Q. **Reference: Response to PUB-NLH-016**

a) How many customers currently receive electrical service in Paradise River?

b) Of the customers receiving service in Paradise River, how many of the premises are primary residences and how many of the premises are seasonal residences or cottages?

c) Clarify the relationship between the Hatch assessment identified as completed in 2013 and the report dated December 18, 2009 provided in Attachment 1. Confirm whether a separate assessment was completed in 2013 and, if so, provide a copy.

A. **a)** Throughout 2026, Newfoundland and Labrador Hydro ("Hydro") provided service to 38 unique service addresses in Paradise River. Three of these service addresses had two service points at the same address, for a total of 41 unique services. A service address typically distinguishes a unique civic lot. If there are electrical services to separate buildings on the same lot, they would have the same service address but considered a unique service point.

b) Data from the 2021 Census indicates that Paradise River has a population of five. Hydro is unable to discern from billing data alone whether or not a premises is a permanent or seasonal residence.

c) The 2009 report is the original Phase II – Draft Report Diesel Plant Remediation condition assessment of ten of Hydro's diesel plants. The 2013 report is titled "Phase II Diesel Plant Remediation" and is provided as Attachment 1. As a continuation of the work completed in 2009, Hydro contracted Hatch Ltd. in October 2012 to develop remediation options with order of magnitude estimates for deficiencies at six of these ten diesel plants. The six plants were:

- Charlottetown (destroyed by fire 2019);
- Little Bay Islands (resettled and demolished in 2020);

- Makkovik (plant extension and upgrades in 2020);
- Paradise River;
- Postville (complete building envelope upgrade in 2024); and
- Ramea.

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Newfoundland and Labrador Hydro

Phase II - Draft Report

For

Diesel Plant Remediation

H342925-0000-00-124-0002
Rev. A
March 8, 2013

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Newfoundland and Labrador Hydro

Phase II - Draft Report

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Newfoundland and Labrador Hydro
Diesel Plant Remediation

Phase II - Draft Report

2013-03-08	A	Issued for Client Review	K. D'Andrea S. Hancock K. Savoury	D. French	D. French	
Date	**Rev.**	**Status**	**Prepared By**	**Checked By**	**Approved By**	**Approved By**
			HATCH			**Client**

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Executive Summary

Site	Deficiency	Remediation Options	Capital Cost
Charlottetown	Inadequate ventilation	Minimum Requirements – minimal cost fixes that will bring the ventilation system into reasonable working order, typically via repair and rearrangement of existing equipment. If existing equipment is repairable, this option will restore ventilation airflow and comfort in the building. If existing equipment is beyond repair, this option is not feasible.	$60k
		Basic Improvements – alternate/additional improvements that can be implemented to decrease heat rejection rate from the generator sets into the building and improve ventilation airflow more than the minimum requirements. The costs associated with the new equipment required in this option can be weighed against the expected benefits.	$110k
		Redesign/System Modifications – more extensive changes to the system that will bring the facility into compliance with 'best practice'. These modifications go beyond the Basic Improvements and will further decrease the heat rejection rate from the generator sets, improve ventilation airflow overall as well as in localized areas. The costs associated with these upgrades are generally higher due to the new equipment required.	$160k
Makkovik	Over the years, the siding has become damaged and weathered. There are many patches around the perimeter due to repairing the damaged areas and covering unused equipment penetrations.	Replace siding and door on north facing wall only.	$45k
		Replace siding, door and windows on half of building only.	$111k
		Replace siding, door and windows in entire building.	$195k
Paradise River	The concrete foundation supporting the wall closest to the ocean has moved outward and the wall is bowed out so it is no longer vertical. A section of the	Replace only the 9.5 m long section of exterior wall that appears to have moved and the shallow concrete footing that has cracked as well as the section of the interior concrete slab that has settled and cracked. This option provides immediate repairs to the wall and concrete footing that are in distress but does not address investigating the source of the structural problems or carrying out additional work to prevent similar problems from occurring in the future.	$325k

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Site	Deficiency	Remediation Options	Capital Cost
	concrete floor slab in this area also appears to have settled and cracked. The building envelope develops open gaps during winter primarily along the connection between the original building and the extension	Carry out more extensive repairs to the existing building including, a geotechnical investigation to determine the location and characteristics of the soil and bedrock in the vicinity of the building, replacement of the existing shallow concrete foundations with deeper concrete foundations more suitable for the Labrador climate, and replacement of the original structure with new materials in the original building footprint with the extension demolished and removed.	$595k
	Inadequate floor area. There is no washroom in plant, the existing office is small, the workshop is inadequate and there is inadequate storage. No potable water and septic services.	Construction of a new building consisting of an office, workshop, washroom and storage. Provision of potable water and septic services.	$115k (New building) $216k (water and septic services)
	Inadequate ventilation	Install ventilation.	$50k
Postville	Inadequate storage. Currently relies on small detached sheds for storage. No workshop.	Construction of a new building consisting of a workshop and storage area.	$83k
Ramea	Inadequate ventilation	Minimum Requirements – minimal cost fixes that will bring the ventilation system into reasonable working order, typically via repair and rearrangement of existing equipment. If existing equipment is repairable, this option will restore ventilation airflow and comfort in the building. If existing equipment is beyond repair, this option is not feasible.	Not Feasible
		Basic Improvements – alternate/additional improvements that can be implemented to decrease heat rejection rate from the generator sets into the building and improve ventilation airflow more than the minimum requirements. The costs	$120k

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Site	Deficiency	Remediation Options	Capital Cost
		associated with the new equipment required in this option can be weighed against the expected benefits.	
		Redesign/System Modifications – more extensive changes to the system that will bring the facility into compliance with 'best practice'. These modifications go beyond the Basic Improvements and will further decrease the heat rejection rate from the generator sets, improve ventilation airflow overall as well as in localized areas. The costs associated with these upgrades are generally higher due to the new equipment required.	$170k

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1. Introduction

In 2009 Hatch was contracted by Newfoundland and Labrador Hydro (NL Hydro) to complete a condition assessment of ten of their remotely located diesel plants located in Newfoundland and Labrador. These plants, some of which date back to rural electrification, were modified over the years to meet the increased load demand.

As a continuation to the work completed in 2009, NL Hydro contracted Hatch in October 2012 to develop remediation options with order of magnitude estimates for deficiencies at five of these ten diesel plants. The five plants are:

- Charlottetown
- Little Bay Islands
- Makkovik
- Paradise River
- Postville

In addition, NL Hydro identified a deficiency at one additional plant and requested Hatch develop remediation options with order of magnitude estimates. This additional plant is located at:

- Ramea

This work was executed in two Phases. Phase I involved preliminary information gathering and the identification of remediation options for each site. The following site visits were performed for Phase I.

- Charlottetown on November 13, 2012. Attended by Derrick French and Steve Hiscock.
- Paradise River on November 14, 2012. Attended by Derrick French, Scott Hancock and Steve Hiscock.
- Little Bay Islands on December 4, 2012. Attended by Derrick French and Elizabeth McPhail.

During the site visit to Little Bay Islands, it was determined that the structural concerns identified by Hatch in 2009 appear to have been addressed. No further action is required.

Phase II involved preliminary engineering for the development of order of magnitude estimates for these remediation options. The report details Phase II.

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2. Deficiencies

2.1 Charlottetown

The following was noted in Hatch's 2009 Condition Assessment Final Report.

- Ventilation – Temperature in plant was fairly high and uncomfortable. This plant has a two-story layout; the upstairs office, lunchroom and storage areas were all too warm [1].

This deficiency has been chosen by NL Hydro for remediation.

2.2 Makkovik

The following was noted in Hatch's 2009 Condition Assessment Final Report.

- Building envelope - Bad to fair condition [1].

This deficiency has been chosen by NL Hydro for remediation.

2.3 Paradise River

The following was noted in Hatch's 2009 Condition Assessment Final Report.

- Building envelope - Wooded structure, asbestos sheeting, cracked foundation. Ice damming is a problem due to open trusses (bad to fair condition). Recommend further structural analysis to determine adequacy of building envelope [1].
- Availability/condition of office – Office was small but generally adequate [1].
- Availability/condition of lunchroom – No lunch room at plant [1].
- Availability/condition of washroom facilities – No washroom in plant. During winter months, the nearest washroom is in the operator's house approximately ½ km away [1].
- Plant has no mechanical ventilation. Plant relies on two turbine ventilators in the roof, eave soffit venting and windows. Plant was very warm at time of visit. Office has small A/C unit installed keeping temperature at an acceptable level [1].

These deficiencies have been chosen by NL Hydro for remediation.

2.4 Postville

The following was noted in Hatch's 2009 Condition Assessment Final Report.

- Storage – Storage area in plant was extremely small. Relies on small detached sheds for most storage requirements. Storage space generally inadequate [1].

This deficiency has been chosen by NL Hydro for remediation.

2.5 Ramea

The deficiency selected by NL Hydro for remediation at Ramea is inadequate ventilation.

Ramea was not a part of the assessment completed by Hatch in 2009.

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3. Charlottetown

The Charlottetown plant is located in and serves the community of Charlottetown, on the Atlantic coast of Southern Labrador. The ventilation system at the plant was selected for remediation by NL Hydro because the plant is too warm.

3.1 Existing Conditions

Charlottetown's generator building consists of a 2-storey engine hall containing three gensets, a downstairs office and control room with a lunchroom, washroom and storage areas above. There is no insulation on the genset turbochargers, engine exhaust manifolds or exhaust ducting.

The ventilation system consists of 4 roof-mounted exhaust fans (2 old and 2 new) 2 wall-mounted fan-forced supply louvres and 2 additional passive-ventilation wall louvres. The ventilation equipment is summarized in Table 3-1, below.

Table 3-1: Charlottetown Equipment

Diesel Gensets					
Unit #	**Model #**	**Gen. (kW)**	**Exh. Dia. (m)**	**Exh. Mat.**	**Exh. Ht. (m)**
2079	Cat. 3412	725	0.254	S.S.	10.67
2087	Cat. 3406	545	0.152	S.S.	10.67
2034	Cat. 3412	330	0.203	S.S.	10.67

Exhaust Fans						
ID	**Make**	**Model**	**Cat #**	**Power (hp)**	**SP (" w.g.)**	**Q (Am^3/hr)**
EF1	Penn Ventilator	Domex	QB36	2	0.125	23,446
EF2	Penn Ventilator	Domex	QB36	2	0.125	23,446
EF3	Penn Ventilator	Domex	DX36B	3	0.125	27,135
EF4	Penn Ventilator	Domex	DX36B	3	0.125	27,135

Supply Fans						
ID	**Make**	**Model**	**Cat #**	**Power (hp)**	**SP (" w.g.)**	**Q (Am^3/hr)**
SF1	Penn Ventilator	Breezeway	BC36QS	7.5	0.125	43,212
SF2	Penn Ventilator	Breezeway	BC36QS	7.5	0.125	43,212

Louvres					
ID	**Location**	**Length (m)**	**Width (m)**	**Free (%)**	**Free (m^2)**
LV1	South side - for supply fan	1.07	1.07	60	0.7
LV2	South side - for supply fan	0.91	0.91	60	0.5
LV3	West side	0.91	1.52	60	0.8
LV4	North side	0.91	1.52	60	0.8

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Historical weather data most representative of the Charlottetown location was obtained from Environment Canada's Cartwright station. The mean daily maximum temperature in July is 18°C (considered to be summer maximum) while the mean daily minimum temperature in January is -20°C (considered to be winter minimum). Winds are most frequently from the south at an average speed of 20.2 km/h. Exposure to the harsh climate and high levels of salt in the air has been the main cause of ventilation system equipment failure at this plant.

