Existing Portable Diesel Generation:

Condition Assessment & Review

October 2002

Introductory Note

The following report *Existing Portable Diesel Generation: Condition Assessment and Review* addresses the condition and continued suitability of Newfoundland Power's existing portable diesel generating units. It summarizes the results of engineering studies, analyses and assessments performed by Newfoundland Power's Engineering & Energy Supply Department.

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Table of Contents

Introduction 1

Description of Portable Diesel Units 1

Condition of Portable Diesel Units 2

Environmental Hazards 2

Utilization of Portable Diesel Units 4

Remaining Service Life 6

Conclusions 7

Recommendations 7

Appendices

Appendix A: Condition Assessments of Portable Diesel Units

Appendix B: Portable Diesel Unit Data Sheets

Appendix C: Photographs of Diesel Units

Introduction

This study reviews the condition and viability of Newfoundland Power's (NP's) two portable diesel units.

Currently, Newfoundland Power has two portable diesel plants. The installed capacities of these units are 700kW and 670 kW for Portable #1 and Portable #2, respectively. The average annual generation of these two units was 35,873 kWh (1990-1999 average) and the total average annual usage (including test runs) was approximately 95 hours per year.

The 2000 condition assessment of the two diesels indicate that both are in fair to poor condition and had an estimated remaining service life of 2 years. The diesel engine models are no longer in production. Most spare parts are no longer manufactured for the units and surplus parts are limited and costly.

Description of Portable Diesel Units

Portable Diesel Units

The Portable Diesel units consist of one 700 kW and one 670 kW diesel generator package, each mounted in a self-contained high bed road trailer. These trailers come complete with all auxiliaries, controls, fuel tanks, switchgear and transformers necessary to operate the units in an emergency or backup generation role. Portable #l was purchased in 1973 and Portable #2 was purchased in 1976.

Trailers

All equipment is contained within the trailers. The trailers are of steel frame construction with sheet metal siding. The trailer chassis are both double axle units.

Turbine-Generators

Caterpillar manufactured both diesel engines. Portable #1 generator was manufactured by Tamper-Camron and is rated at 700 kW. Portable #2 generator was manufactured by Brown-Boveri and is rated at 670 kW.

Fuel Tank

In both units, the fuel tanks are located on the trailers and are relatively small in size. There is currently no secondary containment associated with either of the fuel tanks. No fuel meters are installed on either tank.

Substation

The transformer needed to step-up the generator output voltage of 347/600V to distribution voltages for each of these units is mounted on the trailer.

Condition of Portable Diesel Units

Newfoundland Power personnel undertook an inspection of all diesel units in 1996. Acres International and D.G. Champion supplemented this inspection with an assessment in 1997. The Acres report also investigated the availability of spare parts. NP personnel conducted a further condition assessment in 2000 (See Appendix A).

Portable Diesel #1 is in fair to poor condition with engine oil leaks and corroded and dirty radiators and fans. The continued use of this unit will require the installation of secondary containment for the fuel tanks onboard, fuel meter installation, an engine overhaul, a governor overhaul, and substantial repair work to the trailer chassis. These minimum repairs are estimated to cost $75,000.

Portable Diesel #2 is in fair to poor condition. The chassis is in very poor condition and is presently not roadworthy. Continued use of this unit would require the replacement of the chassis with a new unit, an overhaul of the engine, the installation of secondary fuel containment, fuel meter installation, and a governor overhaul. Minimum repairs to Portable #2 are estimated to cost in excess of $125,000.

The two portable diesel engine models are no longer in production. Most spare parts are no longer manufactured for these units and surplus parts are limited and costly. Considering the age and condition of these units, it is foreseeable that many components will require replacement in the near future. Sourcing and acquiring these parts will be more expensive than the cost of comparable parts for newer diesel units that are still in production. In addition, the manufacture of replacement parts can require long lead times. As this is unacceptable for units that are needed in a back-up generation role, a substantial investment in spare parts would be required for units having a limited remaining service life.

