the end of its service life.

The roof has not been the subject of any major work or upgrades since its original installation.

¹ **Ballast** - Older style roofing systems as similar to the system at Hydro Place use a membrane, layer of insulation, vapor barrier and the surface materials to hold it all down are usually in the form of large gravel and cement patio stones i.e.: ballast.

² **Single-Ply Membrane** - A roof membrane consists of layers of rubber or polyvinyl chloride (pvc), which serves as the waterproofing component, with plies of reinforcement fabric installed between each layer. A single-ply application consists of but one membrane layer.

3.2 Operating Experience

Hydro Place serves as the main headquarters for the Hydro group of Companies. It provides office space for approximately 500 employees, and houses Hydro's Energy Control Center, which allows System Operators to monitor the amount power being generated throughout the system, voltage conditions across the system and the status of equipment on the main power grid. This allows for the optimization of system performance and reliability.

3.2.1 Industry Experience

Developed in the early 1980s cold-applied roofing systems are becoming increasingly common in today's industry. Typical roofing applications contain a 15 year service warranty and have a life expectancy ranging from 25 to 30 years.

Aside from its superior weatherproofing ability, cold-applied systems are widely preferred as they reduce fumes and pollution and eliminate the danger of fire during installation, thus making them the ideal choice for use in occupied buildings.

3.2.2 Vendor Recommendations

In 2009, Hydro engaged BAE – Newplan Group Limited to conduct a condition assessment of Hydro Place. The assessment findings noted that the existing roofing system has outlived its service life and its replacement was recommended.

3.2.3 Maintenance or Support Arrangements

Maintenance for this asset is typically completed by external contractors, who are contracted as required to complete required repairs and maintenance. Replacement of the existing roofing system will essentially eliminate maintenance requirements for the next 15 to 20 years.

3.2.4 Maintenance History

The five-year maintenance history for the Hydro Place roofing system is shown in Table 1.

Table 1: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$000)
2014	0.0	1.4	1.4
2013	0.0	2.4	2.4
2012	0.0	11.9	11.9
2011	0.0	3.1	3.1
2010	0.0	10.1	10.1

3.2.5 Historical Information

Table 2 details the costs associated with roof upgrade projects within the past five years.

Table 2: Historical Information

Year	Capital Budget (\$000)	Actual Expenditures (\$000)	Units	Cost per unit (\$000)	Comments
2015B	671.9	-			Level 6, Level 5, and ECC
2013	199.7	162.9			Mechanical Penthouse

3.2.10 Anticipated Useful Life

The anticipated service life for this asset is 25 years.

3.3 Development of Alternatives

The existing roofing system has outlived its useful service life. A complete roof replacement is the only viable alternative to ensure that the roof remains weather tight.

4 CONCLUSION

The existing roofing system has reached the end of its service life. It is starting to show signs of deterioration, typical for a roof of its age, with multiple repairs having been enacted to deal with problematic leaks throughout the past few years. If left unaddressed, the roof will continue to form leaks which may impact the use of the building and potentially lead to mold growth and deterioration.

The replacement of the roof must be completed to mitigate this risk and to provide a new roofing system capable of providing maintenance free protection for the next 20 years.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 3.

Table 3: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	113.4	0.0	0.0	113.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	390.8	0.0	0.0	390.8
Other Direct Costs	0.0	0.0	0.0	0.0
Interest and Escalation	34.5	0.0	0.0	34.5
Contingency	100.8	0.0	0.0	100.8
TOTAL	639.5	0.0	0.0	639.5

4.2 Project Schedule

The anticipated project schedule is shown in Table 4.

Table 4: Project Schedule

Activity		Start Date	End Date
Planning	Scope Statement, Schedule, Resource Allocation	March 2016	March 2016
Design	Preparation of Tender Package	April 2016	May 2016
Procurement	Tender/Award	May 2016	June 2016
Construction	Roof Replacement	July 2016	September 2016
Commissioning	Final Inspection and Acceptance	-	September 2016
Closeout	Certificate of Completion, Final Billing	-	October 2016

APPENDIX A

Condition Assessment of Hydro Place, Bae-Newplan Group Limited (Report Summary, Recommendation and Planning Priority Matrix)

7 SUMMARY AND RECOMMENDATIONS

Generally speaking the building is solidly constructed and well maintained

Those items requiring action are primarily issues pertaining to the general aging of the building and the requirement to perform necessary repairs and/or replacements of major building components; in particular those related to the building envelope such as roofing and windows, building caulking, etc.

With respect to the building mechanical systems it is our opinion that the existing cooling tower should be replaced with a newer and more efficient model that can more effectively utilized in controlling the interior building environment. Other mechanical items of note such as the replacement of existing plumbing fixtures while not a particular area of immediate concern, will provide improved efficiencies of water usage and energy consumption in today's energy conscious workplace.

The building electrical systems is in reasonably good shape ; however, it is noted that many of the lighting and power panels within the building are at capacity and the addition of any further service loads will necessitate the installation of additional panels to accommodate the increased requirements for the general lighting and power loads.

Our review of the Life-Safety and Fire Code aspects of the building did not result in any findings that would be of immediate or urgent concern for the safety of the building or the building occupants. We did note that there are some issues with respect to exit signage and lighting which will need to be addressed. As well, we note that there are some adjustments recommended to the exits for the Daycare area. The location and functionality of the area around the existing garbage bins should be addressed. This may require a relocation of the bins or modifications to the area around Shipping and Receiving to functionally and safely accommodate the bins in their present location.