Charlottetown's Phase I site visit was conducted on November 13, 2012. On this day, the ambient temperature was 5°C, while inside the plant, it was 30°C. It was noted that most ventilation equipment was not operable. Only one genset (Unit #2034) was running, only one exhaust fan was operating and all louvres, windows and doors were open.

A schematic of the ventilation system operation on the day of the site visit is shown below.

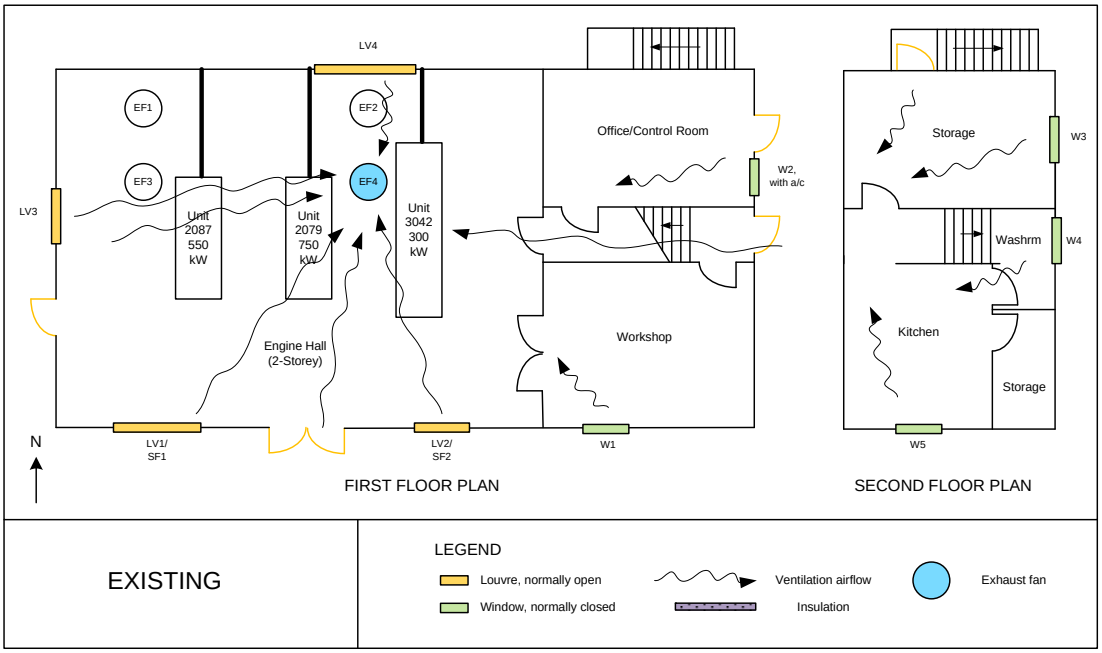


Figure 3-1: Charlottetown – Existing Ventilation System (Nov 13, 2012)

Ventilation systems must be designed to operate with all doors and windows closed in case of bad weather. When plant personnel resort to opening all doors and windows for cooling relief, the system is not functioning properly. At the time of the site visit, ventilation air flow was not adequate. If the one operating exhaust fan was running at its design flow capacity, the temperature rise would theoretically only have been 10°C and inside temperature would have been comfortable. It is likely that the exhaust fan was running below capacity. Additionally, with only this fan running, the path of fresh supply air from the open louvres, windows and doors to the exhaust point was not "sweeping" over the warmest part of the operating generator. Although some air was being exchanged in the building, the warm air was not being removed at an adequate active rate.

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Operators have seen the plant reach 50°C in the summer which is unacceptable from both an equipment and personnel standpoint.

Typically, with effective exhaust ventilation via the roof exhausters, air at the inlet to the generators will be sufficiently cool, making fan-forced supply redundant and unnecessary. It is suspected that the supply fans were added to the louvres on the front of the building in an attempt to provide spot cooling at the inlet of the generator sets because the roof exhausters were not operating correctly.

Another indication that the ventilation system is not effective is the presence of a separate air conditioning unit in the main floor office/control room. This small unit can be left as-is in any of the ventilation remediation options to provide additional spot-cooling in this area as desired.

3.2 Generator Building Ventilation Considerations

The primary aspects of a properly designed diesel generator building ventilation system are cooling air and combustion air. Cooling air is necessary to remove the heat rejected from the engine, generator and auxiliary components. Combustion air is required for the engine to burn the diesel fuel.

Poorly sized or malfunctioning ventilation systems can result in the following problems.

- High temperatures around the generator set that can lead to poor performance, overheating and subsequent shutdown as well as a decrease in service life.
- Issues with other equipment in the building that may be sensitive to high or low temperatures.
- An uncomfortable environment for personnel to perform maintenance and work in.

3.2.1 Determining Airflow Requirements

Required generator building ventilation airflow depends on the cooling air and combustion air requirements as well as the desired building temperature. Proper ventilation is also dependent on the path of the ventilation air.

3.2.1.1 Cooling Air

Cooling air is the exhaust required to convey heat out of the building and maintain the desired indoor workplace temperature rise, per the following equation.

$$V_{cool} = \frac{Q_{Total}}{C_p \Delta T d}$$

where:

V_{cool} = cooling air flowrate at STP (Nm^3/h);

Q_{Total} = total heat rejected from genset to building (kW);

C_p = specific heat of air at STP (1.006 kJ/kg/°C);

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ΔT = generator building maximum permissible temperature rise (°C);

d = density of air at STP (1.269 kg/m^3).

Q_{Total}, total heat emitted to a generator building comes from the generator and engine carcases Q_{GS}, as well as from the exhaust piping system and muffler $Q_P + Q_M$, as depicted in Figures 3-2 and 3-3 below.

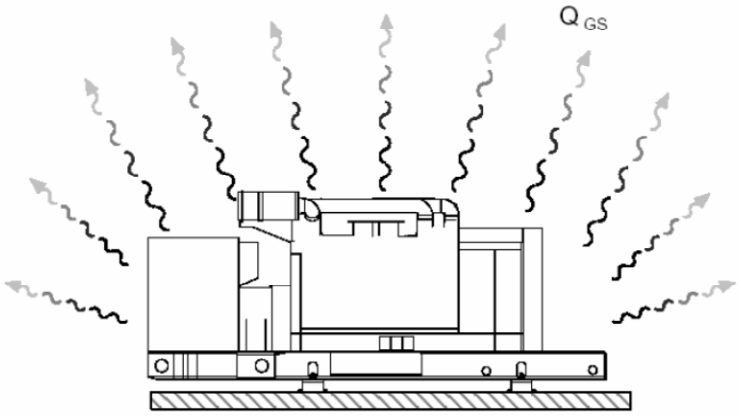


Figure 3-2: Heat Rejected from Generator Set

(Cummins Power Generation, 2011)

A conservative approximation of Q_{GS} is ~14% of engine output power rating.

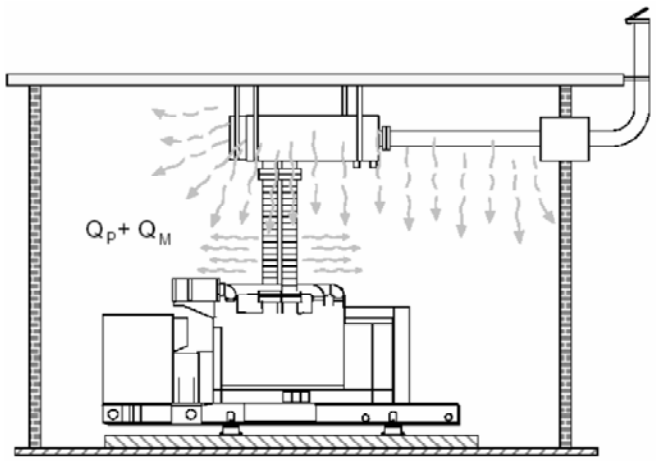


Figure 3-3: Heat Rejected from Exhaust Piping and Muffler

(Cummins Power Generation, 2011)

Approximations of Q_{GS} and Q_{GS} vary based on piping diameter. For this assessment, estimates were made using standard Cummins values.(Cummins Power Generation, 2011)

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The maximum permissible temperature rise is the difference between the maximum ambient temperature and the maximum temperature inside the generator plant. Typically, ΔT is set to no more than 10°C (lower values are better) when the engines are running. Engine de-rating can be considered when indoor temperatures reach 25°C (ISO, 2002). Building temperatures must be kept below 40°C to avoid having to de-rate the engines. It is also recommended that air temperature around engines not exceed 50°C. (Caterpillar, 2008) If this happens, engines are susceptible to shut down.

3.2.1.2 *Combustion Air*

Combustion air at the selected NL Hydro diesel plants is drawn directly from the engine room and is therefore included in ventilation system design. Approximate consumption of air for a diesel engine, V_{comb}, is:

V_{comb} = 0.1 Am^3 air/min/bkW produced**.** (Caterpillar, 2008)

3.2.1.3 *Total Ventilation Requirement*

The total ventilation air flow required, V_{total}, is the sum of cooling and combustion air.

$$V_{total} = V_{cool} + V_{comb}$$

3.2.2 *Ventilation Systems*

Ventilation air exhaust systems are designed to maintain a slight positive or slight negative pressure in the generator building, depending on application. In the case of NL Hydro's selected plants, a slight positive should be maintained. Positive pressure within the generator building creates an out draft to expel heat and odour from the building. It also prevents the ingress of dust and dirt which is preferred for engines that draw their combustion air from the engine room. The positive pressure should not normally exceed 0.2 " w.g.

Natural or passive draft ventilation is not practical in generator building ventilation due to the low building height. Adequate quantities of fresh air are best supplied by fan-assisted ventilation systems. Fans are most effective when they withdraw ventilation air from the generator building and exhaust the hot air to the atmosphere. A multiple fan system allows the most amount of control of ventilation air distribution and modulation. Fan motors should be mounted outside of the direct flow of hot air for the longest life.

3.2.2.1 *In-Leakage of Air*

Some air will naturally enter the generator building due to porosity. Opening louvres are required to achieve recommended ventilation rates and inlet velocities. Static pressure inside the generator building is obtained from the following equation:

$$SP = 1.5\left(v/4005\right)^2$$

where:

v = velocity in feet per minute (fpm);

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SP = static pressure in inches of water gauge (" w.g.)

