Q. [Decommissioning] – Please identify each generating unit and/or station that the Company is aware of that has been dismantled. For each such unit provide the owner, location of the unit, the year demolished and the related gross and net costs. Further, provide all documents relating to each dismantlement in the Company's possession.

A. The Company does not have the information requested for generating units and/or stations owned by others. The Company does have the information requested for its own generating units and/or stations dismantled in recent years.

Table 1 includes the location, year retired, decommissioning cost and any salvage received for the generating units retired since 1998.

Table 1
Decommissioned Diesel Generators
($)

Location	Year Retired	Decommissioning Cost	Salvage
Aguathuna Diesel Plant	1998	67,895	18,400
Gander Diesel Plant	1998	476,299	0
Port aux Basques Diesel Plant	2000	54,231	0
Salt Pond Diesel Plant	1998	271,781	0
St. John's Diesel Plant	2005	197,208	0
St. John's Steam Plant	2000	902,055	0

Attachment A includes the report titled *Diesel Power Plant Review 1997*.

Attachment B includes the report *St. John's Diesel Plant August 2003*.

Diesel Power Plant Review
1997

Diesel Power Plant Review

CA-17 (n)
Attachment C

July 1997

NEWFOUNDLAND POWER
A FORTIS COMPANY

NEWFOUNDLAND POWER

DIESEL POWER PLANT REVIEW

JULY, 1997

EXECUTIVE SUMMARY

The purpose of the study was to determine the condition, necessary maintenance and future requirement for Newfoundland Power's diesel generating plants. There are eight plants comprised of 8 slow speed and 10 high speed diesel generator sets which were installed between 1945 and 1976. The total nameplate capacity is 14,229 Kw and the average annual generation is 206,068 Kwh. Operating restrictions and unit problems have reduced the total actual available capacity to 12,295 Kw. The plants have been used very little in the past few years for peaking and emergency service. With the exception of the facilities at Port Aux Basques, the average annual operation amounts to 5.1 hours per year most of which represents test runs. The Port Aux Basques units average more operation at 29.5 hours annually due to outages on the long radial transmission line servicing the area.

An initial review was performed by Newfoundland Power (NP) engineering. It was recognized that NP's experience with diesel generation is limited due to retirement of personnel over the years. Outside consultants, Acres International in conjunction with D.G. Champion, were retained to provide an independent, experienced assessment of the facilities.

The assessments identified many issues requiring attention. The most notable of these issues are;

Salt Pond

Engine overhauls required. Controls are obsolete. Fuel day tanks vented inside the building and lack appropriate safety devices. Floor trenches require fire suppression system. Unit # 3 removed from service due to possibility of crankshaft failure. Parts no longer readily available.

Aguathuna

Engine overhaul required. Instrumentation inadequate. Asbestos on engine in poor condition. Governor overspeed safety inoperative. Parts no longer available for engine.

St. John's

Engine overhaul required. Instrumentation inadequate. Fuel tank requires replacement. Switchgear is obsolete. Engine parts no longer manufactured.

Gander

Engines and auxiliary systems are in need of substantial repair and overhaul. Instrumentation inadequate. Switchgear obsolete. Limited

parts available but are very costly.

Portable Diesel # 1 & # 2

Instrumentation/safeties require replacement. Chassis of # 2 in poor condition. Some spares available.

Port Aux Basques

Switchgear in main plant is obsolete and dangerous to operate. Fault levels exceed breaker ratings. Operations changed to limit risk. Unit # 2 generator is faulted. Instrumentation/controls unreliable. Inadequate ventilation in plant. Four machines are obsolete with a very limited number of parts available. Two other small units have not been manufactured since 1980 but parts can still be obtained. Unit # 10 in good condition and is still supported by the manufacturer.

Port Union

Instrumentation limited. Unit no longer manufactured but parts are still available.

In addition to issues observed by NP personnel and the Consultants, NP's insurer, BI&I, has expressed serious concern over the condition of the facilities. These concerns are as a result of inspections they have carried out.

The historical operating costs were determined and estimates were made of the operating and capital funds required to bring the plants to an acceptable state of repair.

PLANT	Historical Annual Operating Cost	Projected Operating Expenses	Projected Grossed - up Capital Expenses	Life Extension (Yrs)
Aguathuna	$15,159	$195,000	$97,000	10
Gander	$28,122	$508,000	$56,000	10
Port Union	$893	$6,000	$2,000	10
Port Aux Basques -Main Plant-	$49,733	$27,000	$703,000	10
Port Aux Basques -Unit 10-	$12,899	$210,000	$4,000	15

St. John's	$23,991	$159,000	$22,000	10
Salt Pond	$9,997	$345,000	$192,000	10
Portable # 1	$3,294	$11,000	$7,000	10
Portable # 2	$4,853	$11,000	$72,000	10
TOTALS	$148,941	$1,472,000	$1,155,000	

The total projected annual fixed costs were determined on a $/Kw-Yr basis using the historical and required maintenance costs. These were compared to new thermal and hydro generation alternatives and to the capacity credit that NP currently receives for installed capacity.

PLANT	TOTAL ANNUAL FIXED COST ($/Kw-Yr)	VARIABLE COST ($/Kwh)
Aguathuna	$51.95	$0.113
Gander	$45.52	$0.192
Port Union	$3.02	$0.130
Port Aux Basques Main Plant	$98.83	$0.109
Port Aux Basques Unit 10	$14.24	$0.072
St. John's	$20.95	$0.071
Salt Pond	$65.13	$0.138
Portable # 1	$5.88	$0.108
Portable # 2	$25.47	$0.115
	THERMAL ALTERNATIVES	
25 Mw Gas Turbine	$129.00	$0.070
2500 Kw Diesel	$114.00	$0.083
2225 Kw Gas Turbine	$107.00	$0.112

	HYDRO ALTERNATIVES	
Rose Blanche	-	$0.061
Scheffield Lake	-	$0.064
Garia Bay	-	$0.066
Connaire Bay	-	$0.064
	CAPACITY CREDIT	
Capacity Credit	$14.00	-

Even though the projected total annual fixed costs of the diesel plants are less than the alternative replacement thermal generation, investing additional funds to maintain the older diesels is not recommended. If a major component on the engine failed, it could not be replaced as parts are either not available or are very expensive with long delivery times. This would leave any new investment stranded. There is little doubt that if the facilities are expected to operate safely and effectively, maintenance and capital expenditures are required. The engine overhauls are necessary but obtaining the spares required to do the work would be difficult and costly. NP does not have the expertise on staff to perform this work so it would have to be contracted out. The low utilization rate of the facilities indicate that, with the exception of Port Aux Basques, they are no longer used for peaking or emergency service.

It is recommended that the Gander, Salt Pond, Aguathuna and Port Aux Basques - Main Plant be retired over the period 1997 to 1998. This will result in a reduction of 7009 Kw in nameplate capacity (5425 Kw actual due to deratings) and a cost saving, on a net present value basis, of approximately $2,379,000. The annual cost savings, projected avoided costs and estimated retirement costs are shown below;

PLANT	CAPACITY (KW)	CURRENT ANNUAL OPERATING COSTS	PROJECTED ADDITIONAL OPERATING COSTS	PROJECTED ADDITIONAL CAPITAL COST	RETIRE-MENT COST
Aguathuna	1200	$6,000	$195,000	$97,000	$130,000
Gander	2650	$11,000	$508,000	$56,000	$131,000
Port Aux Basques Main Plant	1659	$20,000	$27,000	$703,000	$50,700
Salt Pond	1500	$5,000	$345,000	$192,000	$78,500
TOTAL	7009	$42,000	$1,075,000	$1,048,000	$390,200

It is recommended that the St. John's Diesel and Portable # 2 undergo a detailed assessment to determine their long term viability.

If the retired peaking/emergency service capacity is replaced, it is recommended that refurbished diesels or gas turbines be purchased and installed at Port Aux Basques. The estimated installed cost of a 2500 Kw diesel similar to Unit # 10 is $2,320,000. If energy capacity is required, the better alternative is to install additional small hydro plants.

TABLE OF CONTENTS

1. INTRODUCTION

This report summarizes the results of a detailed review of the existing condition, required maintenance and current and projected costs associated with the diesel power plants owned and operated by Newfoundland Power (NP). The purpose of this study is to determine the future requirement for the diesel plants and the value of retaining them on the system. The study was prompted by the age of the plants, the level of deterioration observed and the reduction in workforce resulting in the loss of experienced operating and maintenance personnel. The company insurers, BI&I, have also expressed serious concern over the level of maintenance being performed at the facilities.

A listing of current NP diesel power plants is shown on Table 1.

TABLE 1

NEWFOUNDLAND POWER

DIESEL POWER PLANTS

Plant Type	Location	Unit No.	Nameplate Capacity Kw	Date Commissioned	Manufacturer
Low Speed Diesel	St. John's	1	2,500	1953	Nordberg
	Aguathuna	1	1,200	1962	Harland & Wolff
	Salt Pond	1	500	1963	Worthington
	Salt Pond	2	500	1963	Worthington
	Salt Pond	3	500	1963	Worthington
	Gander	1	1,000	1949	Atlas-Polar
	Gander	2	1,000	1957	Nohab-Polar
	Gander	3	1,000	1953	Nohab-Polar
High Speed Diesel	Portable	1	700	1973	Caterpillar
	Portable	2	670	1976	Caterpillar
	Port aux Basques	1	350	1945	Caterpillar
	Port aux Basques	2	250	1953	Caterpillar
	Port aux Basques	3	350	1954	Caterpillar
	Port aux Basques	4	209	1958	Caterpillar
	Port aux Basques	5	250	1965	Caterpillar
	Port aux Basques	8	250	1965	Caterpillar
	Port aux Basques	10	2,500	1969	G.M.
	Port Union	1	500	1962	Caterpillar

2. METHODOLOGY

The original study of the diesel plants was done in 1996 by NP personnel. That study addressed many issues but it was recognized that NP's experience with diesel generation, especially the older, slow speed type, is limited due to retirement of personnel over the years. Outside Consultants, Acres International in conjunction with D.G. Champion, were retained in 1997 to provide an experienced assessment of the facilities. Their mandate was to review the general mechanical and electrical condition of the units, make specific recommendations for a further 10 years of operation and advise where further operation is not recommended. Availability of spare parts was also to be investigated. In conjunction with this work, NP personnel reviewed the condition of the switchgear at the Port Aux Basques Plant and revised the work scope.

The review consisted of field inspections of the all of the diesel plants together with discussions with NP staff to assess the general condition of the property, the level of operation, past and required maintenance and any other factors affecting the viability of the asset. The points considered were the remaining physical life of the basic plant elements such as engine, electrical generator, cooling system, switchgear, transformers, controls and buildings. Based on the inspections, a comprehensive listing of all of the necessary maintenance on each plant was compiled. This was costed and broken down between operating maintenance and capital replacements. The Consultants provided estimates for unit overhauls and parts. In accordance with the 1996 Depreciation Study, all diesel plants are assumed to be fully depreciated at this point. The total projected cost per kilowatt-year of the required maintenance was determined using an estimated life extension for each plant as a result of the proposed expenditures.

An historical review of the actual operating costs for each plant was undertaken for the years 1990 to 1995. The costs were subdivided into net operating (labour, consumables, general maintenance), fuel, insurance, tax and other costs. From this data, an historical average fixed cost per kilowatt-year was developed.

The efficiency of each plant was determined and, using current diesel fuel costs and labour rates, the variable cost per kilowatt hour per plant was calculated.

The value of generation capacity (ie. capacity credit) to NP was determined using Newfoundland and Labrador Hydro's (NLH) 1995 Cost of Service Study as submitted to the Public Utilities Board for their Rural Rate Hearing. Newfoundland Power's generation capacity was taken as the total company capacity less an 18% reserve margin. The cost allocations were determined for the years 1997 to 2001 both with and without the total generation capacity thus determining the capacity credit in terms of dollars per kilowatt year.

3. UTILIZATION OF DIESEL POWER PLANTS

Newfoundland Power diesel plants are used for emergency service or as reserve capacity for power generated by NLH and purchased by NP.

This status has existed for nearly 30 years and during this period the plants have been required to run on relatively few occasions. Such circumstances have been the outage of transmission lines due to ice storms, major coincidental generating capacity problems or in the extremely unusual occasion where lack of water for hydro generation coincided with a forced outage at the NLH Holyrood Thermal Plant.

The units are also operated occasionally to test the systems thus ensuring operating difficulties are resolved prior to the units being required. For the most part, test runs account for the majority of the fuel burnt in the plants. The notable exception to this are the units stationed at Port Aux Basques, which operate more than others when there are difficulties with NLH's TL214 and TL215 transmission lines. One unit at Salt Pond is occasionally used to black start the Salt Pond Gas Turbine when that units' batteries discharge.

A summary of each plants' actual available capacity, average annual production and hours operated are shown in Table 2.

TABLE 2

PLANT UTILIZATION

PLANT	AVAILABLE CAPACITY (KW)	AVERAGE GENERATION (KWH)	ANNUAL OPERATION (HRS)
Aguathuna	1200	6178	5.1
Gander	2650	1183	0.4
Port Union	500	4883	9.8
Port Aux Basques - Main Plant -	575	53535	32.3
Port Aux Basques - Unit # 10 -	2500	80673	32.3
St. John's	2500	18626	7.5
Salt Pond	1000	4072	2.7
Portable # 1	700	24184	34.5
Portable # 2	670	12734	19.0

4. <u>OPERATION AND MAINTENANCE</u>

The extremely low utilization of the NP diesel plants results in most operating and maintenance staff having principal duties beyond the diesels. A centralized mechanical maintenance section is responsible for heavy maintenance at diesel, gas turbine and hydro plants. Electrical and civil maintenance is handled in a similar manner. Day to day maintenance activities are the responsibility of Plant Supervisors and their staff who may also be responsible for hydro and gas turbine plant operation as well as Regional electrical maintenance.

In general, minimal maintenance has been performed on the diesels due to the nature of their operation. The exception to this is Port Aux Basques where a diesel plant operator is assigned to the plant and performs regular work on the units.

It is significant to note that recent retirement of experienced personnel has reduced the ability to effectively operate the equipment and perform the necessary maintenance. It is expected that any future major maintenance would have to be contracted out to companies familiar with the engines.

5. CONDITION OF DIESEL POWER PLANTS

5.1 GENERAL

The inspection of plants generally consisted of a tour of the property including the diesels, generators and associated equipment, cooling systems, stacks, buildings, fuel storage and electrical substation, followed by discussions with plant personnel on the operating and maintenance history and present practices.

The physical inspection was external only and as such is limited as a means of determining the condition of equipment. An accurate assessment of the condition of the plant is only possible by opening up the diesels to assess wear, clearances and other critical parameters. It is still possible to assess the general condition of a plant from a review of the operating and maintenance history together with the general condition of the equipment.

Specific comments made by the outside Consultants on specific plants/units will be indicated. The full Consultant's report is contained in Appendix E.

The following are general assessments of the condition of each of the two main types of diesel plant.

4.1.1 Low Speed Diesels

All of the engines are old and require major overhauls if reliable operation is to be expected. Spare parts are difficult and costly to obtain as the machines are obsolete. This being the case, the extent and benefit of an overhaul would be limited. Protective relaying, controls and switchgear tend to be obsolete. Fuel flow meters are required in order to comply with environmental regulations on fuel storage. Fuel storage tanks have to be dipped and reconciled weekly to conform to environmental regulations.

Salt Pond

The plant is comprised of three 1940's vintage 500 KW Worthington diesel generator sets complete with auxiliaries and fuel storage, switchgear and transformers. The equipment is housed in a building which also serves as a distribution transformer maintenance shop. Units were installed in Salt Pond in 1963. Unit # 1 has accumulated 16935 hours, # 2 17112 hours and # 3 15462 hours since 1962. They were operated at Fort Pepperal in St. John's from 1941 to 1963. The operating hours on the units during their time at Pepperal is unknown.

Units are in fair condition. Controls are obsolete and replacement is necessary. Exhaust pipes are in good condition but mufflers are rusty. Air intakes are rusty and deteriorating. Unit #1 has a continuing problem of water ingress into the base oil and Unit #3 has one piston missing. Switchgear is in good condition. The fuel tank is in good condition. The building is generally in good condition.

Consultant's Comments - Engines have operated beyond the usual manufacturer's recommended major overhaul period. Three day tanks in the building are vented in the building and do not have high level alarms or shut off devices. Floor trenches contain pools of oil. Unit # 3 should not be operated due to the possibility of crankshaft failure. Instrumentation inadequate. Some parts may be available but would be expensive and have long delivery times. Major components likely not available.

Consultant's Recommendation - These units are the oldest on the system and have numerous problems associated with equipment condition and safety considerations. It is recommended that the units be decommissioned.

Aguathuna

Plant is comprised of one 1200 KW diesel generator manufactured by Harland and Wolff. The plant contains auxiliaries such as lube oil cooler, pumps, day tank, fuel tank, radiator, switchgear and transformer. The equipment is housed in a steel building which also serves as a distribution transformer maintenance shop. The plant was commissioned in 1962. Since 1962, the engine has logged approximately 10,086 hours.

Plant is in fair condition. The engine has a few minor oil leaks and a continuing problem with air start valves sticking open. This is a potentially dangerous situation as hot exhaust gasses blow back into the pressure piping. Replacement air start valve springs cannot be sourced and will have to be manufactured. Auxiliaries are in good condition. The diesel driven air compressor is faulty and requires replacement. One radiator fan motor has burnt out. The plant building aesthetics are poor. Fuel piping is exposed and rusty. Cooling lines are rusty and deteriorated. Building ventilation louvres are damaged.

Consultant's Comments - Numerous minor water and oil leaks. Asbestos wrap on exhaust in bad condition. Collapsible link on governor safety system seized resulting in the overspeed shutdown system being inactive. Engine due for a major overhaul. Piston blow-by creates a health and fire hazard. The disabled overspeed mechanism creates a serious danger. Instrumentation inadequate. The manufacturer no longer makes diesel engines and parts are no longer available.

Consultant's Recommendation - Extensive costs would be involved with rehabilitating this unit. This combined with the manufacturer no longer supporting the engine leads to the conclusion that the unit be decommissioned.

St. John's

Plant is comprised of one 2500 KW diesel generator manufactured by Nordberg. The plant contains auxiliaries such as lube oil coolers, pump, day tank, fuel tank, air compressor & receivers, switchgear and transformers. The equipment is housed in a building with asbestos siding. The unit was installed in 1953 and has accumulated 2425 operating hours.

Plant is in good condition. Engine instrumentation and switchgear are obsolete. Internally, the building is cluttered as it is used for the storage of miscellaneous surplus equipment. The top portion of fuel tank is dented. This tank is in excess of 30 years old and requires replacement.

Consultant's Comments - Switchgear is open contact type, old and dangerous to operate. Instrumentation is obsolete rendering safety alarm and shutdown devices unreliable. Plant has poor lighting and is cluttered with old stored equipment. Parts are no longer manufactured. Some surplus parts are available from non OEMs but they are limited and are costly.

Consultant's Recommendation - Detailed inspection required to verify condition. If there is a significant benefit to maintaining this unit for emergency generation, the noted maintenance/improvements should be carried out and the unit kept in service.

Gander

The plant contains three 1000 KW diesel generating sets and auxiliaries such as fuel tank, day tanks, coolers, lube oil pumps, air compressors and receivers, furnace, switchgear and transformers. The building and land are owned by Transport Canada and leased by NP for $1 per year. The generators were installed between 1949 and 1957. The facility was taken over by NP in 1962. These units operated more or less continuously until 1969.

The plant is in fair condition. All engines suffer from oil leaks. The stack on Unit # 2 has oil deposits on the exterior. The engine foundations are cracked with the most severe being on Unit #3. The unit coolers are undersized and restrict unit load to approximately 75 to 80% of the machine rating. Switchgear and controls are obsolete. Ground water is continuously running into the plant sumps. These sumps and the sump outfall area require continuous attention. The building aesthetics are extremely poor.

Consultant's Comments - Engines and auxiliary systems are in need of substantial repair. Unit # 2 had large amounts of oil leak from the hot exhaust manifold resulting in a dangerous condition. Foundation on Unit # 3 requires major repair work as does the drive mechanism on the scavenger blower. Units have accumulated about 100,000 hours each and are overdue for major overhauls.

Evaporative cooler systems require major work. All instrumentation and controls need to be replaced. A limited number of parts are available for these engines. Suppliers indicate that major components may be difficult and costly to obtain.

Consultant's Recommendation - A substantial investment would be required to make the plant safe and operable. It is recommended that the plant be decommissioned.

5.1.2 High Speed Diesels

In general, the high speed diesels are in relatively good condition. Protection and controls require calibration and maintenance. The major concern is the switchgear at the Port Aux Basques plant which is obsolete and requires replacement. Fuel flow meters are required in all plants in order to comply with environmental regulations. Fuel storage tanks have to be dipped and reconciled weekly to conform to environmental regulations.

Portable Units

Each unit consists of diesel generator sets mounted in a self contained high bed road trailers. Each trailer includes all auxiliaries such as fuel tank, switchgear and transformers. Unit #1, purchased in 1973, is rated at 700 KW and has 4610 operating hours. Unit #2, purchased in 1976, is rated at 670 KW and has 2204 operating hours. Both portables are currently stationed at the Grand Bay Substation in Port Aux Basques.

Both generating units are in good condition. Mufflers are rusty and there are minor oil leaks on both engines. Radiators and fans are dirty. The trailer chassis on Unit #2 is very deteriorated. This machine is no longer roadworthy and, in fact, requires attention so that it is safe for stationary use.

Consultant's Comments - All instrumentation and safety devices require calibration or replacement. Chassis of Unit # 2 in poor condition. Both engines have been out of production since 1978. OEM has a normal amount of maintenance spares on hand but service spare stock levels are diminishing.

Consultant's Recommendations - Units should undergo maintenance on the engine and control panel instrumentation. The Unit # 2 chassis should be refurbished if future portability is required.

Port Aux Basques

Plant comprised of six Caterpillar diesel generator sets ranging in size from 209 Kw to 350 Kw located in the main building and one 2500 Kw packaged General Motors Electromotive Diesel generator set located adjacent to the building. Plant also includes auxiliaries such as controls, switchgear, fuel storage and transformers.

Total installed capacity of the plant is 4159 KW. Unit #1 was installed in 1949; Unit #2 1953; Unit #3 1954; Unit #4 1958; Unit #5 1965; Unit #8 1965; and Unit #10 1969. The Caterpillar units (# 1 through #8) ran continuously until 1968.

Overall, the units are in fair to good operating condition. Unit #2 generator is faulted and has yet to be repaired. Some mufflers require rebuild. All generators require cleaning. The main plant switchgear was manufactured in 1937 and is obsolete with the only plant protection being overcurrent on the main breaker. The fuel tank system is in excellent condition as it was replaced in 1995. Of note is that $4800 per year is paid to the Town of Port Aux Basques for cooling water used at the main plant.

In March 1997, a further review was undertaken by NP personnel into the condition of the switchgear in the main plant(memo - B. Nickerson to J. Simmons - Appendix E). The maximum fault levels were determined for the main plant under both parallel and isolated operating conditions. This revealed that all four generator breakers on the T2 bus are exposed to fault levels in excess of their ratings. The operating practices of the plant were changed immediately to limit the fault levels. This results in the main plant capacity when operating in parallel to the system being reduced to 575 Kw from 1635 Kw. The main plant capacity in isolation to the system was reduced to 925 Kw. The cost of replacing the switchgear and providing adequate electrical instrumentation and controls was reassessed in early 1997 (Appendix E) and determined to be approximately $460,000.

<u>Consultant's Comments</u> -

<u>Main Plant:</u> Instrumentation unreliable. Unit # 3 overloaded. Rapid rise of plant interior temperature to 34°C. Engine speed control had to be done at the engine rather than at a "raise/lower" switch at the switchgear. Rapid deterioration of breathing conditions in plant due to crankcase breathers emitting fumes. Periodic heat exchanger tube failures. Unit # 8 has a faulty lubricating oil pressure switch which has to be defeated to run the unit. The obsolete open faced switchgear is considered detrimental to personnel safety due to the inaccuracy of many instruments and the potential hazard of operator contact with live components. Uninsulated exhaust pipes are a personnel hazard as operator has to work around engine while it is operating. Staffing level during emergency service considered inadequate given the current control/switchgear arrangement. Parts for the engines are limited as four machines are obsolete and have either reached or are approaching the OEM's 50 year guarantee for service parts availability. The other two units have been out of production since 1980.

<u>Unit # 10</u> - Enclosure is corroded. Overall unit in good condition and operates well. Unit is still manufactured and is supported with both maintenance and service spares.

Consultant's Recommendations -

Main Plant - Because of the age, control and instrumentation problems and their relatively small sizes, consideration should be given to retiring these units. If this causes a shortage of power, consideration should be given to a second unit similar to Unit # 10.

Unit # 10 - Consideration should be given to moving the unit indoors due to the condition of the enclosure.

Port Union

Unit consists of one 500 KW diesel generator set manufactured by Caterpillar. The diesel generator set is located in the Port Union Hydro Plant and includes auxiliaries such as cooler, fuel tank and switchgear. The plant was commissioned in 1962. The equipment is in good condition. A new fuel tank has been installed. Fuel flow meter is inoperative.

Consultant's Comments - Engine instrumentation is limited. Engine muffler rusty. Engine has been out of production since 1985 but parts are readily available.

Consultant's Recommendation - The unit is in good condition and it is recommended that it be kept in service.

6. REMAINING SERVICE LIFE

The service life of a plant is typically determined by the running time until normal replacement is necessary for the major item of plant. Much of the plant's present condition 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 the duty cycle changes, the increased stops, starts and load swings may cause major components to become more susceptible to failure through fatigue or creep. Based on the Consultants' experience, older diesels were well made and were designed for base load operation under constant observation. Contrary to the common belief, the deterioration of these early design of engines takes place just as rapidly and frequently more rapidly when they are left idle and not operated in the manner for which they were designed.

Based on normal operation, high speed diesels are not designed for continuous running and have 15 years lives. Low speed diesels are generally expected to last 25 years.

Estimates have been made as to the remaining life on the diesels assuming existing operating and maintenance levels are continued. Factors taken into account in determining the remaining service life of each generating unit were as follows:

- total hours run
- expected operating cycle
- availability of spare parts
- operating and maintenance history.

The expected remaining service life for each generating unit is summarized in Table 3.

TABLE 3

REMAINING SERVICE LIFE

UNIT		NAMEPLATE CAPACITY Kw	REMAINING SERVICE LIFE YEARS
Low Speed Diesels,			
St. John's		2,500	5
Aguathuna		1,200	2
Salt Pond	1	500	2
	2	500	2
	3	500	2
Gander	1	1,000	2
	2	1,000	2
	3	1,000	2
High Speed Diesels,			
Mobile	1	700	5
	2	670	5
Port aux Basques			
	1	350	5
	2	250	0
	3	350	5
	4	209	5
	5	250	5
	8	250	5
	10	2,500	10
Port Union		500	5

7. PLANT COSTS

As mentioned previously, historical and projected costs were determined for each plant based upon the inspections. Costs were broken down between operating and capital. Base capital costs received a loading of 30% to account for financing, taxes and depreciation. A summary of the historical and projected costs and life extensions are shown in Table 4.

TABLE 4

PLANT COSTS

PLANT	Historical Annual Operating Cost	Projected Operating Expenses	Projected Grossed - up Capital Expenses	Life Extension (Yrs)
Aguathuna	$15,159	$195,000	$97,000	10
Gander	$28,122	$508,000	$56,000	10
Port Union	$893	$6,000	$2,000	10
Port Aux Basques -Main Plant-	$49,733	$27,000	$703,000	10
Port Aux Basques -Unit 10-	$12,899	$210,000	$4,000	15
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Portable # 1	$3,294	$11,000	$7,000	10
Portable # 2	$4,853	$11,000	$72,000	10
TOTALS	$148,941	$1,472,000	$1,155,000	

The total of all projected one-time operating and capital costs is $2,627,000. Detailed cost analysis may be found in Appendix D.

Table 5 provides a summary of the diesel plants on an annual fixed cost basis ($/Kw-Yr) and an average annual variable cost basis ($/Kwh). The average annual fixed cost is the historical cost with the variable costs subtracted. The grossed-up capital costs were added to the projected operating expenses and a levelized projected annual cost produced using a 10.25 % discount rate and projected life extension as a result of the monies spent. The total annual fixed cost is the sum of the average annual historical and projected levelized annual costs divided by plant capacity. The average variable cost is based upon plant fuel efficiency, fuel cost and labour required to operate the plant for generation. Total annual plant cost would be the product of the installed capacity and the total fixed costs plus the product of the average annual generation and the variable cost.

TABLE 5

DIESEL PLANT SUMMARY

PLANT	Installed Capacity (Kw)	Average Annual Generation (Kwh)	Average Effy (Kwh/L)	Average Annual Fixed Cost ($/Kw-Yr)	Projected Additional Annual Fixed Cost ($/Kw-Yr)	Total Annual Fixed Cost ($/Kw-Yr)	Average Annual Variable Cost ($/Kwh)
Aguathuna	1200	6178	3.54	$11.92	$40.03	$51.95	$0.113
Gander	2650	1183	1.72	$10.51	$35.01	$45.52	$0.192
Port Union	500	4883	3.03	$0.39	$2.63	$3.02	$0.130
Port Aux Basques Main Plant	1659	53535	2.57	$26.45	$72.38	$98.83	$0.109
Port Aux Basques Unit 10	2500	80673	3.49	$2.82	$11.42	$14.24	$0.072
St. John's	2500	18626	3.98	$9.04	$11.91	$20.95	$0.071
Salt Pond	1500	4072	1.98	$6.24	$58.89	$65.13	$0.138
Portable # 1	700	24184	3.46	$1.65	$4.23	$5.88	$0.108
Portable # 2	670	12734	3.18	$5.09	$20.38	$25.47	$0.115

It should be noted that the Port Aux Basques main plant was separated from Port Aux Basques Unit #10 because of the size, age and independent nature of #10.

8. ANALYSIS

A matrix was developed to rank the diesel plants on six critical parameters, namely; hours of annual operation, annual generation, plant fuel efficiency, average annual fixed cost, projected annual fixed cost and variable cost. The parameters for each plant were ranked relative to one another where 1 was the best and 9 the worst. The ranks for the various parameters were totalled for each plant and an overall plant rank developed based on the sum where 1 was best (lowest total) and 9 worst (highest total). The matrix is shown in Table 6:

TABLE 6

EVALUATION MATRIX

PLANT	OPERATION HRS	OPERATION KWH	EFFICIENCY	AVERAGE ANNUAL FIXED COST	PROJECTED ANNUAL FIXED COST	VARIABLE COST	TOTALS	OVERALL RANKING
Aguathuna	6	6	2	8	7	5	34	7
Gander	8	9	9	7	6	9	48	9
Port Union	4	7	6	1	1	7	26	4
Port Aux Basques Main Plant	2	2	7	9	9	4	33	6
Port Aux Basques Unit 10	2	1	3	3	3	2	14	1
St. John's	5	4	1	6	4	1	21	3
Salt Pond	7	8	8	5	8	8	44	8
Portable # 1	1	3	4	2	2	3	15	2
Portable # 2	3	5	5	4	5	6	28	5

The value of generation in terms of a capacity credit on costs assigned to NP by NLH was determined using the 1995 Cost of Service Study. Over the time frame studied (1997 to 2001) the average credit is $14.00/Kw-Yr. Plants which have a total annual fixed cost of less than this amount are of benefit to the company while those higher have less benefit to NP but may be of value to the island interconnected customer as they may be less expensive than the cheapest generation alternative.

Typically, the cheapest generation alternative where energy is not required (ie. capacity or peak coverage only) is a gas turbine plant. If some of the diesels are retired, the capacity shortfall would be made up as part of a new 25 to 50 MW gas turbine installation. In 1992, specifications were issued and bids received for a new gas turbine at Port Aux Basques. The project was cancelled but the prices may be used as an indication of generation alternative costs. Escalating the estimate to 1997 and accounting for financing, a 25 MW peak rated unit would cost approximately $126.00/Kw-Yr. Fixed operating costs are assumed to be similar to NP's existing Greenhill 25 MW unit which is approximately $ 3.00/Kw-Yr making the total cost $129.00/Kw-Yr. Compared to the total annual fixed costs for the existing diesels, it can be seen that maintaining the diesels is cheaper than replacing them with a new gas turbine installation.

As alternatives, replacement with refurbished diesels or gas turbines was investigated. A quote was received on 2500 Kw General Motors EMD modular housed diesel generators complete with all auxiliaries. These units are similar to the existing Unit # 10 at Port Aux Basques. Five of these diesels are available. In addition, a quote was obtained on 2225 Kw Allison 501 KA outdoor enclosed gas turbines complete with auxiliaries. Five of these are available as well. Both these units are still in production by the original manufacturer, have low operating hours and would be refurbished prior to purchase. Costs were developed based on installation at the Port Aux Basques location. This site was chosen as there is more of a requirement for standby generation and a full time diesel operator is employed there. It was estimated that the total installed cost (including financing) of the 2500 Kw diesel would be $2,319,810. This translates to $111/Kw-Yr. The gas turbine option costed at $1,936,310 which is $104/Kw-Yr. The fixed operating cost for both options would be in the vicinity of the cost of the Port Aux Basques Unit # 10 diesel which was approximately $3.00/Kw-Yr. The cost estimates may be found in Appendix D.

When energy is required, the cheaper alternative to fossil plants are hydro plants. Rose Blanche (5.5 Mw) is scheduled to be constructed in 1998 and three additional new small hydro alternatives were costed; Sheffield Lake (4.5 Mw): $0.0639/Kwh, Garia Bay (15 MW): $0.0654/Kwh and Connaire Bay (15 MW): $0.0638/Kwh. As these are energy plants, the costs are on a $/Kwh basis with no annual fixed cost calculated.

A summary of the existing and alternative costs are shown in Table 7.

TABLE 7

EXISTING AND ALTERNATIVE COSTS

PLANT	TOTAL ANNUAL FIXED COST ($/Kw-Yr)	VARIABLE COST ($/Kwh)
Aguathuna	$51.95	$0.113
Gander	$45.52	$0.192
Port Union	$3.02	$0.130
Port Aux Basques Main Plant	$98.83	$0.109
Port Aux Basques Unit 10	$14.24	$0.072
St. John's	$20.95	$0.071
Salt Pond	$65.13	$0.138
Portable # 1	$5.88	$0.108
Portable # 2	$25.47	$0.115
25 Mw Gas Turbine	$129.00	$0.070
2500 Kw Diesel	$114.00	$0.083
2225 Kw Gas Turbine	$107.00	$0.112
Rose Blanche	-	$0.061
Scheffield Lake	-	$0.064
Garia Bay	-	$0.066
Connaire Bay	-	$0.064
Capacity Credit	$14.00	-

Even though the projected total fixed costs for the diesels are less than the alternative new thermal generation, investing additional funds to maintain the older diesels is not recommended. If a major component on the engine failed, it could not be replaced as parts are either not available or are very expensive with long delivery times. This would leave any new investment stranded. There is little doubt that if the facilities are expected to operate, operating maintenance and capital expenditures are required. Even to be maintained for the additional years as estimated in the 1996 Depreciation Study would require some investment during that period to deal with environmental, safety and operating issues. Savings in terms of existing and projected operating and capital costs would be realized by shutting down the plants with costs higher than the capacity credit. These costs were determined for Aguathuna, Gander, Salt Pond and Port Aux Basques - Main Plant. In determining the existing cost savings, salaries were factored out as individuals involved in maintaining and operating the plants have other duties and the labour costs would be absorbed by those functions (ie. hydro, gas turbine, distribution and substation operation and maintenance). Costs savings are shown in Table 8.

TABLE 8

COST SAVINGS

PLANT	CAPACITY (KW)	CURRENT OPERATING COSTS	PROJECTED ADDITIONAL OPERATING COSTS	PROJECTED ADDITIONAL CAPITAL COST
Aguathuna	1200	$6,000	$195,000	$97,000
Gander	2650	$11,000	$508,000	$56,000
Port Aux Basques Main Plant	1659	$20,000	$27,000	$703,000
Salt Pond	1500	$5,000	$345,000	$192,000
TOTAL	7009	$42,000	$1,075,000	$1,048,000

The total of the projected additional operating and capital costs is $2,123,000. The present worth of the current annual operating cost over 10 years at 10.25% is $256,000 bringing the net present value of the total projected savings to $2,379,000.

The unit at St. John's and Portable # 2 are located in strategic locations for the provision of emergency service. These units should undergo a detailed assessment to determine their long term viability.

If retired, it is recommended that the buildings at Salt Pond and Port Aux Basques be retained. The Salt Pond plant is used as a base for distribution and substation maintenance. Removal of the diesels would give an opportunity to better utilize the building for that purpose as it is crowded there now. The Port Aux Basques building would be retained to provide a stores area and maintenance depot for Unit # 10 and the Portable Gas Turbine which is located at the Grand Bay Substation. The diesel plant operator will still be required as Port Aux Basques will still be base to the Portable Gas Turbine, Portable Diesel # 1 and Unit # 10 at the Main Plant. The operator also doubles as a storekeeper and would be involved in the operation of the proposed Rose Blanche Hydro Development scheduled for 1998-99. The building at Aguathuna is used for distribution and substation maintenance as well but it is not in a convenient location and it is subject to vandalism. It would probably be more cost effective to ship any large substation equipment to the Transformer Shop where a crane is available and for minor distribution service work to be done in Stephenville.

If it is necessary to replace the 7 MW of generation, it is recommended that any thermal capacity be consolidated at Port Aux Basques as this area uses back up generation more than others and it has a full time employee in the area responsible for diesel plant operation and maintenance. Either the refurbished diesel or gas turbine options would be good alternatives. The specific requirement to provide local generation for reliability purposes would have to be studied further in terms of expected load growth and current customer outage statistics combined with the impending construction of the Rose Blanche Hydro Development or any other generation in the area. The combination of the 5.5 Mw Rose Blanche Plant and a 2.5 MW refurbished diesel would replace most of the capacity.

If energy is required, it is suggested that the small hydro option be explored further as replacements for the lost capacity. This is in keeping with the expertise being retained at NP and would be the cheaper alternative.

The requirement for an auxiliary power unit for the Salt Pond Gas Turbine should be studied if the diesels are retired. A 40 Kw unit would cost approximately $30,000.

The cost to decommission the plants developed as part of the 1996 Depreciation study along with the recommended years of retirement are shown in Table 9.

TABLE 9

DECOMMISSIONING COSTS

Plant	Decommissioning Cost	Retirement Year
Gander	$ 131,000	1997
Salt Pond	$ 78,500	1998
Aguathuna	$ 130,000	1998
Port aux Basques - Main Plant	$ 50,700	1998

It is recommended that Gander be decommissioned in 1997 so that environmental issues associated with the plant may be dealt with. On the overall ranking it scored 9 which made it the worst plant on the system. The Salt Pond and Aguathuna plants would be shut down in 1997 so that minimal operating expenses would be incurred. These would be decommissioned in 1998. These plants ranked 8 and 7 respectively. The Port Aux Basques - Main Plant should remain in service until 1998 at which time other generation may be in place. (eg. Rose Blanche, refurbished diesels/gas turbines, new gas turbine). This plant ranked 6.

9. CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions

9.1.1 The total nameplate diesel plant capacity is 14,229 Kw and the average annual generation is 206,068 Kwh. Operating restrictions and unit problems have reduced the total actual capacity to 12,295 Kw. In recent years the plants have recieved very little operation.

9.1.2 The total historical average annual operating cost is $148,941.

9.1.3 The total of the projected operating maintenance and capital expenses required to maintain the plants into the future is $2,123,000.

9.1.4 The plants were ranked based on six critical parameters and are, from best to worst; Port Aux Basques #10, Portable #1, St. John's, Port Union, Portable #2, Port Aux Basques - Main Plant, Aguathuna, Salt Pond, Gander.

9.1.5 The capacity credit that Newfoundland Power receives is $14.00/Kw-Yr based on Newfoundland Hydro's 1995 Cost of Service Study.

9.1.6 The total annual fixed costs of the diesel plants range from a low of $3.02/Kw-Yr (Port Union) to a high of $98.83/Kw-Yr (Port Aux Basques - Main Plant).

9.1.7 A new 25 Mw gas turbine installation would have an annual fixed cost of $129/Kw-Yr.

9.1.8 A refurbished packaged 2500 Kw diesel plant would have an annual fixed cost of $114/Kw-Yr.

9.1.9 A refurbished packaged 2225 Kw gas turbine plant would have an annual fixed cost of $107/Kw-Yr.

9.1.10 Small hydro generation would have a cost of $0.065/Kwh.

9.1.11 Replacement components either cannot be sourced for the older diesels or they are very limited and costly.

9.1.12 Retiring Gander, Aguathuna, Port Aux Basques - Main Plant and Salt Pond will eliminate 7009 Kw in capacity and save the expenditure of approximately $2,379,000 on a net present value basis.

9.1.13 The total decommissioning cost for Gander, Aguathuna, Port Aux Basques - Main Plant and Salt Pond is estimated at $390,200.

9.2 Recommendations

9.2.1 Investment of additional funds to maintain some diesel plants is not recommended as a major component failure would leave the investment stranded.

9.2.2 Gander, Salt Pond, Aguathuna and Port Aux Basques - Main Plant should be retired over the period 1997 to 1998.

9.2.3 Gander should be decommissioned in 1997 to deal with outstanding environmental issues.

9.2.4 The Salt Pond and Aguathuna plants should be shut down in 1997 and decommissioned in 1998.

9.2.5 The Port Aux Basques main plant should remain in service until 1998 at which time other generation alternatives may be in place in the area.

9.2.6 The St. John's plant and Portable # 2 should undergo further detailed assessment to determine their long term viability.

9.2.7 Port Union, Port Aux Basques - Unit #10 and Portable #1 plants should be kept in service and the recommended maintenance performed.

9.2.8 The buildings at Salt Pond and Port Aux Basques should be retained for distribution and diesel/gas turbine maintenance.

9.2.9 The building at Aguathuna should not be retained and distribution maintenance should be moved to the Stephenville Area facility.

9.2.10 If it is necessary to replace the peaking/emergency generation it should be consolidated at Port Aux Basques.

9.2.11 Refurbished diesels or gas turbines would be good alternatives to replace the removed peaking/emergency service generation.

9.2.12 The requirement to provide local generation in the Port Aux Basques area would need further study.

9.2.13 If energy requirements dictate, the capacity should be replaced with small hydro.

9.2.14 The requirement for an auxiliary power unit for black starting the Salt Pond gas turbine should be assessed.

APPENDIX A

INSPECTION REPORTS

A1 SLOW SPEED

A2 HIGH SPEED

APPENDIX A1

SLOW SPEED DIESELS

Plant: Salt Pond Diesel
Location: Salt Pond, Burin

Inspected by: M. Hunter
Date: 1996-02-01

Description: Plant is comprised of three 500 KW Worthington diesel generator sets complete with auxiliaries and fuel storage, switchgear and transformers. The equipment is housed in a building which serves as a distribution transformer maintenance shop.

Specifications: See Technical Data Sheet in Appendix B3.

Date Installed: 1963. Units were operated at Fort Pepperal from 1941 to 1963.

Operational Duty: Emergency generation in the event of transmission line or system outage.

Operating Hours (1963 to Date):

Unit #1:	16935.2
Unit #2:	17112.0
Unit #3:	15462.0

Recent Operating Pattern:

Year	Generation (Kwh)
1991	2460
1992	7170
1993	5620
1994	1440
1995	3940

Operation for Reliability Check: Started monthly , synchronized and ran on load quarterly.

General Condition: Units are in fair condition. Controls are obsolete. Exhaust pipes are in good condition but mufflers are rusty. Air intakes are rusty and deteriorating. Unit #1 has a continuing problem of water ingress into the base oil and Unit #3 has one piston missing. Switchgear is in good condition. Fuel tanks are in good condition. Building is generally in good condition.

Recent Maintenance:

1995

- Complete oil change on Unit #1

1994

- Complete oil change on all units.
- Repaired crankshaft and bearing on Unit #1.