Included under Appendix 'C' is our summary of action items including a scheduling for the work and some preliminary budget projections for implementing these changes.

In summary, this facility is very well constructed and is generally very well maintained. There are a number of areas where the age of the building now requires the expenditure of monies to ensure that the facility achieves another 25-30 years of reliable usage before major upgrades are again required. This will help to ensure that major failures of building elements do not occur. Other applicable action items are described within the report. Overall this is a well designed and well constructed facility with many years of service life remaining.

PLANNING PRIORITY MATRIX

Item	Building Component	Description	Condition	Priority Rating	Recommended Timing of Repair or Replacement	Suggested Planning Year	Estimated Cost of Repair/Replacement (2009 \$)
A.	Building Envelope & Structure						
	Roof System	Modified Protected Membrane Roof System - Nearing End of Service Life, Replacement Recommended	Good but nearing the end of its normally accepted service life	2	Within the next 2 -years	2011	\$ 1,200,000.00
	Roof Flashings	Metal Flashings and Trims - Nearing End of Service Life, Replacement recommended	Reasonably good but nearing the end of its normally accepted service life, recommend replacing with the roof replacement	2	Within the next 2-years	2011	\$ 200,000.00
	Windows	Thermally broken aluminum curtain wall framing with hermetically sealed window units (blue tint). All as manufactured by PPG Industries. Windows are progressively failing and require replacement. - Nearing End of Service Life, Replacement Recommended	Good to poor, depending on location. Recommend replacement of the sealed units and restoration of frame coloring	2	Within the next 5-years	2013	\$ 3,000,000.00
	Main Entrance Doors & Roof Accessories	Fully glazed aluminum frames with blue factory applied coating - no major concerns - Maintenance Item	Generally Good	3	No immediate action required other than the continuation of routine maintenance	Maintenance Item	\$ 3,000.00
	Caulking	Dynemic caulking on foam backer rod for precast installation. There are concerns at the roof /precast interface and repairs are required	Good within the general body of the precast concrete but poor at the roof and precast upstand juncture. Work is required at the intersection of the roof flashings and the precast upstand; recommend complete reworking at the time of the roof replacement.	2	Within the next 2-years	2011	\$ 120,000.00
	Code Compliance	Detailed review completed. No major areas of concern with the exception of the existing at the Day Care Centre where revisions to the exits are recommended. Further Discussion is Required.	Relocate existing door or provide new exit door	2	Potential area of concern. Recommend this as an item for review	2010	\$ 10,000.00
	B. Electrical Systems						
	Electrical Power	Original Equipment. Filters are missing on some panels and these are required to be added. A thermal scan of panels is recommended	Good but with some deficiencies noted. Recommend that a thermal scan and load distribution study be commissioned	3	Add filter panels, as noted. Commission studies.	2010	\$ 25,000.00
	Lighting	Original Fixtures - Replacement of Exit Lighting is Recommended	Not meeting code requirements, replacement is recommended	1	Recommend replacement as soon as possible	2010	\$ 12,000.00
	Emergency Lighting	Original Fixtures - Verify Illumination Levels and add Additional Lights as required.	Verification required on Illumination being provided. This needs to be verified and fixtures relocated or additional lights added, as necessary	2	Light levels need to be metered and lights added as necessary	2010	\$ 5,000.00

Item	Building Component	Description	Condition	Priority Rating	Recommended Timing of Repair or Replacement	Suggested Planning Year	Estimated Cost of Repair/Replacement (2009 \$)
	Code Compliance	Not Met - Replace or Add as Noted Above	As noted above. The existing exit lights do not meet code requirements and should be replaced	1	Recommend replacement in the near future	2010	As noted above
C	Cooling Tower	The existing cooling tower is a counter flow, forced draft, open cooling tower. The cooling tower is located on the Level 6 roof and is accessed from the adjacent penthouse. Replacement is recommended for improved Operating Efficiency.	It is recommended to replace the cooling tower with a closed circuit evaporative fluid cooler, change the circulating fluid from water to ethylene glycol, and provide a remote indoor pump for spray water.	2	Recommend replacement in the near future	2011	\$ 300,000.00
D	Plumbing Systems						
	Water Entrance	The water entrance consists of a 4 1/2" cast iron supply pipe that penetrates the foundation wall of the building with a 4 1/2" cast iron GSAV gate valve. Water Entrance to be replaced to City of St. John's Standards.	Does not meet the present City of St. John's or building code requirements	3	Install new pressure gauge, pressure test the backflow preventer, conform to latest City of St. John's standards	2012	\$ 25,000.00
	Plumbing Fixtures						
	Washroom Lavatories	The washroom lavatories are irregularly turned into the counter top as a continuous solid surface counter / lavatory - Maintenance Item	Fair to Poor	4	Operational but should be replaced under the building maintenance program	Maintenance Item	\$ 60,000.00
	Water Closets	The water closets throughout the building are wall mounted type with exposed manual flush valves - Maintenance Item	Good	3	Handicapped battery operations can be added to all units under the building maintenance program	Maintenance Item	\$ 50,000.00
	Urinals	The urinal fixtures throughout the building are wall mounted with exposed manual flush valves - Maintenance Item	Good	3	Handicapped battery operations can be added to all units under the building maintenance program	Maintenance Item	\$ 40,000.00
	Coffee Station Sinks	The coffee station sinks consist of large back stainless steel sinks with deck-mounted faucets complete with lever handles and goose-neck spouts - Maintenance Item	Poor	3	Replace sinks and water boosters under the building maintenance program	Maintenance Item	\$ 20,000.00
	Commercial Kitchen Sinks	The commercial kitchen located on Level 1 is equipped with a multiple compartment stainless steel sink complete with two sets of trim - Maintenance Item	Good	4	Replace trim, clean out the grease interceptor, check operation of booster heater - all work to be performed under the building maintenance program	Maintenance Item	\$ 5,000.00
	Barbells	The Energy Control Center washroom is equipped with bath-hub complete with stand-up shower - Maintenance Item	Fair to Poor	4	Replace under maintenance program	Maintenance Item	\$ 4,000.00