3.2.2.2 *Routing Considerations*

Maintaining the desired maximum temperature inside the generator building is not possible without correct routing of the ventilation air. The following are recommended principles to be followed in the system design: (Caterpillar, 2008)

- Inlets and outlets shall be located such that air will flow across the entire generator set from alternator end to radiator end.
- Fresh air inlets shall draw air directly from the outdoors and are to be located as far from the generators and as low as possible.
- Ventilation air should be exhausted directly to the outdoors from the engine room at the highest point possible, preferably directly over the engine and on the downwind side of the building.
- Ventilation air inlets should be positioned so as to prevent exhaust air from being drawn into the inlets (recirculation) and to prevent pockets of stagnant air forming, especially in the vicinity of the generator combustion air inlet.
- Where possible, individual exhaust suction points can be located directly above primary heat sources to remove heat before it has a chance to mix with engine room air. This practice must also have supply air distributed around the primary sources and is impractical in NL Hydro's generator plants.
- Avoid ventilation air supply ducts that blow cool air directly toward hot engine components. This mixes the hottest building air with incoming cold air and raises the average temperature.
- For installations that draw engine combustion air from within the engine room, the coolest combustion air should be provided to the turbocharger inlets.
- Multiple engine sites will generally utilize multiple ventilation fans, dedicated to each engine.

The figure below shows an example of the preferred routing in a multi-engine plant.

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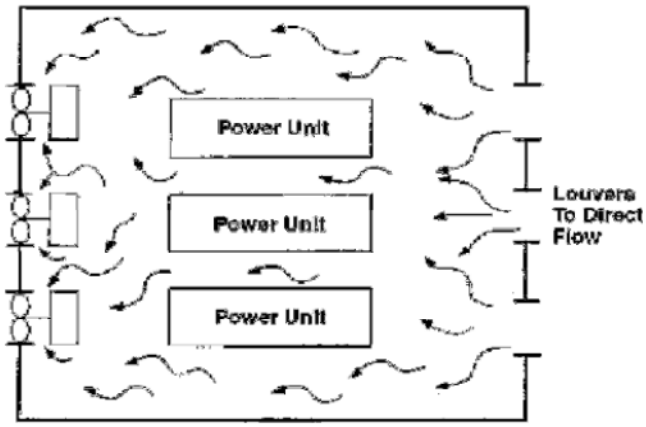


Figure 3-4: Correct Airflow Pattern in a Multi-Engine Plant

(Caterpillar, 2008)

Exhaust fans and louvres should be thermostatically controlled to allow for adequate generator combustion air and a modulating amount of cooling air to control the temperature in the building. In the hottest summer periods when all generators are operating at full load, louvres should be fully open with fans at full speed. Louvres should be open only partially and fans decreased to low speed (or turned off in facilities with multiple fans) as temperatures and operations decrease to avoid overcooling of the building.

3.2.2.3 Crankcase Ventilation

Engine crankcase ventilation systems exhaust oil-laden air into the engine room. The oil can then foul intake air filters and be deposited on other equipment, impeding operation. Use of crankcase ventilation breather traps or venting of the crankcase to the outdoors is best practice.

Additional benefits of crankcase ventilation filters include:

- cleaner ambient air; and
- reduced oil consumption when oil droplets are returned to the sump.

Ventilation breather traps, while effective, can block maintenance access and quickly plug. They will often be removed by maintenance personnel after the first filter is spent.

Vent mist eliminators on the other hand, are wall-mounted away from the generator allowing normal access and require less frequent maintenance. They are the preferred method of crankcase ventilation treatment. (Conversation with Joe VanShaick of Toromont/Cat, 2013)

3.2.2.4 Insulation Blankets

Heat radiation can be reduced by covering engine and exhaust components with high temperature insulation, preferably in the form of a removable style blanket. Insulating blankets are made of an insulating inner layer and a thermal cloth outer layer. They are typically held in place with stainless steel buttons and wire which is laced over the blankets.

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Insulation blankets can reduce heat rejection from exhaust piping systems by as much as 95%. When installed on engine exhaust manifolds, they can reduce overall generator heat rejection by around 5%. (Conversation with Paul Herman of Firwin, 2013) It is not recommended to use blankets on turbochargers as use may lead to premature failure of parts.

Additional benefits of insulating blankets include:

- low installation and tooling costs (no requirement for highly skilled technicians);
- removable and reusable for inspection and maintenance;
- modular design making for east replacement of damaged parts;
- protection of personnel from burns from hot exhaust piping; and
- noise control capabilities.

3.3 Remediation Options

Three tiers of options have been investigated with varying degrees of performance and cost impacts. They range from the minimum requirements to basic improvements to complete redesign and system modifications. Details of each option are presented below.

3.3.1 Minimum Requirements

The minimum requirements for the Charlottetown plant include:

- decommissioning of the supply fans;
- repairing the remaining existing system components; and
- addition of a window air conditioning unit in the kitchen.

A schematic of this option is shown below:

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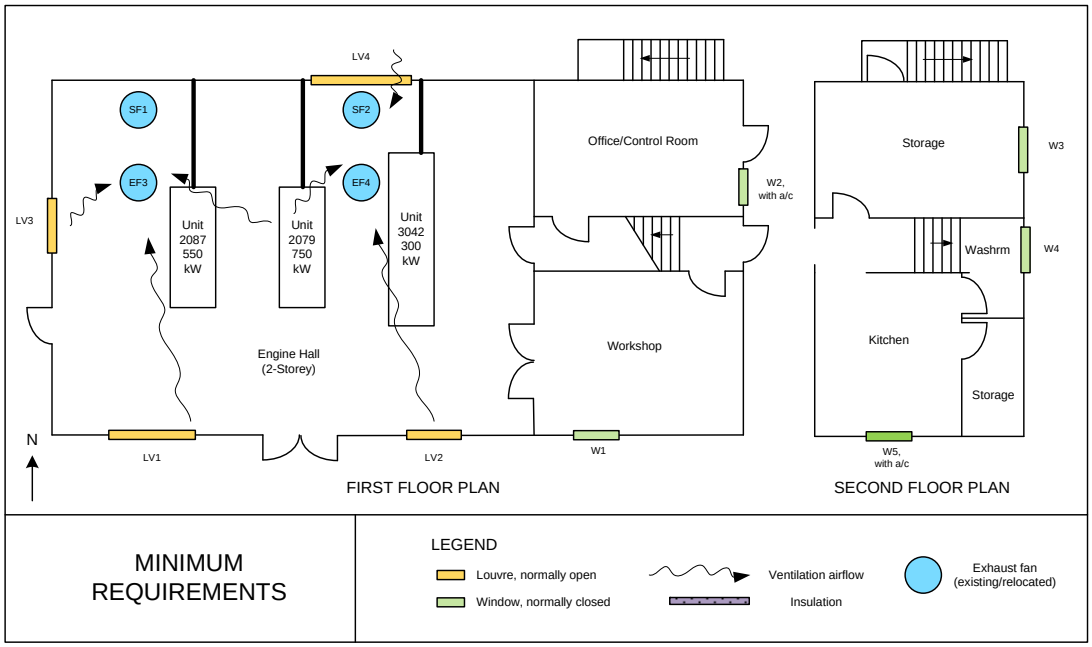


Figure 3-5: Charlottetown – Minimum Requirements Schematic

Heat rejection from all three generator sets running on full load is 493 kW without insulating the exhaust piping. This equates to a maximum ventilation requirement of 162,639 Am^3/h (154,251 Am^3/h cooling airflow and 8,388 Am^3/h combustion airflow) to achieve a temperature rise of no more than 10°C.

The capacity of the existing roof exhausters, at 101,162 Am^3/hr (0.125" w.g. static), does not meet the current ventilation requirement. All four roof exhausters operating at design would result in a maximum temperature rise of 16°C, which is likely intolerable. Alternatively, the decommissioned supply fans could be relocated to the roof in place of any of the existing roof exhausters to increase capacity. With this configuration air flow could be increased to 140,693 Am^3/hr, which would result in a maximum 12°C temperature rise. This may be acceptable for the plant.

In addition, a window air conditioner unit installed in the second level kitchen will allow for spot cooling on this level for relief in the warmest periods, regardless of operation of the generators.

Prior to committing to this refurbishment work, more information regarding the inoperable equipment is recommended (i.e., a detailed inspection of all ventilation system components and the identification of degree of repair required for each). If there are simple fixes to get equipment functioning correctly again, such as replacing fan belts, cleaning corrosion and debris, etc, this solution would be of minimal cost. If however, existing equipment is severely damaged, this option may not be practical.

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The total capital cost for minimum requirements is estimated at $60,000, with a $20,000 material cost allowance for the refurbishment work, as detailed below. If estimates for repairs exceed this amount, it is advisable to instead look at replacement options.

Table 3-2: Charlottetown – Order of Magnitude (+/- 30%) Capital Cost Estimate – Minimum Requirements

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
Air conditioner for kitchen	1	unit	1,200	1,200	300	1,500
Repair/refurbishment allowance	1	package	20,000	20,000	5,000	25,000
Mechanical Total						**26,500**
Based on 35% of Mechanical Total for Civil/Structural						9,275
Civil/Structural Total						**9,275**
Based on 10% of Mechanical Total for Electrical Equipment						2,650
Electrical Total						**2,650**
Based on 10% of Mechanical Total for Instrumentation						2,650
Instrumentation Total						**2,650**
DIRECT COST TOTAL						**41,075**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						8,000
Based on 5% of Direct Cost for other Indirects including spares and freight						2,000
INDIRECT COST TOTAL						**10,000**
			ESTIMATED TOTAL			**50,000**
			Contingency (20% of Estimate)			**10,000**
			TOTAL CAPITAL COST (+/- 30%)			**60,000**

Even with ventilation capacity increased to design requirements, no measures are currently in place to reduce heat rejection from the generator sets. Furthermore, airflow routing in the building as is it currently set up is not ideal. There are improvements that could be made to address these issues.

3.3.2 Basic Improvements

Basic improvements for the Charlottetown plant would include:

- installation of 2 new ‘corrosion resistant’, direct-drive roof exhausters in place of EF1 and EF2;
- closure of 1 supply louvre on the back wall relative to the generator sets (LV4) to improve ventilation airflow routing;
- replacement of the 2 existing south wall louvres (LV1 and LV2) with larger ones (equivalent to 1.5m x 1.5m each);
- replacement in-kind of the remaining existing louvre on the west wall (LV3), assuming it is beyond repair;
- installation of insulation blankets on the exhaust piping;

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- addition of a window air conditioning unit in the kitchen;
- installation of generator mounted crankcase breather filters to remove oil from the building atmosphere; and
- decommission the existing exhaust and supply fans and seal the existing exhaust fan roof openings.