- Repaired centrifuge.
- Isolating valve installed on cooling water line to Unit #3.
- Main valve on water to plant installed.

<u>1993</u>

- Fuel tank dyke checked and repaired.

Required Maintenance:

- Controls replacement.
- Water ingress into Unit #1 crankcase.
- Unit #3 operating stresses due to missing piston is a concern.
- Battery bank requires replacement.
- General protection and control relaying improvements required.
- Cooling water system requires reinstatement to original concept.
- All units require major inspection/overhaul.
- Governor overhaul.
- Fuel meter required.

Required Inspections:

- Air receiver and system require annual inspection and certification by Department of Labour.

Spare Parts:

- Engines are obsolete. Some minor spares kept on site.
- Other components may be repaired or are easily replaced.

Environmental Restraints: None

Remaining Service Life: 2 years

Factors Affecting Remaining Life:

1. Low usage of plant.
2. Major overhauls required on engines if reliable performance is to be expected.
3. Lack of spare parts.

Plant:	**Aguathuna Diesel**	**Inspected by:**	**M. Hunter**
Location:	**Aguathuna**	**Date:**	**1996-03-15**

Description: Plant is comprised of one 1200 KW diesel generator manufactured by Harland and Wolff. The plant contains auxiliaries such as lube oil cooler, pumps, day tank, fuel tank, radiator, switchgear and transformer. The equipment is housed in a steel building which serves as a distribution transformer maintenance shop.

Specifications: See Technical Data Sheet in Appendix B1.

Year Installed: 1962

Operational Duty: Emergency generation in the event of transmission line or system outage.

Operating Hours: 10,086 hrs (approximately)

Recent Operating Pattern:

Year	Generation (Kwh)
1991	4,890
1992	7,540
1993	7,190
1994	5,790
1995	4,980

Operation for Reliability Check: Started, synchronized and ran on load monthly.

General Condition: Plant is in fair condition. The engine has a few minor oil leaks and a continuing problem with air start valves sticking open. Auxiliaries are in good condition. The diesel driven air compressor is faulty and requires overhaul. One radiator fan motor has burnt out. The plant building aesthetics are poor. Fuel piping is exposed and rusty. Cooling lines are rusty and deteriorated. Ventilation louvres are damaged. The unit transformer radiators are rusty and pitted.

Recent Maintenance:

1996

- Furnace fan motor, fuel pump and ignition transformer replaced.

1994

- Old fuel tank removed and replaced by one 22,700 L self dyked steel tank.

1993

- New battery bank installed.
- Cooling lines and radiator sandblasted and painted.
- Angle iron and part of skirt replaced on building.
- Building intruder alarm installed.

Required Maintenance:

- Diesel driven air compressor requires repair or replacement.
- Engine intake and exhaust valve ports require gaskets.
- Turbo charger requires overhaul.
- Engine lube oil requires changing and sump cleaning is necessary.
- New springs required for air starter valves.
- Exhaust stack requires painting.
- Cooling lines to radiator require replacement.
- Radiator frame requires painting and one fan motor has to be replaced. Fan blades are deteriorated and may require replacement.
- Building exhaust fan louvres require replacement.
- Unit requires major inspection/overhaul.
- Main plant lighting requires maintenance.
- Doors in building are flimsy and corroded and should be replaced.
- Transformer cooling radiator is deteriorated and requires replacement.
- Instrumentation requires calibration.
- Protective relay maintenance required.
- Building requires painting.
- Engine air intake filers require replacement.
- Governor overhaul.
- Fuel meter required.

Required Inspections:

- Air receiver and system require annual inspection and certification by Department of Labour.
- Building crane requires regular inspection to maintain Department of Labour approval.

Spare Parts:

- Engine is obsolete and recent attempt to obtain spares from the OEM was unsuccessful. Some minor spares kept on site.
- Other components are easily repaired or replaced.

Environmental Restraints: None

Remaining Service Life: 2 years

Factors Affecting Remaining Service Life:

1. Low usage of plant.
2. Major overhaul required on engine if reliable performance is to be expected.
3. Lack of spare parts.

Plant: St. John's Diesel
Location: St. John's

Inspected by: M. Hunter
Date: 1996-03-26

Description: Plant is comprised of one 2500 KW diesel generator manufactured by Nordberg. The plant contains auxiliaries such as lube oil coolers, pump, day tank, fuel tank, air compressor & receivers, switchgear and transformers. The equipment is housed in a building with asbestos siding.

Specifications: See Technical Data Sheet in Appendix B2.

Date Installed: 1953

Operational Duty: Emergency generation in the event of transmission line or system outages.

Operating Hours: 2425 hrs

Recent Operating Pattern:

Year	Generation (Kwh)
1991	800
1992	27,608
1993	12,160
1994	34,480
1995	0

Operation for Reliability Check: Run to speed-no-load monthly; synchronized and loaded quarterly.

General Condition: Plant is in good condition. Engine instrumentation and switchgear are obsolete. Building has asbestos panels. Building is cluttered as it is used for the storage of miscellaneous surplus equipment. Top portion of fuel tank is dented.

Recent Maintenance:

1994

- Air valve on #8 cylinder replaced with spare unit.

Required Maintenance:

- Exhaust stack requires painting.
- Fuel tank requires replacement.
- Fuel tank fencing required.
- Steps on ladder to plant require painting.

- Plant requires spill kit.
- Fuel flow meter.
- Governor overhaul.

Required Inspections:

- Air receiver and system require annual inspection and certification by Department of Labour.

- Building crane requires regular inspection to maintain Department of Labour approval.

Spare Parts:

- Engine is obsolete, some minor spares kept on site.
- Other components are easily repaired or replaced.

Environmental Restraints: Only 9000 litres kept in fuel tank due to age and condition.

Remaining Service Life: 5 years

Factors Affecting Remaining Service Life:

1. Low usage of plant.
2. Engine overhaul required within next 5 years if reliable operation is to be expected.
3. Lack of spare parts.

Plant: Gander Diesel Plant
Location: Gander

Inspected by: M. Hunter
Date: 1996-04-02

Description: The plant contains three 1000 KW diesel generating sets and auxiliaries such as fuel tank, day tanks, coolers, lube oil pumps, air compressors and receivers, furnace, switchgear and transformers. The building and land are owned by Transport Canada and leased by Newfoundland Power For $1 per year.

Specifications: See Technical Data Sheet in Appendix B4.

Operational Duty: Emergency generation in the event of transmission line or system outages.

Recent Operating Pattern:

Year	Generation (Kwh)
1991	1,200
1992	1,200
1993	1,000
1994	2,500
1995	600

Operation for Reliability Check: Started quarterly, synchronized and run on load annually.

General Condition: The plant is in fair condition. All engines suffer from oil leaks. Engine foundations are cracked with the most severe being on Unit #3. All ancillary equipment is in good condition. The unit coolers are undersized and restrict unit load to 75% of rating. Switchgear is obsolete.

Ground water is continuously running into the plant sumps. These sumps and the sump outfall area require continuous attention. The building aesthetics are poor.

Recent Major Maintenance:

<u>1995</u>

- Covers installed on fuel tank dyke.
- All air receivers inspected ultrasonically and new drain piping and fittings installed. Dyke fabricated for bottom of #1 air receiver.
- Seals in #1 & #2 oil circulating pump replaced.

<u>1994</u>

- Intruder alarm system installed.

1993

- #2 cooler fan motor replaced.
- Unused fuel tank removed.
- Evaporative coolers cleaned.
- Battery bank installed.

1992

- Blow off valves on Units #1, 2, & 3 inspected and repacked.
- Engines cleaned and minor oil and coolant leaks attended to.
- General plant cleanup and painting.
- Shut off valve on #1 air receiver repaired and new relief valve installed.
- Minor maintenance performed on crane.
- Safety barrier installed around switchgear.
- Guards installed on windows.
- Roof repaired.
- New sump pump installed.
- Furnace exhaust stack repaired.

1991

- Oil changed in Unit #1.

Required Maintenance:

- Thermoscan on switchgear.
- Building exterior repairs.
- Protective relay maintenance required.
- Sump and outfall area cleaning.
- Engine overhauls required on all units.
- Removal of unused buried fuel pipes.
- #2 diesel stack requires cleaning and painting.
- #1 & #3 diesel stacks require painting.
- Fuel tank requires painting.
- Fuel flow meter.
- Governor overhaul.

Required Inspections:

- Air receivers and systems require annual inspections and certification by Department of Labour.
- Building crane requires regular inspection to maintain Department of Labour approval.

Spare Parts:

- Engines are obsolete. Some minor spares kept on site.
- Other component are easily repaired or replaced.

Environmental Restraints:

- Drain valves on exhaust manifolds must be left open when units are off line to prevent oil from blowing out of the stack on startup.

Remaining Service Life: 2 years.

Factors Affecting Remaining Service Life:

1. Low usage of plant.
2. Major overhauls required on engines if reliable performance is to be expected.
3. Lack of spare parts.

APPENDIX A2

HIGH SPEED DIESELS

Plant: **Portable Diesel Units #1 & 2**
Location: **Grand Bay Substation**
Port Aux Basques

Inspected by: **M. Hunter**
Date: **1996-02-13**

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 #1 is rated at 700 KW and Unit #2, 670 KW.

Specifications: See Technical Data Sheet in Appendix C1.

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

Operating Duty: Emergency generation in the event of transmission line or system outage.

Operating Hours: Unit #1: 4610 hrs
Unit #2: 2204 hrs

Recent Operating Pattern:

Year	Generation (Kwh) Unit #1	Generation (Kwh) Unit #2
1993	22,610	17,900
1994	26,120	19,660
1995	15,280	12,700

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

General Condition: Both generating units are in good condition. Mufflers are rusty, minor oil leaks on both engines. Radiators and fans are dirty. Trailer chassis on Unit #2 is very deteriorated and is no longer road worthy.

Recent Maintenance:

1995

- Exhaust manifold guards installed.
- Intake louvre doors installed on Unit #2.
- HV transformer bushings and lightening arrestors 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 #1 - 4489 hrs, Unit #2 - 2088 hrs)
- Unit #1 batteries replaced.

1992

- Unit #2 batteries replaced.
- Unit #1 governor overhauled.
- Unit #1 chassis underwent minor repairs and painting.
- Unit #2 chassis underwent temporary structural repairs.

Required Maintenance:

Unit #1

- Engine oil leak repair.
- Reverse power relay repair.
- Annual tire, brake and light inspection (Budgeted - 1996)
- New battery charger required.
- Chassis minor painting (Budgeted - 1996)
- Generator, radiation and fan cleaning.
- Fuel meter.
- Governor overhaul.

Unit #2

- Automatic voltage regulator repair.
- Underfrequency relay not operational.
- Belt driven alternator repair.
- Chassis repair.
- Engine minor oil leak.
- Generator, radiator and fan cleaning.
- Unit to fence grounding.
- Fuel meter.
- Governor overhaul.

Required Inspections:

- Annual fire extinguisher inspection.

Spare Parts:

- Engines are older vintage Caterpillar but parts can still be obtained.
- Other components are easily repaired or replaced.

Environmental Restraints: None

Remaining Service Life: 5 years

Factors Affecting Service Life:

1. Low usage of plant.
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.

Plant: Port Aux Basques Diesel
Location: Port Aux Basques

Inspected by: M. Hunter
Date: 1996-02-14

Description: Plant comprised of six Caterpillar diesel generator sets ranging in size from 262 kVA to 438 kVA located in the main building and one 3250 kVA packaged Electromotive Diesel (GM) diesel generator set located adjacent to the building. Plant also includes auxiliaries such as controls, switchgear, fuel storage and transformers. Total installed capacity of the plant is 4159 KW.

Specifications: See Technical Data Sheet in Appendix C2.

Date Installed:

Unit #1:	1949	Unit #5:	1965
Unit #2:	1953	Unit #8:	1965
Unit #3:	1954	Unit #10:	1969
Unit #4:	1958		

Operating Duty: Emergency generation in the event of transmission line or system outage.

Operating Hours: Unit #10: 1627 hrs

The Caterpillar units ran continuously until 1968. The units do not have operating hour meters.

Recent Operating Pattern:

Year	Generation (Kwh)
1991	177,640
1992	252,350
1993	139,669
1994	149,493
1995	65,716

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

General Condition: Overall units are in fair to good operating condition. Unit #2 generator is faulted and has yet to be repaired. Some mufflers require rebuild. Generators require cleaning. The switchgear was manufactured in 1937 and is obsolete. The only unit protection is overcurrent on the main breaker. Fuel tank system is in excellent condition.

Recent Maintenance:

Unit #1

1995

- Muffler repaired and painted.
- Engine cleaned and painted.

Unit #2

1995

- Engine cleaned and painted.
- Muffler painted.

Unit #3

1995

- Muffler repaired and painted.
- Engine cleaned and painted.

1993

- Section of exhaust manifold replaced.
- Cooling fan fin repaired (third time).

Unit #4

1995

- Muffler painted.
- Engine cleaned and painted.

1993

- Engine oil changed.

1991

- Rebuilt cylinder head installed.

Unit #5

1995

- Muffler painted.
- Engine cleaned and painted.

1994

- Engine oil changed.
- V section stripped and gasket renewed

1991

- Cylinder head repaired.

Unit #8

1995

- Muffler painted.
- Engine cleaned and painted.

1992

- Rectifier board replaced.

Unit #10

1996

- Immersion heater replaced.

1995

- Muffler repaired and painted.
- New exhaust stack liner installed.

1993

- Generator air filters replaced.
- Engine cooling tower air intake louvres and actuator motor replaced.
- Engine oil changed (@ 1533 hrs).
- Cooling system antifreeze changed.
- Governor oil changed.

<u>Other</u>

1995

- Main powerhouse control room extended to include Unit #10 controls. Old enclosure retired.
- Main powerhouse shingles replaced/repaired.
- Old main fuel tanks and day tanks removed and replaced by two 22,700 L self dyked tanks.

Required Maintenance:

- Unit #2 generator rewind.
- Main powerhouse generators require stator/rotor cleaning.
- Installation of anti condensation strip heaters on main powerhouse generators.
- Minor water leaks around exhaust pipes.
- Main powerhouse roof leaks.
- Main powerhouse requires painting (Budgeted - 1996).
- Mufflers on Units #2, 4, 5 & 8 require repair.
- Window repair/replacement in main powerhouse (Budgeted - 1996).
- Main powerhouse switchgear metering and protection require replacement.
- New fuel tanks require grating on steps (Budgeted - 1996).
- Fuel tank grounding and site grading required (Budgeted - 1996).
- Fuel flow metering required for main plant.
- Governor overhaul.

Unit #10 Maintenance:

- Exterior repair and painting (Budgeted - 1996).
- Internal lighting (Budgeted - 1996)
- Governor overhaul.
- Cooling air louvre motor controls.
- Black start feature inoperative.
- Fuel flow meter.

Required Inspections:

- Air receiver and system requires annual inspection and certification by Department of Labour.

Spare Parts:

- Unit #10 engine is still in production and is supported by GM through Midwest Power Products, Winnipeg. Caterpillar engines are old but parts can still be obtained. Some spares are kept on site.
- Other components are easily repaired or replaced.

Environmental Restraints: None

Remaining Service Life:

Unit #1, 3, 4, 5, 8: 5 years
Unit #2: 0 years
Unit #10: 10 years

Factors Affecting Remaining Service Life:

1. Plant usage.
2. Generator stator/rotor cleaning.
3. Availability of spare parts.
4. Implementation of preventative maintenance program.

Plant: Port Union Diesel
Location: Port Union

Inspected by: M. Hunter
Date: 1996-04-01

Description: Unit consists of one 500 KW diesel generator set manufactured by Caterpillar. Unit is located in the Port Union Hydro Plant and consists of auxiliaries such as cooler, fuel tank and switchgear.

Specifications: See Technical Data Sheet in Appendix C3.

Date Installed: 1962

Operational Duty: Emergency power in the event of transmission line system outage.

Recent Operating Pattern:

Year	Generation (Kwh)
1991	4,620
1992	3,560
1993	3,320
1994	7,160
1995	4,070

Operation for Reliability Check: Unit is started, synchronized and put on load monthly.

General Conditions: Equipment is in good condition. New fuel tank has been installed. Fuel flow meter is inoperative.

Recent Major Maintenance:

1996
- Cooler and after cooler cleaned.

1994
- 9000 litre self-dyked steel fuel storage tank installed.

1991
- Two new batteries installed.

Required Maintenance:

- New fuel flow meter required.
- Tachometer required for engine.
- Muffler requires painting.
- Governor overhaul.

Required Inspections:

- Underground fuel lines require annual testing for leaks and corrosion protection.

Spare Parts:

- Caterpillar still stock spares for the engine. Some minor spares kept on site.
- Other components are easily repaired or replaced.

Environmental Restraints: None

Remaining Service Life: 5 years

Factors Affecting Service Life:

1. Low usage of plant.
2. Regular preventative maintenance.
3. Spare parts availability.

APPENDIX B

LOW SPEED DIESEL PLANT SPECIFICATIONS

B1 AGUATHUNA

B2 ST. JOHN'S

B3 SALT POND

B4 GANDER

APPENDIX B1

Aguathuna Diesel Plant - Data Sheet

Engine Manufacturer	Harland & Wolff
Engine No.	2476
Engine HP	2000
Alternator Manufacturer	Harland & Wolff
No.	18180
kW	1200
rpm	327
Volts	2400
Amps	361
Phase	3
Cycles (Hz)	60
Power Factor	.8
Rating	Continuous
Excitation Volts	102
Excitation Amps	147
Exciter Manufacturer	Harland & Wolff
No.	18140
kW	15.6
rpm	327
Volts	104
Amps	150
Rating	Continuous

APPENDIX B2

St. John's Diesel Plant - Data Sheet

Engine Manufacturer	Nordberg
Engine No.	201200804
Bore x Stroke	21-1/2" x 31
rpm	225
Governor	Woodward Type 1C 500
BHP	3580
Generator Manufacturer	General Electric Type A.T.1
kVa	3125
kW	2500
Volts	6600
Amps	274 Armature 228 Field
Excitation	125 V
Phase	3
Cycles (Hz)	60
Temp. Rise	60 degrees C
P.F.	.8
Exciter Model	33G743
Type	CD 1126
Speed	1150 rom
Volts	125
Amps	240

APPENDIX B3

Salt Pond Diesel Plant - Data Sheet

Engine	Unit G1	Unit G2	Unit G3
Manufacturer	Worthington	Worthington	Worthington
Engine No.	VO1633	VO1635	VO1680
Type	EE 6 Std	EE 6 Std	EE 6 Std
rpm	327	327	327
Generator			
Manufacturer	Electric Machinery	Electric Machinery	Electric Machinery
Serial No.	82363	83539	82362
kVa	625	625	625
PF	.8	.8	.8
Volts	4160	4160	4160
Amps	87	87	87
rpm	327	327	327
Phase	3	3	3
Cycles (Hz)	60	60	60
Temp. Rise			
Armature	40 degrees C	40 degrees C	40 degrees C
Field	50 degrees C	50 degrees C	50 degrees C
Time Rating		25% overload 2 hours	
Exciter			
Serial No.	1899422	1899402	19001100
kW	15	15	15
Volts	125	125	125
Amps	120	120	120
rpm	327	327	327

APPENDIX B4

Gander Diesel Plant - Data Sheet

Unit No.	No. 1	No. 2	No. 3
Engine			
Manufacturer	Polar Atlas	Nohab-Polar	Nohab-Polar
Type	K57M	K57M	K57M
BHP	1470	1470	1470
rpm	300	300	300
No.	86190	1611	1466
Generator			
Manufacturer	CGE	CGE	CGE
Frame	6426M	6426M	6426M
Model	664021	78393	74258
No.	404125	604571	604318
kVa	1250	1250	1250
kW	1000	1000	1000
Volts	2300	2300	2300
Excitation			
Volts	125	125	125
Amps	100	100	100

APPENDIX C

HIGH SPEED DIESEL PLANT SPECIFICATIONS

C1 MOBILE DIESELS

C2 PORT AUX BASQUES

C3 PORT UNION

APPENDIX C1

MOBILE DIESELS

	Unit #1	Unit #2
Engine		
Manufacturer	Caterpillar	Caterpillar
Model	D-349	D-349
Serial No.	61P476	61P809
Rating (HP)	980	980
Alternator		
Manufacturer	Tamper-Camron	Brown-Boveri
Model	SG-1473	715
Serial No.	363-088-101	C-360-690-601
Rating (kW)	700	670
RPM	1800	1800
Volts	347/600	347/600
P.F.	0.85	0.85

APPENDIX C2

Port Aux Basques

	1	4	2	8	3	5	10
Engine	Caterpillar	Caterpillar	Caterpillar	Caterpillar	Caterpillar	Caterpillar	GM
Type	D397	D386	D353	D353	D397	D386	20-645-E4
Serial No.	41B1388	15B1	46B	46B1663	48B1181	15V54	64E1 1081
H.P.	505	344			505	364	3600
Size	12 cyl 5-3/ 4x8 5.75 x 8"	12 cyl. 5.75 x 8"	6 cyl. 6.25 x 8"	6 cyl. 6.25 x 8"	12 cyl 5-3/ 4x8" 5.75 x 8"	12 cyl 5-3/ 4x8" 5.75 x 8"	20 cyl. 9-1/16x10"
rpm	1200	1200	1200	1200	1200	1200	900
Generator		Gen. Elect.					
Serial No.	850RN60 0	6842237	2505N17	2050N16	350RN2	6917550	69-E1-1199 (1081)
Frame		966	683	683			
kVa	438	262	315	312	438	282	3125
kW	350	209	250	250	350	250	2500
P.F.	.8	.8	.8	.8	.8	.8	.8
Volts	2400	2400	2400	2400	2400	2400	4160
Amps	105	71	75	75	108	75.4	
Phase	3	3	3	3	3	3	3
Cycle	60	60	60	60	60	60	60
Exciter							
Amps	40	40	53	53	40	40	
Volts	125	125	77	77	125	125	

APPENDIX C3

Port Union Diesel

Engine

Manufacturer:	Caterpillar
Model:	D-398A
Serial No.:	6613127, Series A
Rating (HP):	750
RPM:	1200

Alternator

Manufacturer:	General Electric
Model:	102041-A
Frame:	7635
Serial No.:	754784
Rating (kW):	500
Volts:	2400
PF:	0.80
RPM:	1200

Exciter

Manufacturer:	General Electric
Model:	101424A
Type:	BF-823
Serial No.:	749761
Rating (kW):	6

APPENDIX D

COSTING

TABLE 1

PLANT	1990 TOTAL OPERATING COST	1990 FUEL COST	1990 NET OPERATING	1991 TOTAL OPERATING COST	1991 FUEL COST	1991 NET OPERATING	1992 TOTAL OPERATING COST	1992 FUEL COST	1992 NET OPERATING	1993 TOTAL OPERATING COST	1993 FUEL COST	1993 NET OPERATING	1994 TOTAL OPERATING COST	1994 FUEL COST	1994 NET OPERATING	1995 TOTAL OPERATING COST	1995 FUEL COST	1995 NET OPERATING
Aguathuna	$ 5,347.00	$ 433.00	$ 4,914.00	$ 17,558.00	$ 435.00	$ 17,123.00	$ 8,373.00	$ 745.00	$ 7,628.00	$ 21,865.00	$ 795.00	$ 21,070.00	$ 13,472.00	$ 596.00	$ 12,876.00	$12,453.00	$ 447.00	$12,006.00
Gander	$ 3,520.00	$ 66.00	$ 3,454.00	$ 32,806.00	$ 182.00	$ 32,624.00	$ 76,989.00	$ 332.00	$ 76,657.00	$ 16,023.00	$ 188.00	$ 15,835.00	$ 26,790.00	$ 512.00	$ 26,278.00	$39,934.00	$ 137.00	$39,797.00
Port Union	$ 1,308.00	$ 786.00	$ 522.00	$ 189.00	$ 438.00	$ (249.00)	$ 681.00	$ 326.00	$ 355.00	$ 762.00	$ 235.00	$ 527.00	$ 1,404.00	$ 623.00	$ 781.00	$ 314.00	$ 292.00	$ 22.00
PAB	$ 57,055.00	$ 3,953.00	$ 53,102.00	$ 75,130.00	$ 12,788.00	$ 62,342.00	$ 69,490.00	$ 19,863.00	$ 49,627.00	$ 54,553.00	$12,649.00	$ 41,904.00	$ 55,784.00	$12,404.00	$ 43,380.00	$42,115.00	$ 5,190.00	$36,925.00
St.John's	$ 19,480.00	$ 1,524.00	$ 17,956.00	$ 12,795.00	$ 50.00	$ 12,745.00	$ 44,719.00	$ 2,102.00	$ 42,617.00	$ 4,428.00	$ 998.00	$ 3,430.00	$ 8,152.00	$ 2,562.00	$ 5,590.00	$ 6,927.00	$ -	$ 6,927.00
Salt Pond	$ 8,704.00	$ 453.00	$ 8,251.00	$ 8,741.00	$ 250.00	$ 8,491.00	$ 6,124.00	$ 1,203.00	$ 4,921.00	$ 5,659.00	$ 859.00	$ 4,800.00	$ 7,038.00	$ 156.00	$ 6,882.00	$ 6,178.00	$ 480.00	$ 5,698.00
Portable # 1	$ -	$ 2,029.00	$ (2,029.00)	$ 3,335.00	$ -	$ 3,335.00	$ 45,576.00	$ 1,996.00	$ 43,580.00	$ 4,458.00	$ 2,049.00	$ 2,409.00	$ 3,013.00	$ 2,015.00	$ 998.00	$ 2,371.00	$ 1,042.00	$ 1,329.00
Portable # 2	$ 4,858.00	$ 769.00	$ 4,089.00	$ 3,650.00	$ -	$ 3,650.00	$ 13,827.00	$ 52.00	$ 13,775.00	$ 4,769.00	$ 1,613.00	$ 3,156.00	$ 4,332.00	$ 1,584.00	$ 2,748.00	$ 6,658.00	$ 885.00	$ 5,773.00
			$ -			$ -			$ -			$ -			$ -			$ -
Greenhill GT	$ 156,308.00	$ 129,804.00	$ 26,504.00	$ 81,761.00	$ 55,181.00	$ 26,580.00	$110,308.00	$ 25,142.00	$ 85,166.00	$ 83,207.00	$35,587.00	$ 47,620.00	$ 137,742.00	$75,853.00	$ 61,889.00	$86,875.00	$ 4,500.00	$82,375.00
Salt Pond GT	$ 85,303.00	$ 64,116.00	$ 21,187.00	$ 85,666.00	$ 25,590.00	$ 60,076.00	$ 60,017.00	$ 16,170.00	$ 43,847.00	$ 55,459.00	$ 1,207.00	$ 54,252.00	$ 68,970.00	$31,078.00	$ 37,892.00	$60,548.00	$12,656.00	$47,892.00
Portable GT	$ 134,687.00	$ 59,087.00	$ 75,600.00	$ 44,363.00	$ 56,631.00	$(12,268.00)	$106,166.00	$ 49,432.00	$ 56,734.00	$ 27,121.00	$28,236.00	$ (1,115.00)	$ 48,922.00	$31,078.00	$ 17,844.00	$53,905.00	$22,900.00	$31,005.00

TABLE 2

PLANT	TOTAL OPERATING AVERAGE	TOTAL FUEL AVERAGE	TOTAL NET AVERAGE	INSURANCE COST	MUNICIPAL TAXES	OTHER COSTS	TOTAL VARIABLE COST	VARIABLE LABOUR COST PER KWH	NORMALIZED FUEL COST PER KWH	TOTAL VARIABLE COST PER KWH	FIXED COST PER KW	TAX, INSUR & OTHER PER KW	TOTAL FIXED COST PER KW	AVERAGE ANNUAL COST PER KW	AVERAGE ANNUAL COST PER KWH
Aguathuna	$ 13,178.00	$ 575.17	$ 12,602.83	$ 1,515.00	$ 466.25	$ -	$ 853.88	$ 0.045	$ 0.068	$ 0.113	$ 10.27	$ 1.65	$ 11.92	$ 12.50	$ 2.43
Gander	$ 23,814.60	$ 217.00	$ 23,597.60	$ 2,659.00	$ 1,649.17	$ -	$ 278.16	$ 0.052	$ 0.140	$ 0.192	$ 8.88	$ 1.63	$ 10.51	$ 10.59	$ 23.73
Port Union	$ 893.80	$ 452.40	$ 441.40	$ -	$ -	$ -	$ 696.55	$ 0.050	$ 0.080	$ 0.130	$ 0.39	$ -	$ 0.39	$ 1.66	$ 0.17
PAB - Main Plant	$ 47,098.89	$ 5,155.96	$ 41,942.93	$ 1,564.00	$ 1,070.66	$ -	$ 5,847.45	$ 0.013	$ 0.096	$ 0.109	$ 24.87	$ 1.59	$ 26.45	$ 29.97	$ 0.93
PAB - Unit 10	$ 11,922.28	$ 5,732.64	$ 6,189.64	$ 801.00	$ 175.74	$ -	$ 5,847.89	$ 0.001	$ 0.071	$ 0.072	$ 2.43	$ 0.39	$ 2.82	$ 5.16	$ 0.16
St.John's	$ 16,083.50	$ 1,206.00	$ 14,877.50	$ 3,639.00	$ 4,268.86	$ -	$ 1,392.26	$ 0.010	$ 0.061	$ 0.071	$ 5.88	$ 3.16	$ 9.04	$ 9.57	$ 1.28
Salt Pond	$ 7,074.00	$ 566.83	$ 6,507.17	$ 1,764.00	$ 1,159.20	$ -	$ 634.70	$ 0.017	$ 0.121	$ 0.138	$ 4.29	$ 1.95	$ 6.24	$ 6.62	$ 2.44
Portable # 1	$ 3,294.25	$ 1,276.50	$ 2,017.75	$ -	$ -	$ -	$ 2,140.21	$ 0.036	$ 0.072	$ 0.108	$ 1.65	$ -	$ 1.65	$ 5.37	$ 0.16
Portable # 2	$ 4,853.40	$ 970.20	$ 3,883.20	$ -	$ -	$ -	$ 1,445.35	$ 0.037	$ 0.078	$ 0.115	$ 5.09	$ -	$ 5.09	$ 7.28	$ 0.38
TOTALS	$ 128,212.72	$ 16,152.70	$ 112,060.02	$ 11,942.00	$ 8,789.88	$ -									
Greenhill GT	$ 109,366.83	$ 54,344.50	$ 55,022.33	$ 17,444.00	$ 1,470.00		$ 54,886.90	$ 0.001	$ 0.119	$ 0.120	$ 2.18	$ 0.76	$ 2.94	$ 5.30	$ 0.27
Salt Pond GT	$ 69,327.17	$ 25,136.17	$ 44,191.00	$ 11,600.00	$ -		$ 25,521.88	$ 0.002	$ 0.112	$ 0.114	$ 2.98	$ 0.79	$ 3.77	$ 5.52	$ 0.36
Portable GT	$ 85,920.00	$ 40,624.25	$ 45,295.75	$ 9,406.00	$ -	$ -	$ 41,469.28	$ 0.003	$ 0.152	$ 0.155	$ 6.09	$ 1.29	$ 7.38	$ 12.63	$ 0.37

NOTES:

1. Averages corrected for data anomolies in Table 1.
2. Total variable cost is based on operating hours per year times $25/hr plus actual fuel costs.
3. Variable cost per year is based on operating hours per year times $25.hr divided by average generation for years 1990 to 1995 (Diesel Plant Efficiency calculation).
4. Normalized fuel cost from Diesel Plant Efficiency calculation.
5. Fixed cost is total operating average minus total variable cost divided by installed capacity.
6. Aguathuna variable labour adjusted by 6 hours per year for travel to/from plant for production purposes (ie. quarterly run - 2 hrs per trip).
7. Gander and Greenhill variable cost adjusted by 2 hours per year for travel to/from plant for production purposes (ie. travel for annual operation - 2 hours per run).
8. Other cost for Gander is for the rent of the land on which the building sits. To be effective July 1, 1996.
9. Salt Pond costs split betwen gas turbine & diesel based on installed capacities as there is one account code for both.
10. Diesel insurance is for structures /property only as equipment premium is insignificant. Gas turbine insurance premium is for both.
11. PAB diesel generation split based on installed capacity. Operating cost split based on # of units in plant.
Fuel Costs based on Unit # 10 efficiency and calculated net plant efficiency. Insurance split based on actual equipment value. Taxes split based on area occupied by main plant and Unit # 10.

ST. JOHN'S DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	AVE
Production (kwh)	18080	800	27608	12160	34480	0	18626
Fuel (l)	5258	159	7122	3386	8690	0	4923
Cost ($)	$ 1,524.16	$ 50.05	$ 2,102.11	$ 998.19	$ 2,561.81	$ -	$ 1,447.26
Fuel Efficiency (kwh/l)	3.44	5.03	3.88	3.59	3.97	#DIV/0!	3.98
Cost Efficiency ($/kwh)	$ 0.084	$ 0.063	$ 0.076	$ 0.082	$ 0.074	#DIV/0!	$ 0.076
			Normalized Cost Effy @		$ 0.2420	per litre	$ 0.061

GANDER DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	
Production (kwh)	600	1200	1200	1000	2500	600	1183
Fuel (l)	250	568	1037	585	1598	428	744
Cost ($)	$ 66.11	$ 181.95	$ 332.46	$ 187.55	$ 512.32	$ 137.22	$ 236.27
Fuel Efficiency (kwh/l)	2.40	2.11	1.16	1.71	1.56	1.40	1.72
Cost Efficiency ($/kwh)	$ 0.110	$ 0.152	$ 0.277	$ 0.188	$ 0.205	$ 0.229	$ 0.193
			Normalized Cost Effy @		$ 0.2420	per litre	$ 0.140

SALT POND DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	
Production (kwh)	3800	2460	7170	5620	1440	3940	4072
Fuel (l)	1824	1005	4825	3224	635	2137	2275
Cost ($)	$ 453.00	$ 250.75	$ 1,203.85	$ 859.05	$ 156.17	$ 479.61	$ 567.07
Fuel Efficiency (kwh/l)	2.08	2.45	1.49	1.74	2.27	1.84	1.98
Cost Efficiency ($/kwh)	$ 0.119	$ 0.102	$ 0.168	$ 0.153	$ 0.108	$ 0.122	$ 0.129
			Normalized Cost Effy @		$ 0.2398	per litre	$ 0.121

AGUATHUNA DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	
Production (kwh)	6680	4890	7540	7190	5790	4980	6178
Fuel (l)	1783	1476	2045	2183	1636	1365	1748
Cost ($)	$ 433.09	$ 435.52	$ 745.00	$ 795.27	$ 596.00	$ 446.61	$ 575.25
Fuel Efficiency (kwh/l)	3.75	3.31	3.69	3.29	3.54	3.65	3.54
Cost Efficiency ($/kwh)	$ 0.065	$ 0.089	$ 0.099	$ 0.111	$ 0.103	$ 0.090	$ 0.093
			Normalized Cost Effy @		$ 0.2420	per litre	$ 0.068

PORT UNION DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	
Production (kwh)	6570	4620	3560	3320	7160	4070	4883
Fuel (l)	2340	1616	1269	914	2444	1305	1648
Cost ($)	$ 786.24	$ 437.95	$ 326.39	$ 235.46	$ 623.08	$ 291.99	$ 450.19
Fuel Efficiency (kwh/l)	2.81	2.86	2.81	3.63	2.93	3.12	3.03
Cost Efficiency ($/kwh)	$ 0.120	$ 0.095	$ 0.092	$ 0.071	$ 0.087	$ 0.072	$ 0.089
			Normalized Cost Effy @		$ 0.2420	per litre	$ 0.080

PORT AUX BASQUES DIESEL

	YEAR						
	1990	1991	1992	1993	1994	1995	
Production (kwh)	44498	177640	228230	139669	149493	65716	134208
Fuel (l)	16779	49678	66953	43619	44967	19046	40174
Cost ($)	$ 3,953.00	$12,789.67	$19,862.99	$12,649.33	$12,404.17	$ 5,190.06	$ 11,141.54
Fuel Efficiency (kwh/l)	2.65	3.58	3.41	3.20	3.32	3.45	3.27
Cost Efficiency ($/kwh)	$ 0.089	$ 0.072	$ 0.087	$ 0.091	$ 0.083	$ 0.079	$ 0.083
			Normalized Cost Effy @		$ 0.2480	per litre	$ 0.076

PORTABLE DIESEL # 1

YEAR	1990	1991	1992	1993	1994	1995	
Production (kwh)	33830	0	23080	22610	26120	15280	24184
Fuel (l)	8385	0	6498	7538	7811	4513	6949
Cost ($)	$ 2,029.17	$ -	$ 1,996.43	$ 2,048.73	$ 2,015.10	$ 1,042.47	$ 1,826.38
Fuel Efficiency (kwh/l)	4.03	#DIV/0!	3.55	3.00	3.34	3.39	3.46
Cost Efficiency ($/kwh)	$ 0.060	#DIV/0!	$ 0.087	$ 0.091	$ 0.077	$ 0.068	$ 0.076
			Normalized Cost Effy @		$ 0.2480	per litre	$ 0.072

PORTABLE DIESEL # 2

YEAR	1990	1991	1992	1993	1994	1995	
Production (kwh)	13000	0	410	17900	19660	12700	12734
Fuel (l)	3176	0	177	5966	6164	3822	3861
Cost ($)	$ 768.60	$ -	$ 52.57	$ 1,612.67	$ 1,583.65	$ 884.66	$ 980.43
Fuel Efficiency (kwh/l)	4.09	#DIV/0!	2.32	3.00	3.19	3.32	3.18
Cost Efficiency ($/kwh)	$ 0.059	#DIV/0!	$ 0.128	$ 0.090	$ 0.081	$ 0.070	$ 0.086
			Normalized Cost Effy @		$ 0.2480	per litre	$ 0.078

SALT POND GAS TURBINE

YEAR	1990	1991	1992	1993	1994	1995	
Production (kwh)	475900	217400	134700	7600	396400	128800	226800
Fuel (l)	273200	92590	54419	4360	175415	56478	109410
Cost ($)	$ 64,116.26	$25,590.19	$16,170.64	$ 1,207.20	$31,077.74	$12,656.29	$ 25,136.39
Fuel Efficiency (kwh/l)	1.74	2.35	2.48	1.74	2.26	2.28	2.14
Cost Efficiency ($/kwh)	$ 0.135	$ 0.118	$ 0.120	$ 0.159	$ 0.078	$ 0.098	$ 0.118
			Normalized Cost Effy @		$ 0.2398	per litre	$ 0.112

MOBILE GAS TURBINE

YEAR	1990	1991	1992	1993	1994	1995	
Production (kwh)	378000	319200	279250	160650	194300	149100	246750
Fuel (l)	244781	186480	158377	102634	119553	94245	151012
Cost ($)	$ 59,087.43	$56,631.48	$49,432.07	$28,236.02	$31,077.74	$22,899.85	$ 41,227.43
Fuel Efficiency (kwh/l)	1.54	1.71	1.76	1.57	1.63	1.58	1.63
Cost Efficiency ($/kwh)	$ 0.156	$ 0.177	$ 0.177	$ 0.176	$ 0.160	$ 0.154	$ 0.167
			Normalized Cost Effy @		$ 0.2480	per litre	$ 0.152

GREENHILL GAS TURBINE

YEAR	1990	1991	1992	1993	1994	1995	
Production (kwh)	953000	433000	172000	238000	666000	29000	492400
Fuel (l)	544744	184705	80496	120964	289049	18458	243992
Cost ($)	$ 129,804.46	$55,181.05	$25,142.32	$35,586.55	$75,853.46	$ 4,500.13	$ 64,313.57
Fuel Efficiency (kwh/l)	1.75	2.34	2.14	1.97	2.30	1.57	2.01
Cost Efficiency ($/kwh)	$ 0.136	$ 0.127	$ 0.146	$ 0.150	$ 0.114	$ 0.155	$ 0.138
			Normalized Cost Effy @		$ 0.2398	per litre	$ 0.119

		Years	5	10	15
	Discount	Rate	10.25%		
	Capital Cost Gross-up	Factor	1.3		
	AGUATHUNA				
ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
1	Unit Overhaul	$ 150,000.00			
2	Insulation Replacement	$ 10,000.00			
3	Air Compressor Repair		$ 10,000.00		
4	Lube oil change and sump cleaning	$ 10,000.00			
5	New springs for air starter valves	$ 5,000.00			
6	Exhaust stack painting	$ 3,500.00			
7	Radiator cooling lines replacement		$ 4,000.00		
8	Radiator frame painting	$ 3,500.00			
9	Radiator fan & motor replacement		$ 10,000.00		
10	Building exhaust fan louvre replacement		$ 2,000.00		
11	Main plant lighting maintenance	$ 2,000.00			
12	Replacement of damaged & corroded doors		$ 2,000.00		
13	Transformer radiator replacement		$ 30,000.00		
14	Instrumentation Replacement		$ 10,000.00		
15	Protective relay maintenance	$ 1,500.00			
16	Building painting	$ 5,000.00			
17	Replacement of air intake filters		$ 5,000.00		
18	Fuel flow meter		$ 1,500.00		
19	Thermoscan on switchgear	$ 500.00			
20	Crane Inspection	$ 500.00			
21	Governor overhaul	$ 2,000.00			
	Capital Total		$ 74,500.00		
	Totals inc. Financing Costs	$ 193,500.00	$ 96,850.00	$ 290,350.00	
	Average Annual Cost		@10yr ext	($47,761.79)	
	Average Annual cost per KW			($39.80)	
	GANDER				
ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
1	Evaporative Cooler Overhaul	$ 30,000.00			
2	Insulation Replacement	$ 10,000.00			
3	Thermoscan on switchgear	$ 500.00			
4	Building exterior repairs and painting		$ 20,000.00		
5	Protective relay maintenance	$ 1,500.00			
6	Sump & outfall area cleaning	$ 1,500.00			
7	Engine overhauls	$ 450,000.00			
8	Cleaning and painting of # 2 Stack	$ 2,500.00			
9	Painting of # 1 & 3 stack	$ 2,500.00			
10	Fuel tank painting	$ 2,500.00			
11	Fuel flow meter		$ 1,500.00		
12	Instrumentation Replacement		$ 21,000.00		
13	Crane Inspection	$ 500.00			
14	Governor overhauls	$ 6,000.00			
	Capital Total		$ 42,500.00		
	Totals inc. Financing Costs	$ 507,500.00	$ 55,250.00	$ 562,750.00	
	Average Annual Cost		@ 10 yr ext	($92,570.86)	
	Average Annual Cost per KW			($34.93)	

ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
	PORT UNION				
1	Fuel flow meter		$ 600.00		
2	Engine tachometer		$ 700.00		
3	Muffler repairs and painting	$ 2,000.00			
4	Protective relay maintenance	$ 1,000.00			
5	Instrumentation calibration	$ 1,000.00			
6	Governor overhaul	$ 2,000.00			
	Capital Total		$ 1,300.00		
	Totals inc. Financing Costs	$ 6,000.00	$ 1,690.00	$ 7,690.00	
	Average Annual Cost		@ 10 yr ext	($1,264.98)	
	Average Annual Cost per KW			($2.53)	

ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
	PORT AUX BASQUES				
1	Plant Ventilation		$ 15,000.00		
2	Exhaust Pipe Insulation		$ 20,000.00		
3	Unit # 2 rewind		$ 20,000.00		
4	Main powerhouse generator cleaning	$ 5,500.00			
5	Anticondensation strip heaters on generators		$ 5,000.00		
6	Powerhouse painting	$ 3,000.00			
7	Muffler # 2,4,5 & 8 repair	$ 5,500.00			
8	Window replacement in main powerhouse		$ 4,000.00		
9	Main powerhouse switchgear replacement		$ 460,000.00		
10	Fuel tank grating	$ 250.00			
11	Fuel tank grounding & grading	$ 250.00			
12	Fuel flow meter		$ 1,500.00		
13	Instrumentation Replacement		$ 15,000.00		
14	Governor overhauls	$ 12,000.00			
	Capital Total		$ 540,500.00		
	Totals inc. Financing Costs	$ 26,500.00	$ 702,650.00	$ 729,150.00	
	Average Annual Cost		@ 10 yr ext	($119,943.21)	
	Average Annual Cost per KW			($72.30)	

ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
	PORT AUX BASQUES - Unit # 10				
1	Unit Overhaul	$ 190,000.00			
2	Fuel flow meter		$ 1,500.00		
3	Unit # 10 exterior repair & painting	$ 5,000.00			
4	Unit # 10 improved internal lighting	$ 1,600.00			
5	Unit # 10 governor overhaul & calibration	$ 5,000.00			
6	Unit # 10 new cooling air louvre controls		$ 1,000.00		
7	Unit # 10 repair of black start feature	$ 2,000.00			
8	Instrumentation Calibration	$ 3,500.00			
9	Fuel tank grounding & grading	$ 250.00			
10	Fuel tank grating	$ 250.00			
11	Instrument calibration	$ 500.00			
12	Protective relay calibration	$ 1,000.00			
	Capital Total		$ 2,500.00		
	Totals inc. Financing Costs	$ 209,100.00	$ 3,250.00	$ 212,350.00	
	Average Annual Cost		@ 15 yr ext	($28,318.03)	
	Average Annual Cost per KW			($11.33)	

	ST. JOHN'S			
ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST	
1	Unit Overhaul	$ 150,000.00		
2	Exhaust stack painting	$ 5,000.00		
3	Fuel tank replacement & security fencing		$ 5,000.00	
4	Access ladder painting	$ 1,200.00		
5	Plant spill kit	$ 600.00		
6	New fuel flow meter		$ 1,500.00	
7	Instrumentation Replacement		$ 10,000.00	
8	Governor overhaul	$ 2,000.00		
	Capital Total		$ 16,500.00	
	Totals inc. Financing Costs	$ 158,800.00	$ 21,450.00	$ 180,250.00
	Average Annual Cost		@ 10 yr ext	($29,650.64)
	Average Annual Cost per KW			($11.86)
	SALT POND			
ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST	
1	Unit overhauls and general repairs	$ 333,000.00		
2	Fire Suppression System		$ 30,000.00	
3	Fuel Day Tank		$ 5,000.00	
4	Muffler Painting	$ 5,000.00		
5	New battery bank		$ 10,000.00	
6	Protection & relay improvements		$ 50,000.00	
7	Cooling water system reinstatement		$ 30,000.00	
8	Fuel flow meter		$ 1,500.00	
9	Crane inspection	$ 800.00		
10	Instrumentation Replacement		$ 21,000.00	
11	Governor overhauls	$ 6,000.00		
	Capital Total		$ 147,500.00	
	Totals inc. Financing Costs	$ 344,800.00	$ 191,750.00	$ 536,550.00
	Average Annual Cost		@ 10 yr ext	($88,261.03)
	Average Annual Cost per KW			($58.84)
	PORTABLE # 1			
ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST	
1	Repair oil leak/clean generator, rad & fan	$ 5,500.00		
2	Reverse power relay repair/replacement		$ 1,000.00	
3	New battery charger	$ 250.00		
4	Chasis painting	$ 2,000.00		
5	Relay Maintenance	$ 500.00		
6	Instrumentation Replacement		$ 2,500.00	
7	Flow Meter		$ 1,500.00	
8	Governor overhaul	$ 2,000.00		
	Capital Total		$ 5,000.00	
	Totals inc. Financing Costs	$ 10,250.00	$ 6,500.00	$ 16,750.00
	Average Annual Cost		@ 10 yr ext	($2,755.33)
	Average Annual Cost per KW			($3.94)

ITEM	DESCRIPTION	OPERATING COST	CAPITAL COST		
	PORTABLE # 2				
1	AVR repair	$ 1,000.00			
2	Repair/replacement of underfrequency relay		$ 1,000.00		
3	Alternator repair	$ 500.00			
4	Chasis repair		$ 50,000.00		
5	Repair oil leak/clean gen, rad & fan	$ 5,500.00			
6	Unit grounding	$ 500.00			
7	Relay Maintenance	$ 500.00			
8	Instrumentation Replacement		$ 2,500.00		
9	Flow Meter		$ 1,500.00		
10	Governor overhaul	$ 2,000.00			
	Capital Total		$ 55,000.00		
	Totals inc. Financing Costs	$ 10,000.00	$ 71,500.00	$ 81,500.00	
	Average Annual Cost		@ 10 yr ext	($13,406.53)	
	Average Annual Cost per KW			($20.01)	
	TOTAL COSTS ON ALL DIESELS	$ 1,466,450.00	$ 1,150,890.00	$ 2,617,340.00	
	Average Annual Cost			$ (423,932.40)	
	Average Annual Cost per KW			($30.54)	

Notes:

1. Annual cost developed by adding the capital and operating expense.
2. PTU, PAB, AGA, SJN, SLP & Mobiles assumed to have 10 yrs life; GM @ PAB assumed to have 15 yrs life; GAN to have 5 yrs life.
3. Capital cost gross-up calculation based on a 10.25 % WACOC, 4% CCA and life noted a tax rate of 42%, a large corp tax of 0.225% and assumes no net salvage. Planning spreadsheet used.