Environmental Hazards

The main environmental concern at each of the diesel plants in NP's system is the storage and handling of bulk diesel fuel. Both portable diesel units have fuel tanks without secondary containment for the fuel products. Temporary spill containment provisions are made while the

units are parked, but a more permanent solution is required. The fuel tank for the Portable Diesel #2 is actually hung beneath the undercarriage of the trailer unit. A puncture of this single-walled tank would leak diesel fuel directly onto the ground beneath or onto the roadway on which it is travelling. The Portable Diesel #1 fuel tank cannot be dipped due to inaccessibility and thus the fuel volumes cannot be reconciled. Such reconciliations are a requirement of environmental regulations. Both fuel tanks would have to be replaced should these units remain in service.

Neither portable diesel unit is equipped with a fuel flow meter. Current engineering standards require the installation of a fuel meter for each unit.

The decommissioning of the two existing portable diesel units may also result in some minor environmental costs. These costs should not be substantial as these units are portable and as such no subsurface contamination is anticipated. All asbestos products have been removed from these units in recent years. The decommissioning costs are estimated below for each of the two portable units.

Portable Diesel #1 Decommissioning Cost Assumptions

Environmental Cost	$10,000
Decommissioning Cost	$15,000
Salvage Value	($10,000)
Decommissioning Estimate	**$15,000**

Portable Diesel #2 Decommissioning Cost Assumptions

Environmental Cost	$10,000
Decommissioning Cost	$15,000
Salvage Value	($10,000)
Decommissioning Estimate	**$15,000**

Utilization of Portable Diesel Units

Emergency Back Up

In recent years the portable diesel plants owned by NP have been used mainly in an emergency back-up generation role. Table A shows the Operating Hour Meter readings for each of the diesel plants from 1991 and then again in 2000.

Table A

Diesel Plant	Meter Readings 1991 (hours)	2000 (hours)	Hours per Year (hours/year)	Plant Age (years)	Lifetime Average (hours/year)
Portable Diesel #1	4341	4824	53.7	28	172.3
Portable Diesel #2	2028	2401	41.4	25	96.0

The usage of the two diesel portable generation units for the years 1999 - 2000 is shown in table B.

Table B

	1999	2000	2001
Diesel Unit No. 1			
Number of Times in Operation	14	11	7
Annual Operating Hours	49.5	31.5	12.0
Annual Production (kWh)	28,180	19,460	6,550
Diesel Unit No. 2			
Number of Times in Operation	11	11	6
Annual Operating Hours	47.5	31.0	10.5
Annual Production (kWh)	24,090	15,870	5,680

The tables show that the portable generators have not been used frequently.

One important reason for the limited utilization of the existing portable generating units is their age and condition. The controls for these units are outdated and the transport chassis are in poor condition. In addition, the diesel generating units themselves are no longer manufactured and therefore parts for these units are difficult or impossible to source. These factors make the existing portable diesel units no longer suitable as emergency portable generators. Replacement of these units with more modern equipment will ensure their reliability for emergency applications and will facilitate their timely relocation when needed.

A second reason for the limited utilization of the portable diesel units is that the combined capacity of the two existing portable diesels is less than 1400kW under ideal conditions. Peak loads on many of NP's rural feeders fall within the range of 2 to 5 MW. The acquisition of 5 MW of portable generation would permit the deployment of this generation to the majority of NP's rural feeders under most loading conditions.

A final reason for the lack of deployment of the existing portable units is their criticality to customers on the southwest coast of the island. The three portable units owned by NP have been stationed in Port Aux Basques for many years and serve as back-up generation for the long radial transmission line which serves the 4 substations in this area (TL214/215). As a result, the portable units are not readily available from November to April. For this reason, operations staff in other parts of the island has been hesitant to include portable generation in their work plans. As more permanent reliability improvements become available to customers served by these lines, the portable units will be more readily available for back-up generation throughout NP's system.

Ancillary Construction Benefits

In addition to their utility as emergency back-up generators, portable diesel units can also be used in providing greater flexibility in completing transmission and distribution line construction. Portable units can be employed at the end of radial transmission or distribution lines to back-feed customers supplied by the lines being maintained or rebuilt. The availability of portable generation effectively reduces distribution and transmission construction costs by allowing work to be done more productively and safely on de-energized lines rather than on energized lines. In some cases, the outages to customers needed to complete line work may also be reduced or eliminated.