A schematic of this option is shown below:

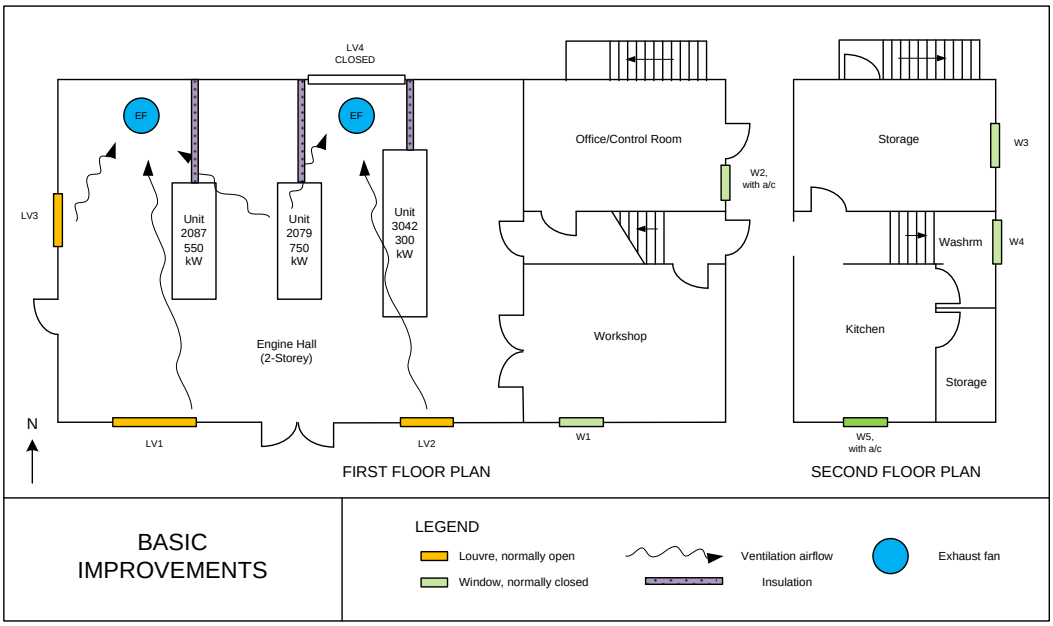


Figure 3-6: Charlottetown – Basic Improvements Schematic

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In this scenario, heat rejection from all three generator sets running on full load is 329 kW with insulation on exhaust piping, which is a 33% reduction of the heat rejection rate to the building from the existing scenario. This equates to a maximum ventilation requirement of 111,243 Am^3/h (102,855 Am^3/h cooling airflow and 8,388 Am^3/h combustion airflow).

The reduced ventilation rate could be achieved with two new direct-drive exhaust fans, each rated for 60,000 Am^3/h installed in the locations of current EF1 and EF2. Fans suitable for the harsh climate will be constructed from either stainless steel or fibreglass reinforced plastic (FRP). It is also recommended that the fans be direct-driven than belt-driven to decrease maintenance requirements. The existing ladder on the south side of the plant allows access to the roof exhausters for regular inspection and maintenance.

This solution would provide adequate ventilation to ensure no more than a 10°C temperature rise in the generator building. Air flow will improve as it would generally “sweep” from the front to rear of the generator sets, although the south side wall louvres must be replaced with larger ones and the west side wall louvre must remain to allow reasonable inlet velocities and building static pressures. Supply velocity to the building will be approximately 8 m/s which correspond to a static pressure of 0.21” w.g.

By reusing existing fan locations, it is not possible to have a dedicated exhaust point for each generator.

This option includes generator-mounted crankcase ventilation filters to prevent oil-laden vapours from condensing on walls and surrounding machinery and to improve air quality in the generator hall. It is important that these filters are replaced as required to maintain the benefits of their use.

An additional window air conditioner unit installed in the second level kitchen will allow for spot cooling on this level for relief in the warmest periods, regardless of operation of the generators and ventilation system.

The total capital cost for basic improvements is estimated at $110,000, as detailed below.

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Table 3-3: Charlottetown – Order of Magnitude (+/- 30%) Capital Cost Estimate – Basic Improvements

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
60,000 Am^3/h direct drive fan	2	unit	10,080	20,160	5,040	25,200
Exhuast piping insulating blanket	1	package	4,500	4,500	1,125	5,625
Louvre	3.62	m^2	323	1,170	293	1,463
Intake Hood	3	unit	500	1,500	375	1,875
Intake Screen	3	unit	500	1,500	375	1,875
Damper	2	unit	1,000	2,000	500	2,500
Actuator	2	unit	1,000	2,000	500	2,500
Crankcase ventilation generator-mounted filter	3	unit	500	1,500	375	1,875
Air conditioner for kitchen	1	unit	1,200	1,200	300	1,500
Mechanical Total						**44,413**
Based on 35% of Mechanical Total for Civil/Structural						15,545
Civil/Structural Total						**15,545**
Based on 10% of Mechanical Total for Electrical Equipment						4,441
Electrical Total						**4,441**
Based on 10% of Mechanical Total for Instrumentation						4,441
Instrumentation Total						**4,441**
DIRECT COST TOTAL						**68,840**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						14,000
Based on 5% of Direct Cost for other Indirects including spares and freight						3,000
INDIRECT COST TOTAL						**17,000**
			ESTIMATED TOTAL			**90,000**
			Contingency (20% of Estimate)			**20,000**
			TOTAL CAPITAL COST (+/- 30%)			**110,000**

3.3.3 Redesign and System Modifications

A complete redesign and modification of the ventilation system to optimize performance would include the following:

- installation of three new 'corrosion resistant', direct-drive roof exhausters in new locations in the engine hall;
- closure of supply louvres on the back and side walls relative to the generator sets (LV3 and LV4) to improve ventilation airflow routing;
- replacement of the two existing louvres on the south wall (LV1 and LV2) with larger ones (equivalent to 1.8 m x 1.8 m each);
- installation of insulation blankets on the exhaust piping and manifolds;
- installation of insulation on the wall between the engine hall and the 2nd-storey kitchen and storage rooms;
- addition of a window air conditioning unit in the kitchen;

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- installation of three (1 for each generator) wall-mounted crankcase mist eliminators to remove oil from the building atmosphere; and
- decommission the existing exhaust and supply fans and seal the existing exhaust fan roof openings.

A schematic of this option is shown below.

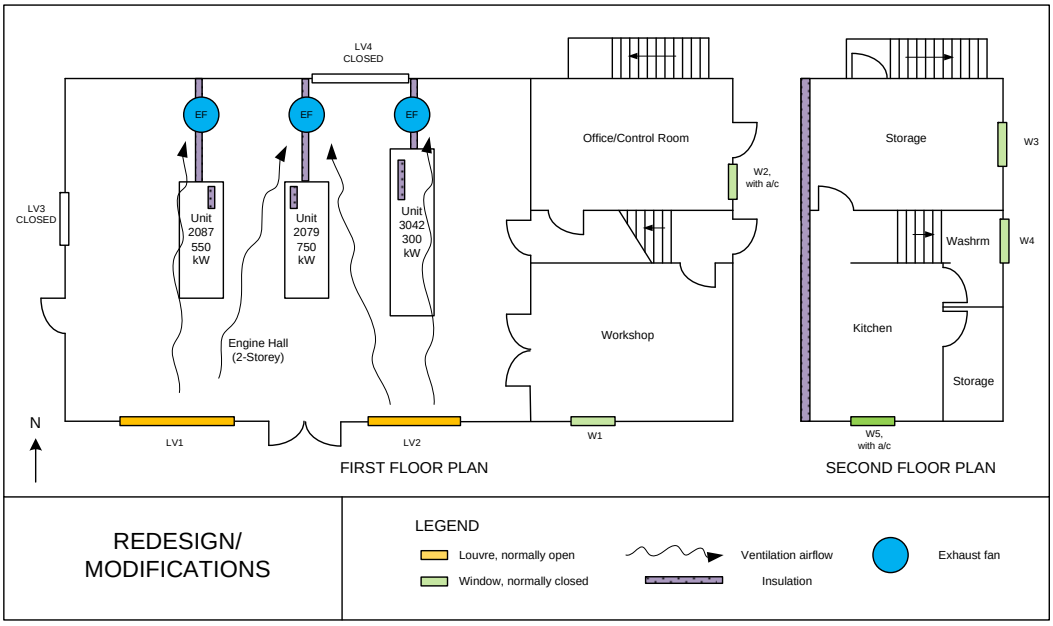


Figure 3-7: Charlottetown – Redesign/Modification Schematic

Heat rejection from all three generator sets running on full load is 313 kW with insulation on exhaust piping and manifolds which is a 37% reduction of the heat rejection rate from the existing scenario. This equates to a maximum ventilation requirement of 106,235 Am^3/h (97,847 Am^3/h cooling airflow and 8,388 Am^3/h combustion airflow).

The reduced ventilation rate could be achieved with three new direct-drive exhaust fans, each rated for 40,000 Am^3/h installed in new locations dedicated to and directly above the back end of each generator set. Fans suitable for the harsh climate will be constructed from either stainless steel or FRP. It is also recommended that the fans be direct-driven than belt-driven to decrease maintenance requirements. The existing ladder on the south side of the plant will continue to allow access to the roof exhausters for regular inspection and maintenance.

This solution would provide adequate ventilation to ensure no more than a 10°C temperature rise in the generator building. Air flow will improve as it will better “sweep” from the front to rear of the generator sets where there is a dedicated outlet point for each generator. A dedicated inlet louvre cannot be supplied for the middle generator (Unit #2079) as it is directly in front of the main doors and a louvre above these would be too high to be effective.

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Increasing the size of the inlet louvres on either side of the main doors however, allows the airflow path to cross this unit while maintaining reasonable inlet velocities and building static pressure. Supply velocity to the building will be approximately 7 m/s which correspond to a static pressure of 0.16” w.g.

This option includes wall-mounted crankcase mist eliminators for each generator. These units require less maintenance than generator-mounted filters but are more costly.

Insulating the 2nd storey interior wall shields this area from the warm, rising air in the engine hall. In addition, a window air conditioner unit and a dedicated exhaust fan in the second level kitchen permits spot cooling and removal of heat when needed, regardless of operation of the generators and the rest of the ventilation system.

The total capital cost for redesign/modifications is estimated at $160,000, as detailed below.

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Table 3-4: Charlottetown – Order of Magnitude (+/- 30%) Capital Cost Estimate – Redesign/Modifications

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
40,000 Am3/h direct drive fan	3	unit	6,720	20,160	5,040	25,200
Exhaust piping insulating blanket	3	unit	1,500	4,500	1,125	5,625
Exhaust manifold insulating blanket	3	unit	300	900	225	1,125
Louvre	4.01	m^2	400	1,605	401	2,007
Intake Hood	2	m^2	700	1,400	350	1,750
Intake Screen	2	m^2	700	1,400	350	1,750
Damper	3	unit	1,000	3,000	750	3,750
Actuator	3	unit	1,000	3,000	750	3,750
Wall Insulation	23	m^2	10	230	58	288
Crankcase ventilation wall-mounted filter	3	unit	6,000	18,000	4,500	22,500
Air conditioner for kitchen	1	unit	1,200	1,200	300	1,500
Mechanical Total						**69,244**
Based on 35% of Mechanical Total for Civil/Structural						24,235
Civil/Structural Total						**24,235**
Based on 10% of Mechanical Total for Electrical Equipment						6,924
Electrical Total						**6,924**
Based on 10% of Mechanical Total for Instrumentation						6,924
Instrumentation Total						**6,924**
DIRECT COST TOTAL						**107,329**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						21,000
Based on 5% of Direct Cost for other Indirects including spares and freight						5,000
INDIRECT COST TOTAL						**26,000**
			ESTIMATED TOTAL			**130,000**
			Contingency (20% of Estimate)			**30,000**
			TOTAL CAPITAL COST (+/- 30%)			**160,000**

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4. Makkovik

4.1 Existing Conditions

Makkovik's generator plant is a single storey building which consists of an engine hall, an office, lunchroom, washroom, workshop and storage areas above the office, lunchroom, washroom and workshop.