PLANT	INSTALLED CAPACITY	AVERAGE GENERATION	OPERATION PER YEAR
Aguathuna	1200	6178	5.1
Gander	2650	1183	0.4
Port Union	500	4883	9.8
PAB - Main Plant	1659	53535	32.3
PAB - Unit 10	2500	80673	32.3
St.John's	2500	18626	7.5
Salt Pond	1500	4072	2.7
Portable # 1	700	24184	34.5
Portable # 2	670	12734	19.0
Total Diesel	13879	206068	143.6
Greenhill GT	25000	492400	19.7
Salt Pond GT	14700	226800	15.4
Portable GT	7300	246750	33.8

	Unit Size	2500	kw			
	Fuel Rate	0.295	l/kwhr			
	Capital Cost Gross-up Factor	1.3				
ITEM	DESCRIPTION	COST ESTIMATE				
1	**General Site**					
	Excavation	$ 14,364.00				
	Site Drainage	$ 8,316.00				
2	**Site Services**					
	Storage Tank Installation	$ 20,034.00				
	Piping, Valves, etc.	$ 15,120.00				
	Foundations	$ 15,120.00				
3	**Prime Mover**					
	Unit Purchase	$ 940,000.00				
	Freight	$ 9,998.10				
	Installation	$ 37,800.00				
4	**Electrical**					
	General Systems	$ 28,350.00				
	Substation & Transformer	$ 315,000.00				
5	**Engineering**					
	Engineering	$ 48,800.00				
	Site Supervision	$ 59,360.00				
6	**IDC**	$ 120,980.97				
7	**Contingency**	$ 151,226.21				
	TOTAL	$ 1,784,469.28				
	NPV of Total & Financing	$ 2,319,810.06				
	Life Expectancy	20	yrs			
	Discount Rate	10.25%				
	Annual Levelized Cost	($277,148.24)				
	Levelized Cost/kw-yr	$ (110.86)				
	Fueling Cost	0.073	$/kwh			
	Variable Labour Rate	0.010	$/kwh			
	Annual Generation	80750	kwh			
	Annual Variable Cost	$ 6,715.17				
	Total Yearly Cost	$ 283,863.41				
Note:	1. Capital cost gross-up calculation based on a 10.25 % WACOC, 4% CCA and life noted a tax rate of 42%, a large corp tax of 0.225% and assumes no net salvage. Planning spreadsheet used.					

New Gas Turbine Estimate

	Unit Size	2225	kw
	Fuel Rate	0.408	l/kwhr
	Capital Cost Gross-up Factor	1.3	
ITEM	DESCRIPTION	COST ESTIMATE	
1	**General Site**		
	Excavation	$ 14,364.00	
	Site Drainage	$ 8,316.00	
2	**Site Services**		
	Storage Tank Installation	$ 20,034.00	
	Piping, Valves, etc.	$ 15,120.00	
	Foundations	$ 15,120.00	
3	**Prime Mover**		
	Unit Purchase	$ 690,000.00	
	Freight	$ 9,998.10	
	Installation	$ 37,800.00	
4	**Electrical**		
	General Systems	$ 28,350.00	
	Substation & Transformer	$ 315,000.00	
5	**Engineering**		
	Engineering	$ 48,800.00	
	Site Supervision	$ 59,360.00	
6	**IDC**	$ 100,980.97	
7	**Contingency**	$ 126,226.21	
	TOTAL	$ 1,489,469.28	
	NPV of Total & Financing	$ 1,936,310.06	
	Life Expectancy	20	yrs
	Discount Rate	10.25%	
	Annual Levelized Cost	($231,331.41)	
	Levelized Cost/kw-yr	$ (103.97)	
	Fueling Cost	0.101	$/kwh
	Variable Labour Rate	0.011	$/kwh
	Annual Generation	71867.5	kwh
	Annual Fuel Cost	$ 8,079.34	
	Total Yearly Cost	$ 239,410.75	

Note: 1. Capital cost gross-up calculation based on a 10.25 % WACOC, 4% CCA and life noted a tax rate of 42%, a large corp tax of 0.225% and assumes no net salvage. Planning spreadsheet used.

APPENDIX E

SUPPORTING DOCUMENTATION

1997-01-28

Memorandum From: B. Nickerson
To: P. Hamilton
Subject: Port Aux Basques Diesel Plant Proposed Renovations
File: ENS-0485.06

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The following is a assessment of problems and proposed solutions to extend the operating life of Port Aux Diesel Plant resulting from a plant inspection by B. Nickerson and K. Gill on Jan. 22, 97.

The switchgear at this plant was originally installed in 1943, and consists of open bus with oil filled breakers. The generator breakers are manually closed with series trip coils with published interrupting ratings of 15 MVA. The incoming breakers have been converted to DC trip and close with estimated interrupting capacity of 25 MVA. Maximum fault level is 23 MVA which can occur if a fault were to originate in a generator with the system and the other generators feeding the fault. This is potentially a disastrous situation should a generator breaker fail to clear.

General inspection of the generator leads and power cables revealed brittle and cracked insulation. Consequently condensation or dirt could easily initiate a fault.

During summer operations when the plant is operated so NLH can preform line maintenance, ambient air temperature in the plant has reached 60 degree Celsius. Since the generators are designed for a maximum of 40 degrees Celsius the generator windings are being exposed to excessive temperatures which shorten life.

The overcurrent tripping on the generators is preformed by series trip coils in the breaker handles. This type of protection is extremely unreliable and could result in a breaker failing to trip, since sustained fault current is less than full load current.

There is no reverse power tripping on the generators. If a generator should be shut down by one of it's mechanical protection trips then the generator would be exposed to reverse power until the generator breaker is tripped. This could easily result in major mechanical damage to the diesel engine.

The incoming breakers are more reliable and have been modified for overcurrent and undervoltage relays tripping DC trip coils.

It was also noted all the disconnects in the switchgear are operated normally open in an effort to eliminate switchgear faults from condensation.

There is no surge protection provided on the generators therefore making them vulnerable to switching and lightening spikes.

During high humidity periods the operator installs a (1) KW heater in the air vent of each generator to prevent condensation in the windings.

Two of the diesels which are electric start, share one battery charger which is manually switched between banks by the operator.

All generators are connected in grounded star configuration with their star points solidly grounded. This connection can easily lead to zero sequence circulating currents and result
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in overcurrent operation on different phases. Therefore causing overheating and premature generator failures.

None of the generators has a operating speeder motor to adjust the speed and load on the generator. The operator must manually adjust the speed reference, then move to the control panel to close the breaker. This awkward situation probably results in the generators being synchronised at greater than optimum slip speeds, therefore shortening the life of generator windings and increasing the time for the plant to pick up load.

With these major shortcomings this plant could become a fire hazard should a fault fail to clear while in operation in parallel with the system.

It is proposed to address all of these identified shortcomings by making the following modifications.

1. Replace the switchgear with 50 MVA, 5 KV, 600A class equipment, complete with ct's and pt's, surge protection, neutral transformers and a complete generator protection package. Protection will include reverse power, ground fault and voltage restrained overcurrent and undervoltage at a minimum.
2. Existing excitation controls will be transferred from the old switchgear to the new.
3. All AC metering will be preformed be digital 'Power Measurements' meters, which can read all electrical quantities in one package. All meters will be all read by a local computer terminal. Other plant related data such as fuel levels, temperatures and battery charger alarms will also be monitored and alarmed by the computer package.
4. Anti-condensation heaters will be installed on all generators and will be switched on automatically when the generator breaker opens.
5. All existing cabling to the generators will be replaced.
6. The single 32 volt battery charger will be replaced with (2) 32 volt chargers.
7. A new 125 volt battery and charger will be installed to power the switchgear as well as a no break inverter to power the monitoring computer.
8. A push fan will be installed to provide a cross draft across the generator floor for summer operations.
9. Speeder motors will be installed on all governors so that speed and load can be controlled at the switchgear.
10. Shutdown solenoids will be installed on each generator so that the generators can be electrically shutdown in response to a electrical trip or command at the control panel.
11. Install new AC distribution panel with adequate capacity for all loads but currently supplying all new loads only.

The attached Cost Estimate for this job comes to $453,100.00 well in excess of the $329,000.00 allocated in the budget. In general the difference in cost is the result of making improvements to additional shortcomings over and above the switchgear.

In light of these findings it would appear further study should be done before committing such a large block of cash to an obsolete diesel plant.

Cost Estimate			
Life Extension at Port Aux Basques Diesel Plant			
Item	Labour	Material	Total
9 cubicles of switchgear c/w protection	$16,000	$270,000	$286,000
6 shutdown solenoids	$1,600	$12,000	$13,600
6 speeder motors	$1,000	$6,000	$7,000
120 volt battery and charger	$2,000	$10,000	$12,000
2, 32 volt battery chargers	$1,000	$3,000	$4,000
AC distribution panel	$1,000	$1,000	$2,000
120 VDC to 120 VAC inverer	$500	$2,000	$2,500
Cable tray	$8,000	$6,000	$14,000
Cooling fan and louvre	$8,000	$12,000	$20,000
6 Anti-condensation heaters	$5,000	$3,000	$8,000
Local alarm and level monitoring	$1,000	$3,000	$4,000
Fuel levels	$3,000	$1,000	$4,000
Battery charger alarms	$1,000		$1,000
Ambient Temperature	$500	$500	$1,000
Computer and printer		$3,000	$3,000
Scada software		$3,000	$3,000
Programing	$2,000		$2,000
Transfer voltage controls	$6,000		$6,000
Power cables	$10,000	$10,000	$20,000
Control cable and conduits	$10,000	$10,000	$20,000
Unforseen	$10,000	$10,000	$20,000
Totals	$87,600	$365,500	$453,100

NEWFOUNDLAND POWER

March 6, 1997

MEMO FROM: B. Nickerson

TO: J. Simmons
ATTENTION: M. Hunter

SUBJECT: Port Aux Basques Diesel Plant

FILE: ENS-0485.06

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The following table lists maximum fault levels at Port Aux Basques Diesel Plant under both parallel and isolated conditions. Since the zero sequence impedance of these units is unknown, a range was assumed as indicated by the maximum and minimum 'Line to Ground' fault levels :

Fault levels at Port Aux Basques Diesel Plant								
Breaker Id.	Fault Level			Fault Level			Breaker	Status
	In Parallel With System			Isolated From System			MVA Rating	
		L-G			L-G			
	LLL	Min	Max	LLL	Min	Max		
T1-B	9.0	4.0	8.0	8.0	4.0	8.0	25	OK
G5-B	11.0	3.0	6.0	10.0	3.0	6.0	15	OK
G3-B	10.0	1.0	2.0	9.0	1.0	2.0	15	OK
T2-B	17.0	7.0	14.0	14.0	7.0	14.0	25	OK
G8-B	21.5	5.4	10.7	18.5	5.4	10.7	15	Over
G2-B	21.5	5.4	10.7	18.5	5.4	10.7	15	Over
G4-B	22.0	5.7	11.3	19.0	5.7	11.3	15	Over
G1-B	21.0	4.7	9.3	18.0	4.7	9.4	15	Over
Note: Shaded areas indicate fault levels in excess of breaker ratings.								

As can be seen in the table the assumed range of 'Line to Ground' fault levels does not contribute to excess fault levels on the breakers.

The table lists fault levels for both parallel and isolated system conditions with all generators on. A serious condition exists on the T2 bus with all four generator breakers being exposed to (LLL) fault levels in excess of their ratings.

We should immediately change our operating practices so that these fault levels are reduced below the 15 MVA level.

Proposed operating rules

1. Since T2 fault level contribution from the system is 17 MVA when the Port Aux Basques area is tied into the provincial grid and exceeds the 15 MVA level of (G8,G2,G4 and G1) breakers. Then (G8,G2,G4 and G1) generators (totaling 1060 Kw) should never be run in parallel with the island grid system.

2. Since T2 fault contributions from the system when the plant is run in isolation from the island grid combined with fault levels from any generator on the T2 bus exceeds the 15 MVA rating of generator breakers. Then only one of the four diesels (G8,G2,G4 or G1) can be run at a time to stay below the 15 MVA limit. Presumably the largest unit G1 rated at 350 Kw would be selected.

3. There is no operating restrictions in operating G5 and G3 (total 575 Kw)

Plant operating capacity prior to restrictions is (1635 Kw) (actually 1415 with G4 unavailable)
Plant capacity in parallel with system (575 Kw)
Plant capacity in isolation from system (925 Kw)

Since G4 (210 Kw) has a stator fault and is unavailable for operation, the rewind of this unit should be deferred until the plant status is clarified.

Several years ago in response to a bus fault on this switchgear it was decided to leave all disconnect switches open in an effort to extend switchgear life by minimizing the number of possible faults. The switchgear is well past its expected service life with an installed date of 1943.

The minimum solution to these problems would be to replace the 4 generator breakers. This change would also dictate that relaying protection would also be replaced. If we were to do this work it would be logical to replace all 8 breakers at the same time. This solution would only be a patch up job since the existing open bus bar switchgear system would be retained. This job would likely expand to include items like replacement of generator power cables etc.

This patch up job would be minimal and designed only to address the fault clearing problem at the plant, no attempt would be made to address other serious problems identified in a previous report.

If we proceed with this temporary repair then consideration should also be given to rewinding G4, estimated cost $20000.

If the temporary operating procedures or repairs are not instituted it is possible for a fault to occur between a generator and it's breaker resulting in failure of the oil filled generator breaker and a resultant fire.

Cost Estimate							
Minimal fix up to return plant to service							
Item					**Labour**	**Material**	**Total**
Purchase and install 8 breakers					$56,000	$40,000	$96,000
Purchase and install 8 sets of protective relays					$16,000	$64,000	$80,000
Rewind G-4 stator					$5,000	$15,000	$20,000
Totals					**$77,000**	**$119,000**	**$196,000**

This is a substantial sum to spend and still end up with a inadequately protected plant. Some of the shortcomings are:

1. Insufficient ventilation for summer operations.
2. No electrical shutdown of a diesel in event of an electrical fault.
3. Some diesels are not temperature protected.
4. The 1943 vintage bus would still be in service and prone to faults.
5. Generator insulation on most generators has been exposed to overtemperatures and is prone to failures.
6. There is no generator anti-condensation protection.
7. All diesels are connected in star configuration leading to uncontrolled zero sequence current circulation which leads to premature generator faults.
8. All diesels in this plant are obsolete and replacement parts are unavailable. Therefore a major mechanical fault could lead to the end of life for that unit.

In summary this plant does not seem to posses any redeeming assets. It would seem the best short term approach would be to immediately institute the ‘Proposed operation rules’ to safeguard breakers from excessive fault levels. It is clear this plant is at the end of life and a major decision is required for the long term solution.

Newfoundland Light & Power Co. Limited
St. John's, Newfoundland

Diesel Generator Review

March 1997

Acres International Limited
St. John's, Newfoundland

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Executive Summary

The Newfoundland Power generation facilities evaluated in this Diesel Generator Review report consist of eight low-speed and ten high-speed diesels located in various parts of the Province. The purpose of the Review is to assess the general Mechanical and Electrical condition of the units and make recommendations on their maintenance requirements for a further 10 years of operation, and to advise where further operation is not recommended.

The units operate under emergency conditions only, when the power normally purchased from Newfoundland and Labrador Hydro is not available due to transmission line outages caused by ice storms, or by the rare coincidental events of inadequate water to drive hydroelectric generation equipment at the same time as the Holyrood Thermal Plant is unavailable for power generation due to an outage.

The units are mostly old to very old, having been installed over the period from 1945 to 1976, and the historic average annual operating hours over the period 1990 to 1995, varies from a minimum of 0.4 hrs/year at Gander to a maximum of 34.5 hrs/year at Port-aux-Basques.

Older diesel generators were well made, over designed, very rugged, and capable of an almost indefinite life given the appropriate operations and maintenance attention. However, they were designed for continuous base-load operation under constant observation and suffer serious deterioration when sitting idle and unattended.

Despite their ruggedness they are built using older materials and do not have the benefit of modern alloys, construction methods and the use of ceramics, teflon, silicone and other modern materials. Thus they require more frequent maintenance and deteriorate more rapidly than modern standby machines when idle for long periods.

Visits were made to generation sites at St. John's, Salt Pond, Port Union, Gander, Aguathuna and Port-aux-Basques. At each site the inspections included an overall assessment of the site, structures, auxiliary equipment, a survey of the engines, and operational tests. Detailed inspections of the machine internals were not carried out, and prior to maintenance of any units this would be necessary to establish their precise condition and replacement parts requirements. Safety concerns were addressed and photographs taken to better illustrate this report. Recommendations were developed on the basis of the inspections and tests, and confirmed after subsequent evaluation of parts availability and probable cost of rehabilitation.

Following the site visits, investigations were made into the availability and costs of spare parts for the engines, and it was found that in a number of cases parts were available, and in others they were not.

The recommendations are as follows

St. John's

The unit should be given a detailed inspection to verify that the favorable condition apparent during the inspection and test run is correct and confirm that there are no hidden defects. Given a favorable result, the general plant improvements outlined in the site inspection report may be carried out, assuming the City of St. John's would benefit from the availability of 2,500 kW emergency power. Alternatively the plant should be decommissioned.

Salt Pond

These units are the oldest in the system and have numerous problems associated with equipment condition and safety considerations. They have a utilization of only 2.7 hrs/year, and parts for these 1940s vintage engines are expensive and on long delivery, providing they are available at all. Given these circumstances it is recommended that the Worthington Units be decommissioned.

Port Union

This unit is in good condition and it is recommended that minor repair mainly in instrumentation work be carried out and the unit remain in service.

Gander

These units are estimated to have run for about 100,000 hrs when they operated continuously from 1949 to 1969. The present average annual use is only 0.4 hrs, the lowest of all the plants inspected. Although parts availability has been established, a substantial investment is required to make the plant safe and operable for a further 10 years. It is therefore recommended that the plant be decommissioned.

Aguathuna

The single unit at Aguathuna was built by a manufacturer no longer making engines, and no source of parts has been identified. It is possible some parts could be made by a specialist manufacturer, but these would be expensive. The machine shows substantial wear and important safety devices are non-functional. Bearing in mind the extensive costs that would be involved in rehabilitating this unit, and the health and safety aspects identified, it is recommended that the unit be decommissioned.

Port-aux-Basques

Unit No. 10 was manufactured and engineered with standby duty in mind and has performed satisfactorily and economically during the last 28 years. The enclosure has corroded at the radiator end and there is insufficient space around the engine for maintenance, therefore moving this unit into the adjacent power plant is to be recommended.

The six Caterpillar units operated fairly well, but the speed adjustment problem and associated switchgear deficiencies, also safety concerns, indicate that retirement or relocation of the better ones to a site requiring fewer units would be the best options. If this recommendation produces a shortage of emergency power at this location a second E.M.D. unit should be considered.

The portable units at Port-aux-Basques should undergo maintenance on the engine instrumentation, and control panel instrument calibration should also be performed. Unit 2 trailer should be refurbished, if future portability is required. Following this work the units can remain in service.

In addition to determining parts costs and availability, an estimate was developed to show that the labor costs for a typical six cylinder engine overhaul would be of the order of $100,000. Alternative means of replacement generation capacity were outlined, and costs shown for medium- and high-speed diesel generation equipment. A 2,500 kW medium speed unit can be purchased new for about $520/kW, a smaller high speed unit for $250/kW. In larger unit sizes gas turbines could be more competitive.

1 Introduction

In response to the Newfoundland Light and Power Co. Limited (Newfoundland Power) request for proposal dated December 16, 1996, to carry out a Diesel Generator Review, Acres International Limited, in association with D.G. Champion Engineering Limited, submitted a successful proposal for the work. This report describes the implementation of this Review and the recommendations forthcoming from it.

Newfoundland Power has a mixture of thermal power generation plant made up of different types and a variety of sizes, all of which are used for emergency power generation or as reserve capacity for power generated by Newfoundland and Labrador Hydro and purchased by Newfoundland Power.

This situation has existed for some 30 years and the thermal plants have only been required to operate on relatively few occasion, particularly in recent years. The need to operate the plants comes about when there are transmission line outages due to ice storms or on the rare occasions when there is a shortage of water to operate hydroelectric stations and this coincides with the forced outage of the Holyrood Thermal Plant.

While the thermal plants include gas turbines and diesels, the larger number are diesel engine powered, either slow speed or high speed.

The purpose of the review forming this report is to assess the general mechanical and electrical condition of the diesel generator units, which are installed at six different sites and consist of eight low-speed diesels and ten high-speed diesels which were installed between 1945 and 1976.

The prime objective of the review is to provide adequate information to Newfoundland Power (NP) management to assist in deciding if the existing diesel generation units should be refurbished to enable at least 10 more years of operation, or if they should be decommissioned and/or replaced.

The installed capacity is approximately 14 MW, but due to the low utilization of the units, the average annual generation has only been approximately 200,000 kWh. This is equivalent to 14 hours of operation per year based on the installed capacity, and although some units operate fewer hours and others more, none of the units typically operate for more than 40 hours per year.

Because of this low utilization and many hours standing idle mostly unattended, it is to be expected that the units would have deteriorated to a greater extent than their accumulated operating hours might suggest.

2 Review Approach

The review was carried out in essentially three stages, commencing with an initial review of available data on the units and preparation of spreadsheets for assembling data prior to, during, and subsequent to, site inspections.

Following the data assembly stage, visits were made to all of the sites where the facilities and equipment were inspected and the generating units given a test run.

The final phase of the work was to evaluate the findings of the site visits and to examine the feasibility and related costs, including input from suppliers, with a view to determining the availability of parts and the overall economics of carrying out what is, in effect, a 10-year life extension of the diesel generator units.

The first step was to review the following Newfoundland Power reports:

Thermal Power Plant Inspection Report dated July, 1991

and

Diesel Power Plant Review dated June, 1996

From these reports, enough basic data on the diesel generators was available to provide a preliminary input to the preparation of information spreadsheets. Spreadsheets were then developed for each category of data as follows:

- General Information
- Historical Data
- Mechanical Data
- Electrical Data
- Engine Test Data.

The spreadsheets became the main information gathering tool used during the site inspections and tests, and were updated each day on a portable computer.

The data gathered can be seen on the completed spreadsheets which form Appendix 'A' to the report.

The site inspections and tests were carried out during the period February 4 to February 12, 1997 and the inspection team consisted of a Diesel Specialist and a Mechanical Engineer from the Acres St. John's, Newfoundland office, who were accompanied by Newfoundland Power's Supervisor of Mechanical Maintenance.

Details of the site inspections and tests are provided in Section 3 of the report, and color photographs taken of plant buildings and equipment at each site during the visit are included in Appendix 'B' of the report.

The inspections consisted of examinations of the externals of the buildings, diesel generator units and auxiliaries, and where practical internal inspections of the diesels with measurements of crankshaft deflections being taken by dial indicator to establish whether foundations had settled. In addition, the general cleanliness of the engine internals were noted and any points of apparent wear of components were recorded as and when seen.

Most of the units were subsequently given a test run to identify any signs of distress or malfunction which might occur. During each test, various readings of temperatures, pressures, power output, etc., were recorded for comparison with normal operating parameters at loaded conditions.

In addition to the inspections and tests, brief reviews of available operating records were made. Discussions were had with operations and maintenance (O&M) personnel to identify the approach to O&M activities and to confirm any concerns which might exist over the general condition of the machines, operational problems and maintenance programs, etc.

Finally, a list of available spare parts was identified at each site. Appendix 'C' lists the spare components which were held in stock.

The remaining step was to confirm availability and typical costs for replacement parts for each machine where possible. Various suppliers and agents were contacted with a view to determine whether Original Equipment Manufacturer (OEM) or parts of other makers were available, and at what cost. Section 4 of the report discusses this topic and responses from various suppliers are shown in Appendix 'D'.

Section 5 of the report provides options and related capital costs for replacing lost capacity due to decommissioning of existing generation capacity.

3 Plant Inspection Reports

The examinations and tests carried out at each site are discussed below. Each site is dealt with as a subsection, written in the order in which the sites were visited. The arrangement of site photographs in Appendix 'B' follow the same sequence.

Each subsection covers, for each site, the following major topics:

- Plant History
- Plant Description and Survey
- Engine Survey
- Unit Operational Test
- Safety Considerations
- Summary
- Recommendations.

3.1 St. John's

Plant History

The plant was built in 1953 comprising a single Nordberg diesel generator. The 3,580 HP engine is of the two-cycle principle arranged with eight cylinders in-line to operate at 225 rpm. The General Electric alternator is direct connected, stator shift with V-belt driven floor mounted exciter outside of the generator single pedestal bearing. The generator is rated 2,500 kW, 6,600 volts, 0.8 power factor. The unit has operated practically maintenance free during its life time necessitating the replacement of an air start valve in 1994 and a complete oil change in 1990.

The installation's primary function was to provide black start capability to the nearby Southside Steam Plant and power to the grid when needed. The unit had operated a total of 2,425 hours without experiencing any significant failure. From 1991 to 1995 the plant generated approximately 75,000 kWh with an estimated additional operating period of approximately 38 hours. Routine operational checks have been carried out with monthly runs at no load and loaded operations quarterly. When operated on February 4, 1997, the unit ran very smoothly accepting full load after warmup and carried full load with all operating pressures and temperatures within acceptable limits, negligible vibration and a clear exhaust.

Plant Description and Survey

The plant is located on the south side of St. John's harbor on the side of the hill above the Southside Road. The foundations are securely tied to bed rock. The building has asbestos siding which is in good condition. The plant has poor interior lighting. The space around the engine is used as storage for old equipment (i.e., wind turbine, etc.). Some minor water leakage through the foundation from the surrounding hill was reported. The engine air intake is built into the foundation of the building with wooden shutters to close the intake when the engine is not in use. An electric forced air heater has been installed in the air passage to preheat the air, thereby avoiding condensation within the engine cylinders and on other engine parts due to direct connection with the outdoor changeable atmospheric conditions. Aspiration air passage to the engine is clean and dry. Heat exchangers for the engine cooling system are supplied with city water. The air compressor and receivers are in good working order, requiring inspection by the Department of Labor annually and certified within the last twelve months.

The fuel system consists of a main outdoor storage tank at the rear of the building and a 200 gallon day tank in the building located below the engine. The main fuel tank is of riveted construction. The fuel level is kept below the half full mark as the upper section is dented. The tank is located in a concrete dyke which appears in good condition. The tank fill line from the Irving dock has been disconnected and deliveries are now made by truck with the hose being dragged around the building and up to the top of the tank where filling is performed through the manhole. This would appear to be a difficult and dangerous task particularly in the winter when the tank and surrounding area is iced covered. The day tank is not fitted with a high level alarm and safety cut-off to shut down the pump when full, and this has resulted in minor spills when the operator has been distracted while filling the tank. Also, there was a recent failure of the tank gauge which resulted in a minor spill of diesel fuel within the building.

The battery pack and charger for switchgear operations requires replacement. Switchgear is open contact type, old and dangerous to operate. There are no markings to tell its age but is estimated to be of 1950's vintage or earlier. The transformer is also of the same vintage as the switchgear and is located in the building. Instrumentation is obsolete, rendering safety alarm and shutdown devices unreliable.

Engine Survey

Crankshaft deflections were taken with a maximum deflection reading of 7/1,000 inches indicating that the outboard pedestal bearing requires adjustment and the generator air gap should be checked at the same time. Internals of the crankcase were found to be very clean in every respect indicating the absence of piston blow-by. The foundations and grouting around the engine display minor surface decay which requires scraping and painting only. The engine itself is very clean relative to age with some minor surface rusting, otherwise the engine appears to be very sound.

The air compressor was operated without difficulty and modulated as required. The main electric motor driven auxiliary lubricating oil pump was operated satisfactorily and the oil inside the engine flowed freely and was clean. The engine barred over freely. The main engine glycol cooling water system circulating pumps were put into operation without difficulty.

Unit Operational Test

The engine test data sheet was completed.

The engine started without hesitation and was allowed to warm up gradually and put on light load with gradual increases to 2,400 kW. The unit carried full load satisfactorily for the duration of the test. Performance was very smooth and relatively quiet, all temperatures and pressures were within normal operating range and the exhaust gas was completely clear. The test may be considered successful.

Safety Considerations

The method of filling the fuel tank is a potentially dangerous operation due to the length of hose and the requirement of filling through the top manhole. The age of the tank and suspected pin holes would warrant its replacement at the earliest opportunity considering its location, near the harbor, and the recent problems experienced by other tank owners in the area as well as the strong public concern regarding fuel storage in the area. The plant is considered somewhat unsafe to operators due to poor lighting, the operating floor generally littered with stored equipment and the potential hazard of the fuel system during normal power plant operations.

Summary

The test was carried out without difficulty and the engine, generator and auxiliary items performed well. All necessary improvements are of a minor nature and there appears to be no reason to question the ability of this plant to continue Standby service indefinitely, given a higher level of attention to mitigate against the natural decline associated with idle machinery of this type.

Recommendations

It is recommended that the engine and all related equipment undergo a more detailed inspection to confirm that the February 4, 1997 brief inspection and short run did not miss any serious defect. If this confirms there are no major problems, general plant improvements, as described above, should be carried out. The main improvement would be to rehabilitate all instrumentation and fit new reliable alarm and shut-down protection devices, and replaee the fuel tank.

3.2 Salt Pond

Plant History

The plant was built in 1963 accommodating three diesel generators acquired from Fort Pepperrell. The Units were operated at Fort Pepperrell from 1941 to 1963 and accumulated between 15,000 and 17,000 operating hours. The engines are of Worthington, Buffalo, New York manufacture with six cylinders, vertically in-line, having an operational speed of 327 rpm and producing 670 HP each. The engines are four cycle, normally aspirated and are the largest units in the system calculated on the basis of output per unit of space occupied, delivering only 165 Watts/cubic foot rendering them the most costly in terms of building space, heating and associated maintenance factors. Worthington Corporation abandoned engine production in the 1960s. The Electric Machinery alternators are directly connected to the engine and have a directly connected exciter. The generators are rated at 500 kW, 4,160 volts, 0.8 power factor.

Some 26 years ago, Unit No. 1 suffered damage to a large end bearing which badly scored a crankshaft journal from which time operation has continued with that piston and connecting rod removed from the engine. The original seawater cooling system utilizing heat exchangers was discarded several years ago and replaced with direct town water cooling operated manually. In recent years, the plant has been on a standby basis only. The units are started monthly and only synchronized for operation on-load quarterly.

Plant Description and Survey

The plant is located on level ground near the ocean in Salt Pond, Burin. The building is of structural steel construction with metal siding, well insulated and with good lighting. Interior and exterior are tidy and well kept. A 2,000 lb wire rope electric winch, 1 ton endless chain with manually operated traveling beam is located within the building. No “load-rating” markings were indicated on the crane beam. The building is used as a transformer storage and repair facility with the area around Unit No. 1 congested with equipment.

The fuel system consists of two main tanks in a concrete dyke outside the building. Only one tank is now in use as the second tank was disconnected and used for storage of used transformer oil until a new steel self-dyked tank was installed. The tank is presently empty. The tanks are surrounded by a concrete dyke which is in good condition and leaks have not been reported. The operator indicated that the dyke drain valve had not been closing properly and water was freely draining from the dyke. This has since been corrected by modifying the valve handle to permit the valve to be more tightly closed.

Each engine has an elevated 300 gallon fuel day tank located above the engine. Uninsulated exhaust pipes run within 6 inches of each of these fuel tanks. There are no high level alarm or shut-off devices on the tanks and one is stained from over filling, diesel fuel having run down the tank and over the instrument panel directly below. The tanks vent inside the building with overflow piping directed into trenches in the floor below.

The multiple floor trenches contain pools of oil and the electrical cables, pipes, etc. within the trenches are soaked with oil. There is a strong smell of fumes in the building, from the transformers under repair in the area next to Unit No. 1, also from the fuel oil day tank vents and from the trenches.

Engine exhausts and air intakes are in good condition but the outdoor piping and silencers require painting. The air compressors and air receivers are in good condition. Building foundations are in generally good condition but leak during heavy rain and spring run-off periods. Water occasionally has to be pumped from the generator pits and floor trenches.

Engine Survey

Unit No. 1 Crankshaft deflections recommended by the manufacturer for these engines should not exceed 1.5/1,000 inches and the maximum reading for this Unit was 3/1,000 inches indicating a slight shimming of the outboard pedestal bearing is necessary. The engine barred over freely. Crankcase and internal motion parts were clean; however, there was evidence of oil/water emulsion in the lubricating oil system. The modified cooling system was traced and found to be contrary to manufacturer's recommendations regarding temperature differential from water inlet to the cylinder jackets and water outlet from the cylinder heads.

Unit No. 2 The maximum crankshaft deflection was measured at 4/1,000 inches indicating a slight shimming of the outboard pedestal is necessary. Evidence of excessive cooling water leaks around the engine blocks and cylinder heads was observed (see Photograph No. 10 in Appendix B). Other remarks are as for Unit No. 1.

Unit No. 3 Attention was drawn to the missing piston and connecting rod from Cylinder No. 5. The oil retaining clamp at the crankshaft journal was removed and the journal inspected. Surface damage is judged to be too serious for operation but no major gouging or depth penetration has taken place and there was no evidence of high temperature with resultant surface cracking. It is judged that the journal could be reground. In-situ crankshaft grinding could be performed, which is available from several countries outside Canada.

Operation of this unit with a missing piston has been successful in the past with an absence of vibration, but concern has to be expressed over crankshaft torsional oscillations, which would be created by the absence of one piston and connecting rod.

Unit Operational Tests

The test sheet data was collected for each engine.

Unit No. 1 Difficulty was experienced in the air start system and the main pilot operated air-start valve had to be opened up and freed before a start was possible. After a warm up period, a 500 kW load was carried for 1 hour. However, difficulty was experienced recording the operating parameters because most of the instrumentation was broken or inaccurate. Safety shut down and alarm devices were not functional.

A serious problem was noted relative to the modified engine cooling system which is a manually operated once-through town water supply without proper temperature regulation compared with what was provided with the original closed circuit installation. This results in extremely cold water entering the lower part of the water jackets which is not recommended. Worthington recommend a temperature differential of water entering the jacket to leaving the cylinder head of not more than 30°F. Observation of the test sheet shows that this differential varied considerably due to periodic manual control and very cold town water. As much as 100°F differential was observed indicating severe thermal stresses would be occurring in the engine block, cylinder liners and cylinder heads. The excessive water temperature rise has resulted in numerous water leaks at those parts of the engine, and created a potential for engine block and cylinder head cracking.

Exhaust gas fumes emanated from the cylinder covers and inspection of that area indicated blow-by at the exhaust valve guides as well as from some exhaust manifold gaskets. In other respects, the 500 kW load was carried without black smoke at the exhaust pipe or excessive vibration throughout the unit.

Unit No. 2 — The unit started on the first attempt and performed similarly to Unit No. 1 with greater quantities of water leaking from the upper block area.

Unit No. 3 — The unit was not run on judgement that the absent piston would seriously alter the torsional oscillation characteristics of the system with the possibility of excessive oscillations at Cylinder No. 5. With this the possibility of crankshaft failure sooner or later could be expected, and there was no reason, on the day, to expose personnel to unnecessary danger.

Safety Considerations

The plant appears to be violating several fundamental aspects of personnel safety particularly fire hazard. The 34 years of lubricating oil and fuel oil seepage and spillage and dripping into the trenches has left deposits that are extremely difficult to remove but present a serious fire hazard. A variety of cleaning methods might be considered but the mix of piping and electrical cable make most methods impractical or excessively costly. Other plants suffering this difficulty have installed fire suppression systems within the trenches which trigger automatically and require swift personnel evacuation. Exacerbating the situation are the three fuel oil day tanks which vent within the building and allow overflow into the trenches, with evidence of previous spillages, as shown by Photographs 7 and 8 in Appendix 'B'. The combined danger arising from the trenches and fuel oil system raises serious safety concerns.

Summary

These engines have operated beyond the usual manufacturer's recommended major overhaul period, but historical records do not identify major overhaul or minor overhauls having taken place, other than repairs as necessary. Therefore, to continue operating Units No. 1 and 2 would involve a major expense. The cooling system is not suitable for the service intended and these heavy robust engines are particularly vulnerable to thermal stress. A second problem with direct flow-through cooling is the accumulation of deposits on the internal surfaces of the engine, oil cooler and pipework, etc., which rapidly lowers efficiency of the cooling system.

Major expense would be required to rehabilitate Unit No. 3. The inability to start Unit No. 1 without spending 15 to 20 minutes freeing up corroded parts illustrated that the basic design of these older slow speed, heavy duty diesels does not lend itself to sitting idle in readiness for an occasional start as is required in their present day Standby mode.

Plant rehabilitation would include at least the following:

- major overhaul of all three units
- new glycol secondary cooling system
- fire suppression in trenches
- new fuel day tank ventilation and overflow piping, etc.

The Salt Pond plant represents the poorest utilization of space relative to the available power (Watts/cubic ft) and includes the oldest engines in the system dating back nearly 60 years.

Recommendations

In order to rectify equipment related problems, overhaul the engines and address safety concerns, a considerable expenditure would be required. The units would still remain the oldest in the system and they are relatively inefficient compared with the other sites. They also have the low average utilization factor of 2.7 hrs/year. Given these circumstances, it is recommended that the Salt Pond plant be decommissioned.

3.3 Port Union

Plant History
The diesel generator located in the Port Union hydro plant was installed in 1962. It is an electric start Caterpillar Model D398A, four cycle, turbocharged engine capable of 750 HP at 1,200 rpm. The GE alternator is direct connected but without a common underbase and is rated for 500 kW, 2,400 volts, 0.8 power factor. The generator is used for emergency service in the event of transmission line failure. From 1991 to 1995, the unit produced 22,730 kWh for an estimated operating period of 45 hours. No information on maintenance or the total running hours was available. Routine operational checks have been carried out with monthly runs at no load and loaded operations quarterly.

Plant Description and Survey
The generator is located in the Port Union Hydro Plant. The building has concrete walls and a wooden roof. It is in good condition, the facility was clean, tidy and well maintained. A high build-up of paint on the floor makes it slippery when wet. There is no craneage available to facilitate repairs. No leaks or foundation problems were reported or noted.

The diesel fuel system consists of a steel self-dyked tank outside the building, installed in 1993. The engine muffler was rusty externally, but appeared to reduce sound level satisfactorily when the unit ran. Engine aspiration air is drawn from within the building and the exhaust insulation is in good repair. Engine cooling is accomplished by heat exchanger utilizing river water. The engine had been recently painted.

Unit Operational Test
The engine started on the first attempt, assisted with a spray of ether which is common practice with Caterpillar engines. Following a brief warm-up, the engine was put on full load and ran smoothly for the 1 hour test. Engine instrumentation is limited but all gauges read in the normal range. Engine exhaust was clear. The test may be considered a success.

Summary
The test was carried out successfully and the engine generator performed well. No improvements are necessary with the exception of painting the exterior portion of the exhaust. Parts for this unit are readily available and based on its performance can be expected to provide many more years of reliable service.