The cost of hot-line work is estimated to be approximately 2 times that of similar work under de-energized conditions. Portable generating unit(s) can be utilized to reduce these costs premiums. De-energized line work has safety benefits which cannot be easily quantified but should certainly be considered as a significant intangible benefit of the use of portable generation in appropriate construction circumstances.

Due to the age and condition of the existing portable generating units, their capability for use in construction is very limited.

Remaining Service Life

The 2000 condition assessment included an assessment of the remaining service. The estimate of a unit's remaining service life depends on how the plant was operated over its lifetime. Most fossil fuel plants were originally designed as base load units and were intended to run steadily with as few starts, stops and cycling as possible. As this mode of operation changes, the increased stops, starts and load swings may cause major components to become more susceptible to failure through fatigue or creep. Typically, NP operated diesel units have been operated infrequently with long down periods between starts. This can substantially shorten diesel engine life.

NP's Portable diesels #1 and #2 are high-speed units, which under typical operating conditions have 15-year lives.

Factors taken into account in determining the remaining service life of each generating unit were as follows:

- total hours run
- expected operating conditions
- availability of spare parts
- operating and maintenance history
- degree of operator supervision

The expected remaining service life for NP's portable generating units as determined in 2000 is summarized in Table C below.

Table C

Plant	*Nameplate Capacity (kW)*	*Lifetime Operation To Date (hours)*	*Remaining Service Life (Years)*
Portable Diesel # 1	700	4,824	2
Portable Diesel # 2	670	2,401	2

Conclusions

1. NP's two portable diesel-generating units require significant investment to continue operating. This includes new fuel tanks and fuel flow meters, a new chassis for Portable #2 and engine and governor overhauls for both units.

2. Continued use of the existing portable diesels in an emergency back-up generation role is not recommended due to the difficulty in acquiring spare parts for these older units.

3. Portable generating units permit improved customer service during sleet storms or similar events by restoring power quickly to areas fed by long radial transmission or distribution lines. Use of the existing portable diesels in this role is severely restricted by the 1400kW capacity of both units together. This limits the number of feeders and the loading conditions under which these units can be employed.

4. Portable generating units can reduce the cost of certain transmission and distribution line maintenance and reconstruction projects by allowing work that would otherwise need to be completed using hot-line methods, to be conducted on de-energized lines. The condition of the two existing portable diesels limits the utility of these units in this role.

Recommendations

It is recommended that both of NP's Portable Diesel units be decommissioned. It is further recommended that the existing portable diesel generating units be replaced with new portable generation.

Appendix A

Condition Assessments of Portable Diesel Units

PORTABLE DIESEL UNITS

Plant: **Portable Diesel Units #l & #2**

Inspected by: K. Nicholson
Date: 2000-02-10

Location: **Grand Bay Substation**
Port-aux-Basques

Description: The units consist of diesel generator sets each mounted in a self contained high bed road trailer. Each trailer includes all auxiliaries such as fuel tank, switchgear and transformers. Unit #l is rated at 700 kW and Unit #2, 670 kW.

Specifications: See Technical Data Sheet in Appendix B1.

Date Commissioned: Unit #1: 1973
Unit #2: 1976

Metered Operating Hours: Unit #1: 4,824 hours
Unit #2: 2,401 hours

Recent Operating Pattern:

Year	Generation (kWh)	
	Unit #l	Unit #2
1990	33,830	13,000
1991	0	0
1992	23,080	410
1993	22,610	17,900
1994	26,120	19,660
1995	15,280	12,700
1996	25,410	21,290
1997	27,940	23,230
1998	14,000	10,000
1999	28,180	24,090
Average	21,645	14,228

Operation For Reliability Check: - Cranked weekly.
- Started monthly, synchronized and run on load for 1 hour.