The building is constructed with metal siding and roofing. Over the years, the siding has become damage and weathered. Also, there are many patches around the perimeter due to repairing the damaged areas and covering unused equipment penetrations. Figure 4-1 shows an example of the damaged metal siding on the north side of the building.



Figure 4-1: Makkovik Generator Plant North End

4.2 Basis of Estimate

Replacement cost for metal siding are based unit rates from Hanscomb 2012 Yardsticks For Costing - Canadian Construction Cost Data, for St. John's, NL.

The unit costs for replacement are estimated as follows.

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Table 4-1: Siding Replacement Unit Cost

ID	Description	Unit Cost
A	Composite Siding Install Cost (from Yardsticks)	$320/m^2
B	Siding Market Price (from Yardsticks)	$93/m^2
C	Siding Install Labour Cost (A-B)	$227/m^2
D	Siding Removal (Assume 1/2 of Install Rate, i.e. C/2)	$113/m^2
E	Total Labour (C+D)	$340/m^2
F	Total Unit Cost for Siding Replacement (B+E)	$433/m^2

External door replacement cost has been estimated in the same manner as presented for the siding.

Labour has been estimated based on $75/person/hr and 10hr/person/day. Mobilization/ demobilization have been estimated at $2000/person. Living allowance/per diems has been estimated at $200/person/day. Material shipping cost has been estimated has $2000/shipping container.

A 20% allowance has been made for engineering and construction management.

A 20% contingency has been added to the total estimated cost.

4.3 Cost Estimate

Cost estimates were developed for three options:

1. Siding replacement for north wall only.
2. Siding replacement for 50% of the building.
3. Siding replacement for the entire building.

Table 4-2: Makkovik – Capital Cost Estimate – Siding Replacement (North Wall Only)

Description	Qty	Unit	$/unit	Total $
Mobilization/ De-mobilization	3	people	$2,000	$6,000
Living Allowance/Per Diems	18	person-days	$200	$3,600
Material Shipment to/from Site	1	Containers	$2,000	$2,000
Siding Replacement	38	m2	$433	$16,454
Metal Door and Hardware Replacement	1	ea	$2,023	$2,023
Total Direct				**$30,077**
Engineering and Construction Supervision			20%	$6,015
Total Indirect				**$6,015**
			Estimated Total	**$37,000**
			Contingency (20%)	**$8,000**
			Total Capital Cost	**$45,000**

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Table 4-3: Makkovik – Capital Cost Estimate – Siding Replacement (50% of the Building)

Description	Qty	Unit	$/unit	Total $
Mobilization/ De-mobilization	5	people	$2,000	$10,000
Living Allowance/Per Diems	50	person-days	$200	$10,000
Material Shipment to/from Site	2	Containers	$2,000	$4,000
Siding Replacement	98	m^2	$433	$42,434
Windows	3	ea	$1,282	$3,846
Metal Door and Hardware Replacement	3	ea	$2,023	$6,068
Total Direct				**$76,348**
Engineering and Construction Supervision			20%	$15,270
Total Indirect				**$15,270**
			Estimated Total	**$92,000**
			Contingency (20%)	**$19,000**
			Total Capital Cost	**$111,000**

Table 4-4: Makkovik – Capital Cost Estimate – Siding Replacement (Entire Building)

Description	Qty	Unit	$/unit	Total $
Mobilization/ De-mobilization	5	people	$2,000	$10,000
Living Allowance/Per Diems	100	person-days	$200	$20,000
Material Shipment to/from Site	2	Containers	$2,000	$4,000
Siding Replacement	195	m^2	$433	$84,503
Windows	8	ea	$1,282	$10,256
Metal Door and Hardware Replacement	3	ea	$2,023	$6,068
Total Direct				**$134,828**
Engineering and Construction Supervision			20%	$26,966
Total Indirect				**$26,966**
			Estimated Total	**162,000**
			Contingency (20%)	**$33,000**
			Total Capital Cost	**195,000**

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5. Paradise River

5.1 Existing Conditions

Paradise River's generator plant is a single storey building constructed in 1971 with an extension which was added some time after the original construction. The engine hall is in the original main building. There is a small storage room, workshop, and office which is located primarily in the building extension and partially within the main original building. There is no washroom in the building. In addition, there is no water or sewer service.

The original building appears to have a shallow concrete foundation supporting the exterior walls with a concrete slab on grade floor. The building extension appears to be constructed with a wooden floor on grade without a foundation wall extending below grade. The building is of wood frame construction with wooden roof trusses. It was reported that the building envelope develops open gaps during winter primarily along the connection between the original building and the extension.

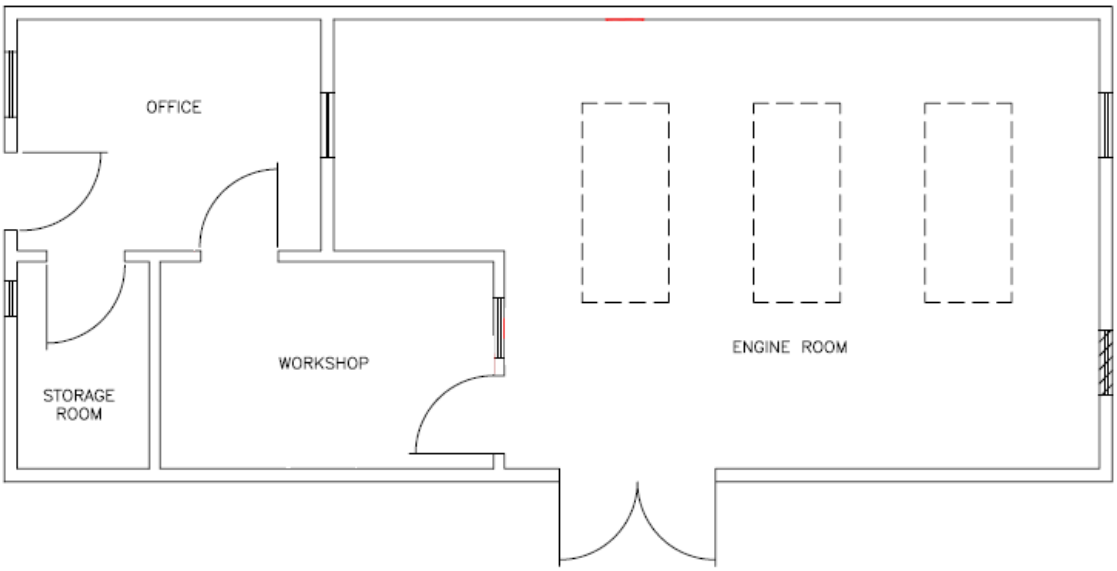


Figure 5-1: Paradise River Original Floor Layout (Extension Not Shown)

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5.2 Structural Upgrades

A structural problem was identified in the original building along the wall closest to the ocean. It appears the concrete foundation supporting this wall has moved outward and the wall is bowed out so it is no longer vertical. A section of the concrete floor slab in this area also appears to have settled and cracked. At a minimum it is necessary to support and realign this wall while replacing the sections of concrete foundation wall and floor slab.

The cause of the concrete foundation movement is unknown. The movement could be caused by frost or water flowing beneath the building or some other reason. There appears to be a quite high water table on one corner of the building and possibly some sections of the building could be constructed on bedrock while other sections are constructed on soil. A geotechnical investigation including test pits is recommended to evaluate site conditions and determine the reason for the foundation movement.

Other structural and construction related issues identified include shallow foundations likely results in frost heave during winter, different foundation types may result in differential heaving and settling throughout the year, drainage around the building may be poor, the wood trusses and wooden frame walls are more than 40 years old and may not meet current standards, a considerable amount of equipment is mounted on the wall that has the most significant structural problems, repairing one wall alone may unintentionally transfer stresses to other sections of the building, operating the diesel plant during construction may be challenging, and replacing only one section of wall and foundation while leaving the remainder of the building intact may result in significant constructability problems.

Two preliminary options were considered for upgrading structural problems within the existing building.

Option A is to replace only the 9.5 m long section of exterior wall that appears to have moved and the shallow concrete footing that has cracked as well as the section of the interior concrete slab that has settled and cracked.

Option A provides immediate repairs to the wall and concrete footing that are in distress but does not address investigating the source of the structural problems or carrying out additional work to prevent similar problems from occurring in the future.

Option B is to carry out more extensive repairs to the existing building. Option B would include a geotechnical investigation to determine the location and characteristics of the soil and bedrock in the vicinity of the building. It would include replacing the existing shallow concrete foundations with deeper concrete foundations more suitable for the Labrador climate.

It would be necessary to replace all concrete foundation walls in Option B requiring either the difficult task of temporarily supporting exterior walls and roof trusses during construction or replacing all exterior walls as well as the roof and trusses. Considering the age and possible structural deficiencies of the existing walls and roof in addition to constructability issues it was

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considered prudent to assume it would be necessary to replace the walls as well as the roof and trusses in the original building and to demolish and remove the building extension.

Under both Option A and Option B electrical wiring upgrades are assumed to be necessary for walls that are replaced. It is assumed that for both options the Owner would need to relocate and replace switchgear and other wall mounted equipment as well as provide a temporary generator to ensure construction worker safety as well as a continuous supply of electricity for customers in Paradise River during the construction period. NL Hydro should review those assumptions.

Option A only involves replacement of the distressed wall and foundation with a new wall and footing of similar construction. Option B only involves replacement of the original structure with new materials in the original building footprint with the extension demolished and removed. For both options, the deficiencies related to the lack of space, washroom facilities and ventilation are excluded from this estimate but addressed in the following sections.

5.3 Office/Control Room, Workshop, Washroom and Storage

Due to the structural deficiencies with the existing building extension, it is recommended that it be removed and additional floor area added for an office/control room, workshop, washroom and storage.

During the 2009 condition assessment, NL Hydro advised that St. Lewis is their benchmark plant. This plant has been used in a relative way to determine the additional floor area requirements for Paradise River.

As shown below, the office/control room, washroom, workshop and storage area of the St. Lewis plant is 52% of the total building floor area.

Table 5-1: Floor Area of St. Lewis Plant

St. Lewis (Benchmark)		
Description	**Floor Area (m2)**	**% of Total**
Total Building	338	100%
Engine Hall	145	43%
Kitchen	17	5%
Office/Control Room	**37**	**11%**
Washroom	**6**	**2%**
Workshop	**24**	**7%**
Storage	**109**	**32%**

The existing plant at Paradise River does not have a washroom, workshop or dedicated storage area.

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Table 5-2: Floor Area of Existing Paradise River Plant

Paradise River (Existing)		
Description	**Floor Area (m^2)**	**% of Total**
Total Building	50	100%
Engine Hall	45	90%
Office/Control Room	5	10%
Workshop	**0.0**	**0%**
Washroom	**0.0**	**0%**
Storage	**0.0**	**0%**

By adding additional floor area of 44 m^2, and utilizing the existing 5m^2 from the existing office, the office/control room, workshop, washroom and storage area will total 49 m^2 and equate to 52% of the total floor area.

Table 5-3: Floor Area of New Paradise River Plant

Paradise River (New)		
Description	**Floor Area (m2)**	**% of Total**
Total Building	94	100%
Engine Hall	45	48%
Office/Control Room, Workshop, Washroom, Storage	**49**	**52%**

5.4 Water and Sewer Services

In addition to the space required to install the new washroom facilities at the plant, the provision of water and sewer service to the plant is required. Since there are no existing town services, a new artesian well to provide the water will have to be drilled. There are two options for sewer service.