Recommendation
The unit should be kept in service and minor repair work carried out.

3.4 Gander Plant

Plant History
The plant was built for the federal government in 1949 and was run continuously until 1969. It is in a very spacious building and is well laid out to accommodate the three units. The building is of concrete wall construction with flat roof and generous headroom. The units are self supporting with fuel supply onsite. Units are cooled using evaporative type coolers with equipment mounted indoors. Switchgear is open-face construction of 1940s vintage, transformers are located outdoors. The main fuel tank is located behind the building and is enclosed in a steel dyke and elevated above the ground. Control room, store rooms and toilet facilities are included in the building.

The engines are two cycle type with 'dry sump', whereby, the lubricating oil is stored in a rectangular steel tank situated several feet below grade. The engines are Swedish made and are extremely robust for base-load continuous power generation and might originally have been expected to last many years, rendering reliable performance. The Nohab-Polar engines have seven cylinders, in-line, rated for 1,470 HP at 300 rpm with direct connected CGE alternators rated at 1,000 kW, 2,300 volts, 0.8 power factor, stator shift and belt driven exciters.

The plant was built to a high standard, being laid out in a very spacious manner with massive concrete foundations, high head room and overhead travelling crane. Good artificial lighting is supplemented by large windows in the upper portion of the walls.

During the life of the plant, the individual units have operated an average of 15 years and assuming an annual operating duty between 6,000 and 7,000 hours it may be estimated that the accumulated operating life for each unit is in the order of 100,000 hours. From 1966 to 1996 the plant has served as standby service operating 1 to 2 hours per month for another 700 or 800 hours per unit.

Plant Description and Survey
Exterior of the building is showing signs of wear, the concrete walls have minor cracks and the concrete facing is spalling, the woodwork requires painting. There is continuous water seepage into the engine pits. Fluid from the pits leaks into the

surrounding land resulting a continual seep of oil which is collected with absorbent. The interior of the building is tidy and well maintained. The overhead crane is not serviceable because the wire rope requires replacing and the chain falls are deemed to be unsafe. The fuel is stored in a steel tank with steel dyke similar to a steel self-dyked tank. The tank was originally of riveted construction and has since had the rivets removed and the joints welded. It is in good condition. Three 2,000 liter day tanks are located within the building, one for each engine. Exhaust stacks are in good condition but the Unit No. 2 stack is stained black externally with oil carried over from the engine. Air receivers have been reconditioned, ultrasonic testing was performed and steel liners installed in the pits to prevent contact with ground water which has been a problem in the past. Air compressors functioned properly. The switchgear is old but functional, there is a new battery pack, and one voltmeter does not function. No problems were experienced when the plant was put on line. Air intakes have viscous oil filters located inside the building and are in good condition. The evaporative coolers are a type which require a high level of maintenance. Each engine is cooled with glycol in a closed circuit. There is a continuously operated lubricating oil heating and circulating system, as shown in Photograph No. 27. Warm lubricating oil is circulated through the engine utilizing a 1.5 HP motor and two 6 kW emersion heaters keeping the engine reasonably warm and ready for starting.

Engine Survey

Unit No. 1 Crankshaft deflections of 2/1,000 inches indicate that the generator outboard bearing pedestal requires minor adjustment. The engine barred over freely. The engine and generator foundations showed no cracking other than superficial. Instrumentation, pressure gauges and thermometers were either lacking or unreliable. Safety alarm and shutdown devices for high operating water temperature and low lubricating pressure, etc. were either not fitted or non-operational.

Unit No. 2 Crankshaft deflections indicated that the generator outboard pedestal required adjustment due to a 5/1,000 inch deflection. The engine barred over freely and other comments are as for Unit No. 1.

Unit No. 3 Crankshaft deflections indicate a serious problem because of a 10/1,000 inch deflection which was consistent with the severe cracking present in the foundations at the generator end, see Photograph No. 26. The engine was very hard barring over and while barring over a nasty knock was evident in the scavenge blower drive mechanism. Instrumentation and safety devices are as for Unit No. 1.

Unit Operational Tests

The Test Sheet operating data was collected for each engine.

Unit No. 1 Repeated attempts were unsuccessful in getting the engine to start and it was diagnosed that either an air start valve or an air start pilot valve was sticking which caused a drain down of the 600 psig starting air receiver. After repeated attempts the test had to be canceled.

Unit No. 2 Unit started on the first attempt and was allowed to idle for a 20 minute warm-up period. During the starting cycle, several cylinder relief cocks lifted making an alarmingly loud noise. This was due to over fueling on several cylinders and is not deemed to be a serious defect. Operators had no difficulty synchronizing with the bus and closing the breaker. The engine was run for 10 minutes on 100 kW and the load then gradually raised to 875 kW. Two problems developed, an excessive amount of black tarry oil dripped from the exhaust manifold and the piston cooling oil temperature quickly became excessive at the discharge from all seven pistons. The engine manual recommends 60°C piston cooling outlet oil running temperature; however, the average of the seven outlets was 76°C after 25 minutes which is close to the danger point for the engine lubrication system. The load was reduced to 500 kW and the temperature began to decline. The cooling pumps and fans were inspected and found to be functioning correctly.

Unit No. 3 Two problems developed similarly to Unit No. 2. The scavenge blower has some axial movement and the generator outboard pedestal bearing support beam has come free from the concrete at one side resulting in movement of the bearing during operation. The engine was warmed up for 1 hour and then placed on light load of 100 kW for 40 minutes and then gradually raised to 700 kW. The lubricating oil temperature immediately rose to an average of 78°C and the load had to be removed. The evaporator fan motor was found to be tripped out on the breaker. The fan was restarted and the load raised to 500 kW where the oil temperature stabilized but remained above normal.

Safety Considerations

Several potentially dangerous operating conditions were identified, particularly by the operational tests at loaded conditions, generally as follows.

Unit No. 1 — Failure to start confirmed concern that non operational conditions are detrimental to the unit, when the engine is left idle for long periods, perhaps equally, if not more seriously than continuous operating conditions. Though the unit had sat idle only for several weeks, functional features had changed and the air start system had become unoperational causing one engine test run to be abandoned. The engine cannot be considered capable of reliable emergency duty if allowed to sit unattended for more than a few days.

Unit No. 2 — Suspicion of a dangerous operating condition was aroused when operating personnel drew attention to the black oil on the exterior of the outdoor stack which must have arrived there due to some abnormal circumstance. During the load test, copious quantities of oil leaked from the hot exhaust manifold, as can be seen in Photographs No. 28 and 29. This provided evidence that the manifold was partially flooded with residue oil which, from experience, would be mostly lubricating oil mixed with unburned fuel oil. Danger to the plant and personnel is a very serious matter unless operators are familiar with this phenomena and know how to deal with an engine exhaust manifold fire.

Unit No. 3 — There has to be considerable alarm relative to the cracked foundation and the presence of an excessive crankshaft deflection which confirms misalignment of the generator in relationship to the engine crankshaft. The direct outcome of crankshaft misalignment is a broken crankshaft which is obviously expensive and can be very dangerous if the engines motion works grind metal on metal, in the presence of oil vapors inside the crankcase.

Summary

Excessive oil leaks at the exhaust manifold are typical of two-cycle engines which pump oil particularly during light loading situations and generate a specific danger of exhaust manifold fires. The blow-through of lubricating oil on Unit No. 2 which left deposits on the exhaust stack emphasizes this danger and extreme care has to be taken with engines of this type when called upon to produce a high level of load after frequent starts and stops and operation at light loads.

The high lubricating oil operating temperatures experienced during the test will be due to general engine wear and tear and the accumulation of scale throughout the cooling water surfaces in the engine, pipework, evaporative coolers and also the oily side of the lubricating oil cooler.

These faults and other observations would indicate that the engines and auxiliary systems are in need of substantial repair. The deteriorated foundation on Unit No. 3 requires major repair, see Photograph No. 26, as does the drive mechanism at the scavenger blower of that unit.

The inability of Unit No. 1 to start is a direct result of non operation conditions where condensation and other atmospheric conditions cause shafts, spindles, glands and similar sliding surfaces and motion works to stick and cause minor malfunction and occasionally total failure as illustrated on February 6, 1997.

Several years ago, Wartsila Diesel Company of Finland purchased the Swedish Nohab Polar Company but the K57 model had long since been discontinued. Present-day parts availability has been established, as discussed in Section 4.

Rehabilitation of the Gander plant requires at least

- considering the baseload continuous operation for 18 years and accumulation of approaching 100,000 operating hours, the units are overdue for a major overhaul

- major concrete work is needed to repair Unit No. 3's deteriorated foundation

- evaporative cooler coils, water boxes, pipework, etc., to be descaled and engine jackets, heat exchangers, pumps, etc., to be descaled and overhauled

- all instrumentation and controls to be replaced

- future manning levels and engine checks to be increased.

Remarks

Contrary to common belief the deterioration of these early design of engines takes place just as rapidly and frequently more rapidly than when they are left idle and not operated in the manner for which they were designed. The engine and the entire plant relies on conventional packings, glands, and manual lubricating points all of which were designed in the 1940's and 1950's strictly with the intention of an experienced operator being continuously in attendance with extensive knowledge of the particular type of equipment in question.

Recommendations

In view of the substantial investment required to make the Gander units safe and reliable for a further 10 years of operation, and considering the fact that the plant has the lowest annual average hours of operation, at 0.4 hours, of all the plants, it is recommended that the plant be decommissioned.

3.5 Aguathuna

Plant History

The plant was installed in 1962 with a single Harland and Wolff 8 cylinder, in-line, diesel generator rated at 1,200 kW when running at 327 rpm. The engine is complete with plant auxiliaries such as lubricating oil circulation, glycol cooling, outdoor radiator, switchgear, etc. The plant is a steel frame, metal sided building with concrete foundations located adjacent to the ocean. Transformers are located at the front of the building, fuel is stored in a relatively new steel self-dyked tank. The building has a storeroom, switchgear room, overhead crane, large engine room and washroom.

The single engine is of the four cycle principle with "dry sump" whereby the lubricating oil is stored in a rectangular steel tank situated several feet below grade. The engine is of Irish manufacture and is massive relative to the modest 1,200 kW output rating; however, this maybe better understood by stating that the intent was to operate on Bunker C fuel. As originally installed, this slow speed machine would be capable of many years operation in a reliable manner.

The plant is of high quality and is laid out in a very spacious manner with massive concrete foundations under the engine and generator. There is high headroom and a 10 ton overhead traveling crane.

The Newfoundland Power 1996 Diesel Power Plant Review states the operating hours of the Harland Wolff Unit up to 1991 was 10,086. Since which time, the Unit has generated 30,000 kWh with an estimated additional operating time between 30 and 40 hours. Compared to this operating history the Harland and Wolff operating manual recommends a major overhaul after 4,000 to 6,000 hours. Indications are that the engine is overdue for a major overhaul.

Plant Survey
The plant is generally in good condition. Building exterior shows some rust stains where windows have been replaced with steel plate. The fuel tank is relatively new. Half of the plant space is used for the repair of transformers. The work space is kept reasonably tidy, but the storeroom needs to be cleaned out and spares catalogued. Water supply is shut off to the basin in the washroom. Building is heated with a forced air furnace located in the machinery space. Site was snow covered at the time of inspection but appears to be well kept. Some water leakage was reported to occur through the foundation into the switchgear room during spring thaw, otherwise concrete is in good condition. The overhead crane is rated for 10 ton and functions well. Air receivers and compressors function properly. Indoor fuel day tank is in good condition and is positioned above a concrete containment dyke. Exhaust stack is heavily rusted but this is a result of the location of the plant near salt water. A comprehensive engine control panel is located in the control room with indicating lamps to warn of a variety of sensitive operating conditions, several instruments are either damaged or inaccurate.

Engine Survey
Crankshaft defections indicate that the generator outboard pedestal requires no adjustment. The engine barred over freely. Engine foundations showed no cracking other than superficial. The Harland Wolff engine is turbocharged but there is no intercooling stage.

Inspection inside the crankcase identified a very sludgy black carbon film deposited on all surfaces with the sump containing sludgy oil with evidence of water/oil emulsion indicating that combustion gases were flowing past the piston rings contaminating the lubricating oil in the crankcase. An attempt was made to carry out static compression "blow-down" tests to confirm that there was blow-by at the piston rings, and results indicated that some cylinders are considerably worse than others.

Blow-down tests were performed on each of the eight cylinders of the engine to evaluate the extent of piston blow-by. The test consisted of attaching an air hose to the cylinder cocks and pressurizing the cylinder with air. The air supply was then shut-off and the cylinder cock opened. The time for the air to vent from the cylinder was recorded. If air was leaking past the piston rings the length of time to vent the air would be reduced as a portion of the volume would have escaped to the crankcase. Due to a lack of fittings and gauges available at the time of the test, the air hose was hand held over the valve during pressurizing. The results therefore provide only a relative indication of the piston blow-by. All pistons were aligned in a similar position to provide a comparable cylinder volume. The results were as follows:

Cylinder No.	Blowdown Time
1	6 sec.
2	7 sec.
3	8 sec.
4	11 sec.
5	9 sec.
6	9 sec.
7	6 sec.
8	10 sec.

Examination of the governor linkage identified the emergency overspeed "collapsible link" was frozen tight, a condition that would prevent the emergency overspeed trip mechanism from functioning, giving rise to a potential overspeed engine and generator destructive condition.

Unit Operational Test

The test operating data was collected for the engine.

The engine started at the first attempt and was allowed to idle for 10 minutes before light load was applied, followed by load increases to 1,100 kW at which condition operation was observed for a 1 hour period. One cylinder appeared to be laboring under excessive load but this could not be confirmed due to non-function of the exhaust gas pyrometer. The cooling system functioned satisfactorily as far as could be ascertained by non functional instruments, and operating conditions soon stabilized. Observation of the exhaust stack indicated black smoke approximately number two on the Bacharach scale indicating a slight overload condition.

The crankcase breather soon started to emit crankcase vapors. The volume increasing as the engine oil and piston cooling circuit reached normal operating temperatures, the excessive flow, which represents piston blow-by is best illustrated by Photograph No. 36 in Appendix 'B'.

Numerous minor water and oil leaks were noted. Asbestos wrap at the exhaust outlet elbows were in badly deteriorated condition, as seen is Photograph No. 37.

Safety Considerations

The asbestos breakdown at the exhaust manifolds requires removal and replacement with modern materials. The excessive and continuous flow of gases escaping from the crankcase breather into the plant atmosphere soon caused eye irritation and presents a health hazard. If allowed to continue, these vapors eventually condense on walls and ceilings creating a fire hazard as well as poor aesthetics. Discovery of a seized overspeed "collapsible link" in the governor safety system revealed a very dangerous condition whereby the overspeed mechanism would not have shut down the engine in a case such as inadvertent breaker trip, rendering the Unit vulnerable to catastrophic failure and the high probability of personal injury.

Summary

The operational test for a period of 1 hour was successfully completed and identified several points requiring attention.

- The engine is overdue for a major overhaul.
- The piston blow-by creates a health and a fire hazard.
- The disabled overspeed protection mechanism creates a serious danger.

The above conditions indicate that this machine should no longer be operated in an unsafe condition.

Remarks

As with other slow speed plants within the system, this inspection/survey identified the difficulty that exists in maintaining heavy duty baseload plant in what has to be termed an emergency Standby mode.

Recommendations
As the above inspection and test indicates, this unit will require substantial funds to be invested to bring it back to a safely operable condition for a 10-year period. The manufacturer is no longer making diesel engines and it is doubtful if any parts are available. It is not considered practical or economic to keep the unit in service. Decommissioning is therefore recommended.

3.6 Port-aux-Basques

Plant History
Portable Unit No. 1 was purchased in 1973 and has been used as a mobile unit since that time. It is equipped with a Caterpillar Model D-349, four cycle, V-12 cylinder engine capable of delivering 980 HP when operating at 1,800 rpm. The generator is Tamper-Canron rated at 700 kW, 600 V. To the present time, the Unit has logged 4,659 operating hours.

Present day operational mode requires cranking over weekly and operation once per month synchronized to the system and run at full load for not less than 1 hour.

Portable Unit No. 2 was purchased in 1976 and has been used as a mobile Unit since that time. It is equipped with a Caterpillar Model D-349, four cycle, V-12 cylinder engine capable of delivering 980 HP when operating at 1,800 rpm. The generator is Brown-Boveri rated at 670 kW, 600 V. To the present time, the Unit has logged 1,966 operating hours but the meter is believed to be inaccurate.

Present day operation requires the Unit to be cranked over weekly and operated once per month synchronized to the system and run at full load for not less than 1 hour.

The main Port-aux-Basques plant was put into operation in the 1940's. The present Caterpillar equipment was installed at various times starting in 1949. The six units consist of a range of Caterpiller models. In 1969, a "Packaged" Electro Motive Diesel (EMD) generator was purchased and located adjacent to the main power plant building. The Caterpillar Units supplied base load continuous power until 1968 when they were placed on Standby duty. The GM unit has only operated 1,654 hours up to the time of this inspection.

Plant Description and Survey
Inspections and tests were carried out February 8, 9 and 10. The two portables are located in the Grand Bay substation outside Port-aux-Basques. Portable

No. 1 is located in a steel framed enclosed tractor trailer. The Unit is complete with a generator room, transformers, two 250 gallon steel fuel tanks and a switchgear/office room. The fuel tanks are similar to the those used for home heating oil storage and are located inside the trailer behind a wooden partition. They can not be inspected as the partition wall is permanently fixed in place. The trailer has a valid licence for 1997 and is presently connected to the grid. The trailer access stairs are constructed of checker plate and can be slippery in winter conditions. The trailer is heated. Engine cooling is by a radiator located at one end of the trailer with fan driven off the end of the engine, glycol is used.

Portable No. 2 is contained in a steel frame enclosed tractor trailer similar to Portable No. 1. The steel under frame is badly corroded and should be inspected and strengthened prior to the next move. The siding is in good condition. The interior is clean and dry and contains a generator room and an office/switchgear room. The trailer has a valid licence for 1997. The 500 gallon fuel storage tanks are attached beneath the trailer and have been recently refurbished. The trailer is heated and is presently connected to the grid. Engine cooling is by a radiator located at one end of the trailer with fan driven off the end of the engine, glycol is used.

The main Port-aux-Basques plant is located near the old railway bed on the road through the town. It is a concrete and wood building in good condition with new exterior wood siding. The building contains six Caterpillar diesels of various models and output. The plant is well lighted and reasonably well laid out with ample space for engine maintenance. It contains a workshop/storeroom and office where switchgear for the self-contained EMD diesel is located. A moveable A-frame hoist is located within the building. The engine exhausts are mounted on the roof and appear to be in good condition though the 1995 NP Diesel Power Plant Report identifies that some work needs to be done on the mufflers. Engine cooling is accomplished by shell and tube heat exchangers utilizing town water. Switchgear for the Caterpillar diesels is obsolete, some dating back to 1937. Engine instrumentation is minimal. The main transformers for the plant are located at the rear of the building.

The EMD diesel is located adjacent to the main plant in a self contained steel enclosure complete with separate engine, generator, and radiator compartments. The engine and generator compartments are cramped. The enclosure is in relatively good condition however. The interior of the radiator compartment is heavily corroded with a number of small holes in the bottom of one main panel.

The stack and exhaust were recently rebuilt. Engine cooling is accomplished by a radiator at the front of the enclosure, glycol is used.

Fuel for the main plant and EMD diesel is supplied from two steel self-dyked tanks at the rear of the main building which are in good condition. The EMD has a day tank within the enclosure.

Engine Survey

Unit No. 10 Crankshaft deflection measurements are not practical in this type of engine but generator coupling alignment should be checked in the near future according to EMD Diesel instructions. The upper cylinder head camshaft and rocker gear area was fully exposed for inspection under the expansive top covers where everything appeared clean and satisfactory. Removal of the air box covers permitted close examination of pistons, piston rings, and inner area of cylinder liner through the air inlet ports. Photograph No. 45 was taken. The air box enclosure was somewhat covered by an oily carbon sludge but this condition is common to this class of two cycle engine breathing arrangement. No broken piston rings were found but the tell tale piston wear-down markings indicate some worn top compression rings, but significant life remains. Interior of the cylinders and exterior of piston skirt were very clean and deposits above the top ring are minimal relative to 1,654 operating hours.

A special feature which makes the EMD engine attractive to operators and economical for maintenance is the "Power Pack" arrangement for replacing a complete line including cylinder head, cylinder liner, piston and connecting rod, all in one assembly as indictated in Appendix 'D'.

Caterpillar The six units were given a visual inspection. Unit No. 2 was out of service due to a generator winding failure. Unit No. 4 and 5 are normally aspirated and produce low power relative to their physical size. All other units are turbo charged and all units operate at 1,200 rpm. Units 2 and 8 are electric start while the remaining are started with compressed air.

All machines were very clean and appeared to have been maintained to a high standard which might be misleading when considering their age and previous hard work when supplying the only source of power for many years.

Unit Operational Tests

Unit No. 10 The unit started at first cranking and settled at idle speed (400 rpm) in the automatic mode before moving up to 900 rpm synchronous speed as controlled by the automatic start sequence. What had been described as a suspicious turbocharger noise was observed before the unit came up to full load, but the unit settled down very smoothly without any unusual noise or vibration. Discussions with the supplier indicate that the bearings could be wearing out, but this is by no means certain and the unit is probably best left until the problem worsens, which may not occur. The supplier indicates catastrophic failure is most unlikely. The cost of a remanufactured turbocharger is around $35,000, taking about 2 days of labor to install, which NP could carry out themselves. The manufacturer can supply a service Engineer if necessary. The 2,700 kW full load condition was sustained for 1 hour without incident, all pressures and temperatures quickly settling down within normal parameters. The exhaust smoke was clear. Voltage and load control were very steady throughout the test. At the end of the test, the unit responded correctly to automatic commands to cool down at idle speed, and eventually stopping.

Caterpillars The six caterpillar units were put on load about 2 pm after a suitable warm-up period and carried various levels of load. However, electrical instrumentation is not sufficiently reliable to determine if the units were on high load or overload. In this respect, Unit No. 3 was noted to have a red hot exhaust manifold and turbocharger casing requiring the load to be reduced for safety's sake.

Several problem areas regarding the overall installation should be recorded.

- Rapid rise of plant interior temperature to 34°C.

- Engine speed control had to be carried out at the engine governor rather than utilization of speed "raise/lower" switch mounted in the switchgear.

- Rapid deterioration of breathing conditions within the plant due to crankcase breathers emitting fumes considered to be excessive.

- Reports of periodic heat exchanger tube failure likely caused by high velocity turbulent city water.

- Unit No. 8 - a faulty lubricating oil pressure switch had to be held open during start up to prevent shutdown while engine was getting up to speed.

- All Units needed ether spray for starting. However, although it is common practice, the use of ether on an engine located in a heated building should not be necessary and indicates the engine is worn and has insufficient compression for a normal start.

Load was carried on the five Units for 1 hour necessitating periodic manual adjustments to the governor controls to maintain the required load sharing levels.

Portables No. 1 and No. 2

Portable No. 1: The engine started easily using ether and was left to idle for 5 minutes while Portable No. 2 was started. Following warmup an attempt was made to synchronize the generator and put the unit on-line. The breaker was activated when the arm on the synchronizing clock reached 12 o'clock but the breaker did not immediately react and the hand was approaching the 6 o'clock position when the breaker attempted to close resulting in an explosion and flash of flame from the bottom of the switch gear. The test was cancelled and the engine shut down.

Portable No. 2: The engine was somewhat hard to start and required a generous application of ether sprayed into the intakes. Once started, the engine was warmed up and put on load. The Unit ran at full load for 1 hour. The crankcase vent was checked 45 minutes into the test and was found to be issuing a steady flow of vapour. The exhaust temperature rose to 950°F and remained constant throughout the test. The pyrometer is located after the turbocharger and 950°F is considered a safe maximum temperature. The engine did not show any signs of overheating but this was due to the cold air flowing over the exhaust manifolds which are located next to the trailer air inlet louvers.

Safety Considerations

The obsolete open faced line up of switchgear at the main plant is regarded as detrimental to personnel safety due to the inaccuracy of many instruments and the potential hazard of operator contact with so many live components unguarded. Most of the exhaust pipes from the engine to the ceiling were without insulation and the operator needs only slip to reach out and be seriously injured. The heat radiated from these exposed metal parts presents a clear danger of engine overheating due to excessively high aspiration air temperature because the air for all units is drawn from within the plant. During the test all engine speed control functions and breaker closure that was required to synchronize and load the diesel generators, was performed by two NP staff members. Apparently, for most of the time the plant is put on line in an emergency by a single person who would be under considerable pressure to work at top speed and escape the numerous dangers that exist. Health aspects of the fumes which particularly cause eye soreness needs consideration. The openness of the switchgear appears to be dangerous compared to present day enclosures but regard has to be given to the lack of incident over 50 years of existence, one section having being manufactured in 1937.

Summary

Unit No. 10 The Unit is self serving in the Standby mode (without daily or weekly attention) and prepares itself, self primes, self starts, idles, moves to synchronous speed, closes the breaker and moves to supply load automatically with all steps being performed for maximum safety and maximum reliability. This report has recorded space utilization in terms of power available relative to cubic space and the EMD Unit has the best ratio of all units, i.e., Watts/cubic ft. Exact operating and maintenance records are not available and can not be assembled from old log books but interviews indicate that this machine requires a minimum of man hours year after year.

Since 1969, the EMD "Package" has suffered corrosion in, on and around the open cooling system end and the resulting process gradually worsens and consideration should be given to removing the equipment to an indoors location and disposing of the enclosure before repair costs rise and unit reliability is impaired.

Newfoundland Power operators stated that their preference would be to operate the Caterpillars in the order of 80 to 90 percent of rated output but find that under emergency conditions there is a need to sustain high load and even overload to meet electrical demand of the area. The large number of Units make this a complex plant to manage and also to operate when an emergency conditions prevail. There are heath and safety conditions to be addressed which must be weighed against the amount of potential work involving six Units with 60 cylinders in a spacious building for a total maximum rated output of 1,200 kW which realistically offers a reliable continuous supply of only 1,020 kW.

Recommendations

It is recommended that Unit No. 10 be retained in service but it would be better relocated into the adjacent power house to minimize further deterioration and to provide better access for maintenance.

Although the six caterpiller units operate reasonably well there are deficiencies in switchgear equipment and speed adjustments in addition to safety concerns. It is recommended that the units be retired and replaced with a larger unit or units. They could alternatively be refurbished and relocated to sites needing smaller numbers of machines.

The portables should undergo rehabilitation of engine instruments and safety devices, and calibration of control panel instrumentation. The trailer base of Unit 2 should be refurbished, if there is any future requirement for portability. Both units can be retained in service.

4 Spare Parts Availability & Engine Overhaul Costs

4.1 Spare Parts Availability

Many manufacturers of diesel engines left the business after World War II (WWII) and on into the 1950s, but the designs and ongoing parts business were purchased by competitors. Manufacture of those engines did not continue as more advanced designs were introduced, usually at higher running speeds. As the population of existing units declined, major companies let the business pass to a variety of machine shop dealers etc., often termed "Parts Pirates". Some Pirates do reliable work and others are to be avoided. The present day status for units owned and operated by NP is as follows:

Nohab Polar/Polar Atlas
Nohab Polar was purchased by Wartsila of Finland over 20 years ago, but parts are still available as per letter in Appendix 'D'. Engineering Products and Services of Lincoln, England, have established a good reputation for supply of obsolete diesel parts, and they can supply some parts for Polar Atlas units, as per letter in Appendix 'D'.

Harland & Wolff
This major U.K. Shipyard discontinued manufacture of diesel engines soon after WWII. Their range of engines were mostly built under licencing agreements and parts availability for the Aguathuna unit is considered to be reliant on remanufacture by machine shops like Marsh Engineering Limited of Port Colborn, Ontario, who do specialize in diesel engine repair.

Nordberg
Cooper Bessemer owned the Nordberg designs for a number of years, but abandoned further supply about 1985. Hatch and Kirk and Jack Purpus Enterprises stock some running parts today but main parts like pistons and cylinder liners are very costly with long deliveries. Jack Purpus Enterprises do extensive business in Canada and their response to a request for typical parts availability and pricing was obtained; See Appendix 'D'.

Electro Motive Division/G.M.
Midwest Power Products Inc. of Winnipeg are the exclusive authorized distributor in Canada and stock a wide range of spares for the Model '645' of which there are 20 to 30 in industrial service in Canada. There will be several

thousand of these locomotive engines in Canada, mainly with C.N. and C.P. The 'Powerpack' arrangement coupled with Midwest Unit Exchange programme means EMD parts are readily available at most competitive prices, as illustrated in Appendix 'D'.

Worthington

This is one of many Power Plant class of equipment supported today by Ingersoll Rand, division of Dresser Industries, Painted Post, NY. State. Parts are very expensive and on very long delivery for these 1940s vintage engines, and although helpful with technical support, Ingersoll Rand may be expected to recommend retirement of the equipment. The factory has not in recent years found it economical to hold on to patterns, molds, drawings, etc., mainly due to a declining population (demand) of engines in service.

Caterpillar

As indicated in Appendix 'D' some of the units can be supplied with spare parts but in other cases they are no longer available.

4.2 Engine Overhaul

Typical Six Cylinder Worthington

For the purposes of this estimate it is being assumed that NP would contract the work out rather than use their own resources, therefore a charge-out rate of $60.00/hour is being used.

To strip down the engine to expose the crankshaft and remove all main bearings for inspection, pull pistons and cylinder liners, dismantle cylinder heads, camshaft, camshaft and governor drive, expose internal water cooling surfaces, generally examine all working parts. To clean components and prepare for re-assembly, measure interface wear and compare to maximum allowable running tolerance. All as needed to carry out major overhaul.

Estimated Manpower	4
(Includes one labourer for cleaning)	
Estimated Project Duration	8 weeks
Estimated Cost	
4 men x 40 hours/week x 8 weeks x $60.00/hour =	$76,800
	for one Unit, Labor only

Estimated cost of a complete set of gaskets, packings, jointing compound, cleaning materials	$1,500/cylinder x 6 = $9,000
Labor in Salt Pond or similar area will call for accommodation, food and transportation to and from site.	Estimate $120/man/day
Estimate: 4 men x 5 days/ week x 8 weeks x $120/man/day =	$19,200
Total Estimate = $76,800 + $9,000 + $19,200 =	$105,000

This labor cost would be similar, on a per cylinder basis, to that required for the Nordberg (8 cylinder) or Harland and Wolff (8 cylinder) units at St. John's and Aguathuna respectively, i.e., increasing the labor cost to about $140,000 or perhaps slightly higher due to the larger physical size of the units.

Note:

(a) Required new or refurbished parts cost would be extra.

It is very difficult to establish what parts might be needed without a detailed inspection. However, at least fuel pump overhaul (at $1,500) and injector overhaul (at $750 per cylinder) would be needed. With regard to replacement of major components such as cylinders and/or pistons, all that can be said at this stage is that the Nordberg unit appeared to be less likely to need major components than the Worthington or Harland and Wolff units.

A limited inspection by using a borescope to inspect inside the cylinder after removing the fuel injectors could identify if serious wear is apparent in the cylinders. Such inspections could be completed in about 2 days per unit. Similarly, entry into the engine crankcase and bottom-bearing removal could reveal any crankshaft/bearing wear which needed machining work to be carried out.

It must be iterated that only detailed inspections, which were not part of the scope of the review, will ascertain for certain if replacement parts are required. Cylinder liners and pistons, if needed, would cost around $8,500 and $6,800 respectively each, and cylinder covers $4,800, based on quotations for Nordberg parts.

(b) Expenditure of $105,000 on modern new replacement diesel generating capacity would purchase about 350 kW.

4.3 Instrumentation and Safety Devices

The following is a typical list of key engine instruments and safety devices required for a Standby Diesel Generator. All units remaining in service should be fitted with these items as a minimum.

High Speed Units	Low Speed Units
Oil Pressure	Oil pressure before and after filter: Low Oil Pressure, Alarm and Shutdown
Jacket Water Outlet Temperature Indicator	Jacket Water Outlet Temperature Alarm and Shutdown
Fuel Pressure	Fuel Pressure
Exhaust (Stack) Temp	Exhaust Temperature:- At each Cylinder Before turbocharger At stack Boost Air Pressure Boost Air Temperature Jacket Water Pressure
Overspeed (shutdown)	Overspeed (shutdown) Vibration (alarm)
Coolant Level	Coolant Level

The engines do have some instrumentation installed at the moment, but a full inventory was not taken. However, an estimate of average costs would be about $1,500 labor and $1,000 for parts for Caterpillar units, about $3,500 for labor and parts for the larger units.

5 Alternative Means of Power Generation

The review has concentrated on establishing whether or not it is practical or worthwhile to rehabilitate the existing units at various locations around Newfoundland. The units are intended, in part at least, to provide emergency power to areas which might be isolated from the electricity grid due to transmission line outages during ice storms, and can also provide peak generation.

In recommending decommissioning of a number of the units, the report recognizes that it is not economic to replace most of the decommissioned units with new units at the same sites. This does mean that replacement power from a centralized site provided by a new generating plant will not reach an isolated site in the event of transmission line failure.

The alternative means for generating replacement power is most practically met by installing new or used gas turbine generators or diesel generators.

The total installed capacity is approximately 14 MW, and depending upon how much of this capacity it is decided to replace, unit sizes are available in relatively small increments to cover the entire range from less than 1 MW to 14 MW, assuming a minimum of two units in order to retain some redundancy against outages, this would mean the maximum unit size would be 7 MW.

In general, the larger the unit size the lower the cost would be, but anomalies can be found when selecting from a manufacturer's range or comparing with another manufacturer's model. A thorough examination of the flexibility in selecting unit size and type should be made in order to minimize expenditure.

For the purposes of identifying typical unit costs, current prices were obtained for the latest production model of the Electro-Motive Diesel Unit installed as Unit 10 at Port-aux-Basques. This machine is a medium-speed diesel generator and can be purchased in skid mounted form for installation in a powerhouse at a cost of $1,300,000 (Canadian funds) or remanufactured to as-new condition for $900,000 to $1,000,000. At a unit output of 2,500 kW, this represents an investment of $360 to $520/kW, to which must be added infrastructure costs. Confirmation of these budget costs can be found in the fax from Midwest Power Products included in Appendix 'D'. This cost can be considered as an expected price to pay for replacement power generation equipment in the size range given.

Replacement costs for higher speed but smaller units have been estimated by Toromont/Cat of Toronto who recently purchased control of Newfoundland Tractor. For sizes ranging 100 kW to 500 kW an estimating cost of $300/kW is suggested, for sizes ranging 500 kW to 1,500 kW an estimating cost of $250/kW is suggested. These units operate at 1,800 rpm and are generally complete with radiator cooling, switchgear and control panel.

The use of gas turbines should also be considered, as on a capital-cost basis they are frequently cheaper than diesels in larger unit sizes. Their lower thermal efficiency is of less importance in an emergency plant which operates infrequently, than in a base-load plant.

Appendix A
Inspection Sheets

- General Information
- Historical Data
- Mechanical Data
- Electrical Data
- Engine Test Data

General Information

Unit Ref. No. (At site)	Location	Fuel Storage Tanks	Building Space and Condition, Foundations	Exhausts and air intakes	Compressors and air Receivers	Oil and Water Leaks	Condition of Switchgear, Transformers and Batteries	Remarks and Observations
1 (1)	Salt Pond	2 Exterior tanks and day tanks in building	ok	ok	See Remarks	yes	Good	Day tanks located close to uninsulated exhaust pipes
2 (2)	Salt Pond		ok	ok	See Remarks	yes	Good	
3 (3)	Salt Pond		ok	ok	See Remarks	see remarks	Good	Not put on test. #5 cylinder piston removed.
4 (1)	Aguathuna	Geep + daytank Ok	ok	Rusty, ok	ok	yes	ok	Repair necessary
5 (1)	St. Johns	Needs replacing	ok	ok	ok	none	old but works, batteries need to be replaced	Engine in sound condition, used equipment cluttering engine space.
6 (1)	Gander	ok	ok	ok	ok	see report	old	Engine would not start
7 (2)	Gander	ok	ok	exhaust stained black	ok	yes	old	Oil leaking from exhaust manifold and crankcase doors Repairs necessary
8 (3)	Gander	ok	Engine foundation cracked	ok	ok	yes	old	Oil leaking from exhaust manifold and crankcase doors Repairs necessary
9 (1)	Port-aux-Basques	All engines	ok	ok	Electric start	yes	Hewitt/ok	Trailer mounted unit Instrumentation unreliable
10 (2)	Port-aux-Basques	supplied from	ok	ok	Electric start		Hewitt/ok	Trailer mounted unit Instrumentation unreliable
11 (1)	Port-aux-Basques	two GEEP	ok	ok	air equipment for air start	yes	All switch gear open contact type	
12 (2)	Port-aux-Basques	located outside	ok	ok	diesels in good	no	old and obselete. Some is 1937	
13 (3)	Port-aux-Basques	building.	ok	ok	condition	no	vintage. No govenor control	Test stopped when exhaust and turbo ran red hot
14 (4)	Port-aux-Basques		ok	ok		no	on switch panel	
15 (5)	Port-aux-Basques		ok	ok				
16 (8)	Port-aux-Basques		ok	ok				Large volume of gas venting from pcv valve during test

General Information - 2

Unit Ref. No. (*At site*)	Location	Fuel Storage Tanks	Building Space and Condition, Foundations	Exhausts and air intakes	Compressors and air Receivers	Oil and Water Leaks	Condition of Switchgear, Transformers and Batteries	Remarks and Observations
17 (10)	Port-aux-Basques		ok	ok	n/a	no		
18 (1)	Port Union	GEEP (93)	ok	ok	n/a	minor leak during operation	good	Unit performed well

Historical Data

Unit Ref. No. (At site)		Location	Make	Model	Serial No.	Rating HP	Year Installed	Age Years	Total Hours Run	L x W x H
1	(1)	Salt Pond	Worthington	EE-6-STD	VO-1633	670	1941	56	16,935[1]	28 x 9 x 12
2	(2)	Salt Pond	Worthington	EE-6-STD	VO-1635	670	1941	56	17,112[1]	28 x 9 x 12
3	(3)	Salt Pond	Worthington	EE-6-STD	VO-1680	670	1941	56	14,562[1]	28 x 9 x 12
4	(1)	Aguathuna	Harland & Wolff	one of a kind	2476	2000	1962	35	10,086	36 x 10 x 14
5	(1)	St. Johns	Nordberg	TS-218	2012-0804	3580	1953	44	2,425	45 x 7 x 18
6	(1)	Gander	Polar Atlas	K57M	86190	1470	1949	48	not available	28 x 9 x 10
7	(2)	Gander	Nohab-Polar	K57M	1611	1470	1957	40	not available	28 x 9 x 10
8	(3)	Gander	Nohab-Polar	K57M	1466	1470	1953	44	not available	28 x 9 x 10
9	(1)	Port-aux-Basques	Caterpillar	D349 (portable)	61P476	980	1973	24	4,659	16 x 5 x 6
10	(2)	Port-aux-Basques	Caterpillar	D349 (portable)	61P809	980	1976	21	1,966	10 x 5 x 6
11	(1)	Port-aux-Basques	Caterpillar	D397	41B1388	505	1945	52	1,910	13 x 5 x 6
12	(2)	Port-aux-Basques	Caterpillar	D353D	46B1667	380	1953	44	9,153	11 x 5 x 7
13	(3)	Port-aux-Basques	Caterpillar	D397	48B1181	505	1954	43	10,555	12 x 6 x 5
14	(4)	Port-aux-Basques	Caterpillar	D386	15B1	344	1958	39	3,856	17 x 5 x 6
15	(5)	Port-aux-Basques	Caterpillar	D386	15B54	364	1965	32	7,803	16 x 6 x 5
16	(8)	Port-aux-Basques	Caterpillar	D353	46B1663	380	1965	32	6,680	11 x 5 x 7
17	(10)	Port-aux-Basques	GM	20-645-E4	69E11081	3600	1969	28	1,654[2]	29 x 8 x 6
18	(1)	Port Union	Caterpillar	D398A	661B127 SER. A	750	1962	35	not available	13 x 5 x 6

[1] At Salt Pond since 1963 only

[2] 1993 air filter changed, louvers repaired, rebuilt exhaust
1996 replaced coolant heater, changed oil
1992 changed oil, changed belts on fan, changed coolant, replaced rubber seals on valve covers.