Item	Building Component	Description	Condition	Priority Rating	Recommended Timing of Repair or Replacement	Suggested Planning Year	Estimated Cost of Repair/Replacement (2009 \$)
	Emergency Eyewash/Drench Shower	An emergency eyewash / drench shower is located adjacent to the battery storage room - Addition of Water Tempering Valve is Recommended	Good	3	Consideration should be given to replacing the cold water supply with an emergency tempering valve to provide the unit with tempered water.	2010	\$ 7,000.00
	Water Conservation	Most of the building fixtures are large users of water, typical of the date of installation. While most fixtures are in fair to good condition some thought should be given to replacing the existing with water reducing units for environmental conservation purposes efficient - Recommend Replacement of Existing Fixtures With Environmentally Efficient Fixtures	Poor	3	Replace fixtures with more environmentally friendly (water conserving) units	2011	\$ 100,000.00
	Domestic Hot Water	Replacement water heaters of differing capacities - Maintenance Item	Generally in good operating condition	4	Replace as required under building maintenance program	Maintenance Item	\$ -
	Plumbing Piping	Copper Piping - Maintenance Item	Generally good condition. There have been two reports of pin-hole leaks within the plumbing system over the past twenty years	4	Repair and replace as necessary under the building maintenance plan	Maintenance Item	\$ -
	Drainage, Waste & Vent Piping	Original piping comprising copper and cast iron - Maintenance Item	Clearing of the system appears to be required in certain locations where blockages are occurring. Recommended that trap seal primers be installed on all floor drains.	3	Work can be carried out under the building maintenance program	Maintenance Item	\$ 15,000.00
	Roof Drainage	Original drains and piping - Replace Drains During Roof Replacement Program	Good		Within the next 5-years, when roof is replaced	2013	\$ 15,000.00
E	Site Issues	Garbage bin location - Relocation of Bins is Recommended	Present location of the garbage bins is creating problems of safety and access.	2	While not a specific violation of codes, the existing access, location and general safety issues should be reviewed to ascertain any potential hazardous conditions. Suggest that drop-off and pickup of bins be restricted to after normal working hours and that the present location be reviewed to find a more appropriate location or modifications to the existing setup.	Review early in 2010	Depending on the chosen solution, the cost of this modification could be as little as \$10,000 to as much as \$100,000

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

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

**Upgrade Telecontrol Facilities
Sandy Brook Hill**

July 2015

SUMMARY

The telecontrol facility at Sandy Brook Hill, near Grand falls-Windsor, is essential to the effective and continued communications and SCADA control of Hydro's island system. The site at Sandy Brook Hill includes a microwave shelter, which houses the communications equipment, and a back up generator and enclosure, which provides back up power to the communications equipment in the event of an electrical outage to the site.

The microwave shelter is between 35 and 40 years old and has not had a significant upgrade since it was built. The shelter is in poor condition and in order to provide continued weather protection to the communications equipment, improvements are required to the shell and foundation of the microwave shelter.

The stand-by generator is 14 years old and is at the end of its service life for a propane genset. In addition, electrical equipment has been added to this site over the past ten years and the current genset is undersized for the increased load. During a three day power outage in 2012, the genset failed, due to overloading and age. There was no interruption to communications, however, this failure caused significant difficulties in maintaining communications and SCADA control on Hydro's system.

This report outlines a project to refurbish the microwave shelter and upgrade the back up generator at the Sandy Brook Hill telecommunications site to ensure continued reliability of communications and SCADA control on Hydro's island system.

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1 INTRODUCTION

Hydro is committed to provide least cost reliable power to the residents of this Province. To ensure that Hydro has the capability to provide a reliable source of electric power to the people and industries of the Province in the most economical manner consistent with the required reliability, a secure and reliable protection and control scheme complete with supporting telecommunications infrastructure is required. The Sandy Brook Hill telecontrol site is vital in the provision of secure and reliable telecommunications.

SBH telecommunications site is located outside of Grand Falls – Winsor and provides a communications link to St. John's. This site is the hub of Hydro's communications system and is the link between Hydro's Energy Control Center (ECC) and the central, south and west facilities on the island. It also provides System Control and Data Acquisition (SCADA) control of the Newfoundland and Labrador Hydro (Hydro) system and teleprotection of the 230 kV transmission lines. This site includes a microwave shelter which houses the communications equipment and a propane back up generator with enclosure which provides back up power to the communications equipment in the event of an electrical outage to the site.