General Condition:
Both generating units are in fair to poor condition. The mufflers are heavily corroded, oil leaks exist on both engines. Radiators and fans are dirty and corroded. Trailer chassis on Unit #2 is extremely corroded and is no longer road worthy. Unit #2 is also fairly difficult to start at times and local operators sometimes use Quick Start (Ether) to start the unit. Both diesel units have numerous environmental issues such as lack of secondary containment for fuel tanks, and no fuel meters for reconciling fuel volumes.

Recent Maintenance:

1999
- Batteries replaced on both Portable Diesels from old batteries from Port-aux-Basques Main Plant diesel units.

1998
- All friable asbestos were removed from the diesel unit with the muffler and exhaust system insulation having been removed and replaced with non-ACM.

1995
- Exhaust manifold guards installed.
- Intake louvre doors installed on Unit #2.
- HV transformer bushings and lightening arresters replaced on Unit #2.
- Unit #2 transformer and deck painted.
- Annual tire, brake and light inspection.

1994
- Unit #2 fuel tank refurbished.

1993

- Complete engine oil changes on both engines (Unit #l - 4489 hrs, Unit #2 – 2088 hrs)
- Unit #l batteries replaced.

1992

- Unit #2 batteries replaced.
- Unit #l governor overhauled.
- Unit #l chassis underwent minor repairs and painting.
- Unit #2 chassis underwent temporary structural repairs.

Required Maintenance:

Unit #l
- Engine overhaul including oil leak repair.
- Reverse power relay repair.
- Annual tire, brake and light inspection.
- New battery charger required.
- Chassis minor painting and repairs.
- Generator, radiator and fan cleaning and repairs.
- Oil change required.
- Governor overhaul required.
- New fuel tank.
- Installation of tow fuel meters required and tank dipping accommodations.

Unit #2

- Engine overhaul including oil leak repair.
- Automatic voltage regulator repair.
- Underfrequency relay not operational.
- Governor overhaul.
- Repairs / Modifications to starting system.
- Chassis replacement.
- Installation of tow fuel meters and tank dipping accommodations required.
- Generator, radiator and fan cleaning and repairs.
- Unit to fence grounding.
- Oil change required.
- New fuel tank.

Required Inspections:

- Annual fire extinguisher inspection.

Spare Parts:

- Engines are older vintage Caterpillar and some trouble have been experienced obtaining spare parts.
- Other components are easily repaired or replaced.

Environmental Restraints: None

Remaining Service Life: Unit #1: 2 years
Unit #2: 2 years

Factors Affecting Service Life:

1 . Low usage of plants.
2. High level of maintenance required on components susceptible to corrosion damage. Chassis on Unit #2 major concern.
3. Spare parts availability.
4. Implementation of preventative maintenance program.

Appendix B

Portable Plant Unit Data Sheets

Appendix B

Portable Diesel Units – Data Sheet

	Unit 1	**Unit 2**
Engine Manufacturer	Caterpillar	Caterpillar
Model	D-349	D-349
Serial No.	61P476	61P809
Rating (HP)	980	980
rpm	1,800	1,800
Generator Manufacturer	Tamper Camron	Brown Boveri
Model	SG-1473	715
Serial No.	363-088-101	C-360-690-601
kW	700	670
rpm	1,800	1,800
Volts	347 / 600	347 / 600
Phases	3	3
Cycles (Hz)	60	60
Power Factor	0.85	0.85