Mechanical Data

Unit Ref. No. (At site)	Location	RPM	Turbo or N/A	Type of Governor	Number of Cylinders	Start Method	Cooling Method	Common Under Base	Average Fuel Rate KWh/L
1 (1)	Salt Pond	327	Normally Aspirated	Pickering	6	Air in cylinder	Direct city water	no	Total Plant 1.98
2 (2)	Salt Pond	327	Normally Aspirated	Pickering	6	Air in cylinder			
3 (3)	Salt Pond	327	Normally Aspirated	Pickering	6	Air in cylinder			
4 (1)	Aguathuna	327	Napier Turbo Blower	Woodward UG-32	8	Air in cylinder	Glycol & Radiator	no	3.54
5 (1)	St. Johns	225	Supercharged Roots Blower	Woodward 1C500	8	Air in cylinder	Heat exchng. city water	no	3.98
6 (1)	Gander	300	Supercharged by Centrifugal Blower	Polar	7	Air in cylinder	Glycol & evaporator	no	Total Plant 1.72
7 (2)	Gander	300		Polar	7	Air in cylinder	Glycol & evaporator	no	
8 (3)	Gander	300		Polar	7	Air in cylinder	Glycol & evaporator	no	
9 (1)	Port-aux-Basques	1800	Tubrocharged	Woodward UG-8	16	Electric	Glycol & Radiator	yes	3.46
10 (2)	Port-aux-Basques	1800	Turbocharged	Woodward UG-8	16	Electric	Glycol & Radiator	yes	3.18
11 (1)	Port-aux-Basques	1200	Turbocharged	Woodward UG-8	12	Air Motor	Heat exchng. City water	yes	Total Plant 2.57
12 (2)	Port-aux-Basques	1200	Turbocharged	Woodward UG-8	6	Electric	Heat exchng. City water	yes	
13 (3)	Port-aux-Basques	1200	Turbocharged	Woodward UG-8	12	Air Motor	Heat exchng. City water	yes	
14 (4)	Port-aux-Basques	1200	Normally Aspirated	Woodward UG-8	12	Air Motor	Heat exchng. City water	no	
15 (5)	Port-aux-Basques	1200	Normally Aspirated	Woodward UG-8	12	Air Motor	Heat exchng. City water	no	
16 (8)	Port-aux-Basques	1200	Turbocharged	Woodward UG-8	6	Electric	Heat exchng. City water	yes	
17 (10)	Port-aux-Basques	900	Turbocharged	Woodward EGB-10	20	Electric	Radiator	yes	3.49
18 (1)	Port Union	1200	Turbocharged	Woodward UG-8	12	Electric	Heat exchng. River water	no	3.03

Electrical Data

Unit Ref. No. (At site)		Location	Generator Make	Generator Serial No.	Rating kW	Power Factor	Service Factor	Voltage	Excitation Method	Remote or Local Start	Transformers and Switchgear, Date of Mfr. (TFMR. Rewound?)
1	(1)	Salt Pond	Electric Machinery	82363	500	0.8		4,160	DC Gen.	Local	G.E.
2	(2)	Salt Pond	ElectricMachinery	83539	500	0.8		4,160	DC Gen.	Local	G.E.
3	(3)	Salt Pond	Electric Machinery	82362	500	0.8		4,160	DC Gen.	Local	G.E.
4	(1)	Aguathuna	Harland & Wolff	18180	1200	0.8		2,400	DC Gen.	Local	G.E.
5	(1)	St. Johns	General Electric		2500	0.8		6,600	DC Gen.	Local	Metro. Vickers
6	(1)	Gander	CGE	404125	1000	0.8		2,300	DC Gen.	Local	
7	(2)	Gander	CGE	604571	1000	0.8		2,300	DC Gen.	Local	
8	(3)	Gander	CGE	604318	1000	0.8		2,300	DC Gen.	Local	
9	(1)	Port-aux-Basques	Tamper-Camron	363-088-101	700	0.8	1.0	347/600	DC Gen.	Local	
10	(2)	Port-aux-Basques	Brown-Boveri	C360-690-	670	0.85	1.0	347/600	DC Gen.	Local	
11	(1)	Port-aux-Basques	Caterpillar	850RN60	350	0.80		2,400	DC Gen.	Local	Gen. Burnt Out
12	(2)	Port-aux-Basques	Caterpillar	2505N17	250	0.80		2,400	DC Gen.	Local	
13	(3)	Port-aux-Basques	Caterpillar	350RN2	350	0.80		2,400	DC Gen.	Local	
14	(4)	Port-aux-Basques	General Electric	6842237	209	0.80		2,400	DC Gen.	Local	
15	(5)	Port-aux-Basques	Caterpillar	6917550	250	0.80		2,400	DC Gen.	Local	
16	(8)	Port-aux-Basques	Caterpillar	2050N16	250	0.80		2,400	DC Gen.	Local	
17	(10)	Port-aux-Basques	Caterpillar	69E11199	2500	0.80		4,160	DC Gen.	Local	
18	(1)	Port Union	General Electric	754784	500	0.80		2,400	DC Gen.	Local	

ENGINE TEST DATA

Unit Ref. No.	Location	Time of Start	Time of Stop	Test Duration mins	Time to Sync. mins	AMPS	Load kW	Pressures (psi)					Temperatures (°F)		
								Lube oil	Boost	Jacket Water	Fuel	Other	Lube oil	Jacket Water	Exhaust
Worthington recommend operating temperatures and pressures							500	20		40			165	130	800
1	Salt Pond	09:15	10:30	75	1	55 to 60	500	32		13	2		76	45 inlet 120 outlet	660
			10:30			55 to 60	500	27		13	2		95	45 inlet 150 outlet	
2	Salt Pond	09:10	10:30	80	1	75 to 80	540 to 600	39		13	2		105	45 inlet 130 outlet	600
		10:30				75 to 80	540 to 600	34		12	2		110	45 inlet 120 outlet	600
3	Salt Pond	Not run as piston missing for #5 Cylinder													
General Notes:	Numerous water and oil leaks. Unit#2 leaking water severely from around exhaust manifold. Fuel pressure is based on static head of elevated day tanks. Approx. 5 ' .														
Nordberg recommended operating temperatures and pressures							2500								
1	St. John's	10:20	10:45	25	5	200	2400	30	1.6	21	20		105	102	400
General Notes:	Engine ran smoothly without any problems, clear exhaust, all temperatures & pressures normal														
1	Port Union	03:10	04:10	60	1	130	500	45	No gauges on engines except parameters indicated						
General Notes:	Minor oil leak on lubrication line to tubrocharger, clear exhaust, limited instrumentation, smooth running														

ENGINE TEST DATA

Unit Ref. No,	Location	Time of Start	Time of Stop	Test Duration mins	Time to Sync. mins	AMPS	Load kW	Pressures (psi) Lube oil	Boost	Jacket Water	Fuel	Other	Temperatures (°F) Lube oil	Jacket Water	Exhaust
Nohab Polar recommended operating pressures and temperatures							1000	28	2.4	14.5	43		140	122	500
2	Gander	02:25			1	280	875	25	1.1	16	43		140	104	270
		02:50				280	850	25	1.1	16	43		162	126	320
		Load cut back to 600 kW at 2:55 due to high lubricating oil temperatures (Maximum permissible 158 degress F)													
		03:06				230	500	25	1.1	16	43		169	136	250
		03:25				230	480	25	1.1	16	43		162	129	220
General Notes:		White smoke from exhaust stack. Numerous oil leaks from exhaust manifold													
3	Gander	02:30			1	200	100	25	2.6		30		131	122	200
		Load raised to 725 kW at 3:05 pm													
		03:10				320	700	15	2.6		30		165	169	360
		Load reduced due to high lubricating oil temperature, reduced to 250 kW													
		Load reduced to 0 at 3:22 pm. Evaporator blower not functioning. Breaker reset and unit placed back on load.													
		03:25				220	500	20	2.6		30		172	147	300
General Notes:		White smoke from exhaust stack													
Harland & Wolff recommended operating pressures and temperatures							1200	15 min.					160 max	165 normal	
1	Aquathuna	04:05		60	1		0	20	0.6		(No Instruments)		90	110	
		04:25				240	900	20	3.6				110	126	
		04:30				270	1100	20	5				114	128	
		04:45				270	1100	20	5				120	130	
		04:55				270	1100	20	5				120	130	

General Notes:

Steady flow of smoke from PCV valve.
Grey smoke from stack at full load
Numerous minor oil leaks from all joints
Leaks around exhaust manifold
Exhaust pyrometer not functioning

ENGINE TEST DATA

Unit Ref. No,	Location	Time of Start	Time of Stop	Test Duration mins	Time to Sync. mins	AMPS	Load kW	Pressures (psi)					Temperatures (°F)		
								Lube oil	Boost	Jacket Water	Fuel	Other	Lube oil	Jacket Water	Exhaust
GM recommended operating pressures and temperatures							2500	125 cold 29 at speed			12 at start 25 at speed			180	
10	Port-aux-Basques EMD GM	11:25		65	0		0	105			15			80	
		11:30				370	2500	115			25			90	
		11:45				395	2600	95			25			150	
		12:00				400	2700	80			22			150	
		12:15				400	2650	80			22			155	
		12:30				400	2700	75			21			160	
General Notes:	Clear exhaust, no problems														
Caterpillar Units Main Plant Port-aux-Basques (limited instrumentation)															
1	Port-aux-Basques	01:52	02:55	63	1	90	280	Minor oil leaks							
2	Port-aux-Basques							Not tested, generator burnt out							
3	Port-aux-Basques	01:50	02:45	55	1	95	305	Test stopped early due to overheating, turbocharger red hot, head gaskets leaking oil							
4	Port-aux-Basques	01:51	02:55	64	1	37	160								
5	Port-aux-Basques	01:45	02:55	70	1	66	220								
8	Port-aux-Basques	01:50	02:55	65	1	90	235	Steady flow of gas from crankcase vent							
Protable Units Grand Bay Substation (limited Instrumentation)															
1	Port-aux Basques	09:00	09:10	10				Breaker blew while trying to synchronize. Flash from bottom of breaker panel. Test stopped							
2	Port-aux-Basques	09:10		65	1	0	0								800
		09:15				640	580								900
		09:25				740	660	All temperatures in normal range							950
		09:40				720	660								950
		09:50				730	660								950
		10:05				720	660								950
		10:15				760	660								950
General Notes:	Vapor issuing from crankcase vent, exhaust temperature is measured after turbo, clear exhaust, minor oil leaks														