The equipment at this site transmits the operational data from the remote generating sites such as Hinds Lake and Cat Arm. Operators and technologists in the Energy Control Center (ECC) use Supervisory Control and Data Acquisition (SCADA) computer systems. This system controls many field operations remotely, such as opening and closing a breaker in a switch yard, provide generation telemetry, frequency control, water levels and all associated control information for power generation. The link to the ECC at Hydro Place also includes the day to day communication traffic at Hydro and therefore, this link is considered critical to Hydro operations. There are approximately 1,200 users of the communications system within Hydro, where the employees use telephones, email services, and video conferences in the course of fulfilling their duties.

This report outlines a project to refurbish the existing microwave shelter and install a larger back up generator that will ensure continued communication and SCADA control of the Hydro system.

2 PROJECT DESCRIPTION

This project includes the following:

- replacement of the standby generator including the generator enclosure and all the associated auxiliary equipment at SBH, and
- refurbishment of the microwave shelter at SBH including replacement of siding, insulation, doors, roofing and refurbishment of concrete foundations.

This project will be managed by Hydro employees and is anticipated to take two years due to an anticipated lead time of 18 to 20 weeks for the genset.

3 JUSTIFICATION

The microwave shelter refurbishment project is justified on the requirement to upgrade aged and deteriorated infrastructure in order for Hydro to provide safe, least-cost, reliable electrical service. A cost benefit analysis was completed to compare the cost to replace or refurbish the microwave shelter with refurbishment being the least cost and thus preferred option.

The stand-by generator replacement project is justified on the requirement to replace the old stand-by generator (genset) on site that is now at the end of its service life (will be 15 years old in 2016) for a propane genset. The current genset was originally installed in 2001 and due to the addition of extra electrical equipment at this location, the current size of the existing genset is no longer suitable. It has been proposed to replace the 7.5 kW propane genset with a 20 kW diesel model to provide reliable uninterrupted back-up power to this vital communication site.

3.1 Existing System

At Sandy Brook Hill, there is a microwave shelter and a back up propane fueled generator. Microwave buildings house communications equipment for SCADA control. The microwave shelter at Sandy Brook Hill is a hub on the communications system whereby information from Bay d’Espoir in the South, and Hinds Lake and Cat Arm in the west, is sent to Hydro Place through the system at Sandy Brook Hill, thus making Sandy Brook Hill equipment key to communications and SCADA control on the island. See Figure 1.

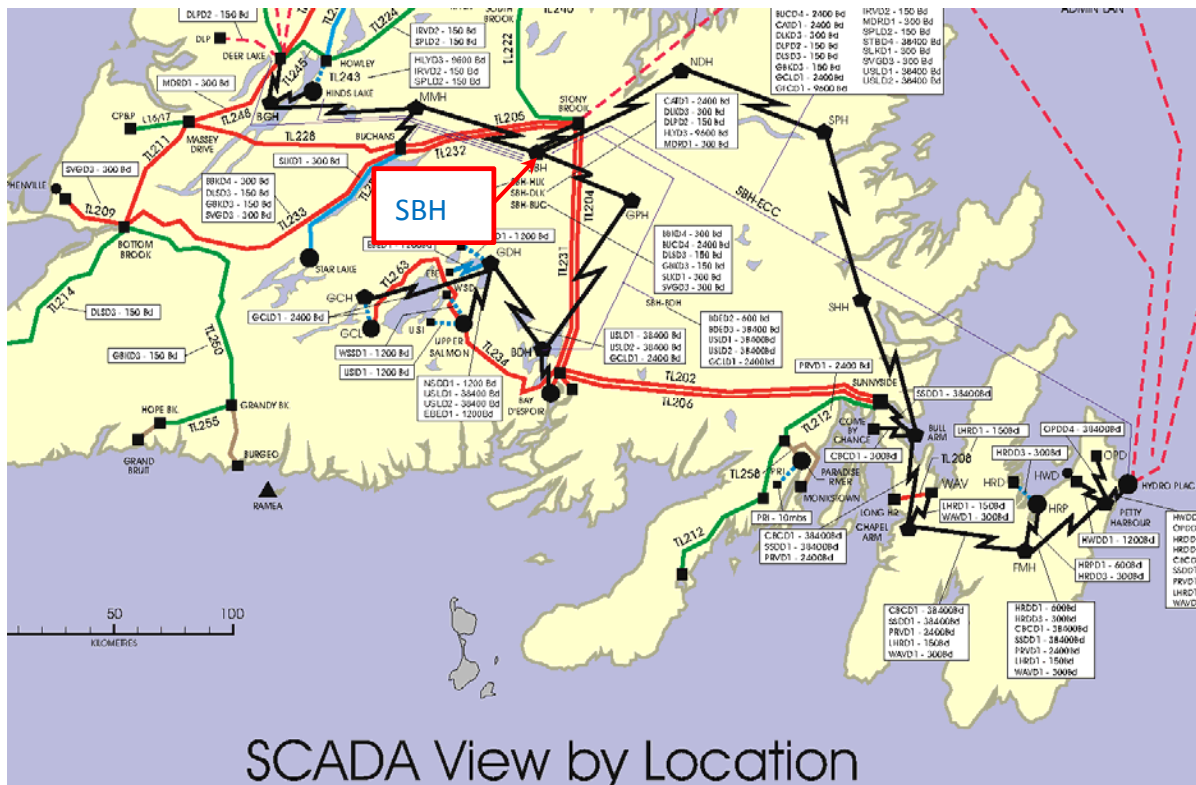


Figure 1: Portion of SCADA System Connection Map

The shelter protects this critical equipment from water, ice and wind damage which ensures uninterrupted communications with and control of system operations. As such, the shelter that houses this communications equipment is very important to the continued communications and operation of Hydro's facilities.