- Option 1 - Septic tank with a traditional leeching field. This option may require land acquisition due to the limited space around the existing plant.
- Option 2 - Hold tank which will be required to be pumped out on a regular basis.

5.5 Ventilation Remediation Options

The existing ventilation system consists of two turbine ventilators in the roof, soffit vents and an A/C unit in the office/control room.

Since there are various options for the structural repairs and layout upgrades for Paradise River, it is likely the repaired/upgraded plant will be quite different than the existing. Design of a ventilation system for the existing plant will likely be inadequate for a repaired/ upgraded plant. However, an estimate has been prepared using the existing generating capacity and approximate building size as a design basis.

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5.6 Cost Estimate

5.6.1 Structural Upgrades

Cost estimates are provided for both Option A and Option B.

Option A assumes a work crew averaging 5 people for 15 work days to complete the project. Option B assumes a work crew averaging 5 people for 30 work days to complete the project. Those work crews are assumed to complete all work except geotechnical investigations, engineering and supervision, and owner's cost items such as providing a temporary generator and temporary switchgear relocation if deemed necessary.

It was assumed in the estimate that sufficient workers would be available in the Labrador region to complete the work in a timely manner paying premium but reasonable wages and benefits for the semi-isolated area.

It was also assumed that materials and equipment would be supplied at premium but reasonable rates from either Cartwright, Happy Valley - Goose Bay area, southern Labrador area, or western Newfoundland. It was assumed all workers, materials, and equipment would access the site by highway or in some cases by ferry at reasonable cost.

Table 5-4: Paradise River – Structural Upgrades Capital Cost Estimate – Option A

Description	Qty	Unit	$/Unit	Total $
Mobilization/ De-mobilization	5	people	$2,000	$10,000
Living Allowance/Per Diems	75	person-days	$200	$15,000
Material Shipment to/from Site	3	Trucks	$2,000	$6,000
Demolition and Removal	1	LS	$5,000	$5,000
Wooden Frame Exterior Wall Replacement and Siding	30	m^2	$1,167	$35,000
Electrical Wiring	1	LS	$5,000	$5,000
Concrete Footing Replacement (900 mm deep)	10	m	$4,000	$40,000
Concrete Floor Slab Replacement	5	m^2	$2,000	$10,000
Temporary Generator (Owner's Cost)	1	ea	$50,000	$50,000
Temporary Switchgear Relocation (Owner's Cost)	1	ea	$50,000	$50,000
Subtotal				**$226,000**
Contingency			25%	$56,500
Subtotal				**$282,500**
Engineering and Construction Supervision			15%	$42,500
Total				**$325,000**

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Table 5-5: Paradise River – Structural Upgrades Capital Cost Estimate – Option B

Description	Qty	Unit	$/Unit	Total $
Geotechnical Investigation and Report	1	ea	$25,000	$25,000
Mobilization/ De-mobilization	5	people	$2,000	$10,000
Living Allowance/Per Diems	150	person-days	$200	$30,000
Material Shipment to/from Site	6	Trucks	$2,000	$12,000
Demolition and Removal	1	LS	$10,000	$10,000
Wooden Frame Exterior Wall Replacement and Siding	107	m^2	$463	$49,500
Concrete Footing Replacement (2400 mm deep)	30	m	$3,833	$115,000
Concrete Floor Slab Replacement	5	m^2	$2,000	$10,000
Roof and Wooden Truss Replacement	50	m^2	$500	$25,000
Electrical Wiring	1	LS	$10,000	$10,000
Windows	4	ea	$2,500	$10,000
Metal Door and Hardware Replacement	3	ea	$2,500	$7,500
Temporary Generator (Owner's Cost)	1		$50,000	$50,000
Temporary Switchgear Relocation (Owner's Cost)	1		$50,000	$50,000
Subtotal				**$414,000**
Contingency			25%	$103,500
Subtotal				**$517,500**
Engineering and Construction Supervision			15%	$77,500
Total				**$595,000**

5.6.2 *Office/Control Room, Workshop, Washroom and Storage*

For the purposes of this estimate, it has been assumed that the additional area required will be added by constructing a new standalone building. This estimate includes electrical and plumbing. A vendor quotation was obtained for supply and delivery of material for the new building.

A work crew averaging 5 people for 10 work days was assumed necessary to complete the project.

Mobilization/demobilization has been estimated at $2000/person. Living allowance/per diems has been estimated at $200/person/day.

A 20% allowance has been made for engineering and construction management.

A 20% contingency has been added to the total estimated cost.

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Table 5-6: Paradise River – Additional Floor Area Capital Cost Estimate

Description	Qty	Unit	$/unit	Total $
Mobilization/ De-mobilization	5	people	$2,000	$6,000
Living Allowance/Per Diems	50	person-days	$200	$10,000
Material Shipment to/from Site	1	Container	$2,000	$2,000
Material	1	Lot	$18,000	$24,000
Labour	44	m^2	$852	$37,500
Total Direct				**$79,500**
Engineering and Construction Supervision			20%	$15,900
Total Indirect				**$15,900**
		Estimated Total		**$96,000**
		Contingency (20%)		**$19,000**
		Total Capital Cost		**$115,000**

5.6.3 Water and Sewer Services

For the purposes of this estimate, it has been assumed that an artesian well is required to provide potable water to the plant. A vendor quotation was obtained for drilling. Vendor quotations were also obtained for septic services. Both options are estimated to be the same cost.

Table 5-7: Paradise River – Water and Sewer Services Capital Cost Estimate

Description	Qty	Unit	$/unit	Total $
Potable Water Service	1	ea	$100,000	$100,000
Septic Service	1	ea	$50,000	$50,000
Total Direct				**$150,000**
Engineering and Construction Supervision			20%	$30,000
Total Indirect				**$30,000**
		Estimated Total		**$180,000**
		Contingency (20%)		**$36,000**
		Total Capital Cost		**$216,000**

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5.6.4 *Ventilation Remediation Options*

Since there is no currently no mechanical ventilation at the plant in Paradise River, a new system design is required. The new system will include:

- Installation of two new corrosion resistant direct-drive roof exhausters.
- Installation of new louvers with approximate total intake area of 0.5 m^2.
- Installation of insulation blankets on the exhaust piping and manifolds.
- Installation of two wall-mounted crankcase mist eliminators to remove oil from the building atmosphere.
- New air conditions for the office/washroom/control room area.
- Decommission existing ventilators and seal roof openings.

The estimated costs for ventilation upgrade options at Paradise River are:

Table 5-8: Paradise River – Ventilation Capital Cost Estimate – Redesign/Modifications

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
5,000 Am^3/h direct drive fan	3	unit	840	2,520	630	3,150
Exhaust piping insulating blanket	3	unit	800	2,400	600	3,000
Exhaust manifold insulating blanket	3	unit	150	450	113	563
Louvre	0.50	m^2	400	200	50	250
Intake Hood	2	unit	500	1,000	250	1,250
Intake Screen	2	unit	500	1,000	250	1,250
Damper	3	unit	500	1,500	375	1,875
Actuator	3	unit	500	1,500	375	1,875
Crankcase ventilation wall-mounted filter	2	unit	1,000	2,000	500	2,500
Air conditioner for personnel area	1	unit	800	800	200	1,000
Mechanical Total						**16,713**
Based on 50% of Mechanical Total for Civil/Structural						8,356
Civil/Structural Total						**8,356**
Based on 10% of Mechanical Total for Electrical Equipment						1,671
Electrical Total						**1,671**
Based on 10% of Mechanical Total for Instrumentation						1,671
Instrumentation Total						**1,671**
DIRECT COST TOTAL						**28,411**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						6,000
Based on 5% of Direct Cost for other Indirects including spares and freight						1,000
INDIRECT COST TOTAL						**7,000**
			ESTIMATED TOTAL			**40,000**
			Contingency (20% of Estimate)			**10,000**
			TOTAL CAPITAL COST (+/- 30%)			**50,000**

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6. Postville

6.1 Existing Conditions

Postville's generator plant is a single storey building which consists of an engine hall, an office and a washroom. The plant currently has no workshop or dedicated storage areas.

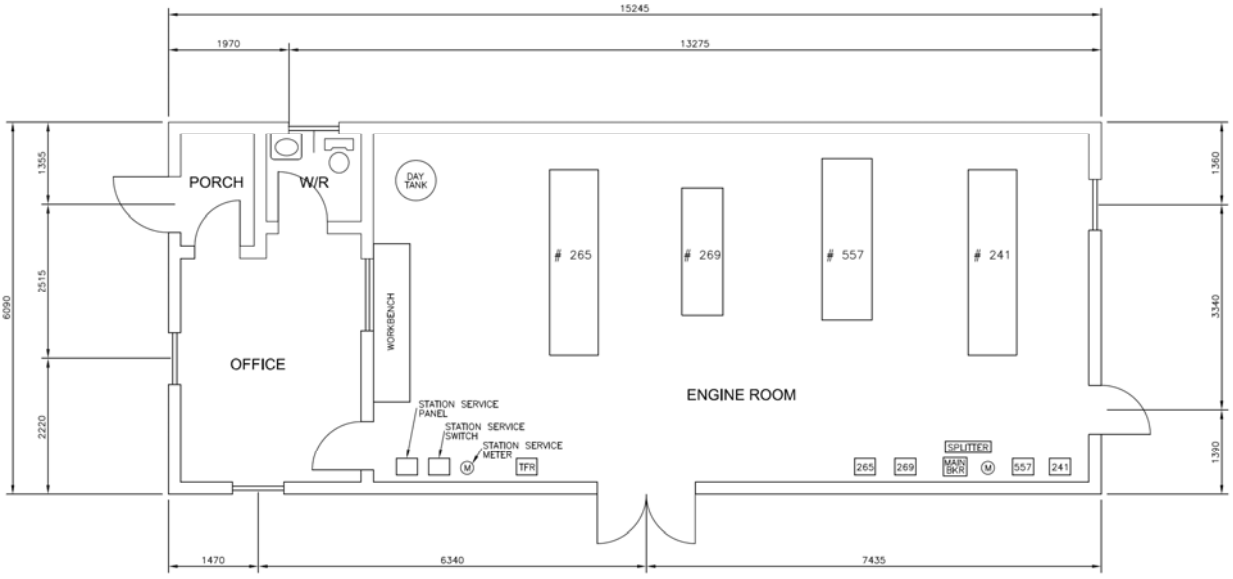


Figure 6-1: Postville Floor Layout

6.2 Basis of Estimate

During the 2009 condition assessment, NL Hydro advised that St. Lewis is their benchmark plant. This plant has been used in a relative way to determine the additional floor area requirements for Postville.

As shown below, the workshop and storage area of the St. Lewis plant is 39% of the total building floor area.

Table 6-1: Floor Area of St. Lewis Plant

St. Lewis (Benchmark)		
Description	**Floor Area (m^2)**	**% of Total**
Total Building	338	100%
Engine Hall	145	43%
Kitchen	17	5%
Office/Control Room	37	11%
Washroom	6	2%
Workshop	**24**	**7%**
Storage	**109**	**32%**

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The existing plant at Postville does not have a workshop or dedicated storage area.