Appendix B
Photographs

ACRES

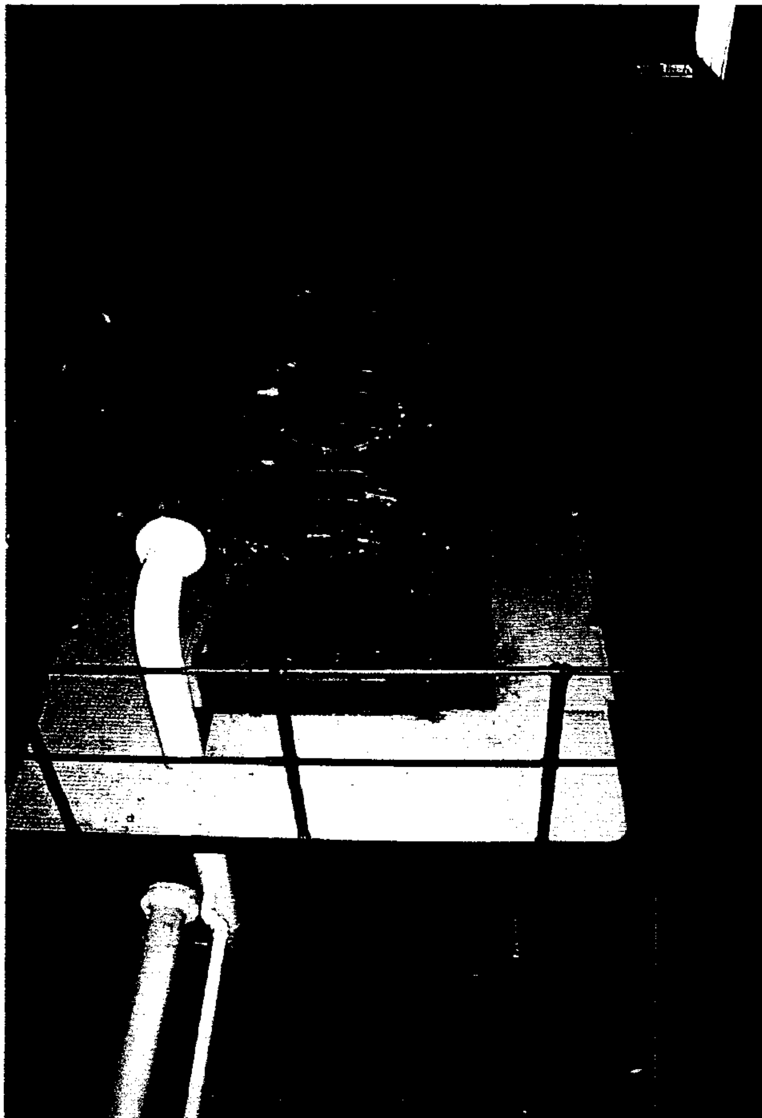


Photo 1
St. John's - Nordberg General View

Photo 2
St. John's - Nordberg crankcase internals

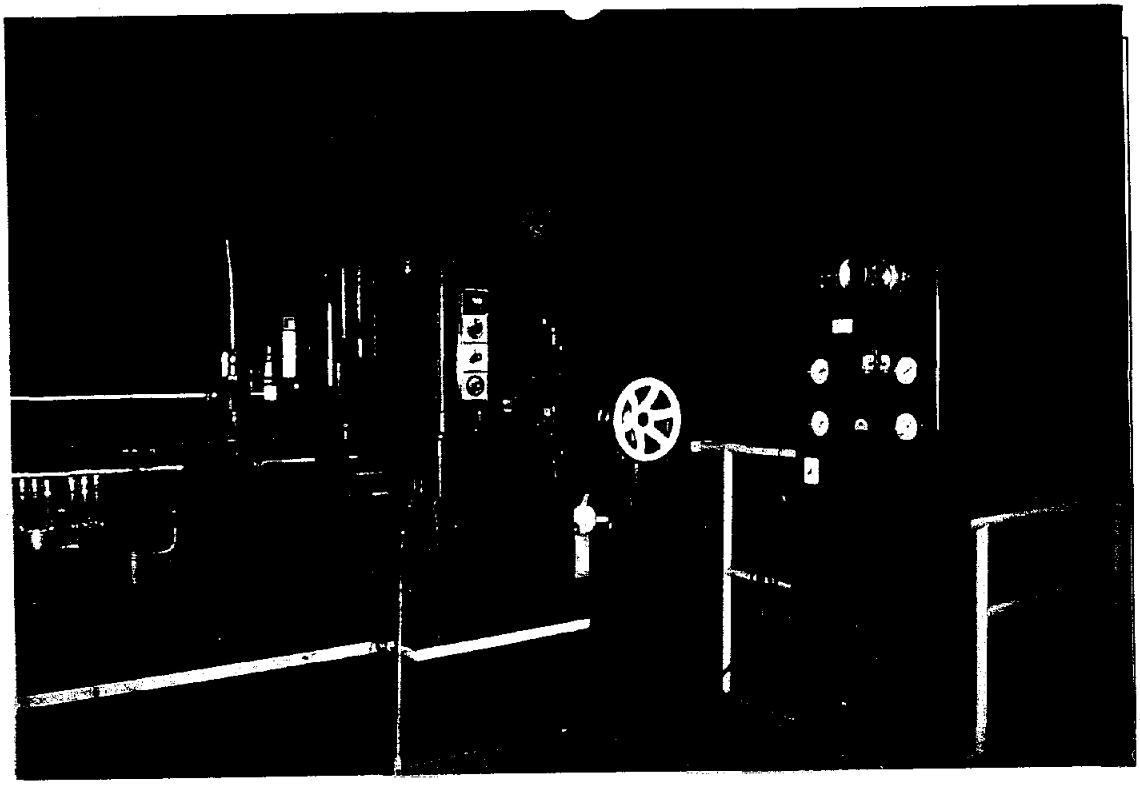


Photo 3
St. John's - Nordberg control position

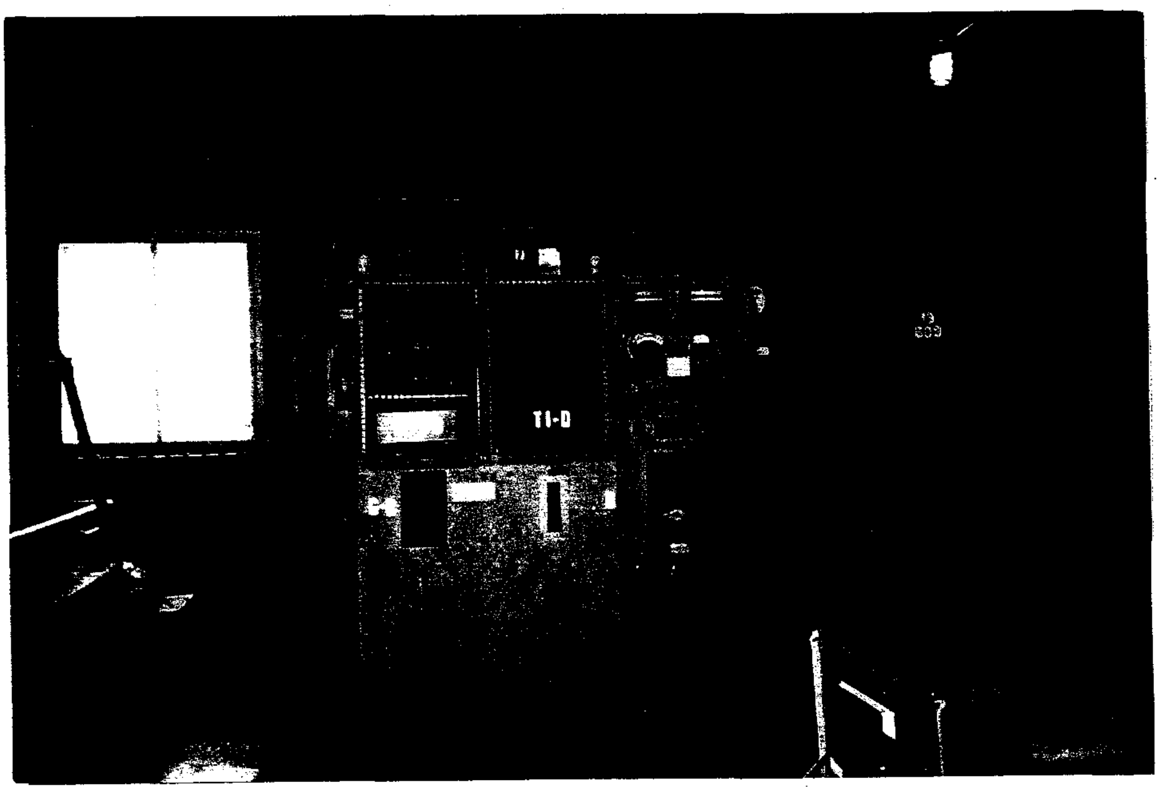


Photo 4
St. John's - Switchgear

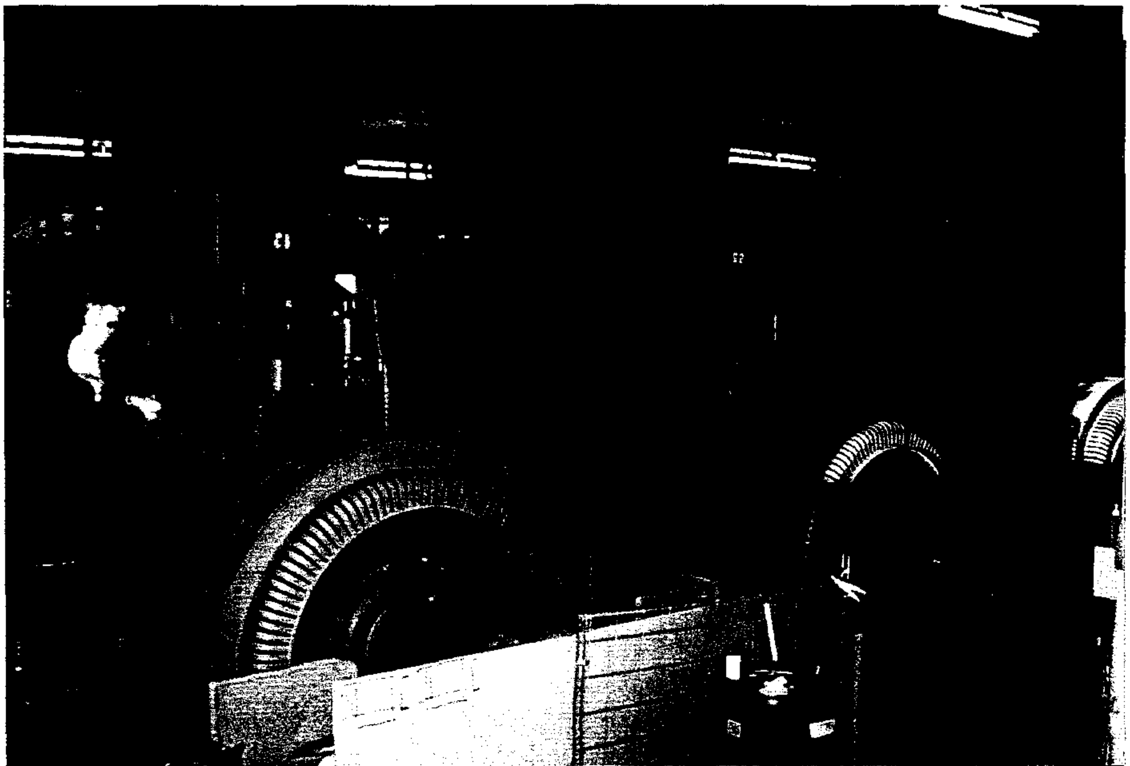


Photo 5
Salt Pond - General view of Worthington units

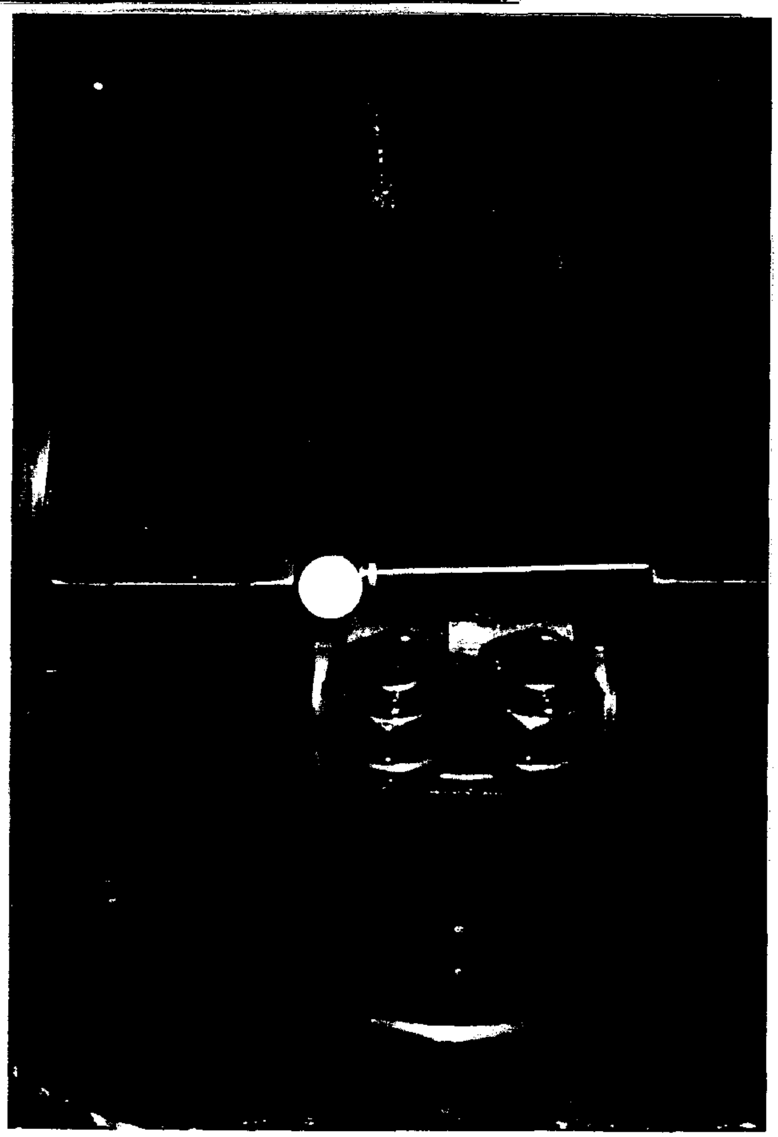


Photo 6
Salt Pond - Worthington crankcase and alignment indicator

Photo 7
Salt Pond - Electric cables oil soaked in trench

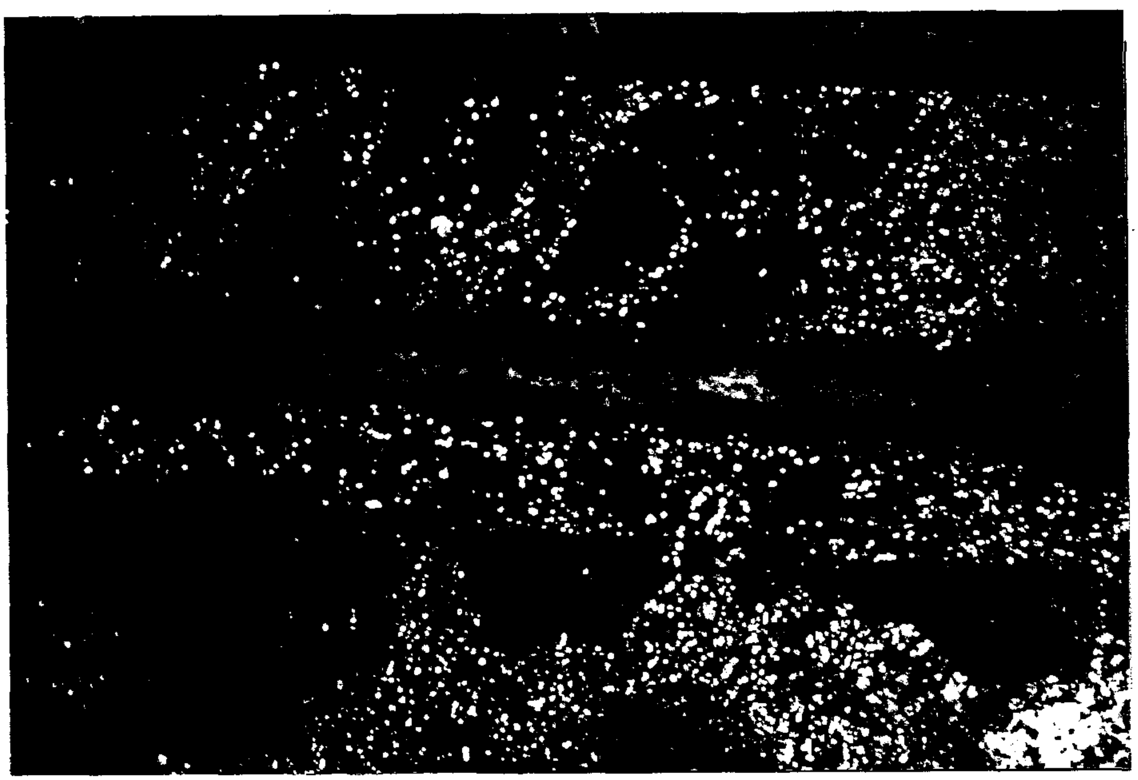


Photo 8
Salt Pond - Oil deposit in trench

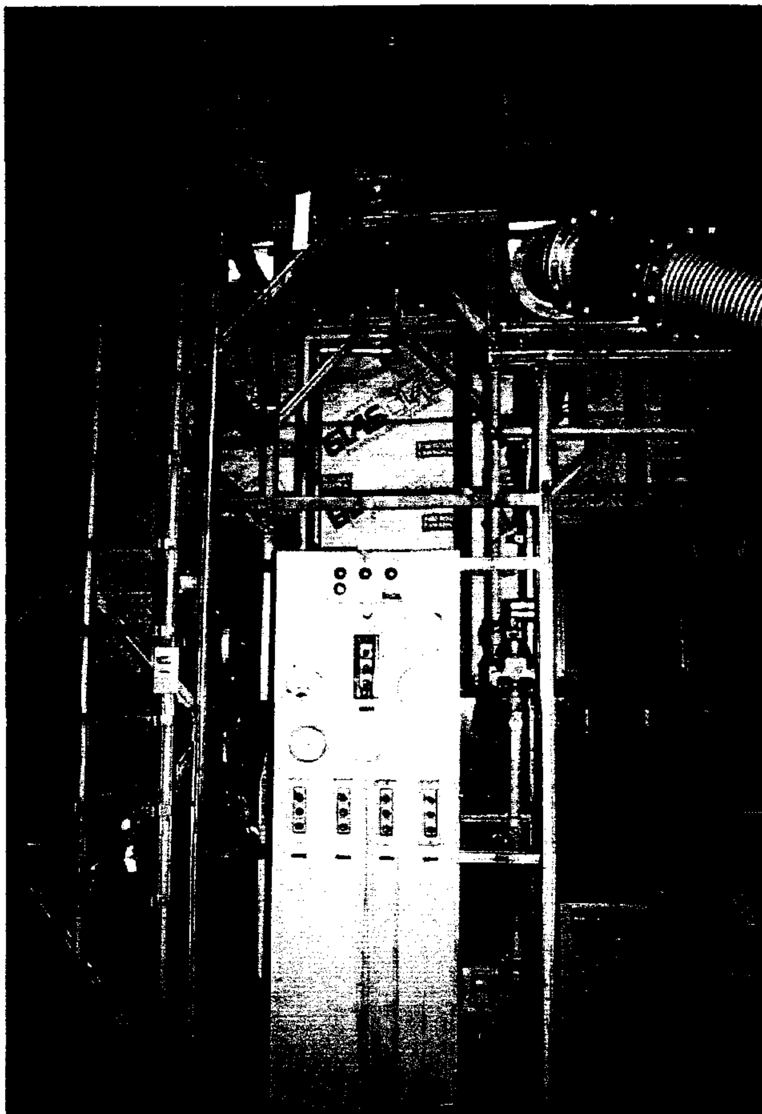


Photo 9
Salt Pond - Fuel tank and exhaust in close proximity

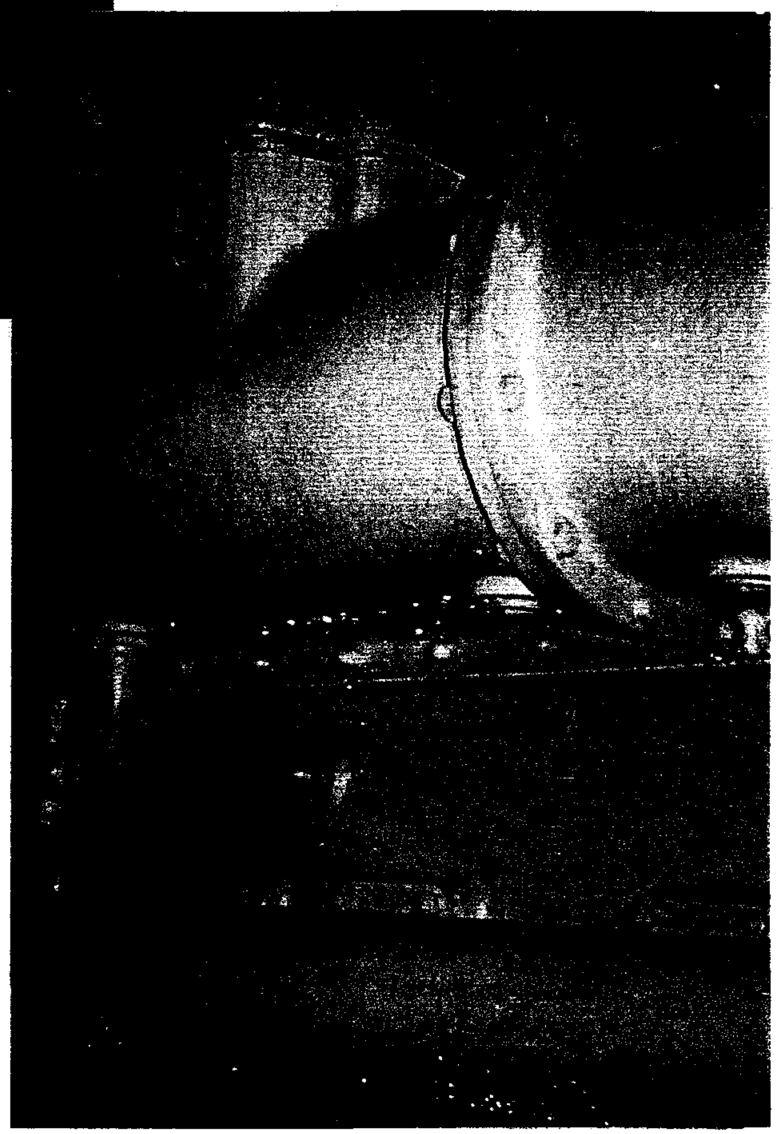


Photo 10
Salt Pond - Excessive water leaks at exhaust manifold

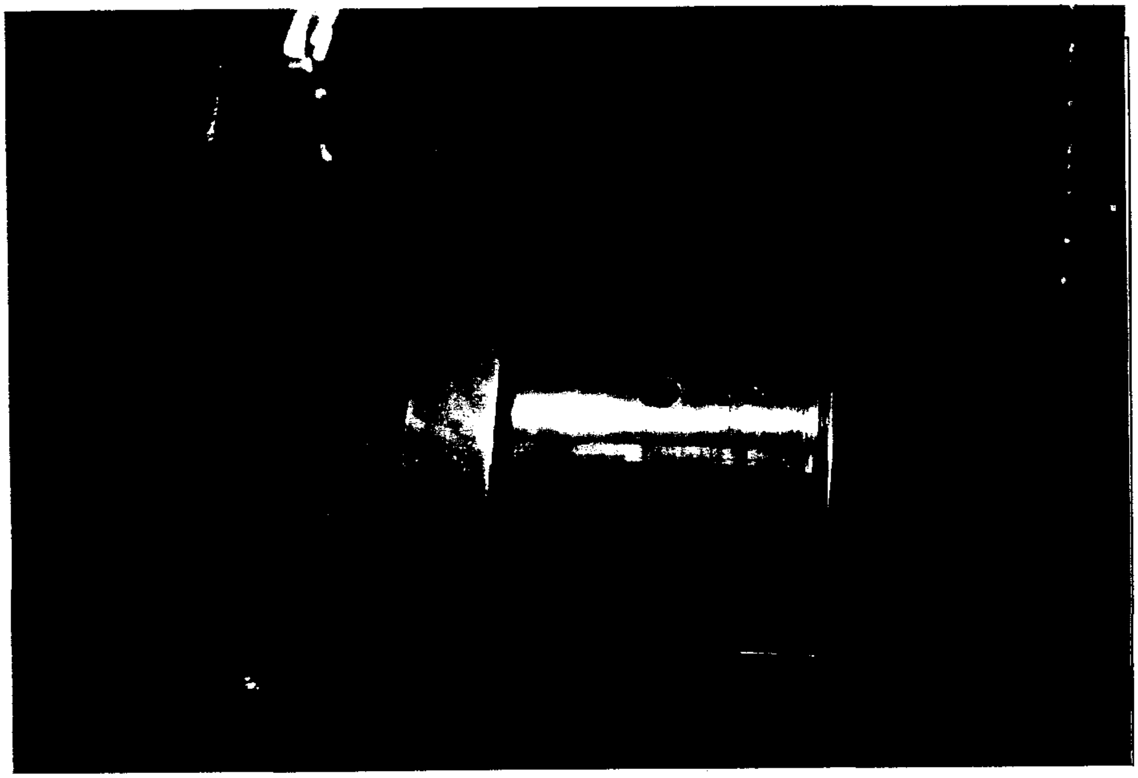


Photo 11
Salt Pond - Damaged crankshaft journal

Photo 12
Salt Pond - Building and fuel tank

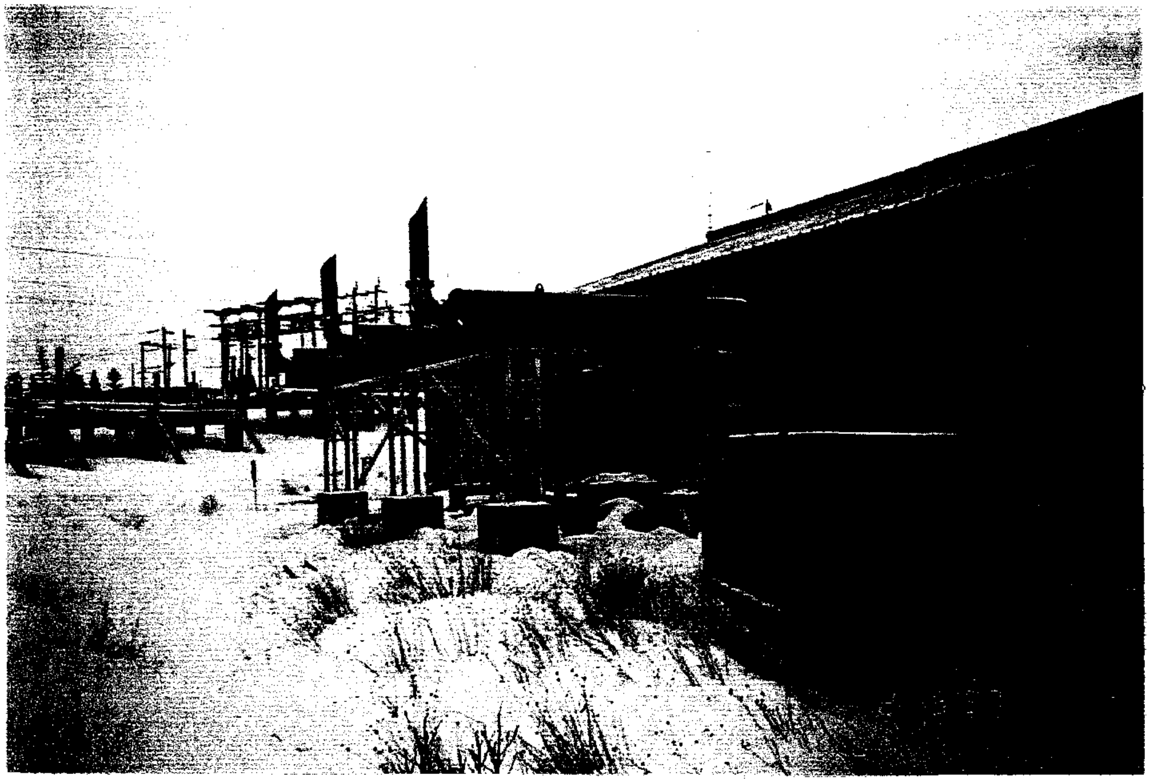


Photo 13
Salt Pond - Air intake and exhaust muffler

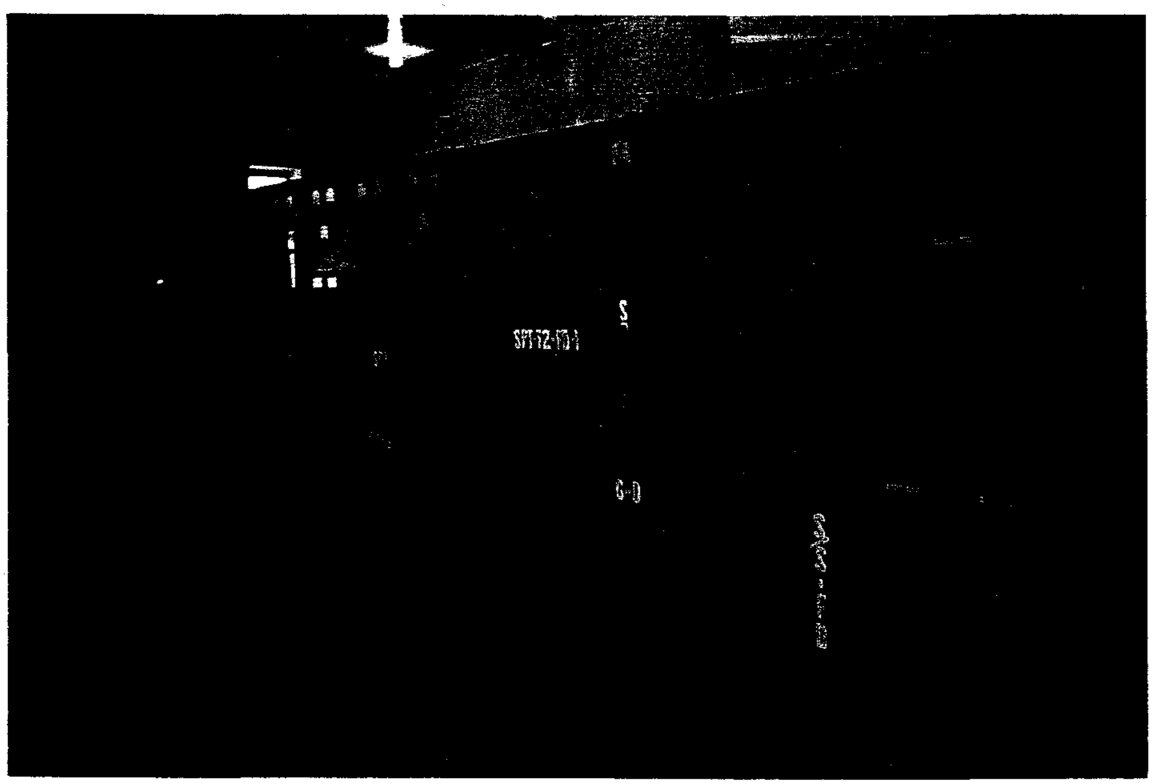


Photo 14
Salt Pond - Switchgear

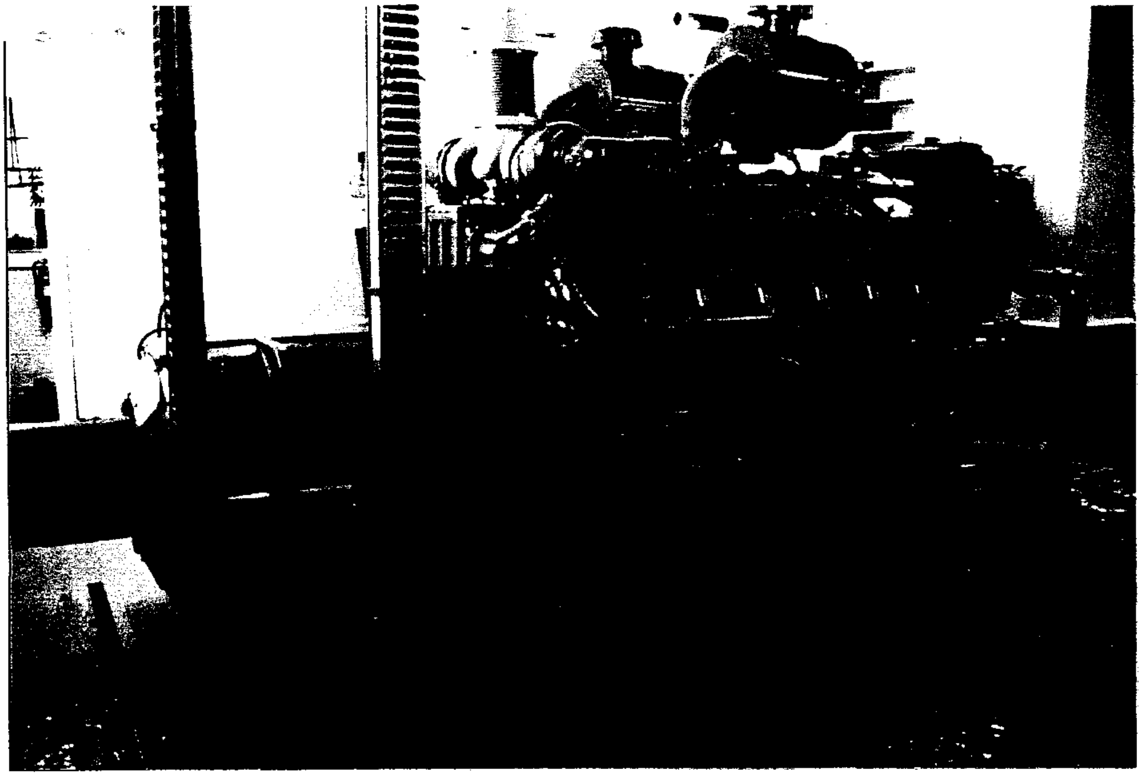


Photo 15
Port Union - Caterpillar 399/500 kW

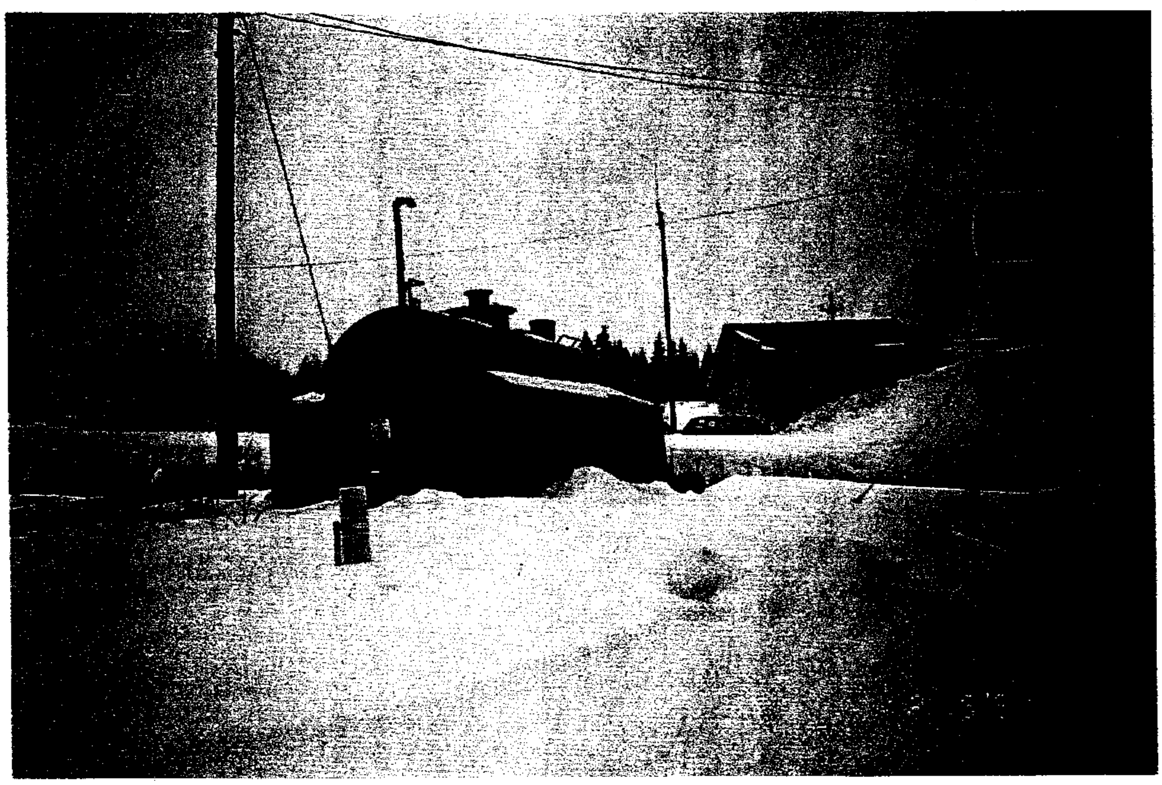


Photo 16
Port Union - Exhaust and fuel tank

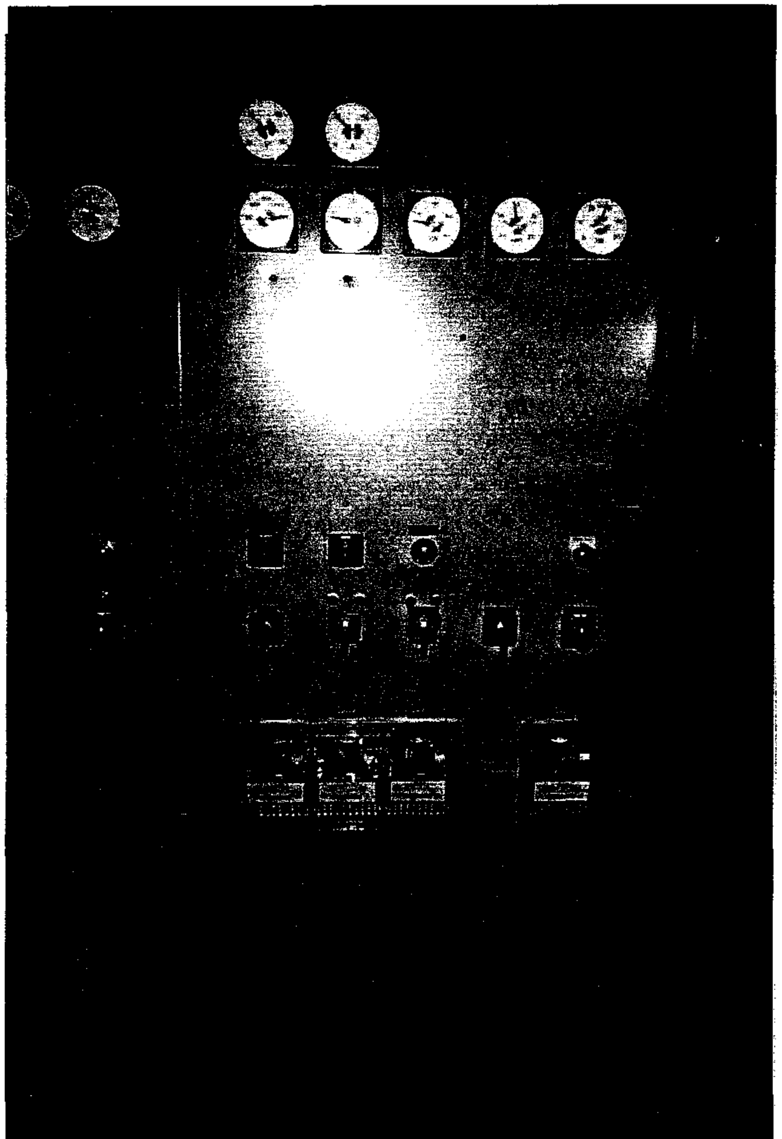


Photo 17
Port Union - Switchgear

Photo 18
Gander - Exhaust and fuel tank

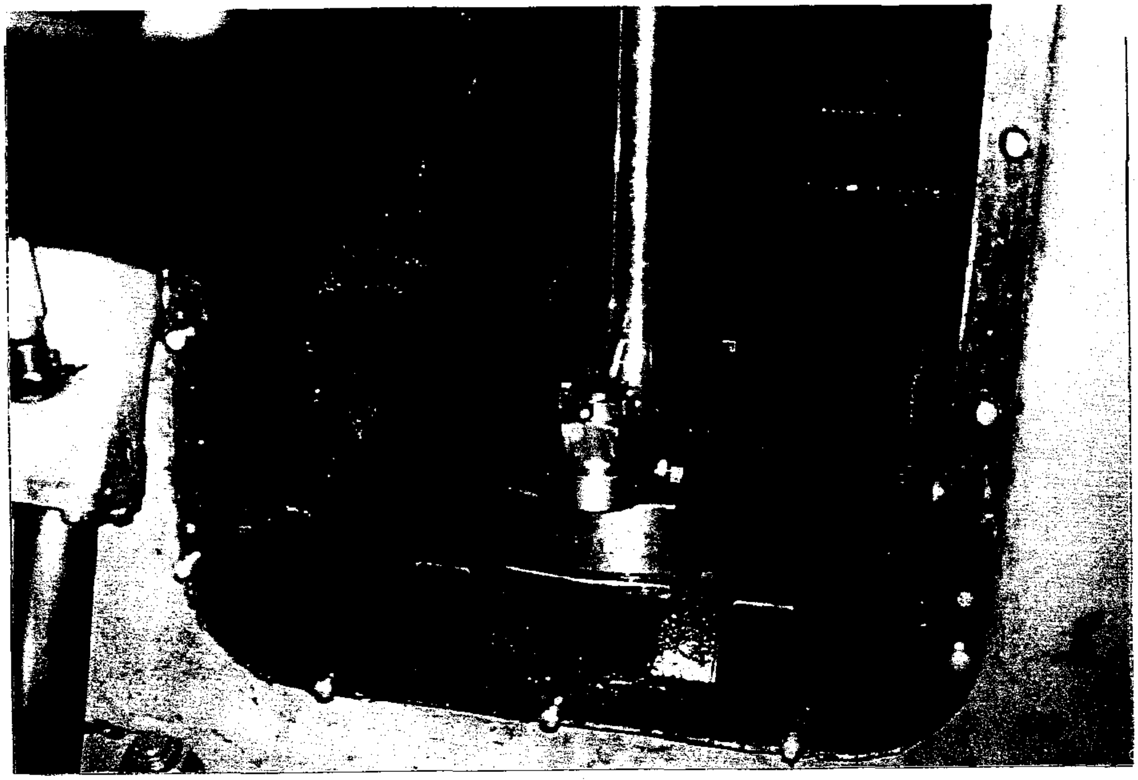


Photo 19
Gander - Atlas Polar crankcase internals

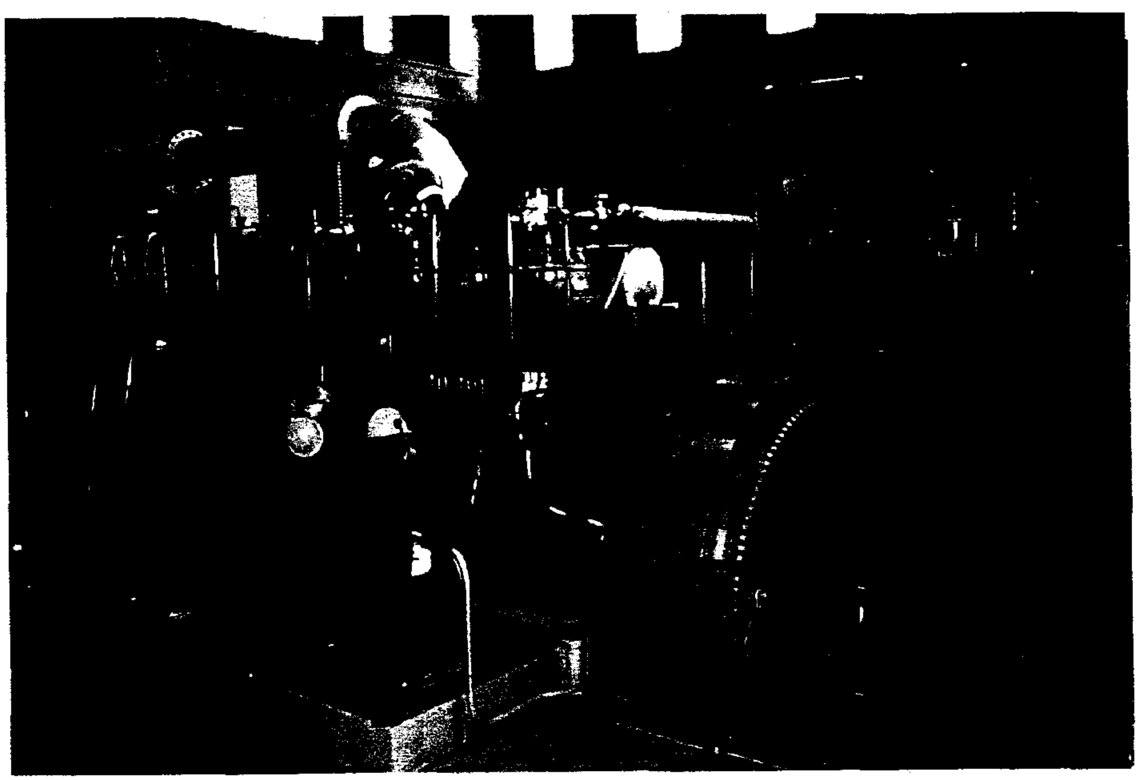


Photo 20
Gander - Unit No. 1 with surplus caterpillar unit in background

Photo 21
Gander - General view of expansive power house

Photo 22
Gander - Unit No.3 evaporative cooler and damaged engine components

Photo 23
Gander - New cylinder liner and worn piston components showing bronze inserts

Photo 24
Gander - New and scrapped cylinder liners

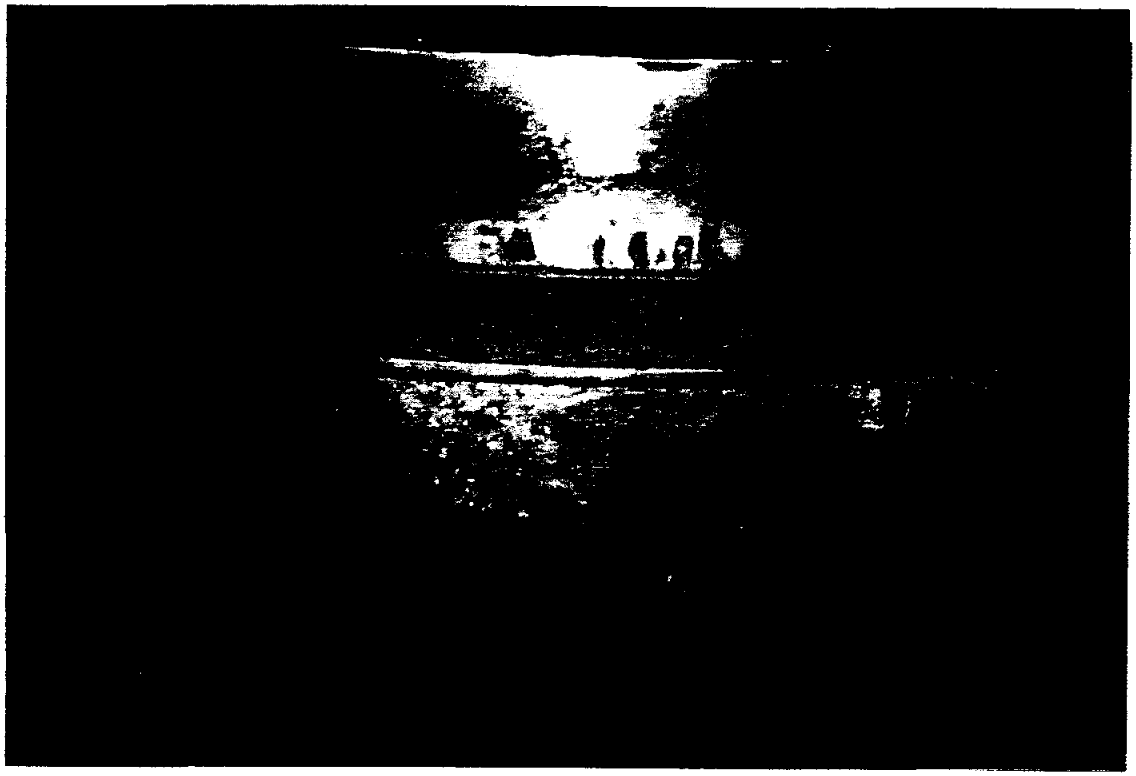


Photo 25
Gander - Cylinder liner O' ring seal area showing badly deteriorated groove face

Photo 26
Gander - Unit No.3 showing cracked foundations

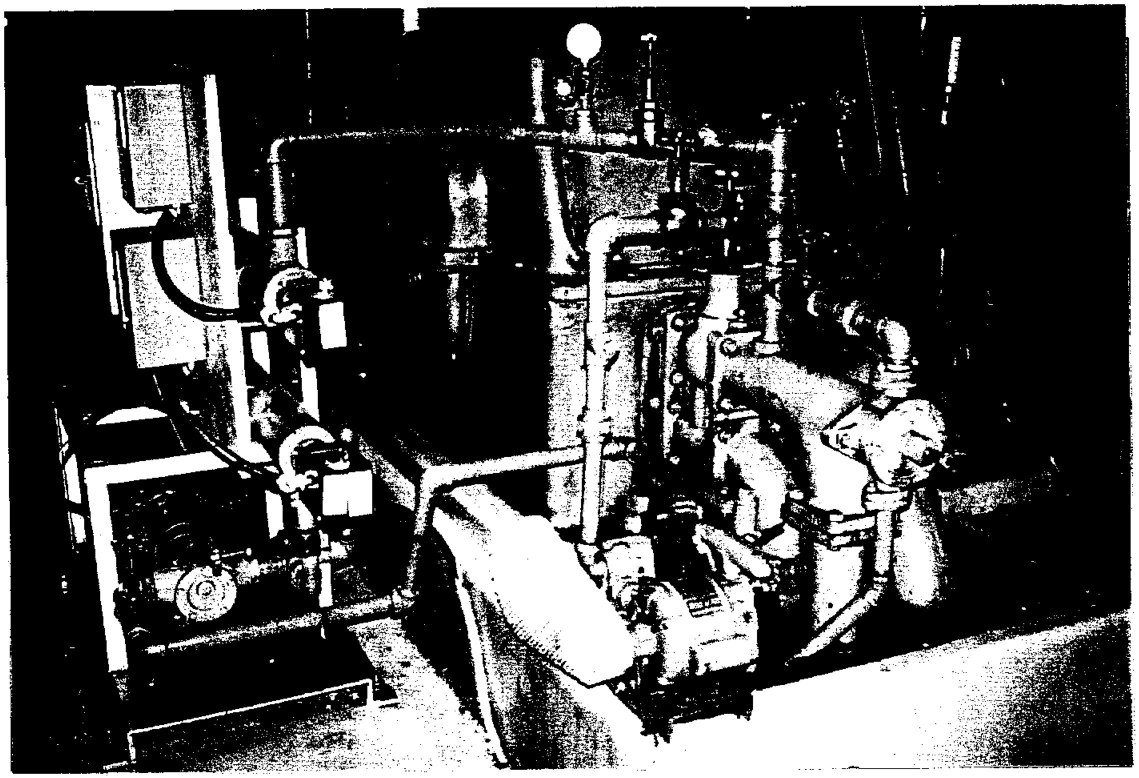


Photo 27
Gander - Typical continuous priming and heating system. Lubricating oil heaters and primary pump

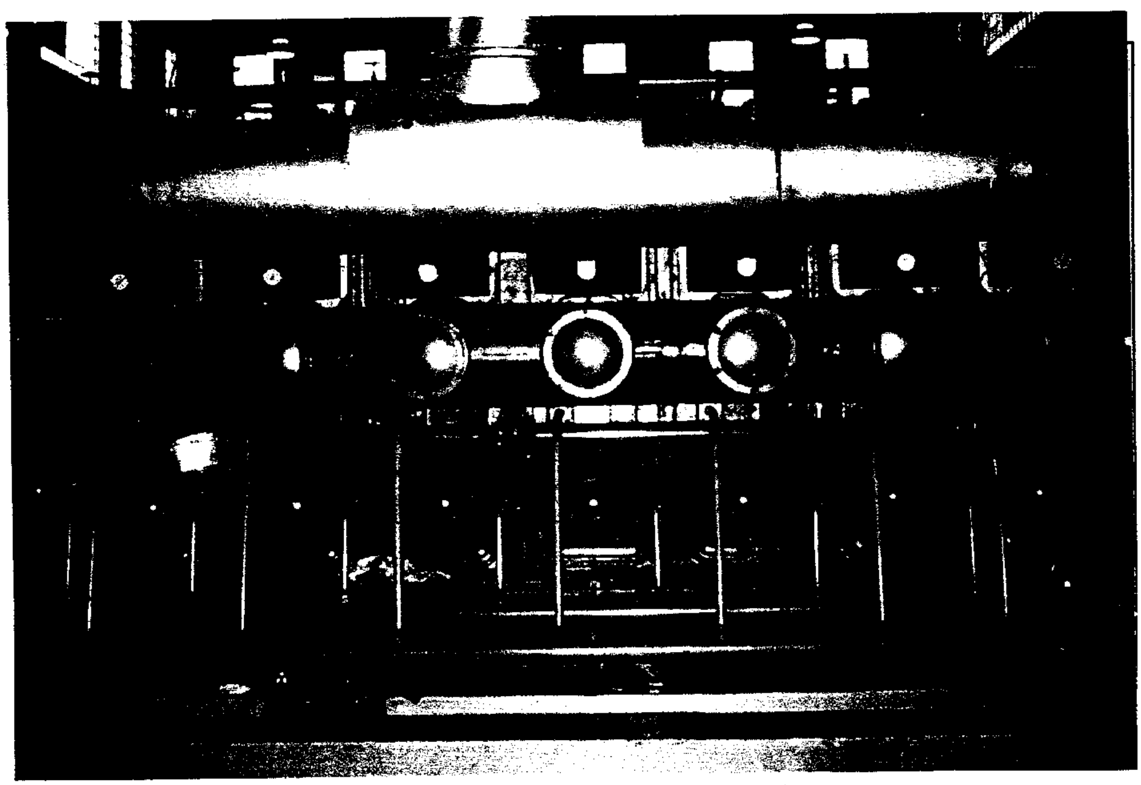


Photo 28
Gander - Unit No.2 showing excessive exhaust oil drips onto air manifold

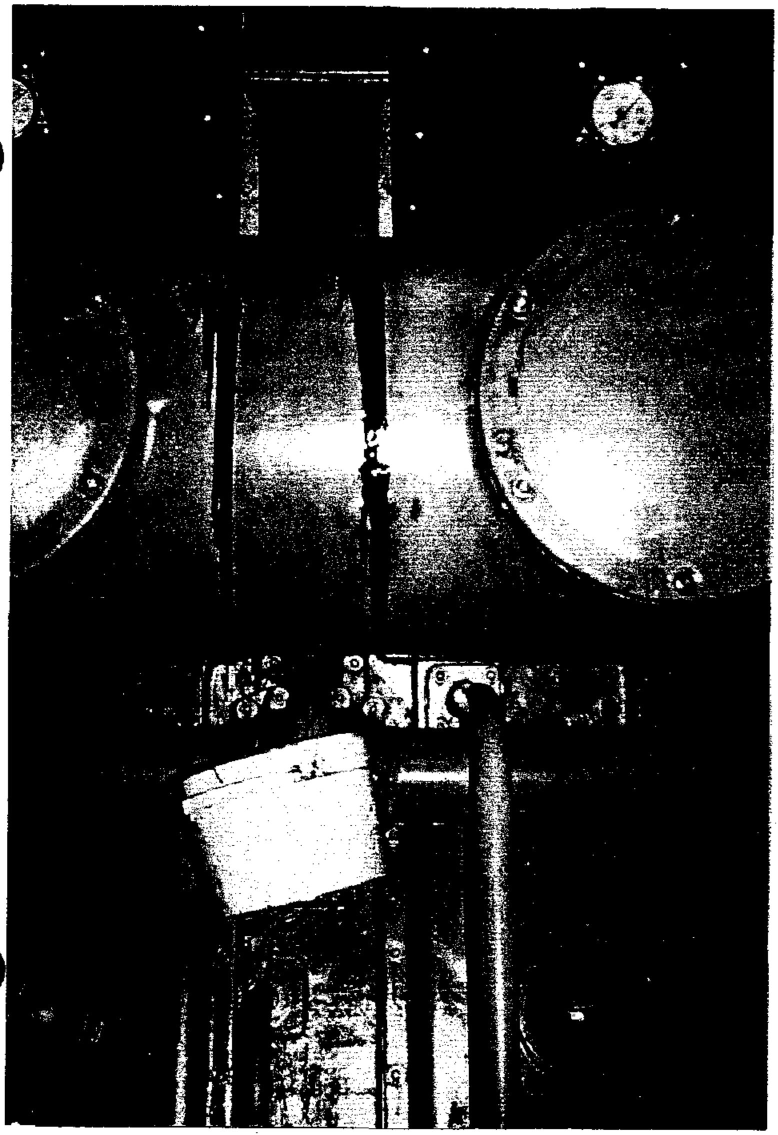


Photo 29
Gander - Close up of manifold

Photo 30
Gander - Switchgear and control panel

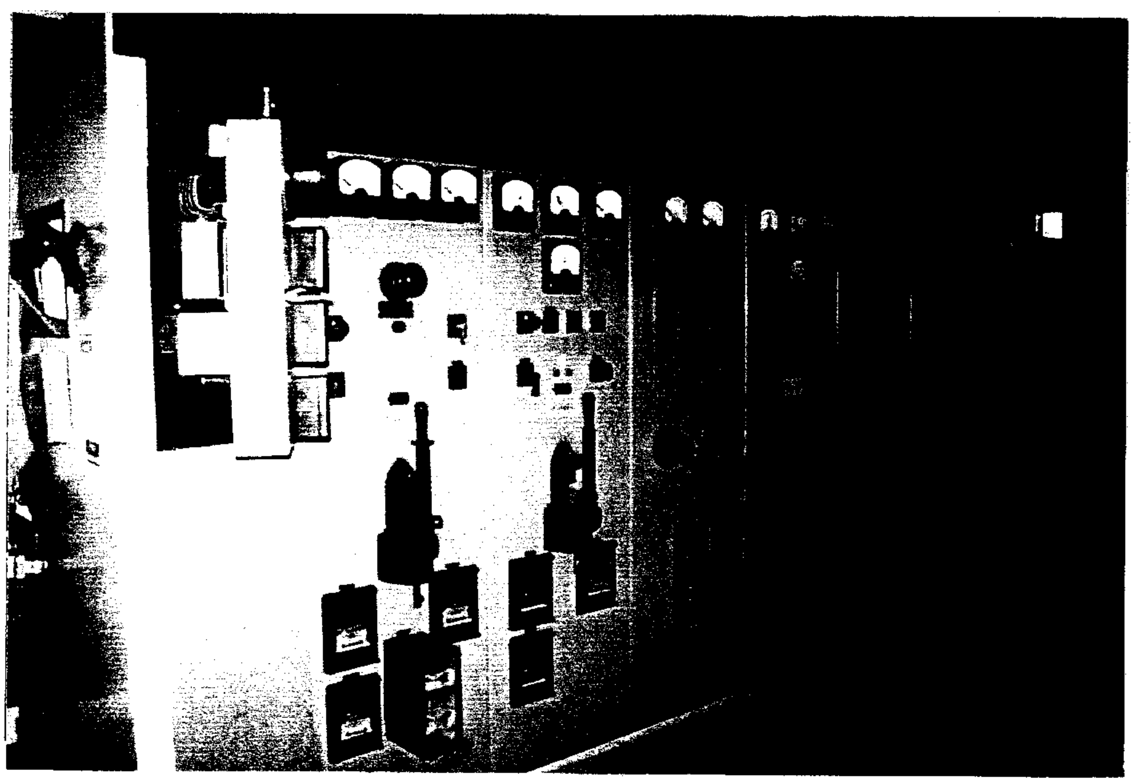


Photo 31
Aguathuna - Building and fuel tank

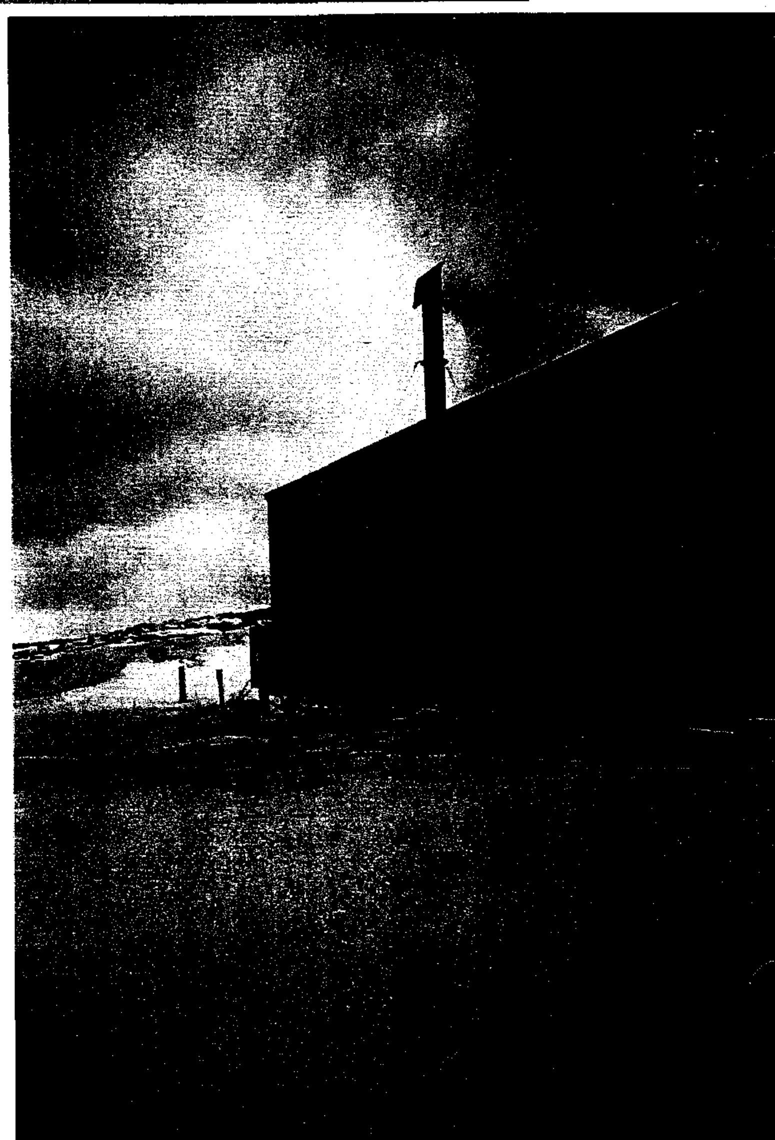


Photo 32
Aguathuna - Radiator and exhaust

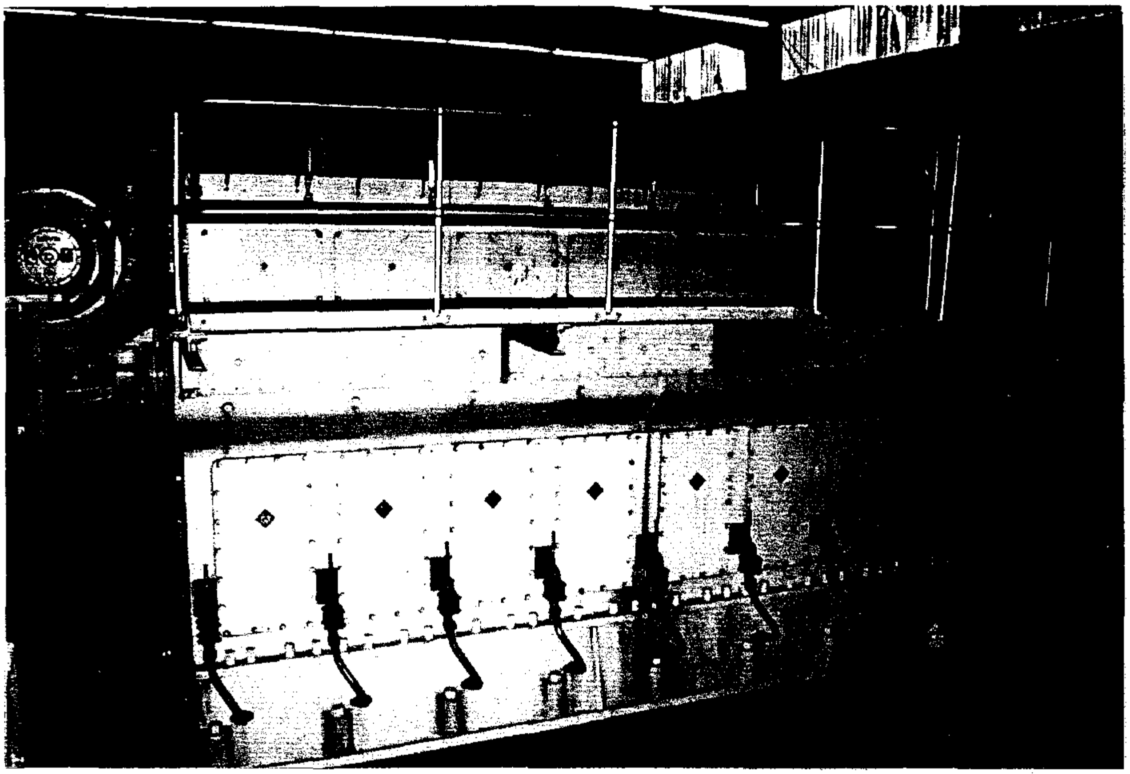


Photo 33
Aguathuna - General view of Harland and Wolff unit

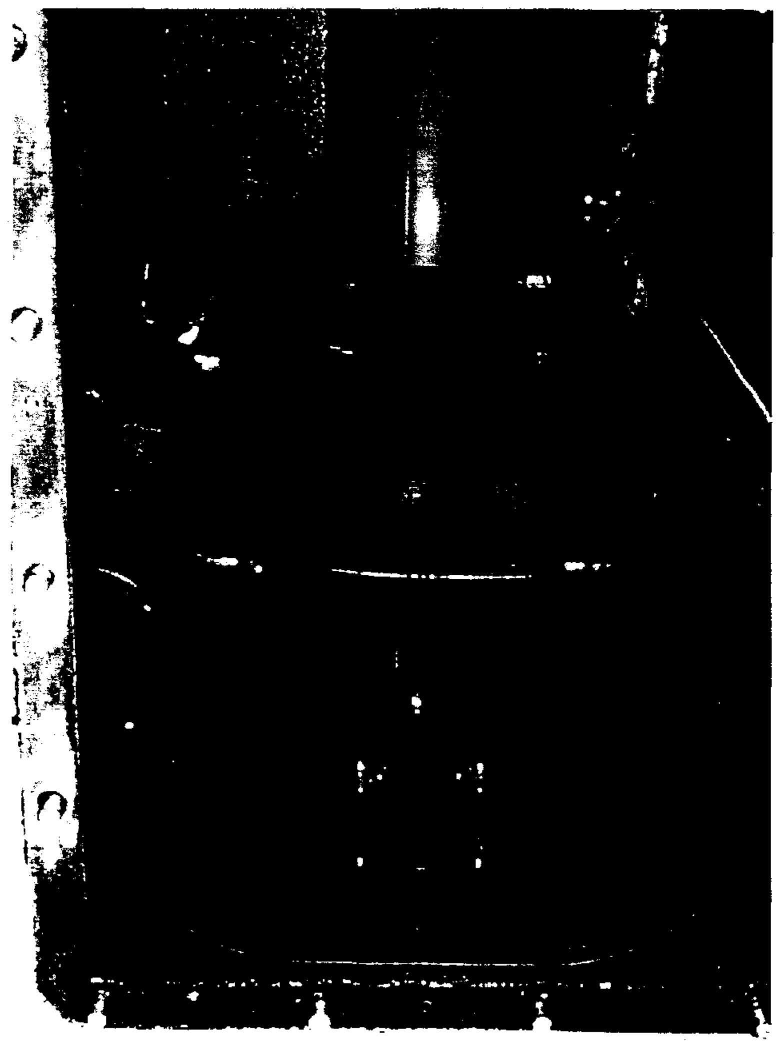


Photo 34
Aguathuna - Crankcase internals showing heavy carbon deposits

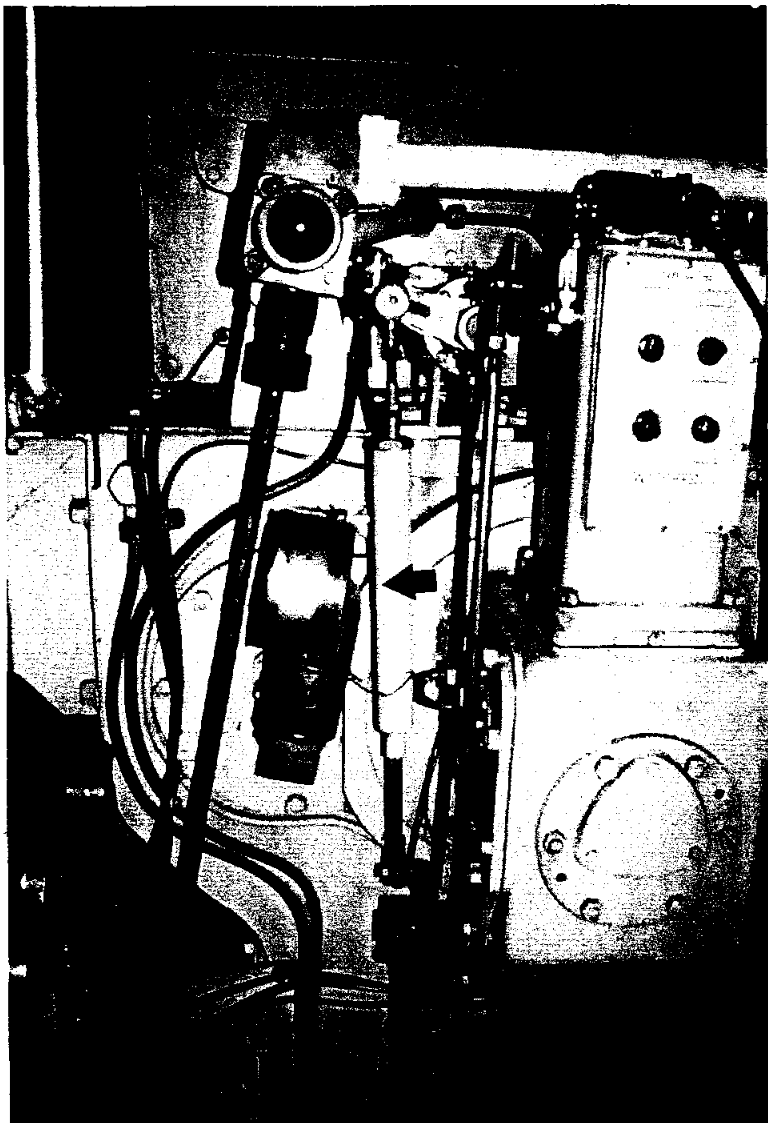


Photo 35
Aguathuna - Governer linkage with collapsible link shown

Photo 36
Aguathuna - Crankcase breather showing excessive piston blowby

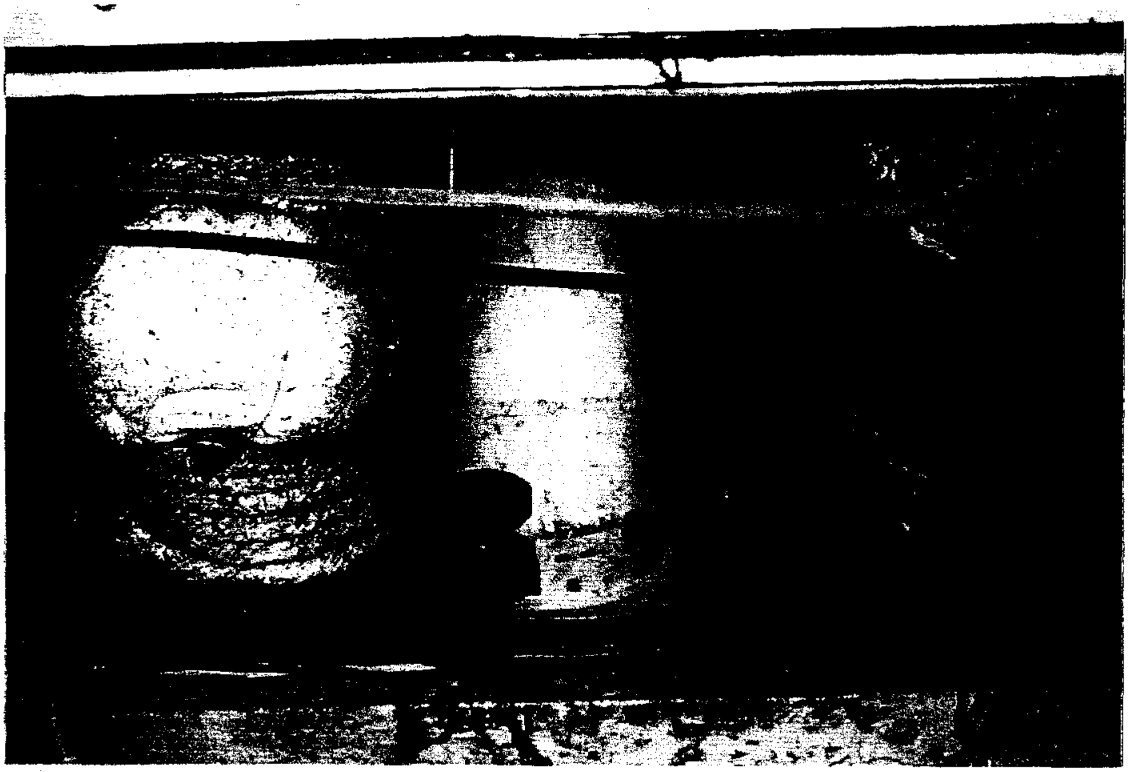


Photo 37
Aguathuna - Asbestos wrapped exhaust manifold sections

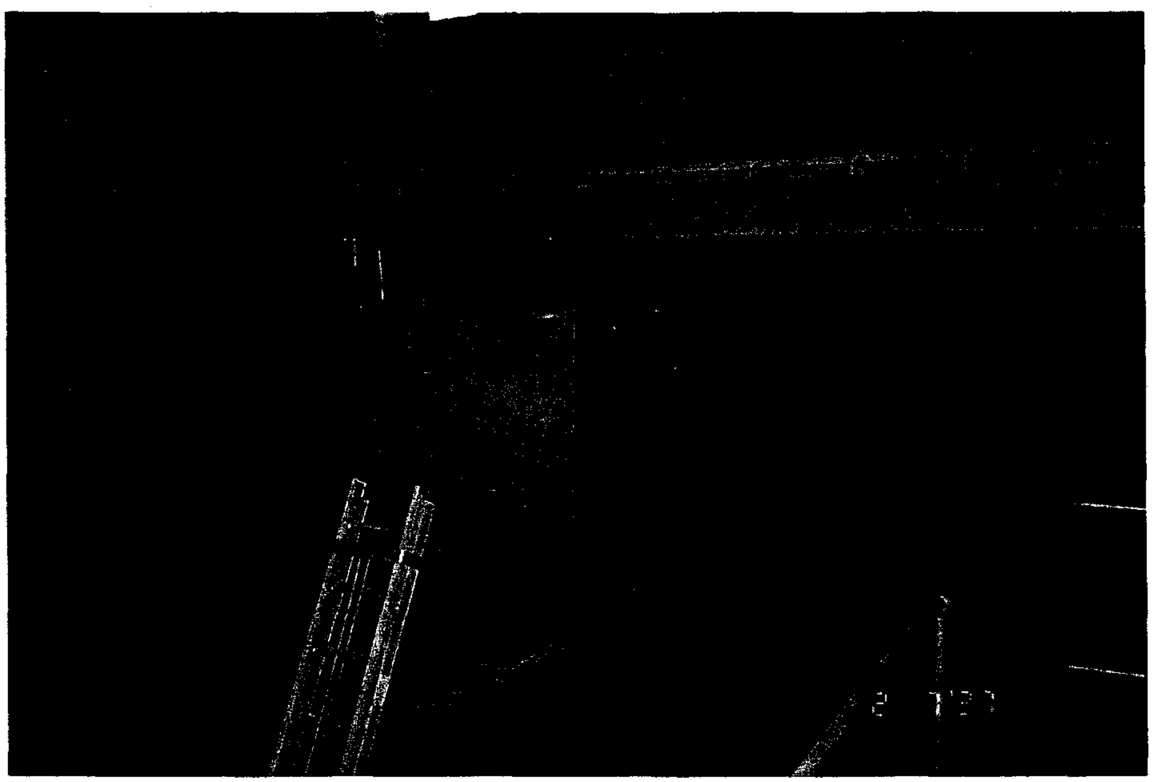


Photo 38
Aguathuna - Fuel tank

Photo 39
Aguathuna - Air compressor

Photo 40
Aguathuna - Engine instrument panel in control room

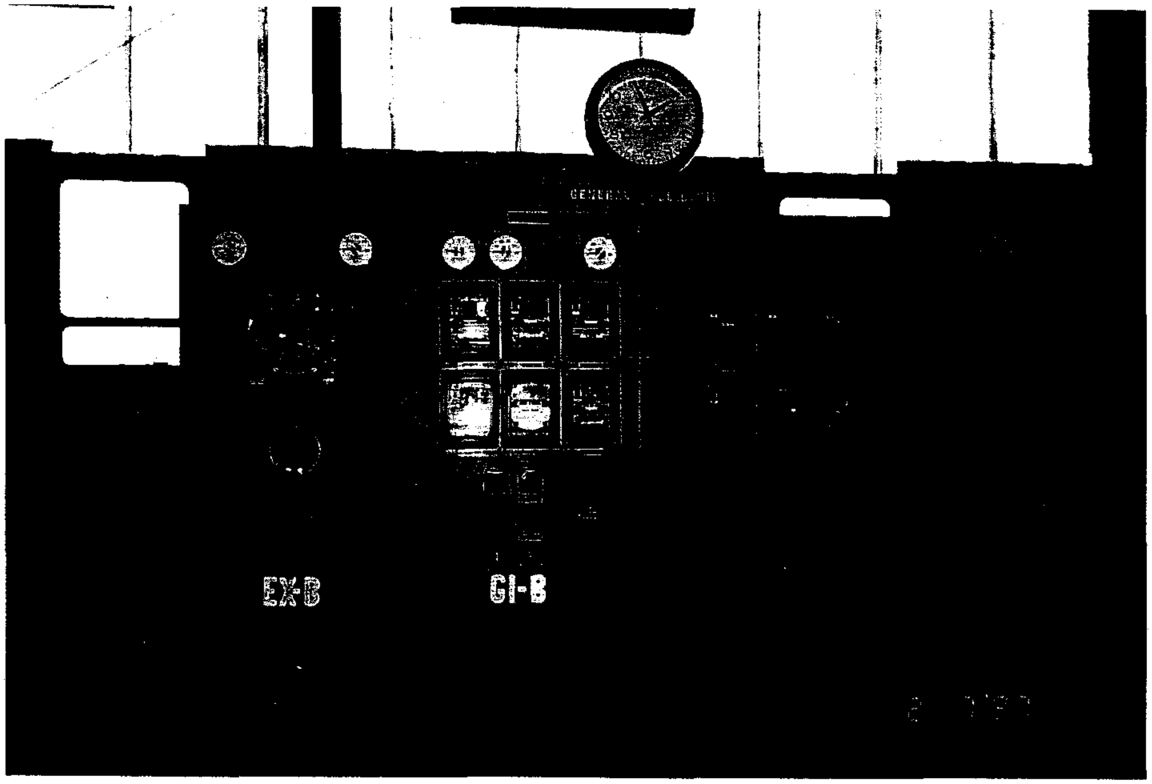


Photo 41
Aguathuna - Switchgear

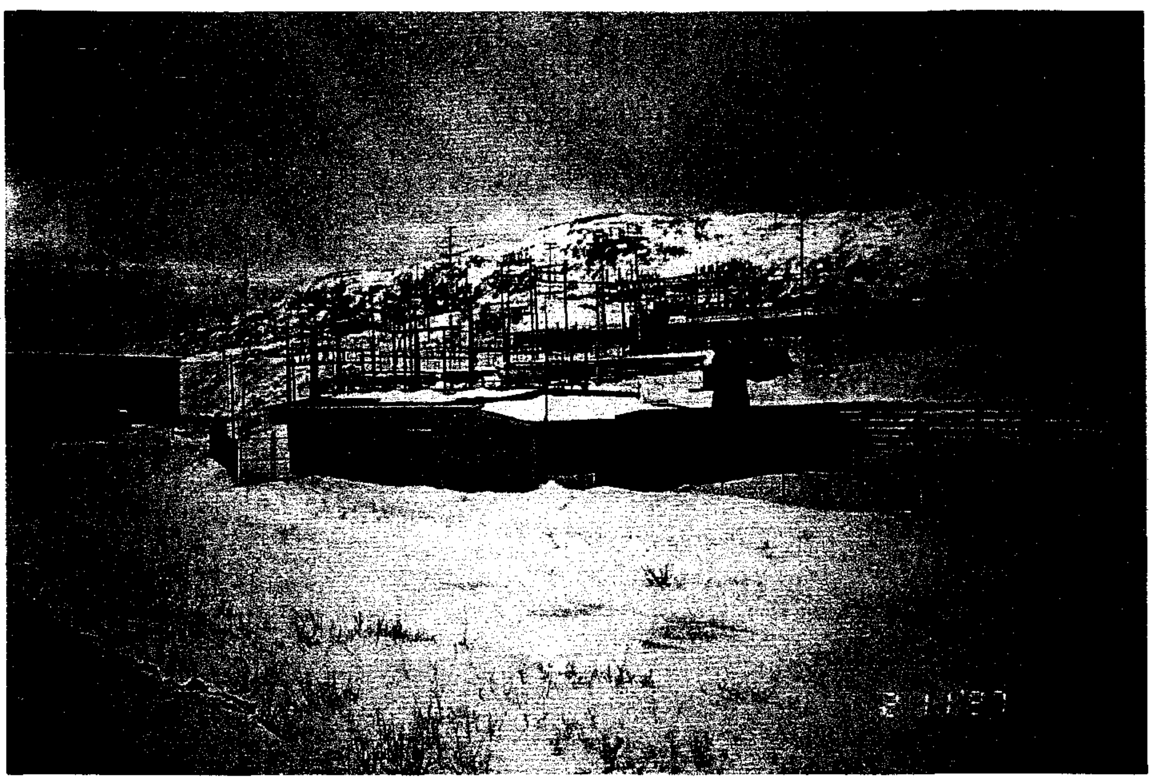


Photo 42
Port-aux-Basques - Site general view

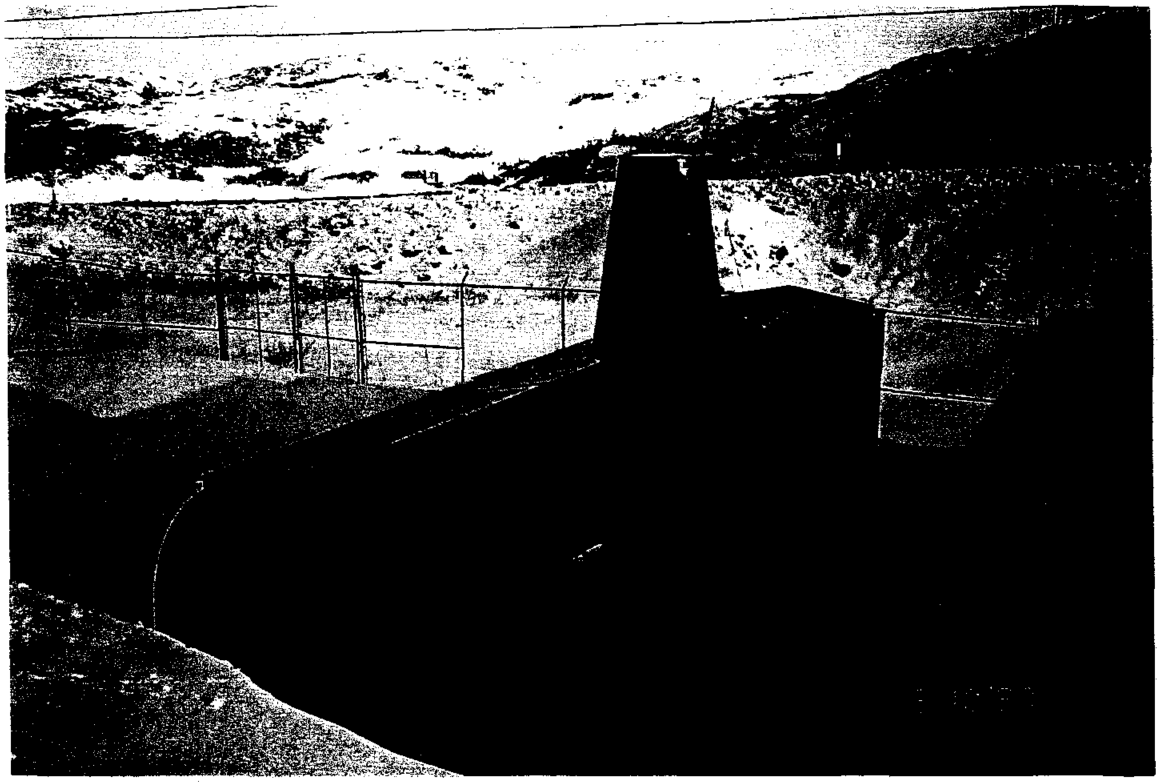


Photo 43
Port-aux-Basques - EMD unit enclosure, open to weather at radiator end, top and side