The microwave shelter at Sandy Brook Hill was constructed in the late 1970's. It is a timber building with metal siding, concrete foundations and metal roof with ice shield. The building is between 35 and 40 years old and has not had a significant upgrade since it was built. A condition assessment revealed cracked concrete foundations (see Figure 2) and worn siding with some corrosion present (see Figure 3). In addition, sheeting behind the siding was exposed and damaged (see Figure 4) and seals were poor around siding extrusions (see Figure 5).



Figure 2: Cracked Concrete Foundation



Figure 3: Weathered Siding



Figure 4: Exposed and Damaged Sheeting



Figure 5: Poor seals in siding and roof

To provide continued weather protection to the communications equipment, improvements are required to the shell and foundation of the microwave shelter.

Backup generation supplies power to the communications equipment in case the primary source was to fail so that critical equipment's data will not be lost, and the SCADA system remains operational. Hydro has three types of fail-safe power at SBH. Fail-safe power means that if one or two of the power sources were to fail (AC commercial and generator), there would still be power available, via the battery bank, to power the communication

equipment. The battery bank can supply 48V dc to the equipment for a minimum of 72 hours, so technologists from Hydro's telecontrol can access these remote sites so maintenance and testing can be conducted. The batteries are re-charged via the primary power or by the genset if primary power is unavailable.

The genset on site was installed in 2001 and is 14 years old. There have been no major works or upgrades on the genset or the existing enclosure since installation just regular scheduled preventative maintenance and corrective maintenance as required.

3.2 Operating Experience

The microwave shelter has performed well to date, however, deterioration of the external components, namely siding, foundations and roof, has been noted as pictured above.

These components are now 35 to 40 years old and require significant upgrades to ensure the shelter continues to resist leaking and settlement; both of which can cause damage to the equipment inside.

The typical life expectancy of metal siding is in the range of 20 years. The siding on this shelter has performed well in the past but is now at the end of its useful life with signs of corrosion and warping. The concrete foundations have large cracks which allow water to penetrate the concrete making it susceptible to freeze/thaw cycles, thus further deteriorating the concrete and affecting the structural integrity of the foundations.

Structural damage to the foundations jeopardizes the function of the internal equipment as the foundation starts to fail.

The shelter function is key to the continued operation of the communication and SCADA equipment. Water penetrating the shell of the building can cause damage to the equipment and result in an unplanned outage on the SCADA system and thus a loss of control across operations. Upgrades to the microwave shelter will minimize the probability of leaks and foundation failure, thus properly protecting the equipment and ensuring

continued SCADA functions of the system.

Over the past number of years, there have been additions to the electrical load at this site. The equipment installed supported the increase in network traffic and advances in microwave radio design. Sandy Brook Hill microwave site is unique from other sites in that it has four radio systems where other sites have a maximum of three.

During 2012, Newfoundland Power distribution to the SBH site experienced a power outage that lasted three days. There was a need to utilize the battery generator configuration as this was the only power available to the site during the outage. The genset did not perform favorably. The unit failed repeatedly due to a clogged carburetor. Once the carburetor was repaired there was a ruptured exhaust pipe that required maintenance. After these two issues were resolved, the genset would only run for a few hours before shutting down due to overheating as the genset could not handle the load required to charge the battery banks. Once power was restored to the site, the Newfoundland Power fuse on the pole blew because the batteries were extremely depleted.

The generators that are used on the East Coast of Newfoundland in the telecommunication sites have a diesel engine arrangement. Central and West Coast generators use primarily propane-fueled generators. The East Coast generators have a rated power output capacity of 25 kW, while the propane unit located at SBH is only rated for 7.5 kW. The East Coast expansion took place in 2002 and consisted of the addition of three new microwave radio repeater sites. The new radio sites were designed complete with towers, building, batteries and chargers, stand-by diesel generators and electronic equipment at Shoal Harbour Hill, Square Pond Hill, and Notre Dame Hill. These three new sites connected with the existing Sandy Brook Hill site and the Bull Arm Hill site in the eastern region, thus completing the cross-island telecommunication network.

During the past number of years the operating group that maintains these sites, Network

Services, has seen the performance of the diesel gensets to be more favorable than the propane gensets. The diesel gensets typically require less maintenance and have a longer life expectancy of 20 years compared to the 15 years of a propane unit. With the need of a larger genset at the SBH location and with the success of the diesels in the East Coast locations, it is recommended to replace the SBH genset with a diesel type genset.

3.2.1 Reliability Performance

The propane unit at the SBH location is at the end of its service life. Continued use of the existing unit will likely result in decreased reliability of this critical communications site. Considering the vital communications that are relayed through this site, the continued use of this genset beyond 2017 is not an option.

3.2.2 Maintenance or Support Arrangements

Inspections of the refurbished microwave shelter will take place on a regular basis and any associated maintenance, such as caulking repair, concrete foundation spall repair, siding and flashing repair will be scheduled accordingly. This work will be added to our preventative maintenance schedule for TRO central.

The maintenance on the genset is performed by the Bishop Falls Diesel Maintenance Department.

3.2.3 Maintenance History

Maintenance, such as caulking and door reframing, has been completed in the past.