Appendix C

Photographs of Diesel Units

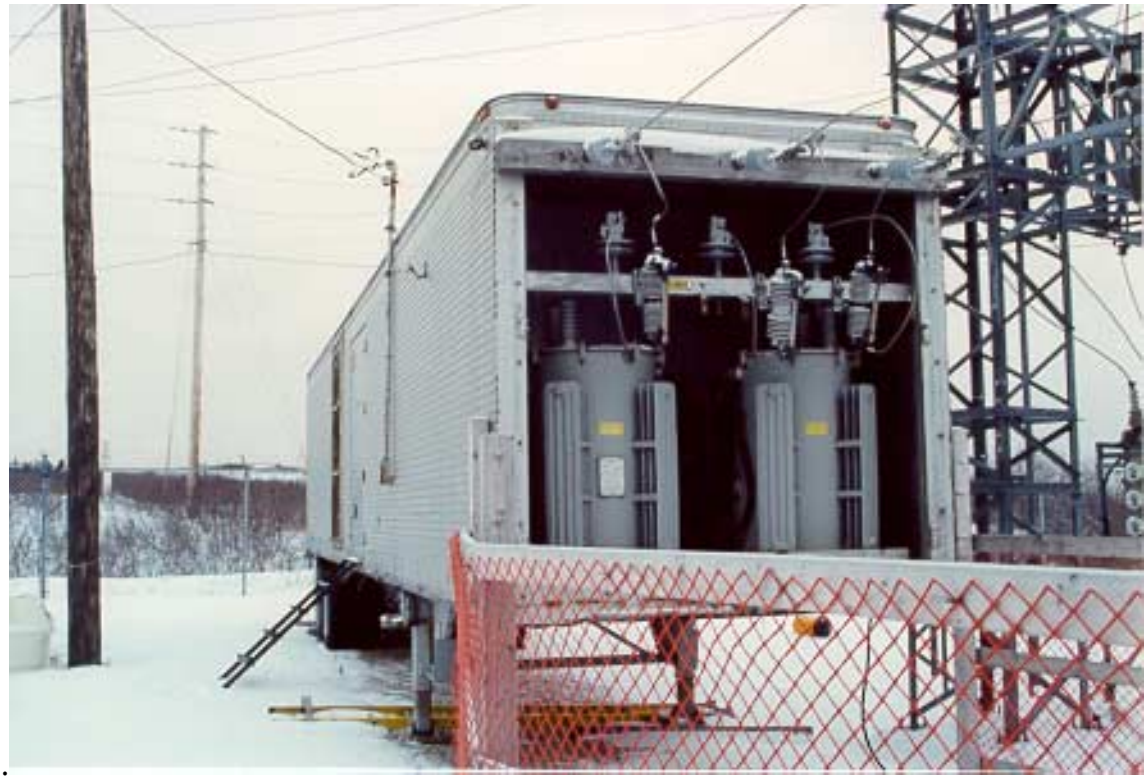

Photo 1 View of Portable Diesel #1 unit with trailer unit and transformers.

Photo 2 View of the 700 kW Portable Diesel #1 manufactured by Caterpillar.