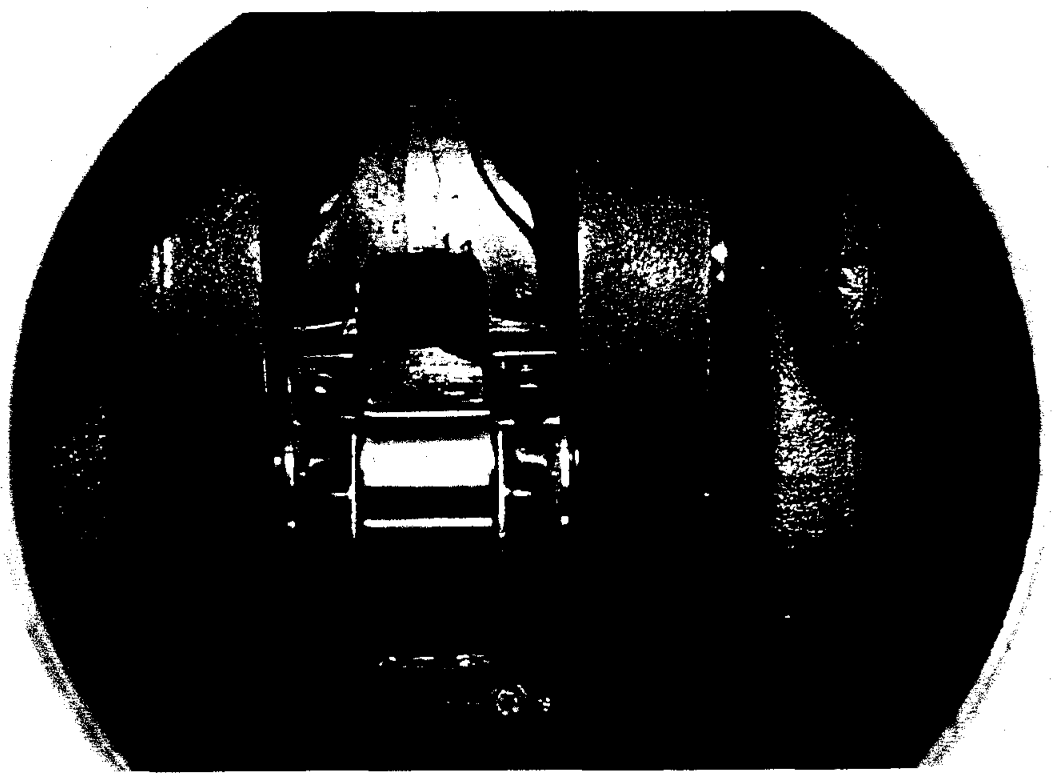


Photo 44
Port-aux-Basques - Large end bearing of unit No. 10, EMD

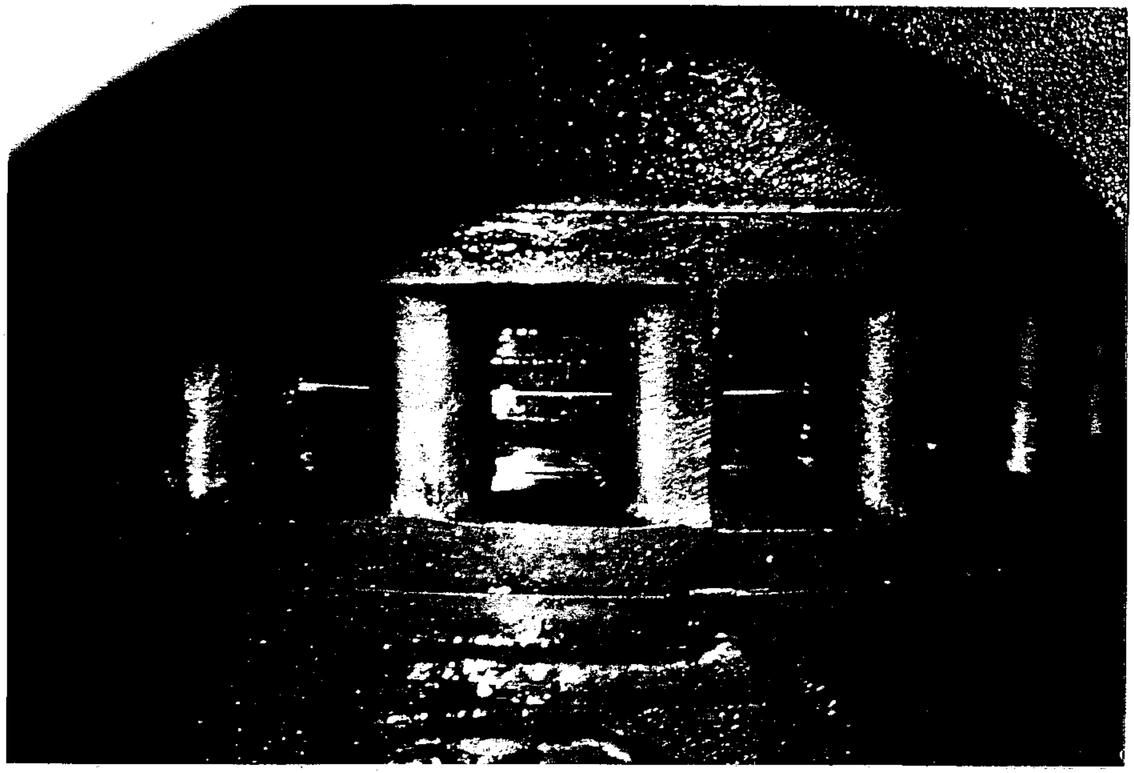


Photo 45
Port-aux-Basques - EMD piston ring inspection showing tell-tale wear grooves on bottom ring and buildup of oily deposits in air box

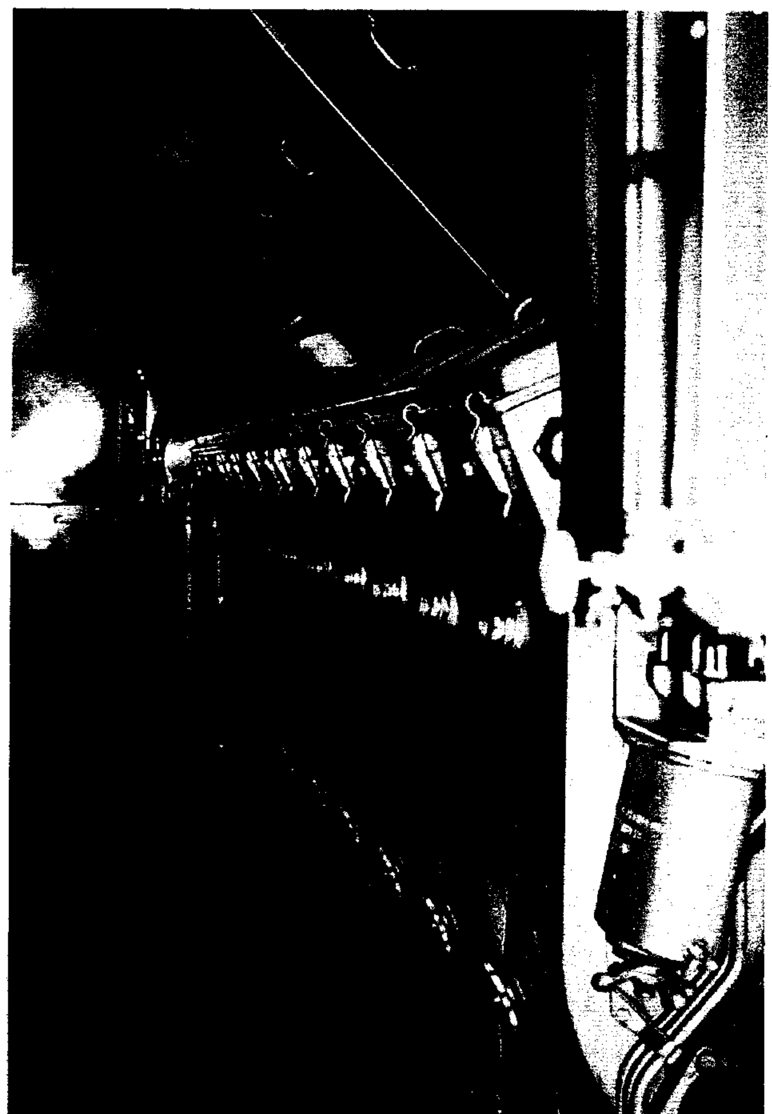


Photo 46
Port-aux-Basques - General view of EMD enclosure showing limited maintenance space between engine and container wall

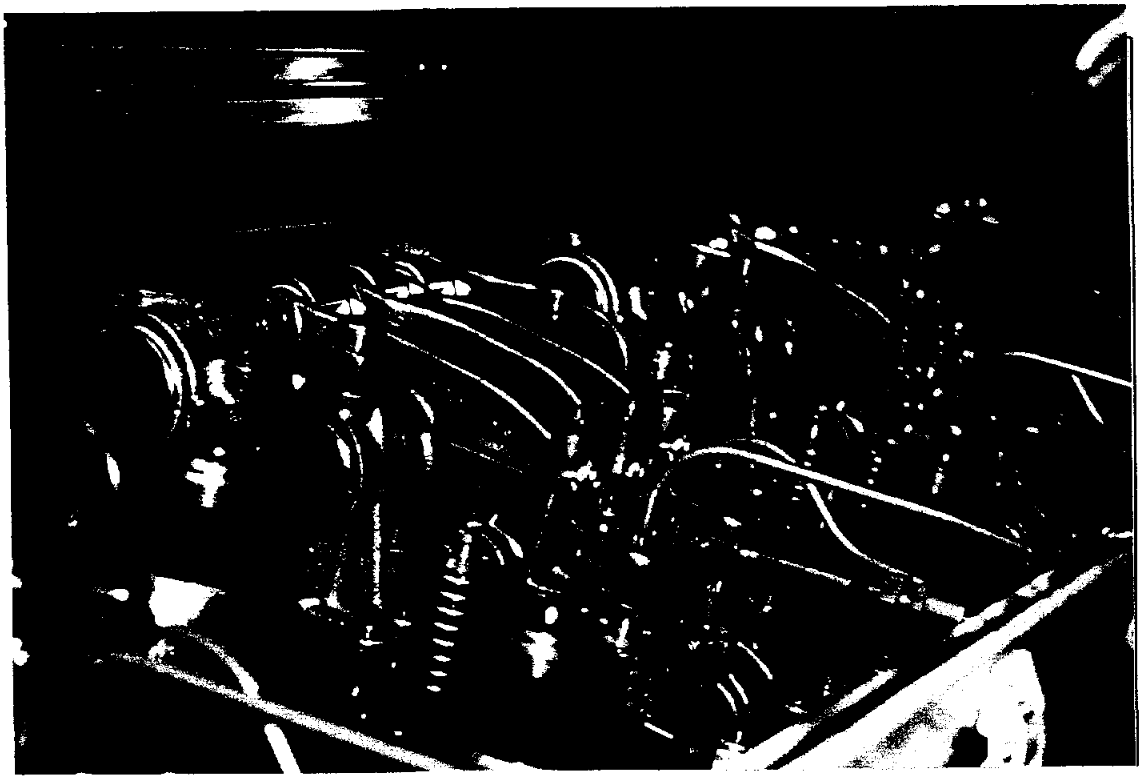


Photo 47
Port-aux-Basques - EMD valve rocker gear

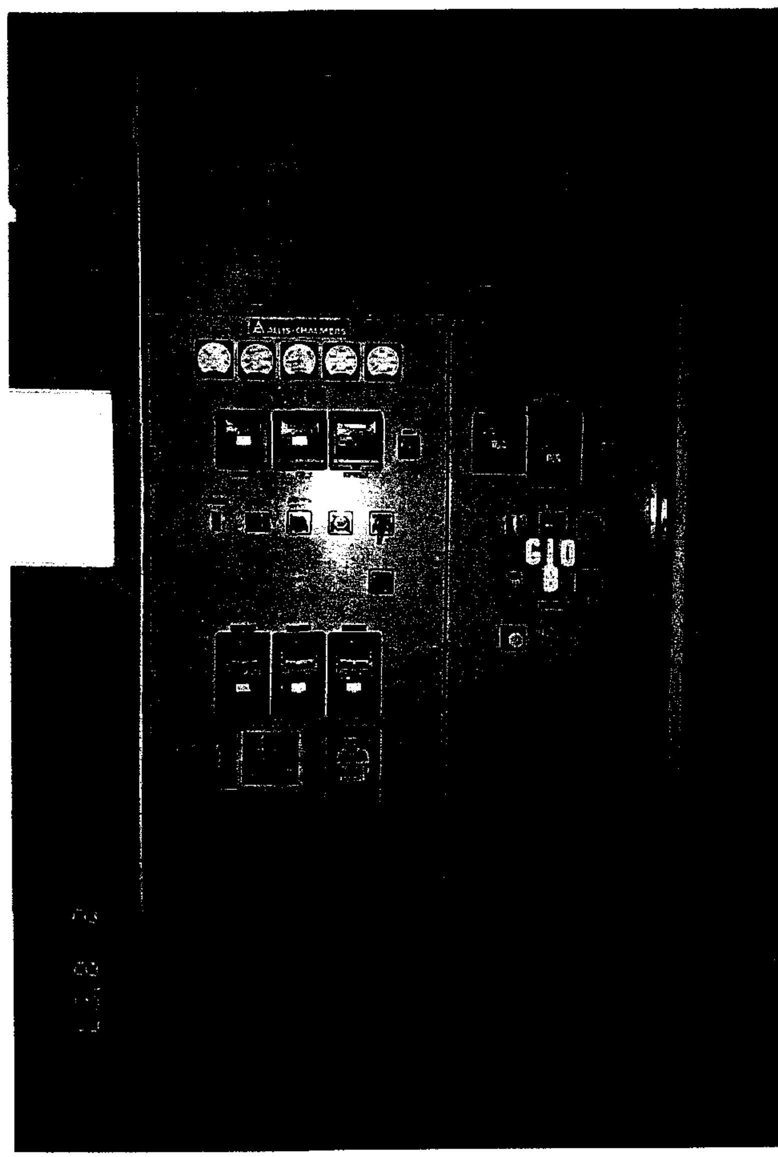


Photo 48
Port-aux-Basques - EMD control panel

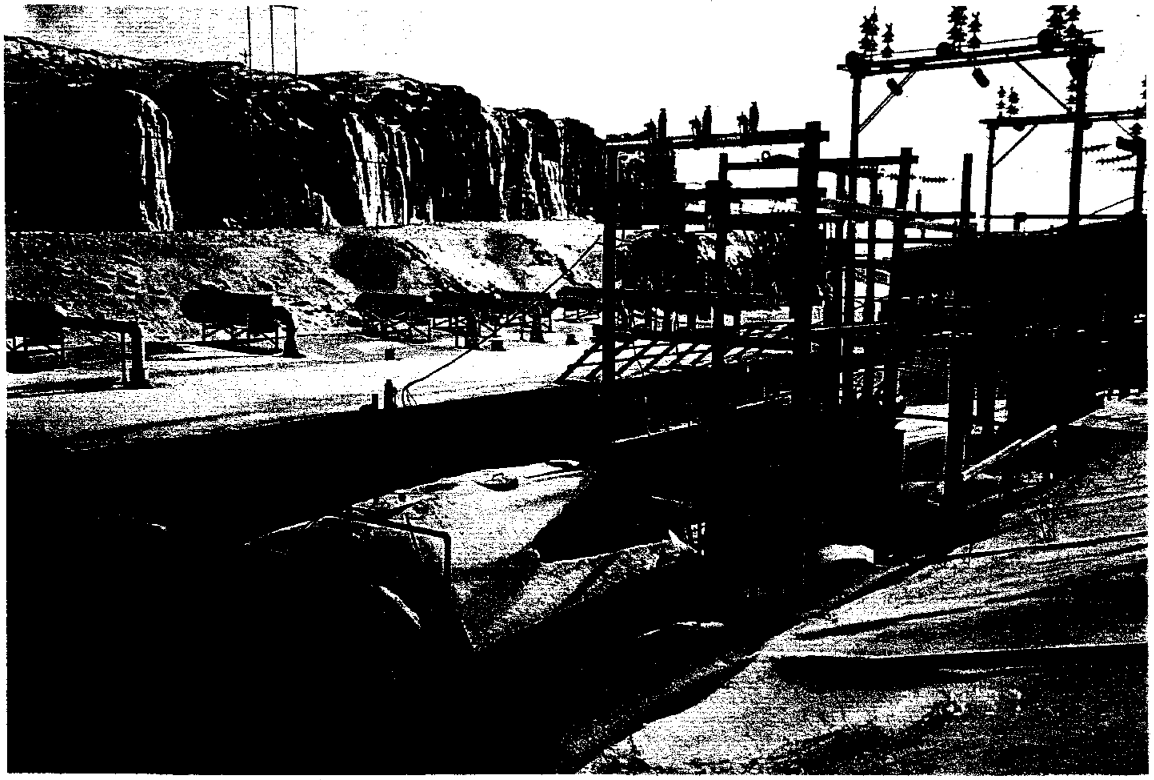


Photo 49
Port-aux-Basques - Fuel tank and transformers

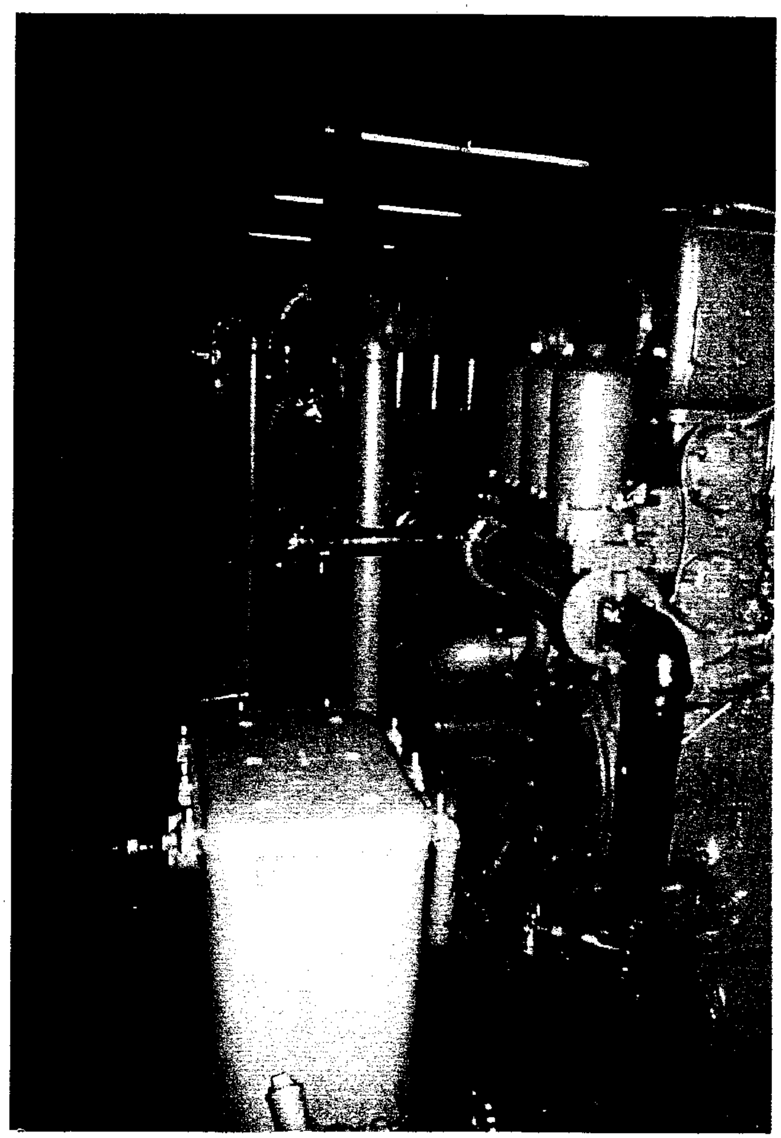
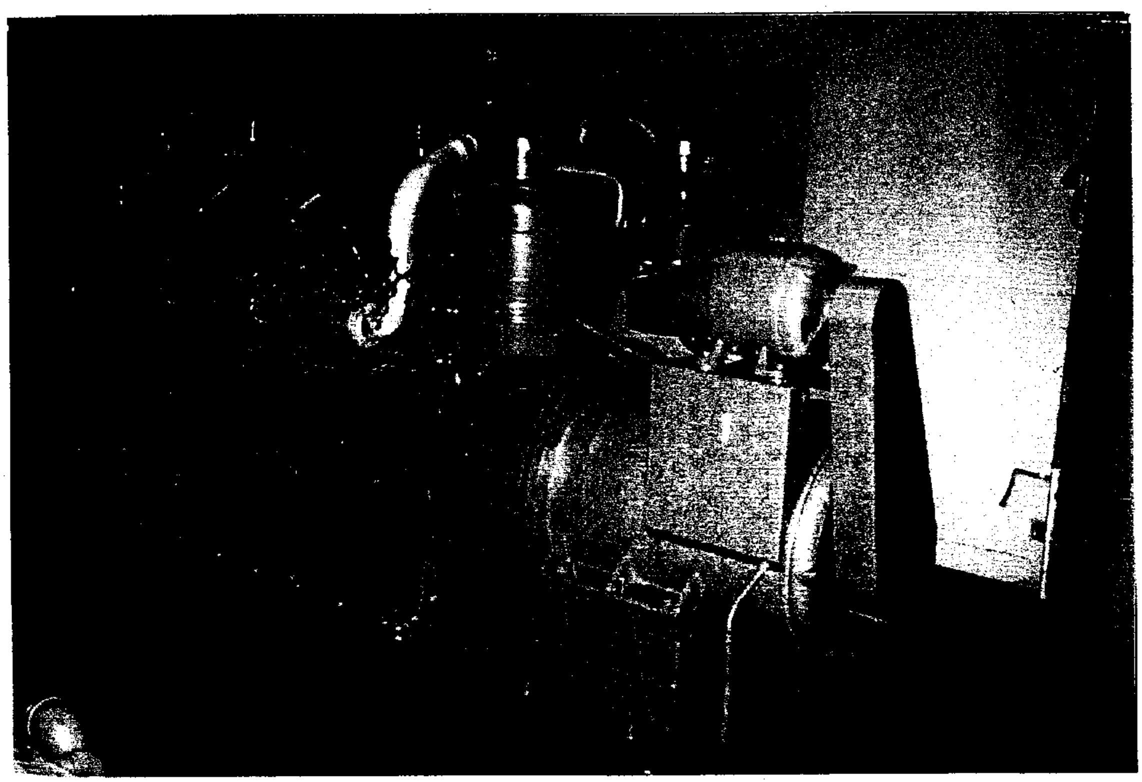


Photo 50
Port-aux-Basques - Typical caterpillar units city water cooling arrangements