The five-year maintenance history for the SBH genset is shown in Table 1:

Table 1: Five-Year Maintenance History

Year	Preventive Maintenance (\$000)	Corrective Maintenance (\$000)	Total Maintenance (\$ 000)
2014	0.0	0.6	0.6
2013	0.0	0.0	0.0
2012	1.9	0.1	2.0
2011	0.3	2.9	3.2
2010	0.5	0.5	1.0

3.2.4 Anticipated Useful Life

The anticipated useful life for the microwave shelter refurbished components are as follows:

- Metal siding – 15 to 20 years
- Refurbished Concrete foundations – 20 years
- Metal roof with ice shield – 15 to 20 years

A condition assessment of the building will be required in approximately 15 years to determine if there are further microwave shelter refurbishments that are necessary to extend the life of the building as a whole.

The anticipated useful life of the current propane genset is 15 years, and the expected useful life of a new diesel genset is 20 years.

3.3 Development of Alternatives

As the existing genset is propane, Hydro considered replacing it with another propane unit, however a 20 kW propane unit would be a special order significantly driving up the upfront cost of the replacement. Therefore, to align with the other locations on the East Coast and based on Hydro's experience with the diesel units, it was decided to replace with a diesel configuration and thus no other alternatives were considered viable. The diesel units in these microwave sites will be the standard going forward in the future to ensure reliable back-up power at these locations. The diesel configurations have a lower up front cost, a

five year longer life cycle with no difference in operational costs.

With respect to the shelter itself, due to the importance of the Sandy Brook Hill equipment to the Island SCADA system, continuing with the existing microwave building without refurbishment or replacement and risking damage to the equipment and unplanned communication outages due to a failing shelter was not considered a viable option.

As a result, two alternatives were considered for the microwave shelter:

1. Refurbish the shelter, and
2. Replace the shelter.

3.3.1 Refurbishment of the shelter

This option includes the following:

- replacing the existing siding with new metal siding;
- replacing the wall sheeting;
- replacing the roof membrane including the ice shield;
- replacing the window and door; and
- replacing the deteriorated above ground portion of the concrete foundations with new concrete.

This alternative does not require the equipment to be relocated which is a considerable cost savings.

Table 2 outlines the budget estimate to refurbish the microwave shelter.

Table 2: Budget Estimate for Refurbishment Option

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	36.7	50.7	0.0	87.4
Consultant	0.0	0.0	0.0	0.0
Contract Work	33.0	74.1	0.0	107.1
Other Direct Costs	1.3	7.6	0.0	8.9
Interest and Escalation	5.2	21.3	0.0	26.5
Contingency	0.0	40.7	0.0	40.7
TOTAL	76.2	194.4	0.0	270.6

3.3.2 Replace the shelter

This option includes the following:

- widen the existing yard¹, including additional grounding, fencing and yard gravel to accommodate the construction of a new building;
- construct new foundations;
- construct new building;
- relocate existing equipment to new building;
- install new pole in yard; and
- install new waveguide conduit to building.

This alternative requires equipment relocation from the existing building to the proposed new building. The relocation of communications equipment, backup power connections, new pole installation with hook up and new waveguide hook up will require multiple communications outages which is time consuming and costly.

¹ In order to minimize system communication outages, a new building would need to be constructed adjacent to the existing building. As the yard is not large enough to accommodate this new building location, the yard would need to be extended.

Table 3 outlines the budget estimate to refurbish the microwave shelter.

Table 3: Budget Estimate for Replacement Option				
Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	47.9	72.9	0.0	120.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	758.0	75.0	0.0	833.0
Other Direct Costs	8.0	7.8	0.0	15.8
Interest and Escalation	42.8	85.9	0.0	128.7
Contingency	0.0	193.9	0.0	193.9
TOTAL	856.6	435.5	0.0	1,292.1

3.4 Evaluation of Alternatives

The alternatives were compared based on least cost using capital expenditures and expected maintenance over a 30 year life expectancy.

For Hydro, the term "least-cost" refers to the lowest Cumulative Present Worth (CPW) of all capital and operating costs associated with a particular incremental supply source (or portfolio of resources) over its useful economic life, versus competing alternatives or portfolios. CPW concerns itself only with the expenditure side of the financial equation. The lower the CPW, the lower the revenue requirement for the utility and hence, the lower the electricity rates will be.

3.4.1 Economic Analysis

The least cost or CPW calculation for each of the alternatives is presented in Table 4.

Table 4: Alternative CPW Comparison

Refurbish Microwave Shelter - SBH		
Alternative Comparison <i>Cumulative Net Present Value</i> <i>To The Year</i> 2015		
Alternatives	Cumulative Net Present Value (CPW)	CPW Difference between Alternative and the Least Cost Alternative
Refurbish	422,801	0
Replace	1,260,042	837,241

As shown in Table 4, the least cost option over a 30 year life expectancy is to refurbish the microwave shelter. As a result, this alternative was selected as the preferred option and is the basis of this budget proposal and cost estimate.

4 CONCLUSION

Hydro's Telecontrol and Network Center main priority is to provide communication access to the Energy Control Center (ECC). ECC needs this communication through microwave, radio, routers, phone, and email so that they can access and control the remote sites that are in Newfoundland and Labrador. These controls may do such things as, start a generator, display alarms, view the grid voltage, KVA, current, and frequency of generation equipment.

The microwave shelter at Sandy Brook Hill houses communications equipment used for SCADA control of system operations across the island. This particular site is a hub of the communication network whereby communications with and control of Bay d'Espoir, Hinds Lake and Cat Arm as well as teleprotection of the 230 kV transmission line and phone and internet communications are routed through Sandy Brook Hill. This shelter is vital to Hydro's communications and the SCADA control grid.