Table 6-2: Floor Area of Existing Postville Plant

Postville (Existing)		
Description	**Floor Area (m^2)**	**% of Total**
Total Building	93	100%
Engine Hall	72	78%
Kitchen	0	0%
Office/Control Room	14	15%
Washroom	3	3%
Porch	4	4%
Workshop	**0**	**0%**
Storage	**0**	**0%**

An additional floor area of 60 m^2, for a total of 153 m^2 is required such that the workshop and storage area equates to 39% of the total floor area.

Table 6-3: Floor Area of Postville Plant with Added Storage

Postville (New)		
Description	**Floor Area (m^2)**	**% of Total**
Total Building (new)	153	100%
Engine Hall	72	48%
Kitchen	0	0%
Office/Control Room	14	9%
Washroom	3	2%
Porch	4	2%
Workshop and Storage	**60**	**39%**

6.3 Cost Estimate

For the purposes of this estimate, it has been assumed that the additional area required will be added by constructing a new standalone building. A vendor quotation was obtained for supply and delivery of material and labour for the new building.

Mobilization/demobilization has been estimated at $2000/person. Living allowance/per diems has been estimated at $200/person/day.

A 20% allowance has been made for engineering and construction management.

A 20% contingency has been added to the total estimated cost.

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Table 6-4: Postville – Capital Cost Estimate

Description	Qty	Unit	$/Unit	Total $
Mobilization/ De-mobilization	3	people	$2,000	$6,000
Living Allowance/Per Diems	27	person-days	$200	$5,400
Material Shipment to/from Site	1	Container	$2,000	$2,000
Material	1	Lot	$24,000	$24,000
Labour	60	m^2	$322	$19,320
Total Direct				**$56,720**
Engineering and Construction Supervision			20%	$11,344
Total Indirect				**$11,344**
		Estimated Total		**$69,000**
		Contingency (20%)		**$14,000**
		Total Capital Cost		**$83,000**

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7. Ramea

The Ramea plant is located in and serves the community of Ramea, on the Northwest Island off the south east coast of Newfoundland. Similar to Charlottetown, the ventilation system at the plant was selected for remediation by NL Hydro because the plant is too warm.

7.1 Existing Conditions

Ramea's generator building consists of a 2-storey engine hall containing three gensets which is adjacent to a downstairs workshop, switchgear room, washroom and control room with a kitchen and storage area above. There is a heat recovery unit (HRU) with supply and return air ducting serving these two levels of rooms adjacent to the engine hall. The exhaust and supply louvre for the HRU has motorized dampers. There is also an exhaust fan dedicated to the workshop.

There is no insulation on the genset turbochargers, engine exhaust manifolds or exhaust ducting and mufflers. The engine hall ventilation system consists of 2 roof-mounted exhaust fans, 2 wall-mounted fan-forced supply louvres and 3 additional passive-ventilation wall louvres. The ventilation equipment is summarized in Table 7-1 below. Equipment locations are shown in the building drawings in Appendix A.

Table 7-1: Ramea Equipment

Diesel Gensets					
Unit #	**Model #**	**Gen. (kW)**	**Exh. Dia. (m)**	**Exh. Mat.**	**Exh. Ht. (m)**
2045	Cat. 3512	925	0.254	S.S.	12.00
2046	Cat. 3512	925	0.254	S.S.	12.00
2047	Cat. 3512	925	0.254	S.S.	12.00

Exhaust Fans						
ID	**Make**	**Model**	**Cat #**	**Power (hp)**	**SP (" w.g.)**	**Q (Am^3/hr)**
EF1	unknown -assumed capacity of intake fans and louvres				0.125	43,435
EF2	unknown -assumed capacity of intake fans and louvres				0.125	43,435

Supply Fans						
ID	**Make**	**Model**	**Cat #**	**Power (hp)**	**SP (" w.g.)**	**Q (Am^3/hr)**
SF1	Penn Ventilator	Breezeway	BF30	1	0.125	16,143
SF2	Penn Ventilator	Breezeway	BF30	1	0.125	16,143

Louvres					
ID	**Location**	**Length (m)**	**Width (m)**	**Free (%)**	**Free (m^2)**
LV1	South side -for supply fan 1	1.22	1.22	60	0.9
LV2	West side -for supply fan 2	1.22	1.22	60	0.9
LV3	East side	0.91	0.91	60	0.5
LV4	South side -low	1.22	1.22	60	0.9
LV5	South side -high	0.91	0.91	60	0.5

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Historical weather data most representative of the Ramea location was obtained from Environment Canada's Port aux Basques station. The mean daily maximum temperature in August is 18°C (considered to be summer maximum) while the mean daily minimum temperature in February is -10°C (considered to be winter minimum). Winds are most frequently from the east at an average speed of 24.4 km/h. Exposure to the harsh climate and high levels of salt in the air has been the main cause of ventilation system equipment failure at this plant.

There was no Phase I site visit conducted at Ramea due to its remote location. An assessment of the ventilation system was completed using data from NL Hydro. A schematic of the current ventilation system is shown below.

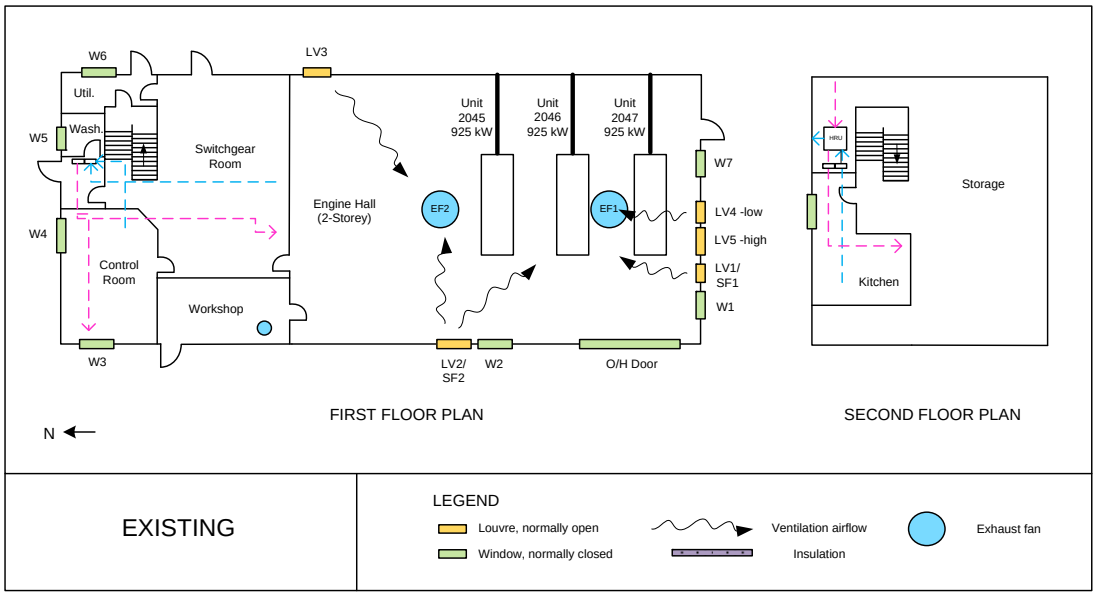


Figure 7-1: Ramea – Existing Ventilation System

Heat rejection from all 3 generator sets running on full load is 718 kW without insulating the exhaust piping/mufflers. This equates to a maximum ventilation requirement of 237,864 Am^3/h (224,742 Am^3/h cooling airflow and 13,122 Am^3/h combustion airflow) to achieve a temperature rise of no more than 10°C.

The capacity of the existing roof exhausters, at 86,869 Am^3/hr, is significantly below the current ventilation requirement. When all gensets are at full load and both roof exhausters are operating at design, the resulting maximum temperature rise would be 26°C, which is intolerable.

Additionally, air flow in the engine hall is routed from all around the generators, not in a "sweeping" motion across the units which results in unnecessary movement of air through areas where heat is not generated and inadequate movement of air across the gensets where it is needed.

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7.2 Generator Building Ventilation Considerations

Refer to Section 3.2.

7.3 Remediation Options

Three tiers of options have been investigated with varying degrees of performance and cost impacts. They range from the minimum requirements to basic improvements to complete redesign and system modifications. Details of each option are presented below.

7.3.1 Minimum Requirements

The minimum requirements for the Ramea plant would include:

- decommissioning of the supply fans;
- repairing the remaining existing system components; and
- restricting generator operation during warm ambient periods.

A schematic of this option is as per the existing system depicted in Figure 7-1.

Even with repairs to make the existing ventilation system operable, it would not meet the airflow requirements for the installed generators. Therefore, this option would only be feasible if generator operation was reduced.

Heat rejection from two generator sets running on full load is 493 kW without insulating the exhaust piping. This equates to a maximum ventilation requirement of 158,576 Am^3/h (149,828 Am^3/h cooling airflow and 8,748 Am^3/h combustion airflow) to achieve a temperature rise of no more than 10°C.

Reducing operation further to one generator set running on full load decreases heat rejection to 239 kW which corresponds to 79,288 Am^3/h (74,914 Am^3/h cooling airflow and 4,374 Am^3/h combustion airflow).

The capacity of the existing roof exhausters would meet the current ventilation requirement only if generator operation was restricted to one unit on.

It is not viable to restrict generator operation to meet ventilation requirements. Therefore improvements to the system, rather than repairs are necessary at Ramea.

7.3.2 Basic Improvements

Basic improvements for the Ramea plant would include:

- installation of 2 new ‘corrosion resistant’, direct-drive roof exhausters;
- closure of 1 supply louvre on the east/back wall relative to the generator sets (LV3) and 1 supply louvre on the second storey of the south wall (LV5) to improve ventilation airflow routing;
- replacement in-kind of the remaining existing louvres on the south and west walls (LV1, LV2 and LV4), assuming they are beyond repair;

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- replacement of the window on the west wall of the engine hall (W2) with a supply louvre (LV6);
- installation of insulation blankets on the exhaust piping and mufflers;
- installation of generator mounted crankcase breather filters to remove oil from the building atmosphere;
- addition of a window air conditioning unit in the kitchen; and
- decommission the existing exhaust and supply fans and seal the roof and wall openings.