Photo 51
Port-aux-Basques - Outdated switchgear

Photo 52
Port-aux-Basques - Unit No. 1



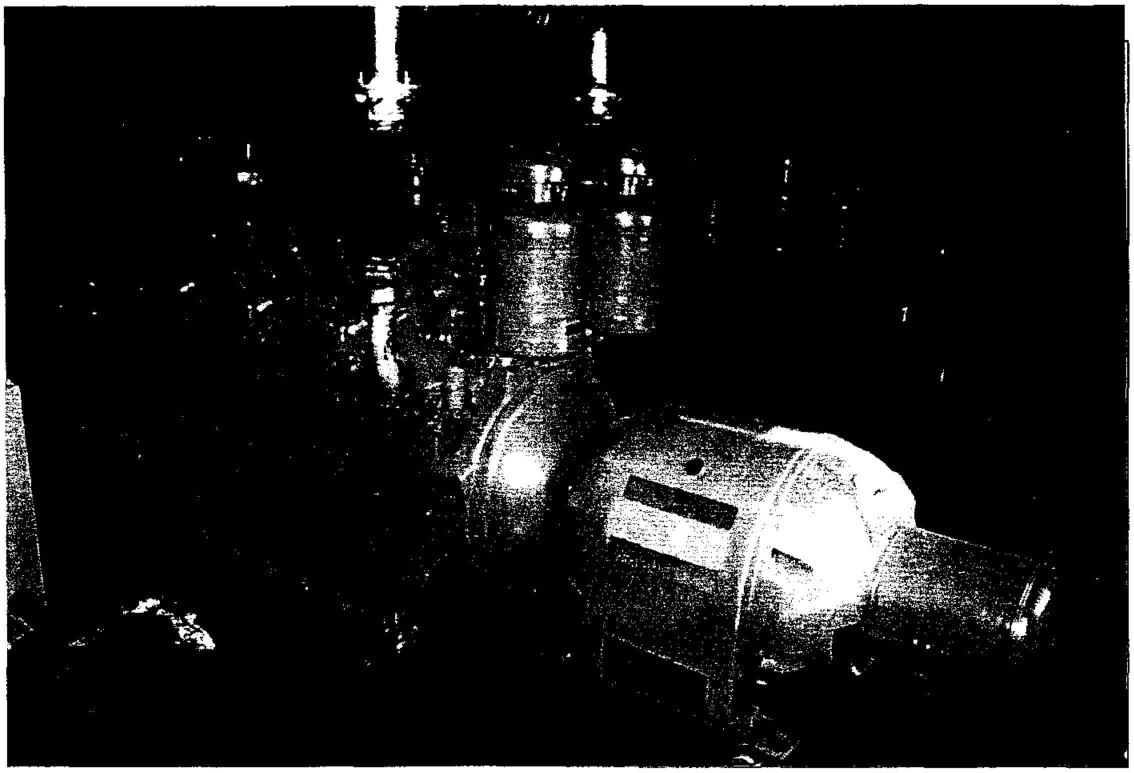


Photo 53
Port-aux-Basques - Unit No. 4

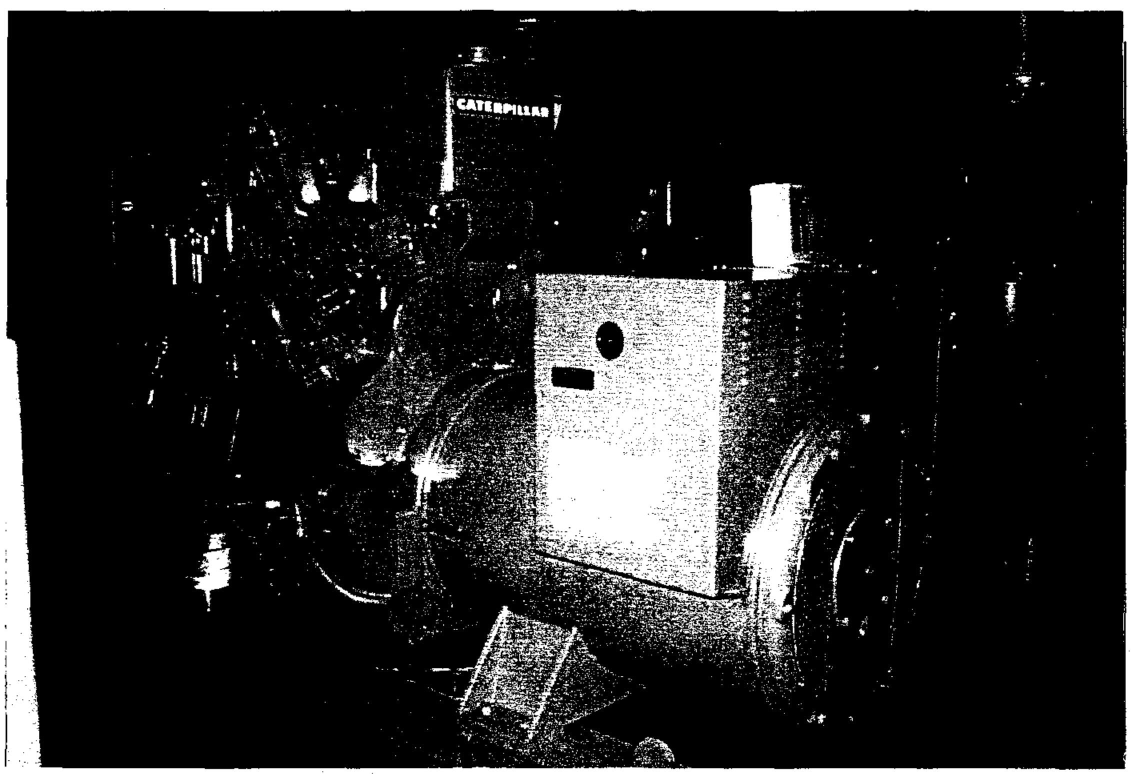


Photo 54
Port-aux-Basques - Unit No. 2

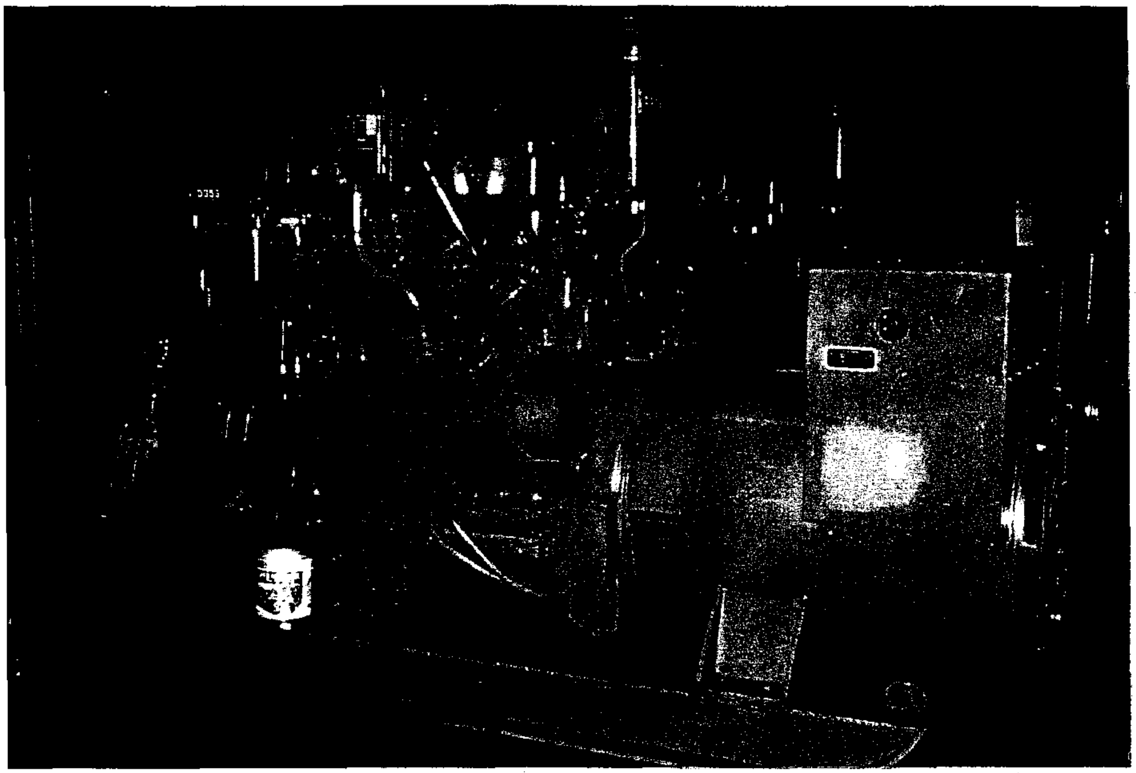


Photo 55
Port-aux-Basques - Unit No. 8

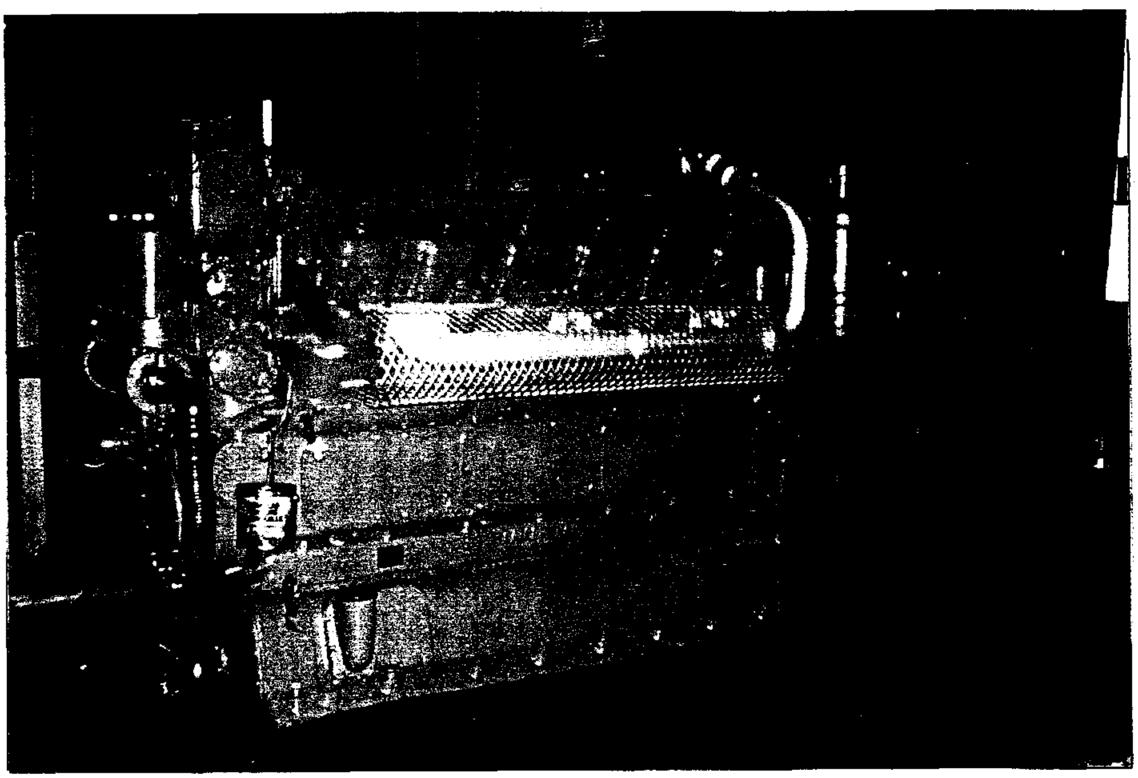


Photo 56
Port-aux-Basques - Unit No. 3

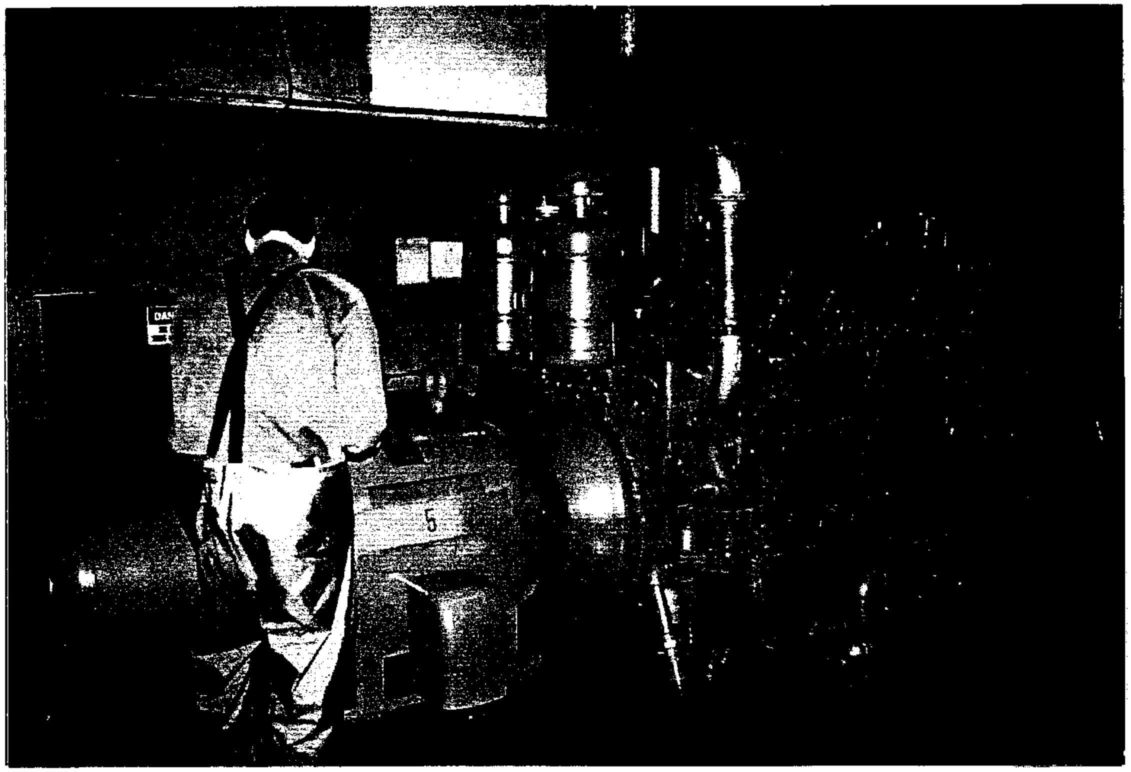


Photo 57
Port-aux-Basques - Unit No. 5

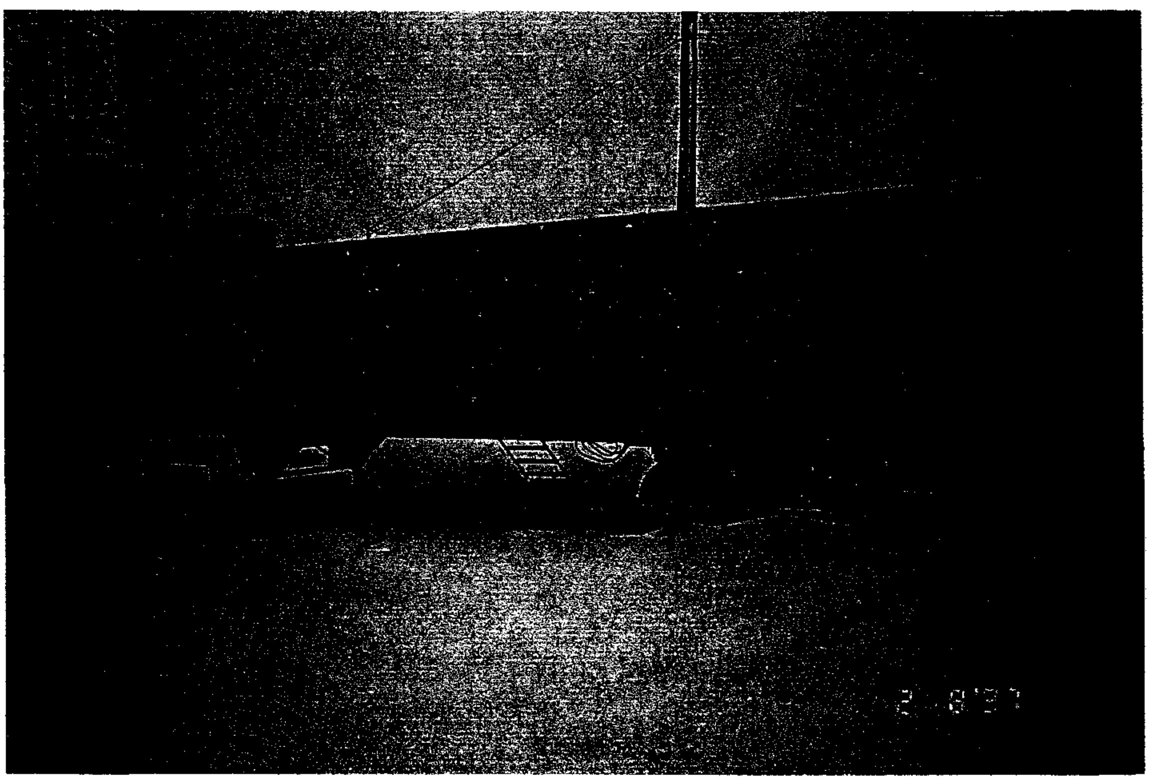


Photo 58
Port-aux-Basques - Portable unit No. 1

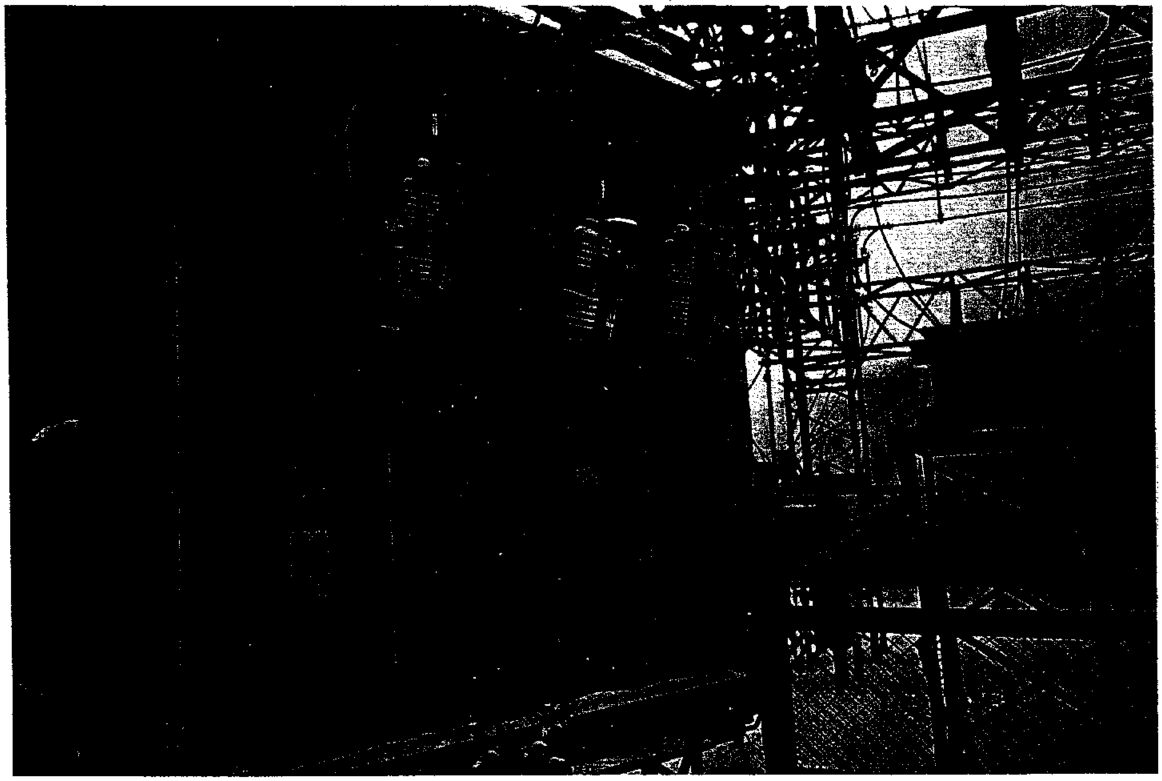


Photo 59
Port-aux-Basques - Portable unit No. 1, transformers

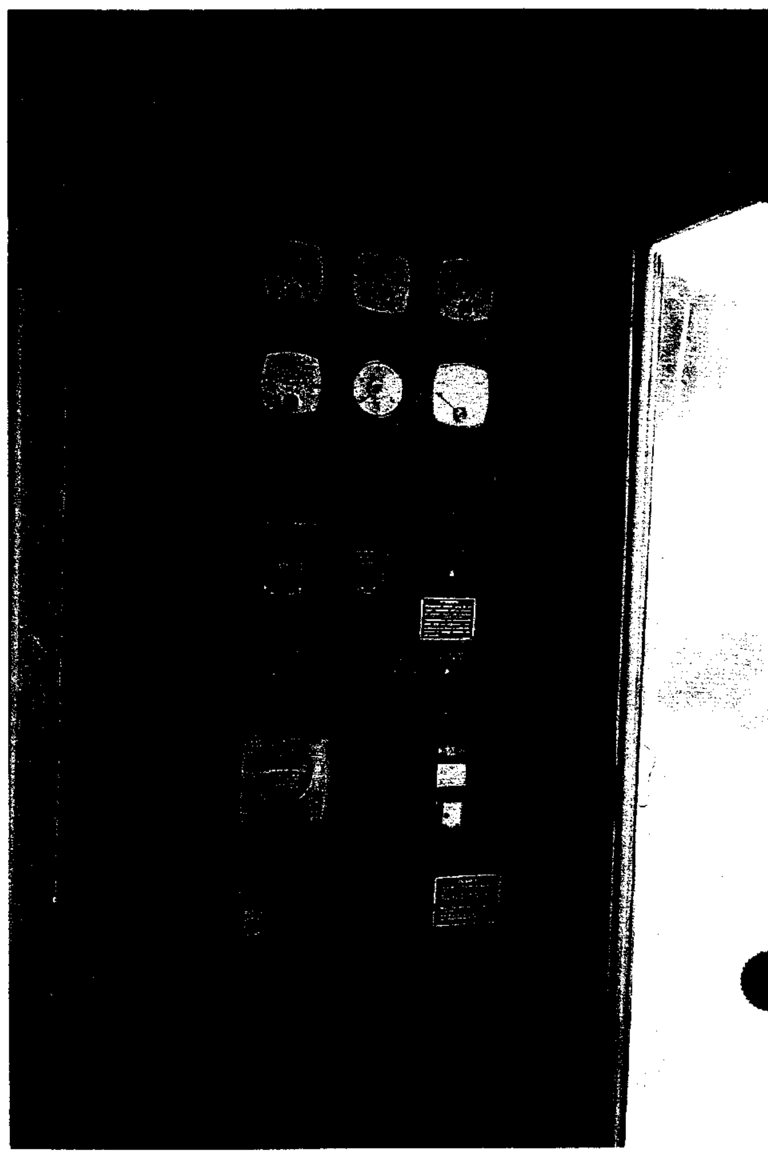


Photo 60
Port-aux-Basques - Portable unit No. 1, control panel

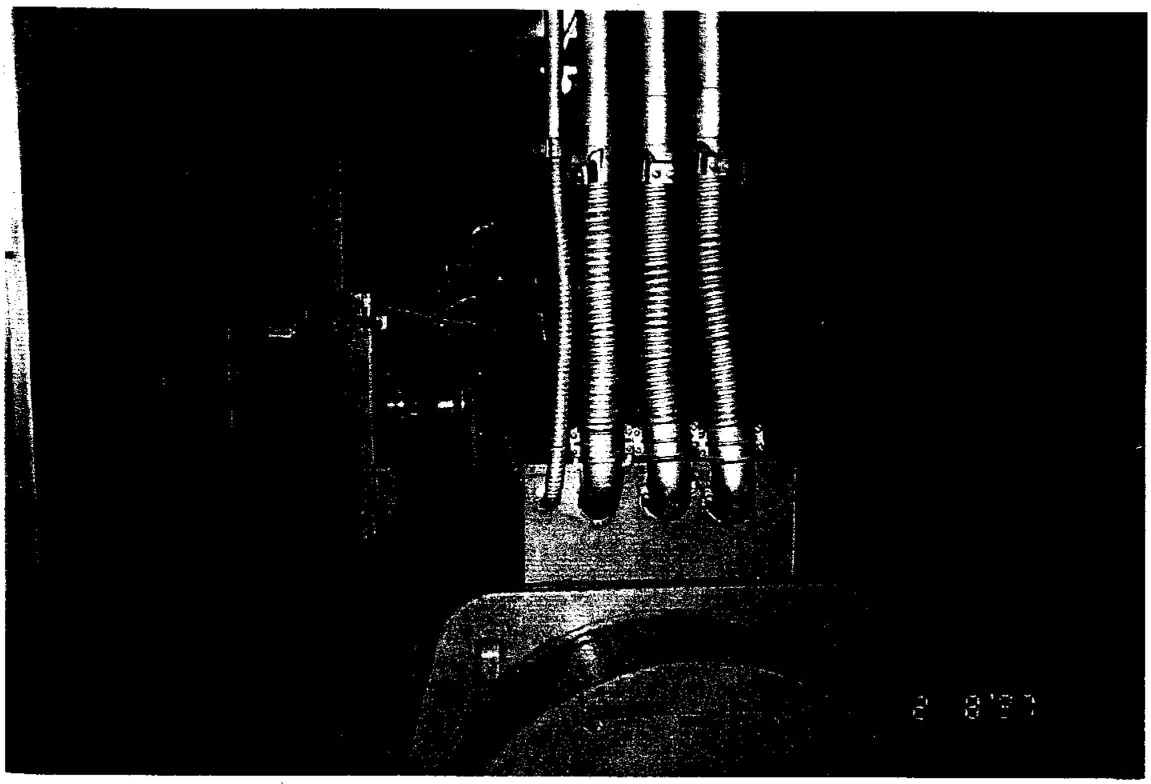


Photo 61
Port-aux-Basques - Portable unit No. 1, diesel generator

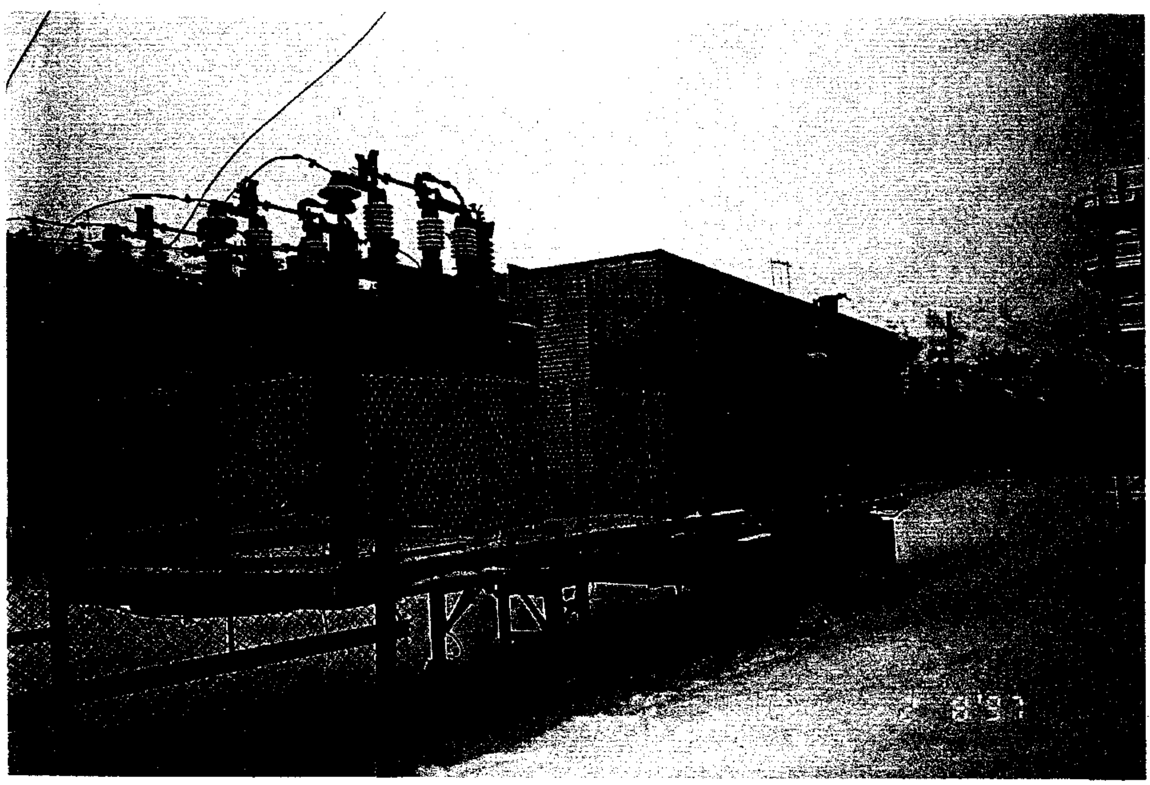


Photo 62
Port-aux-Basques - Portable unit No. 2

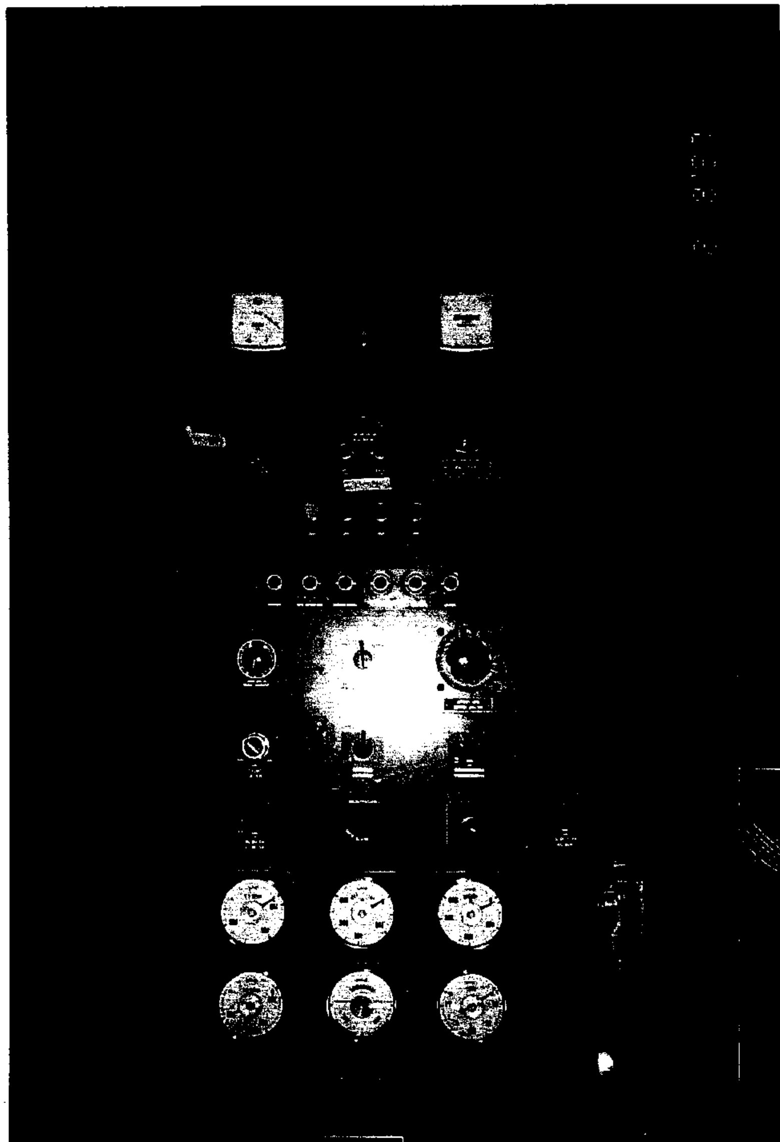


Photo 63
Port-aux-Basques - Portable unit No. 2, control panel

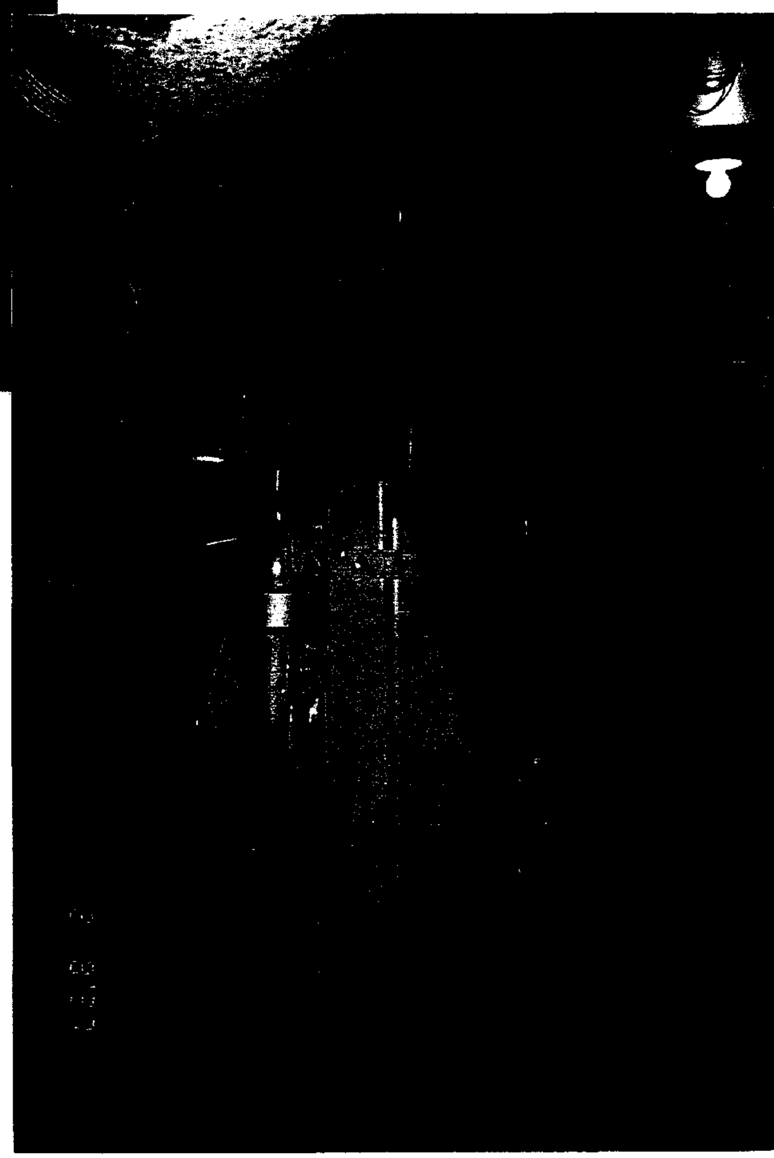


Photo 64
Port-aux-Basques - Portable unit No. 2, diesel generator

Photo 65
Port-aux-Basques - Portable unit No. 2, trailer underside deterioration

Appendix C
Spare Parts Available at Each Site

ACRES

Spare Parts Available at Each Site

St. John's - Nordberg

1 Fuel Pump
1 Scavenging Valve
1 Air Start Valve
1 Cylinder Liner
1 Cylinder Head
1 Piston

Salt Pond - Worthington

None

Gander - Nohab-Polar

2 Cylinder Liners
Quantity of Main Bearing Shells
2 Valve Springs
12 Compression Rings

Port Union - Caterpillar D398A

Parts available from dealer as required. None in stock

Aguathuna - Harland & Wolff

1 Complete Cylinder
1 Liner
Misc. Spare Parts for Turbocharger (ie: bearings and gaskets)

Port-aux-Basques - Caterpillar Engines

Generous supply of parts as required for normal plant operation, mainly piston rings, nozzles, and gasket sets.

Port-aux-Basques - EMD

1 Piston. All parts stocked by Midwest Power Products Inc. in Winnipeg.

Appendix D
Vendor Information

WÄRTSILÄ DIESEL

WÄRTSILÄ DIESEL CANADA INC.

Burnside Industrial Park
50 Akerley Blvd., Unit #11
Dartmouth, Nova Scotia
Canada B3B 1R8

FACSIMILE TRANSMITTAL

Telefax No: (902) 468-1265
Telephone No: (902) 468-1264

TO: Acres International

Attn: Alan Carter

Fax No: 1-416-595-2004

From: M. Gammon

Operator: dg

February 26, 1997

# of pages including Cover sheet:

our ref: 97022601

Subject: Newfoundland Power Corp.
Re: K 57 M Polar nohab Engines
Engine no's 86190, 1466 & 1611

In response to your to call concerning the above engines we are pleased in advising the following.

The Nohab factory in Sweden has a limited number of parts for these engines. Some of the parts available are pistons rings, head gaskets, orings, sprayers, exhaust thermometers and thermometers for cooling water and oil.

In order to supply some of the parts we would need the specific engine numbers and quantitys needed. This would ensure that we supply the proper part for the proper engine as there were some changes in the engines over the years they were constructed.

We hope that you will find this information helpful and that we can be of further service in the near future.

Regards,

Mike Gammon

EPS Engineering Products & Services

Diesel Consultants & Engineers
Spare Parts Suppliers

ENGINEERING PRODUCTS & SERVICES LIMITED
Unit 10 Newporte Business Park,
9 Cardinal Close,
Lincoln,
England.
LN2 4SY

Our Ref: ETP.CJF   Your Ref: D G Champion   Date: 20 February 1997

Mr Alan Carter
Acres International Limited
480 University Avenue
Toronto
Ontario
CANADA
M5G 1V2

Dear Mr Carter

RE: SPARE PARTS FOR NEWFOUNDLAND LIGHT & POWER CO LTD – POLAR ENGINES

As you know, spares for these old Polar engines are very 'few and far between' but, generally speaking, items such as joints, head gaskets and piston rings could still be obtained as new items.

It should be possible to have the large end bearings re-metalled.

Larger parts such as pistons and liners might be obtainable as used/reconditioned items, but the availability would very much depend on the state of the market at the time the goods were required. This would be a very 'hit or miss' situation.

Other smaller parts might be made from samples provided by the user, ie so-called 'pattern parts'.

It is inevitable that the provision of spares for engines approaching 50 years old is going to be problematical, but if the owners decide to keep the engines going for a few more years, we would be pleased to assist in the location of parts.

Yours sincerely

E T Paddison

E T PADDISON

TELEPHONE: (01522) 544218/9
FACSIMILE: (01522) 510720

REGISTERED IN ENGLAND NO. 1739485
VAT REGISTRATION NO. GB 364 6514 43

BANKERS DETAILS:
National Westminster Bank Plc
Lincoln, Smiths Bank Branch
225 High Street, LINCOLN LN2 1AZ
ACCOUNT NO: 90544706 SORT CODE: 60-13-15

Jack Purpus Enterprises

Diesel & Gas Engines
Parts - Sales

Bus: (707) 585-0775
Fax: (707) 585-1794
EMail: JPURPUS@WCO.COM

FACSIMILE COVER SHEET

To: Alan Carter
Company: ACRES INTERNATIONAL
Phone: 416 - 595 - 2002
Fax: 416 - 595 - 2004
Date: 2-21-97
Pages Including this:

Re: NORDBERG TS218 PARTS

Gordon Champion has advised that you have a generating unit in Newfoundland that is or can be placed into operation.

We are specialists in the furnishing of replacement parts for large diesel engines, i.e., Nordberg, Worthington, Cooper Bessemer. We have access to the OEM for these engines.

We supply parts to most U.S. municipal power plants and have a large overseas market.

Attached is an example of pricing for some of the hard parts and gaskets that will give you an idea of costs.

To be certain of proper parts for the engine you have, would need serial # and confirmed part numbers, preferably a copy of the parts book.

Thank you for your interest and trust we can be of service.

Regards,

Halsey Lyon

6050 Commerce Blvd., Suite 226 Rohnert Park, CA 94928

JACK PURPUS ENTERPRISES
6050 Commerce Blvd., Suite 226
Rohnert Park, CA 94928
Bus: (707) 585-0775
Fax: (707) 585-1794

DATE

QUOTATION

TO:

Alan Carter

ACRES INTERNATIONAL

Fax: 416 - 595 - 2004

VALIDITY	TERMS	DELIVERY

PARTS FOR TS 218 NORDBERG

QTY	PART NUMBER		DESCRIPTION	PRICE	AMOUNT
	16953009		Top Conn. Rod. Brg. & Bottom Conn. Rod. Brg.	1395.00	
	1695 3050		Main Brg. Shell	1440.00	
	1695 3075		End Main Brg.	1895.00	
	5103 0011		AKB 344 V 3739 A Inj. Assy.	2600.00	
	5089 0035		DL 125 V 969 Nozzle	569.00	
	3570 6364		Gasket Fuel Injector	6.90	
*	5930 0011		Bosch Fuel Pump Assy. APFIE250N3722A	2961.00	
*	5931 0054		Bendix Fuel Pump Assy. 10-83778-A	2720.00	
	9909 5031		"Piston Assy" 42928054 Head/82125864 Trunk	6800.00	
5	6312 8911		Power		
2	6314 5467		Oil Control SET	995.00	
1	6316 6961		Oil Control		
	4263 5561		Cyl Head	4800.00	
	4844 9305		Cyl Liner	8500.00	
	5371 9572		Piston or Wrist Pin	1250.00	
	9917 5003		Starting Air Timing Valve Assy	2100.00	
	8430 4641		Valve Indicator	125.00	
	8342 4723		Air Start Valve	268.00	
			PRICES ARE BASED ON KNOWN		
			INVENTORY AT THIS TIME		
			* NEED TO KNOW WHICH TYPE YOU HAVE		

JACK PURPUS ENTERPRISES
6050 Commerce Blvd., Suite 226
Rohnert Park, CA 94928
Bus: (707) 585-0775
Fax: (707) 585-1794

DATE ____________

QUOTATION

TO:

____

____

____

VALIDITY	TERMS	DELIVERY

THIS IS FOR AN ENGINE WE'D LIKE TO STAY IN OPERATION

TS 218 NORDBERG PARTS

QTY	PART NUMBER		DESCRIPTION	PRICE	AMOUNT
	3525 4329		Gasket Cyl Head	3.92	
	3536 4581		Gasket Cyl Head	5.20	
	3584 6501		Gasket Cyl Head	5.65	
	3571 0401		Gasket Cyl Head	4.65	
	3543 6961		Gasket Cyl Head	82.20	
	3570 9838		O Ring	8.20	
	3541 1341		Gasket	12.85	
	3570 9838		O Ring Gasket Air Start Valve	8.50	
	3571 0451		O Ring Gasket	12.50	
	3537 2141		O Ring	NA	
	3541 1341		O Ring	9.85	
	3570 6364		Gasket Molded Injector	6.75	
	3585 2221		Water Header Gasket	10.20	
	4501-088		Gasket 1/16 x 11 x 81D Water Outlet	17.25	

DATAFAX TRANSMISSION

MIDWEST
POWER PRODUCTS
a Division of
Midwest Detroit Diesel Allison Ltd.
1460 Waverley Street/Winnipeg, MB R3T 0P6
Phone (204) 452-8244 Fax (204) 452-2153

DATE: February 19, 1997

TO: **ALAN CARTER**
COMPANY: **ACRES INTERNATIONAL LIMITED**
FAX NO: **1-416-595-2004**
FROM: **BRYAN NORRIE**

TOTAL NUMBER OF PAGES INCLUDING COVER SHEET: 2

SUBJECT/MESSAGE: NEWFOUNDLAND POWER - EMD UNIT MODEL 20-645E4 (S/N 64E11081)

Dear Mr. Carter:

Gordon Champion (Champion Engineering) has requested that we forward the following information to your attention.

Based on the Serial Number, it would seem that this unit was manufactured in February of 1964. The unit, has a M.U. (Mobile Unit) or M.P. (Mobile Power) would be designated probably as an M.P. 45. For budgetary purposes, the following would be indicative to replace the Powerpac assemblies with Unit Exchange (Utex) assemblies: parts only, approximately $4,250.00 per cylinder equals $85,000.00.

Unit Exchange Powerpac Assemblies would include removal and cleaning of the heads and pistons, new rings, rehoning or replacement of the cylinder liners, replacement or rectification of the heads, valves, etc. and the provision of new gaskets and other miscellaneous components for reinstallation.

Rebuilt injectors, (Utex) would be in the order of $150/cylinder, for a total cost of $3,000.00.

Freight costs would be extra as would applicable taxes.

A Midwest supervisor could be provided in accordance with the current labour rates, a copy of which is attached. Replacement of all 20 power pacs and injectors, assuming qualified mechanical staff are available to work under our supervisor, should be accomplished within 10 working days.

A major overhaul which would include all the foregoing parts plus exchange/rebuild of water pumps, fuel pumps, turbocharger, aftercooler cores, etc., would be estimated at $140,000.00. Again the supervisor would be available at the same rates as previously indicated, however, the timeframe is more likely to be

TOROMONT CAT Power Systems

Power Systems Division

Fax: 416/667-5682 Ph: 416/667-5758

P.O. Box 20011, 1 Crothers Drive, Concord, Ontario, L4K 4T1, CANADA

FAX TRANSMISSION COVER SHEET

Date: **February 24, 1997**

To: **Alan T. Carter**

Acres International Ltd.

Fax: **416-595-2004**

Re: **Report on Caterpillar Diesel Generators @ Port aux Basques**

Sender: **J.C. (Joe) VanSchaick, Office: 416/667-5609 (direct line)**

YOU SHOULD RECEIVE 2 PAGE(S), INCLUDING THIS COVER SHEET. IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL 416/667-5758.

Alan;

Please find following a table containing information on the list of Caterpillar diesel generators located in Port aux Basques.

I've sent a copy of this chart via e-mail as well so as to assist you in printing off a clean copy for your report.

Please call if I can be of further assistance.

Regards;
Joe

C.C.: Gordon Champion

St. John's Diesel Plant
August 2003

NEWFOUNDLAND POWER

A FORTIS COMPANY

St. John's Diesel Plant

August 2003

Executive Summary

This study was performed in order to evaluate the deteriorating condition and future requirements to maintain the St. John's Diesel Plant in light of current operating strategies. The St. John's Diesel Plant was built in 1953 around the same time that the St. John's Steam Plant was built on the southside of St. John's Harbour. The primary requirement for the St. John's Diesel Plant was to provide power for station services for the start-up of the St. John's Steam Plant. With the decommissioning of the St. John's Steam Plant in the late 1990's, the St. John's Diesel Plant no longer serves any strategic purpose to supply power to the steam plant or backup in the St. John's area.

Some of the equipment at the St. John's Diesel Plant is obsolete and considerable capital investment is required to make the St. John's Diesel Plant operational. However, with the decommissioning of the steam plant the St. John's Diesel Plant is redundant and no longer required within the Newfoundland Power system. Rather than commit capital to upgrade the St. John's Diesel Plant, the recommendation is to decommission the plant.

Table of Contents

Page Number

Introduction

The purpose of this report is to evaluate the need for the continued operation of the St. John's Diesel Plant. The report looks at the condition of the existing plant, operation and maintenance cost, utilization, environmental issues, capital cost to upgrade, remaining service life and decommissioning cost.

Description of Diesel Power Plant

St. John's Diesel Plant Description

The St. John's Diesel Plant is located on the Southside of St. John's Harbour on the Southside Road. The powerhouse contains one 2,500 kW diesel engine and generator set with auxiliaries and was commissioned in 1953. A 22,703 litre #2 diesel self-dyked fuel tank is located at the front of the powerhouse. This plant was originally installed in order to black start the St. John's Steam Plant, which has now been decommissioned.

Powerhouse

The powerhouse is approximately 21 m long by 12 m wide by 10 m high and consists of a structural steel substructure on a concrete foundation. The building walls have asbestos cladding. The interior lighting in the powerhouse is substandard. Lube oil and diesel fuel containment is a problem at the St. John's Diesel Plant.

Turbine – Generator

The diesel engine was manufactured by Nordberg and the generator by General Electric. Auxiliaries include controls, lube oil cooler, cooling water cooler, air compressor, air receivers and fuel day tank. The engine air intake is built into the foundation of the building. The switchgear is very old and of an open design in which all parts are open in plain view.

Fuel Tank

The fuel tank is 22,703 litre self-dyked steel tank of welded construction. There is #2 diesel fuel stored in the tank. An automatic solenoid valve shuts off the fuel flow from the tank when the plant is not running.

Substation

The substation steps the generator voltage down from 6900 V to 4160 V for transmission to the grid. There are 3 – 1500 kVA transformers and two station service transformers associated with this plant.

Transmission Line

This plant ties directly to a distribution line and does not have a transmission line associated with it. The distribution line ties into St. John's Main Substation.

Operation and Maintenance

The St. John's Diesel Plant has not been operated or maintained since December 1999. Because of its size and location, this plant does not serve any strategic purpose in the Newfoundland Power system and there are safety concerns with the operation of the plant.

Safety concerns with the plant operation center around the open contact design of the switchgear and the unit controls and protection. Because of worker safety and the possibility of damage to other plant equipment, the plant is currently not operated. Extensive upgrades are required to make the plant operational.

Since the shutdown of the St. John's Steam Plant around 1988, the St. John's Diesel Plant has been for the most part only started up every few months for maintenance checks.

The St. John's Diesel Plant was for the most part operated only a few hours per year meaning that the rotating machinery has been left standing for long periods of time. This has the potential to cause damage to bearings upon start-up and can result in various other operational problems.

Table A shows the Operating Hour Meter readings for St. John's Diesel Plant for 1991 and again in 2000. It can be seen from the table that the average hours of operation are very low between 1991 and 2000.

Table A – Operating Hour Meter Readings

Diesel Plant	**Meter 1991** (hours)	**Readings 2000** (hours)	**Hours per Year** (hours/year)	**Plant Age** (years)	**Lifetime Average** (hours/year)
St. John's Diesel	2,355	2,455	11.1	50	51.1

Condition of St. John's Diesel Plant

In 1997 Acres International prepared a report on the availability of spare parts, condition of plant and the expected remaining service life of the St. John's Diesel Plant and other diesel units.

The report states that the St. John's Diesel plant is satisfactory to poor overall. The fuel tank was replaced in 1990 with a self-dyked steel unit. However, the switchgear, protection and controls, and engine instrumentation are obsolete and require replacement. Access to this diesel plant in icy winter conditions, must be made by climbing a ladder up the side of a cliff off the Southside Road. The plant continues to have poor lighting levels and the powerhouse requires some upgrade work. The exhaust stack requires painting and the powerhouse requires the installation of an oil / water separator in the future.

Spare parts are no longer manufactured for the St. John's Diesel and surplus parts are limited and costly. It is foreseeable that this unit could require significant spares in the future and would thus cost significant dollars to continue operating.

Environmental Issues

The main environmental liability at diesel plants in the Newfoundland Power system is the storage and handling of bulk amounts of diesel fuel.

The St. John's Diesel Plant has the greatest volume of No.2 marked diesel storage of all Newfoundland Power diesel units and thus the potential environmental liabilities are high with this site. The St. John's Diesel unit is located adjacent to the Southside Road and a major fuel spill could conceivably end up in the St. John's Harbour. The St. John's Diesel powerhouse also has a floor drain system, which flows directly to the Harbour beneath the Southside Road.

Another main area of concern is the fossil fuel emissions resulting from the combustion of No.2 marked diesel fuel. Emission testing has never been completed for any Newfoundland Power diesel plant facilities. The diesel units operate so rarely that annual emission levels are not significant. Emission concentration levels during hours of operation, however could be an issue should regulatory maximum limits continue to drop.

Storage of lubricating products and coolant, such as glycol, also represent an environmental liability in the operation of the diesel plant. The St. John's Diesel plant uses a large quantity of lubricating oil which currently has no secondary containment. The potential for a leak of this product to the St. John's Harbour, through the floor drain system, is high. Environmental requirements will become more stringent in these areas and as such costs will increase in the future.

Non-friable asbestos is also a concern at the St. John's Diesel Plant. The St. John's Diesel plant has transite wall, ceiling and exterior sheeting panels containing 10-25% chrysotile non-friable asbestos.

Remaining Service Life

The service life of a plant is typically determined by the running time until normal replacement is necessary for a major item of the plant. Physical life of a plant is determined by the overall plant life taking into account interim replacement of major components. To determine the physical life of a plant rigorous inspections are required usually involving the original equipment manufacturers. Much of the plant's present condition 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 the duty cycle changes, the increased stops, starts and load swings may cause major components to become more susceptible to failure through fatigue or creep. Typically, Newfoundland Power operated diesel units have been operated rather infrequently with long down periods between starts. This can be particularly hard on engine life.

Based on normal operation, low speed diesels, such as the St. John's Diesel, are generally expected to last 25 years.

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

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

St. John's Diesel Plant has passed its reliable service life as the plant was shutdown in early 2000 due to the need for some major equipment to be replaced and general upgrading at the plant.

Decommissioning Costs

The diesel plant decommissioning costs have been estimated below. These costs have been revised from previous estimates to account for increased costs for asbestos removal, and environmental testing and site remediation.

Estimated St. John's Diesel Plant Decommissioning Costs

Asbestos Removal	$100,000
Equipment Removal	$25,000
Building Demolition	$75,000
Fuel Tank Demolition	$ 2,000
Substation Demolition	$10,000
Site Work	$20,000
Decommissioning Subtotal	**$232,000**
10% Contingency	$23,000
EnvironmentalTesting & Remediation	$100,000
Engineering & Supervision	$20,000
Decommissioning Total	**$375,000**

Conclusions/Recommendations

1. St. John's Diesel Plant has passed its reliable service life and has not operated in the last three (3) years.

2. The St. John's Diesel Plant is no longer required to black start the St. John's Steam Plant, as this plant was decommissioned in the late 1990's.

3. Because of its size and location, the St. John's Diesel Plant is not required for system backup in the St. John's region. Thus capital expenditure to upgrade the plant is not recommended.

4. Due to the lack of spare parts for the plant, operating cost will increase into the future if the plant were upgraded.

5. To reduce environmental exposure and building maintenance costs, the St. John's Diesel Plant should be decommissioned.

Appendix A

Condition Assessment of Diesel Plant

ST. JOHN'S DIESEL PLANT

Plant: **St. John's Diesel**

Inspected by: K. Nicholson
Date: 2000-05-24
Updated: 2003-08-12

Location: **St. John's**
Newfoundland

Description: Plant is comprised of one 2,500 kW diesel generator manufactured by Nordberg. The plant contains auxiliaries such as lube oil coolers, overhead crane, pump, day tank, fuel tank, gasoline fueled air compressor, air receivers, switchgear, controls, and transformers. The equipment is housed in a building with asbestos siding.

Specifications: See Technical Data Sheet in Appendix B.

Date Installed: 1953
Metered Operating Hours: 2,455 hours

Recent Operating Pattern:

Year	Generation (kWh)
1990	18,080
1991	800
1992	27,608
1993	12,160
1994	34,480
1995	0
1996	3,120
1997	7,280
1998	26,000
1999	0
Average	12,953

Operation For
Reliability Check: - No regularly scheduled operation.

General
Plant is in poor operational condition. Engine instrumentation and switchgear are obsolete. Building has asbestos panels throughout.

Recent Maintenance:
1999
- Infrared heater installed directly above lube oil purifier / separator.

1998

- Governor was removed from service to be overhauled, however Diesel Injection Inc. informed Newfoundland Power that the governor could not be overhauled due to its age and type.
- Fuel line piping was modified to allow for manual operation in the event of a solenoid valve failure at the self dyked steel fuel tank.
- Slip Ring brushes were field dressed with stones.
- All friable asbestos were removed from the plant with the engine exhaust manifold insulation having been removed and replaced with non-ACM.

1997

- New batteries and battery charger installed in powerhouse.

1994

- Air valve on #8 cylinder replaced with spare unit.

Required Maintenance:

- Exhaust stack requires painting.
- Governor overhaul.
- Fuel flow meter installation.
- Switchgear requires replacement.
- Instrumentation and protective controls require replacement.
- Entire engine requires major rebuild and overhaul.
- Asbestos panels require removal.
- Overhead crane requires replacement.
- Oil/water separated. Required for building drains system.
- Bearings require refurbishment.

Required Inspections:

- Air receiver and system require annual inspection and certification by Newfoundland and Labrador Department of Labour.
- Building crane requires regular inspection to maintain Department of Labour approval.

Spare Parts:

- Engine is obsolete, some minor spares kept on site.
- Spares on site include: 1 spare cylinder head, 1 liner, 1 piston, and various other smaller spares.

Environmental Restraints: None

Remaining Service Life: 0 years

Factors Affecting Service Life:

1. Low usage of plant.
2. Engine overhaul required immediately if reliable operation is to be expected.
3. Lack of spare parts.

Appendix B

Plant Data Sheet

Appendix B

St. John's Diesel Plant – Data Sheet

Engine Manufacturer	Nordberg
Engine No.	201200804
Bore x Stroke	21-1/2" x 31"
rpm	225
Governor	Woodward Type 1C 500
BHP	3,580
Generator Manufacturer	General Electric Type AT1
kVA	3,125
kW	2,500
Volts	6,600
Amps	274 Armature
	228 Field
Exciter Model	General Electric 33G743
Type	CD 1126
Speed	1150 rpm
Excitation Volts	125
Amps	240
Phases	3
Cycles (Hz)	60
Temp. Rise	60°C
Power Factor	0.80

Appendix C

Photographs of Diesel Unit

Photo 1 St. John's Diesel Powerhouse as seen from the Southside Road.

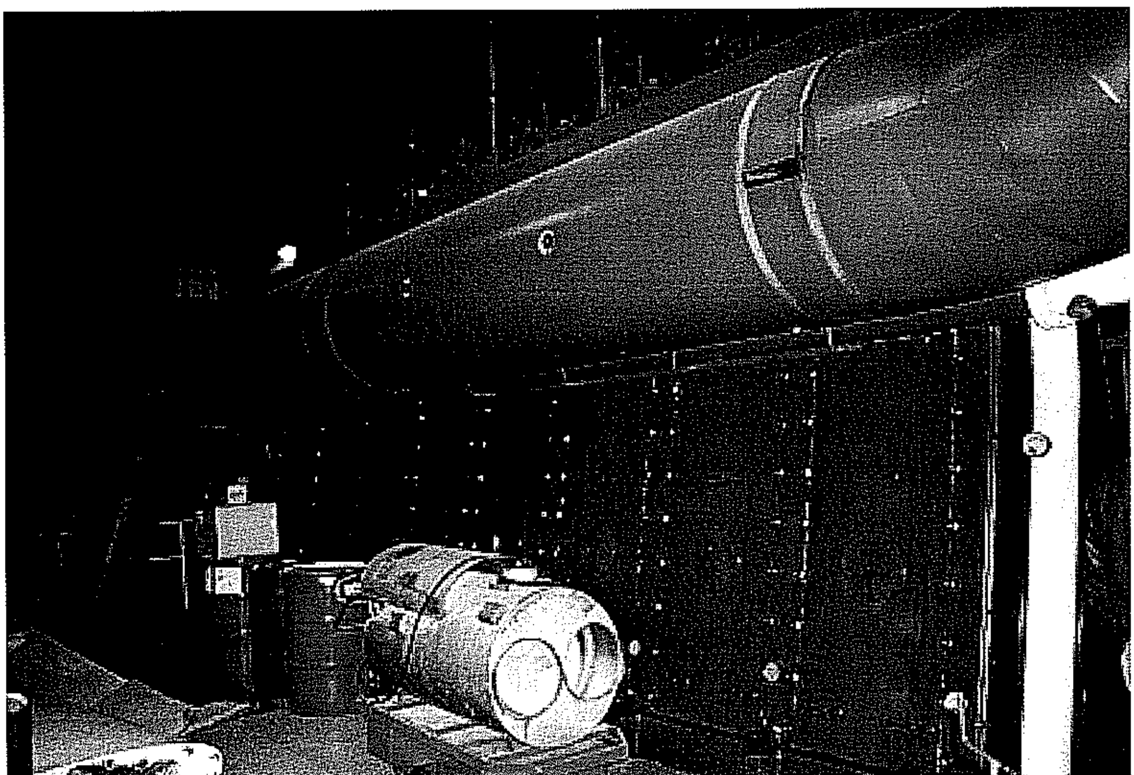


Photo 2 The 2,500 kW St. John's Diesel unit manufactured by Nordberg.