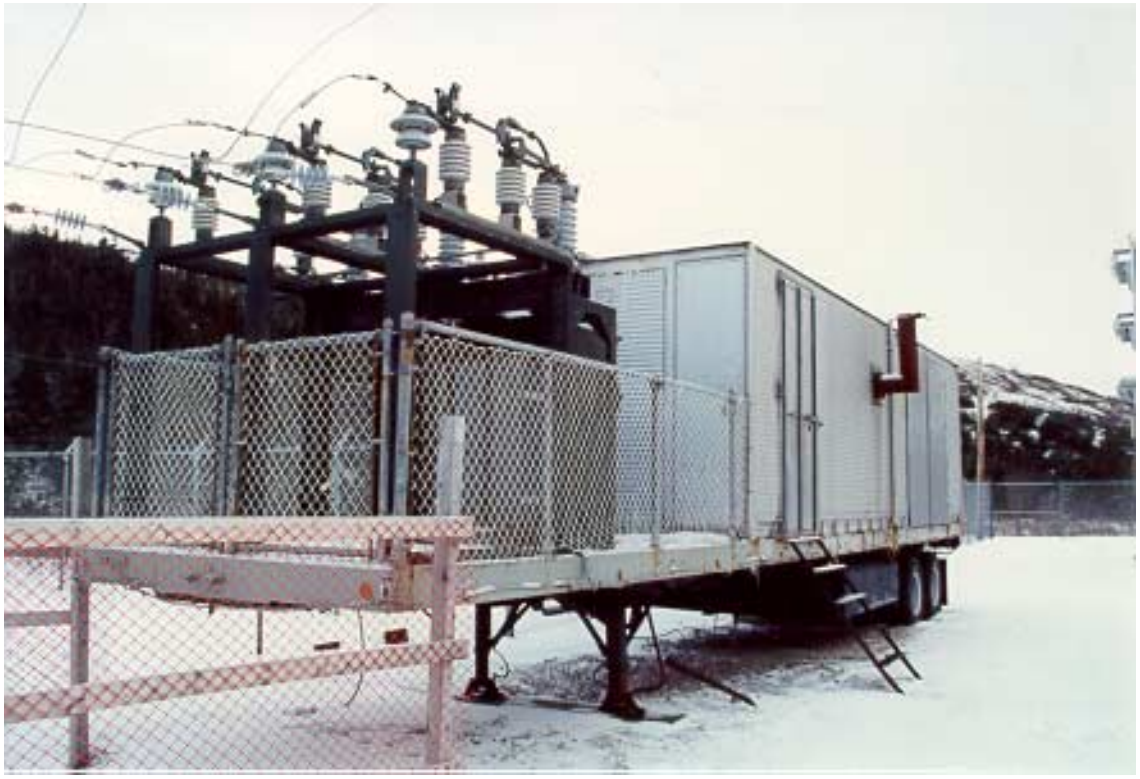

Photo 3 View of Portable Diesel #2 unit with trailer unit and transformer.

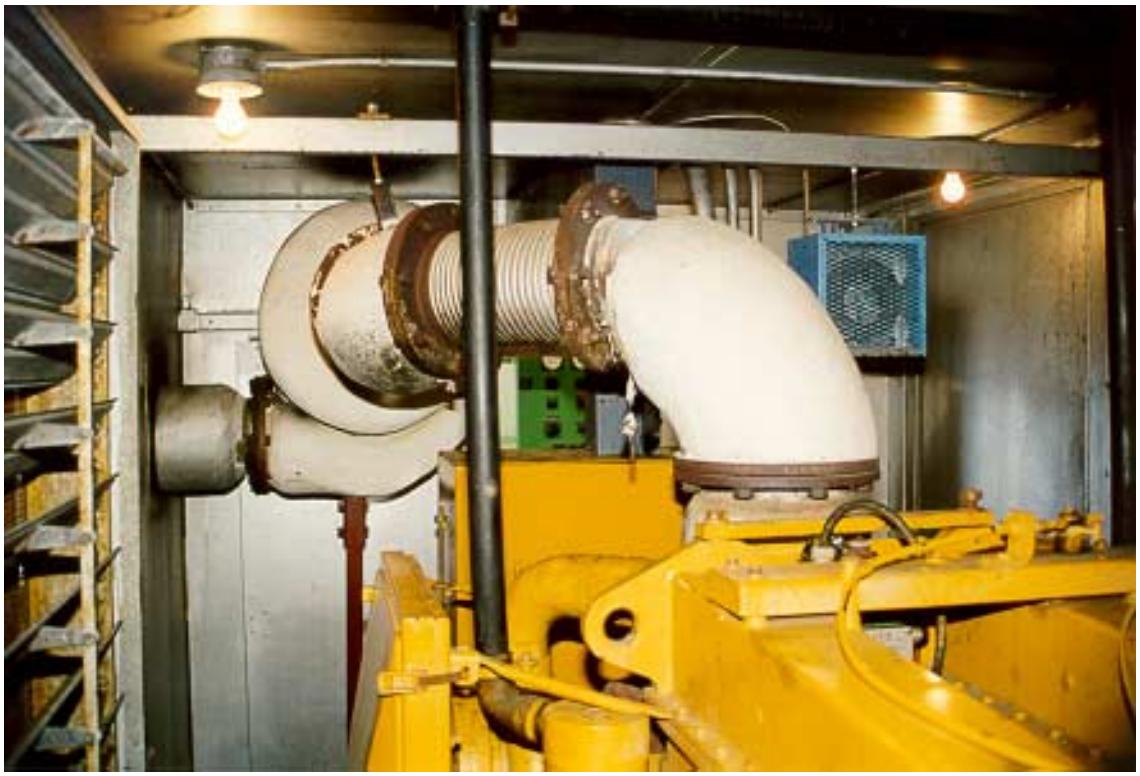

Photo 4 View of the 670 kW Portable Diesel #2 manufactured by Caterpillar.