A schematic of this option is shown below:

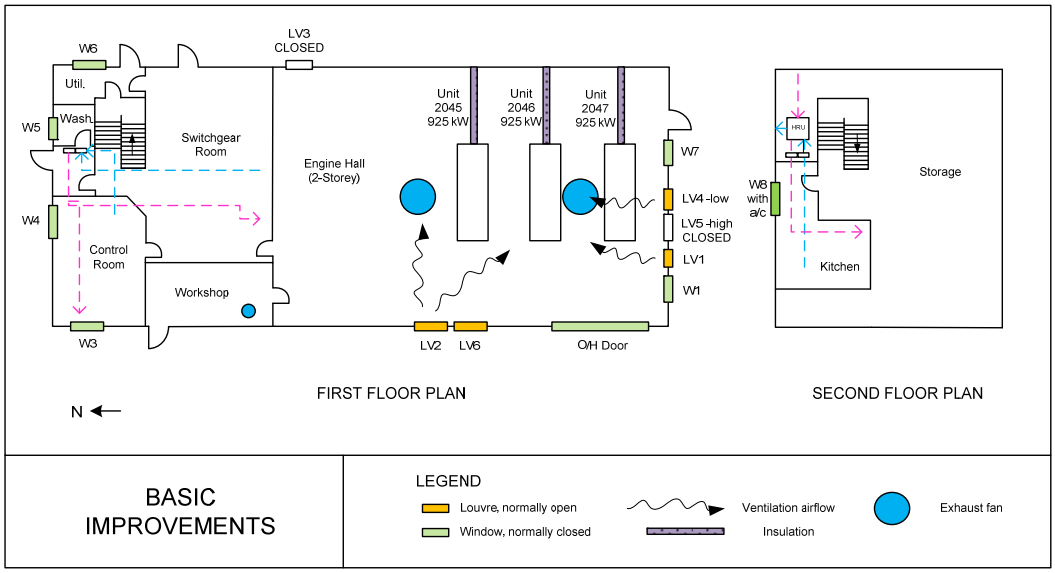


Figure 7-2: Ramea – Basic Improvements Schematic

In this scenario, heat rejection from all 3 generator sets running on full load is 355 kW with insulation on exhaust piping and mufflers, which is a 51% reduction of the heat rejection rate to the building from the existing scenario. This equates to a maximum ventilation requirement of 124,255 Am^3/h (111,133 Am^3/h cooling airflow and 13,122 Am^3/h combustion airflow).

The reduced ventilation rate could be achieved with 2 new direct-drive exhaust fans, each rated for 65,000 Am^3/h installed in the locations of the current roof exhausters. Fans suitable for the harsh climate will be constructed from either stainless steel or FRP. It is also recommended that the fans be direct-driven than belt-driven to decrease maintenance requirements. A ladder added to the exterior of the plant (similar to that at Charlottetown) would allow access to the fans for regular inspection and maintenance.

This solution would provide adequate ventilation to ensure no more than a 10°C temperature rise in the generator building. Air flow will improve as it will generally “sweep” from the front to

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rear of the generator sets, although replacement of the west side window (W2) with a supply louvre is required to allow sufficient inlet velocities and building static pressure. Supply velocity to the building will be approximately 8 m/s which correspond to a static pressure of 0.25" w.g.

This option includes generator-mounted crankcase ventilation filters to improve air quality in the generator hall. It is important that these filters are replaced as required to maintain the benefits of their use.

An additional window air conditioner unit installed in the second level kitchen will allow for spot cooling on this level for relief in the warmest periods, regardless of operation of the generators and ventilation system.

No changes will be made to HRU and associated ducting.

The total capital cost for basic improvements is estimated at $120,000, as detailed below:

Table 7-2: Ramea – Order of Magnitude (+/- 30%) Capital Cost Estimate – Basic Improvements

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
65,000 Am^3/h direct drive fan	2	unit	10,920	21,840	5,460	27,300
Exhuast piping insulating blanket	3	unit	1,821	5,464	1,366	6,831
Louvre	3.57	m^2	400	1,427	357	1,784
Intake Hood	4	unit	500	2,000	500	2,500
Intake Screen	4	unit	500	2,000	500	2,500
Damper	2	unit	1,000	2,000	500	2,500
Actuator	2	unit	1,000	2,000	500	2,500
Crankcase ventilation generator-mounted filter	3	unit	500	1,500	375	1,875
Exterior roof access ladder	1	unit	500	500	125	625
Air conditioner for kitchen	1	unit	1,200	1,200	300	1,500
Mechanical Total						**49,915**
Based on 35% of Mechanical Total for Civil/Structural						17,470
Civil/Structural Total						**17,470**
Based on 10% of Mechanical Total for Electrical Equipment						4,991
Electrical Total						**4,991**
Based on 10% of Mechanical Total for Instrumentation						4,991
Instrumentation Total						**4,991**
DIRECT COST TOTAL						**77,368**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						15,000
Based on 5% of Direct Cost for other Indirects including spares and freight						4,000
INDIRECT COST TOTAL						**19,000**
			ESTIMATED TOTAL			**100,000**
			Contingency (20% of Estimate)			**20,000**
			TOTAL CAPITAL COST (+/- 40%)			**120,000**

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7.3.3 *Redesign and System Modifications*

A complete redesign and modification of the ventilation system to optimize performance would include the following:

- installation of 3 new 'corrosion resistant', direct-drive roof exhausters in new locations in the engine hall;
- closure of 1 supply louvre on the east/back wall relative to the generator sets (LV3) and 2 supply louvres on the south wall (LV1 and LV5) to improve ventilation airflow routing;
- replacement of 1 existing louvre on the south wall (LV4) and 1 existing louvre on the west wall (LV2) with larger ones (equivalent to 1.2m x 2.4m each);
- installation of insulation blankets on the exhaust piping and mufflers;
- installation of insulation on the engine exhaust manifolds;
- installation of insulation on the wall between the engine hall and the 2nd-storey kitchen and storage rooms;
- installation of a 3 (1 for each generator) wall-mounted crankcase mist eliminators to remove oil from the building atmosphere;
- addition of a window air conditioning unit in the kitchen; and
- sealing of the existing exhaust and supply fan and 2 window roof and wall opening.

A schematic of this option is shown below:

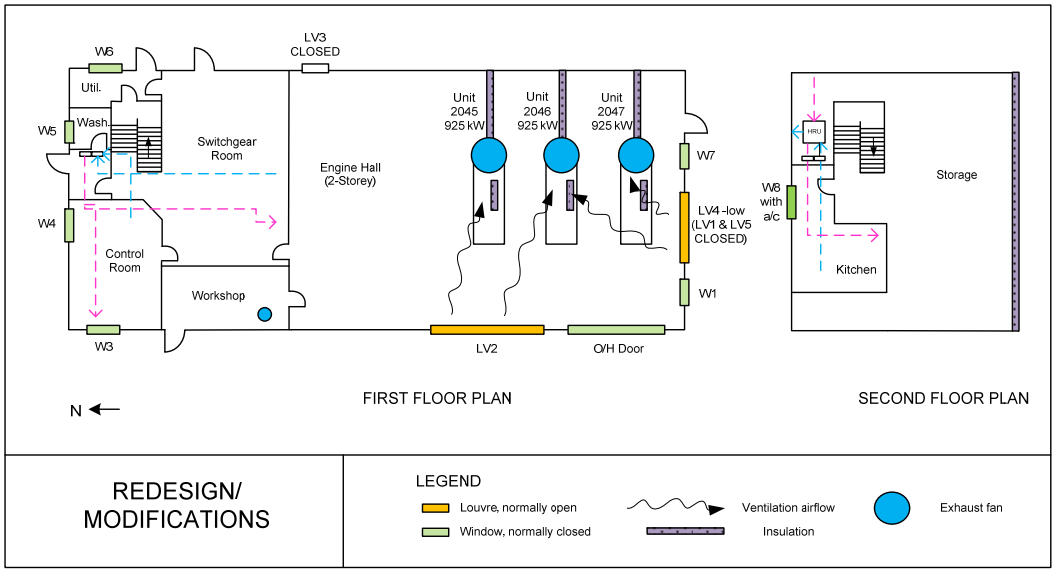


Figure 7-3: Ramea – Redesign/Modification Schematic

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Heat rejection from all 3 generator sets running on full load, is 341 kW with insulation on exhaust piping/mufflers and manifolds which is a 53% reduction of the heat rejection rate from the existing scenario. This equates to a maximum ventilation requirement of 119,845 Am^3/h (106,723 Am^3/h cooling airflow and 13,122 Am^3/h combustion airflow).

The reduced ventilation rate could be achieved with 3 new direct-drive exhaust fans, each rated for 40,000 Am^3/h installed in new locations dedicated to and directly above the back end of each generator set. Fans suitable for the harsh climate will be constructed from either stainless steel or FRP. It is also recommended that the fans be direct-driven rather than belt-driven to decrease maintenance requirements. A ladder added to the exterior of the plant (similar to that at Charlottetown) would allow access to the fans for regular inspection and maintenance.

This solution would provide adequate ventilation to ensure no more than a 10°C temperature rise in the generator building. Air flow will improve as it will better flow in a “sweeping” motion from the front to rear of the generator sets where there is a dedicated outlet point for each generator. A dedicated inlet louvre cannot be supplied for the southernmost generator (unit #2047) as it is directly in front of an overhead door and a louvre above this would be too high to be effective. Increasing the size of the inlet louvres on either side of the main doors however, allows the airflow path to cross this unit while maintaining reasonable inlet velocities and building static pressure. Supply velocity to the building will be approximately 8 m/s which correspond to a static pressure of 0.23” w.g.

This option includes wall-mounted crankcase mist eliminators for each generator. These units require less maintenance than generator-mounted filters but are more costly.

An additional window air conditioner unit installed in the second level kitchen will allow for spot cooling on this level for relief in the warmest periods, regardless of operation of the generators and ventilation system.

No changes will be made to HRU and associated ducting. However, insulating the 2nd storey interior wall shields this area from the warm, rising air in the engine hall allowing it to cool more effectively during warm periods.

The total capital cost for redesign/modifications is estimated at $170,000, as detailed below:

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Table 7-3: Ramea – Order of Magnitude (+/- 30%) Capital Cost Estimate – Redesign/Modifications

DESCRIPTION	QTY.	UNIT	MATERIAL (CAD/UNIT)	MATERIAL COST (CAD)	LABOUR (25% of Estimate) COST (CAD)	TOTAL (CAD)
Mechanical Equipment						
40,000 Am3/h direct drive fan	3	unit	6,720	20,160	5,040	25,200
Exhuast piping insulating blanket	3	unit	1,822	5,465	1,366	6,831
Exhaust manifold insulating blanket	3	unit	300	900	225	1,125
Louvre	3.57	m^2	400	1,428	357	1,785
Intake Hood	2	unit	1,000	2,000	500	2,500
Intake Screen	2	unit	1,000	2,000	500	2,500
Damper	3	unit	1,000	3,000	750	3,750
Actuator	3	unit	1,000	3,000	750	3,750
Wall Insulation	40	m^2	10	400	100	500
Crankcase ventilation wall-mounted filter	3	unit	6,000	18,000	4,500	22,500
Exterior roof access ladder	1	unit	500	500	125	625
Air conditioner for kitchen	1	unit	1,200	1,200	300	1,500
Mechanical Total						**72,566**
Based on 35% of Mechanical Total for Civil/Structural						25,398
Civil/Structural Total						**25,398**
Based on 10% of Mechanical Total for Electrical Equipment						7,257
Electrical Total						**7,257**
Based on 10% of Mechanical Total for Instrumentation						7,257
Instrumentation Total						**7,257**
DIRECT COST TOTAL						**112,477**
INDIRECT COST						
Based on 20% of Direct Cost for Engineering, Procurement and Construction Management						22,000
Based on 5% of Direct Cost for other Indirects including spares and freight						6,000
INDIRECT COST TOTAL						**28,000**
			ESTIMATED TOTAL			**140,000**
			Contingency (20% of Estimate)			**30,000**
			TOTAL CAPITAL COST (+/- 40%)			**170,000**



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