To ensure this communication network is reliable and provides uninterrupted service, there are three levels of power available to the telecommunications sites at any time. This fail-safe arrangement has the direct power line from the grid, a stand-by generator, and a 72 hour battery bank. Should the distribution line fail to the system the batteries will automatically handle the load. If these batteries are required for any length of time the back-up generator will provide power to the battery chargers. Therefore to provide reliable uninterrupted communications to Hydro, the back-up genset at the SBH telecommunication site needs to be replaced.

The microwave shelter protects the equipment against damage due to rain, wind and ice, is currently between 35 and 40 years old, and is in deteriorated condition. Upgrades to the shelter are required given its deteriorated state. The siding and foundations are in poor condition and are at their end of useful life. A deteriorated shelter will result in leaking inside the shelter thus damaging some of the equipment. Damage to the equipment will cause disruption and unplanned outages in the communications grid and ultimately lost Scada control of operations.

A cost benefit analysis was completed comparing replacement and refurbishment of the microwave shelter. The status quo is not considered an option given the existing deteriorated condition of the shelter shell and the consequences of building failure to system operations. Refurbishment of the shelter was calculated to be the least cost option and has been used as the basis of this budget cost estimate.

4.1 Budget Estimate

The budget estimate for this project is shown in Table 5.

Table 5: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	0.0	0.0	0.0	0.0
Labour	58.9	82.9	0.0	141.8
Consultant	0.0	0.0	0.0	0.0
Contract Work	33.0	242.6	0.0	275.6
Other Direct Costs	2.9	9.2	0.0	12.1
Interest and Escalation	6.8	41.8	0.0	48.6
Contingency	0.0	85.9	0.0	85.9
TOTAL	101.6	462.4	0.0	564.0

4.2 Project Schedule

The anticipated project schedule to complete the proposed work is shown in Table 6.

Table 6: Project Schedule

Activity		Start Date	End Date
Planning	Commission consultants for microwave shelter	April 2016	May 2016
	Commission design/build contractor for genset	May 2016	July 2016
Design	Develop tender documents for shelter	May 2016	September 2016
	Develop design drawings for genset	August 2016	May 2017
Procurement	Tender/award construction contract for shelter	March 2017	April 2017
Construction	Construction of microwave shelter	May 2017	August 2017
	Construction of genset	July 2017	July 2017
Commissioning	Final Inspection and Acceptance	August 2017	August 2017
	Commissioning of genset and load bank	July 2017	August 2017
Closeout	Project Closeout		September 2017

Vehicles and Aerial Devices Fleet Additions

Hydro System 2016

July 2015

SUMMARY

This project provides for Vehicles and Aerial Devices Fleet Addition.

Hydro operates in many diverse locations across the Province and it is critical to the ability to provide economical and reliable electricity that employees are provided with safe and reliable equipment.

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1 INTRODUCTION

Hydro operates a fleet of vehicles comprised of approximately 200 light-duty vehicles (cars, pick-ups and vans) and 65 heavy-duty trucks (aerial devices, material handlers and boom trucks).

The vehicle fleet is strategically distributed across Hydro's operating areas throughout the Province and is utilized on a daily basis to support staff engaged in the maintenance and repair of the electrical system.

The Transportation section of Hydro maintains a close liaison with other Canadian Utilities through participation on the Canadian Utility Fleet Council and has established vehicle replacement guidelines, which consider the operating regime for the vehicles, as well as average replacement criteria used by other Canadian utilities.

This project proposes the purchase of 15 additional vehicles for various positions across the Hydro system.

2 PROJECT DESCRIPTION

This project proposes the purchase of 15 vehicles for various positions across Hydro's operating regions. Ten pickups will be allocated to Bishop's Falls, Bay d'Espoir Line Depot, Happy Valley Lines, Happy Valley Protection and Control, Rocky Harbour Lines, Woody Point Lines, Mary's Harbour Lines, Port Saunders Lines and St. Anthony Lines. Three vans will be allocated to Whitbourne and Stephenville. Two SUVs will be allocated to meter readers in Port Saunders and Springdale.

3 JUSTIFICATION

Hydro's requirements for additional fleet vehicles are as follows:

- To fill the need as a result of a larger workforce;
- To improve reliability of and reduce Operating and Maintenance costs on heavy duty vehicles;
- To improve system response and restoration times; and
- To ensure Hydro is providing safe, reliable vehicles for employees that have to drive a significant amount in the performance of their duties.

The workload at Hydro has been increasing over the last few years, which has necessitated the addition of 11 full time technical employees, seven part-time employees, and, on average, 12 line person apprentice trainees on an ongoing basis. The current complement of vehicles is unable to support the vehicle demands of the increased staff. An additional 15 vehicles are required as explained below.

- The additional Protection and Control technicians and Terminal station electricians across the system will require three new additional vehicles to provide transportation for the employees. The majority of these employees work alone, meaning they are the only one with that trade on site. They have their own unique set of tools and equipment. Increased vehicles would increase deployment efficiency and improve response times through expanded coverage.
- Most of our support vehicles are designed to carry two employees and can not be re-configured or built to carry three employees, primarily due to equipment mounted in the cab. This necessitates the need for Nine additional vehicles to transport the line crews and apprentices to their worksites. These vehicles would also be used to transport personnel to meetings or training sessions across the system and be available for use when the heavy-duty vehicles are in the garage for maintenance. The additional line support vehicles would be used to reduce use of the heavy-duty vehicles which, in turn, would reduce the fuel and maintenance costs of these vehicles.

- There is a requirement for one new pool vehicle to provide transportation for office staff in Bishop's Falls, as a result of higher demands.
- Two new vehicles are required for meter readers at the Port Saunders Office and Springdale Offices. Considering the meter reading vehicles proposed for purchase, currently, the meter readers in Port Saunders and Springdale use their personal vehicles for meter reading routes. These meter readers accumulate the highest mileage of all meter readers who use their personal vehicle for work. In 2014, the total mileage of these two areas was in excess of 45,000 kilometers. Further, the routes for these readers contain rough terrain and remote locations, such as cabin areas, exposing personal vehicles to wear and tear, and the road worthiness of the vehicles for these conditions is outside the control of Hydro.

3.1 Existing System

This project proposes the purchase of 15 vehicles for various positions across Hydro.

3.2 Operating Experience

Work vehicles are an essential requirement for employees to complete their work on an ongoing basis across the Hydro system in Central, Labrador and Northern regions.

Due to the increase in personnel positions and the requirement to respond to trouble calls and to report to work across the Hydro system, there is a requirement to add vehicles to the fleet.

3.2.1 Legislative or Regulatory Requirements

Hydro complies with requirements stipulated in the following:

- Occupational and Health Safety Regulations;
- Canadian Motor Vehicle Safety Standards;
- Environmental Protection Act ; and
- Air Pollution Control Regulations.

3.2.2 Safety Performance

The meter readers in these locations are using their personal vehicles and are accumulating the highest mileage of all meter readers who use their personal vehicle for work.

Further, Hydro can control the safety performance of the meter readers vehicles when owned by Hydro.

3.2.3 Environmental Performance

Hydro ensures that the operation of its motorized vehicles is in compliance with the NLR 39/04 Air Pollution Control Regulations, Section 16 Motorized vehicles and has an emission limit not in excess of the standards prescribed in the regulations. The regulations state NLR 39/04 Air Pollution Control Regulations:

Motorized Vehicles

- 16.** (1) A person shall not operate or permit the operation of a light-duty motorized vehicle having an emission in excess of the standards prescribed in Schedule F.
- (2) The opacity of a visible emission from a diesel fuelled heavy duty motorized vehicle, as determined by procedure SAE J1667 entitled *Snap Acceleration Smoke Test Procedure for Heavy-Duty Diesel Vehicles*, shall not exceed:
- (a) 40 percent for 1991 model vehicles and newer; and
 - (b) 55 percent for 1990 model vehicles and older.
- (3) For the purpose of ensuring that the standards prescribed in Schedule F and subsection (2) are met, according to paragraph 111(1)(p) of the Act, the minister may, by regulation, establish an emission inspection and maintenance program as a means of reducing exhaust and evaporative air contaminants.

A fuel consumption analysis is completed on all light-duty vehicles that have a fuel consumption rating to ensure that Hydro purchases fuel efficient vehicles. The fuel cost is calculated on a 55% highway/45% city fuel rating for 150,000 kms. The total cost is factored into the upfront cost of the vehicle and the tender is awarded to the lowest total cost bid.

3.2.4 Vendor Recommendations

There are no vendor recommendations in regards to this project.

3.2.5 Maintenance or Support Arrangements

The current Hydro fleet of vehicles is primarily maintained by external service garages. In-house mechanical maintenance personnel are used to maintain the specialized utility equipment such as our aerial devices, booms and heavy off-road tracked equipment.

3.2.6 Historical Information

Table 2 provides the five-year purchase history for vehicle and aerial device purchases, as well as the budgets for 2014 and 2015.

Table 2: Vehicle and Aerial Device Purchases

Vehicle and Aerial Device Purchases 2011 – 2015				
Year	Units Purchased		Budget (\$000)	Actuals (\$000)
	Vehicles	Aerial Devices		
2015 - 2016B	40	4	2,602	
2014 - 2015B	32	9	2,900	
2013	17	8	1,982	2,049
2012	30	8	2,930	2,878
2011	25	5	2,989	2,011

3.2.7 Anticipated Useful Life

The anticipated useful life for light-duty vehicles is six years and for heavy-duty vehicles it is eight years.

3.3 Forecast Customer Growth

As this project relates to the replacement of vehicle and aerial devices, there is no relevant data related to forecast customer growth.

3.4 Development of Alternatives

Procurement of these vehicles and aerial devices is the only viable option.

4 CONCLUSION

This project provides for the purchase of 15 vehicles for various positions across Hydro.

4.1 Budget Estimate

This budget estimate for this project is shown in Table 3.

Table 3: Project Budget Estimate

Project Cost:(\$ x1,000)	2016	2017	Beyond	Total
Material Supply	366.2	136.1	0.0	502.3
Labour	2.5	0.5	0.0	3.0
Consultant	0.0	0.0	0.0	0.0
Contract Work	0.0	0.0	0.0	0.0
Other Direct Costs	0.0	2.0	0.0	2.0
Interest and Escalation	13.8	8.7	0.0	22.5
Contingency	0.0	25.4	0.0	25.4
TOTAL	382.5	172.7	0.0	555.2

4.2 Project Schedule

This project is scheduled to be completed by December 31, 2017.