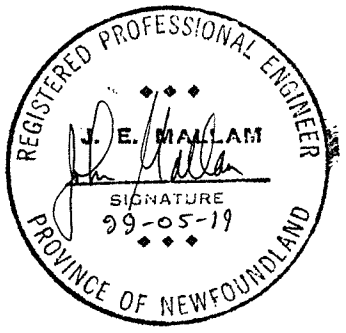
Q. Provide a copy of the report titled: “Prime Thermal Asset Remaining Life Assessment”.

A. The report is attached.

File: 111.50.35/1.00

Prime Thermal Asset
Remaining Life Assessment

GENERATION ENGINEERING
1999-05-19

	Gen Eng Electrical May 21, 99 Gen Eng Civil May 21/99 Gen Eng P&C TRO Electrical May 25/99 TRO Civil June 2/99 TRO P&C MAY 25/99
Approved For Release June 2/99	

DEFINITIONS

There are many terms in use throughout the utility industry to describe the various categories of power plant life. In this report the following will be used:

service life	The economic life assigned to a plant at its inception. It is based on financial considerations and represents the period through which the plant can be expected to operate with a high degree of reliability and minimum maintenance. It is a very conservative estimate used in financial analysis.
design life	The physical life of a plant or component. When the design life is reached the plant or component is considered worn beyond the point where repair is practical.
useful life	Useful life is determined by considering the service life, design life and condition of a plant and is based on a combined engineering and financial analysis. Simply defined, it is that period for which the financing, operating and maintenance costs of the existing plant are less than the equivalent costs of a replacement source of generation plus the cost of decommissioning the existing plant.
remaining useful life	The useful life of a plant or component, less the life expended.

SUMMARY

Newfoundland and Labrador Hydro operates three principal thermal generating plants:

Plant	Capacity (MW)	Year Placed In Service
Holyrood Generating Station	490	Units 1 & 2 1970 Unit 3 1980
Hardwoods Gas Turbine	50	1976
Stephenville Gas Turbine	50	1975

These three plants are reaching the end of their service lives. It was felt that these plants could provide many additional years of economic service and it was decided to formally assess the present condition of the three plants to determine their useful lives. A study team was assembled comprising engineers from the Production Division and the Transmission and Rural Operations Division. The team assessed the three plants using the life assessment techniques developed by the Electric Power Research Institute (EPRI) and estimated the useful life of each. The assessment technique was based on the EPRI Level 1 approach, consisting of visually examining the equipment, reviewing maintenance records and procedures and determining the availability of replacement parts. Equipment was not dismantled for internal inspection and material samples were not taken for analysis. Typical useful lives for similar equipment were also considered. The team concluded that if the three plants are operated in future in a manner similar to which they have been operated in the past, it can be stated conservatively that they can be expected to operate for at least another 20 years.

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INTRODUCTION

Newfoundland and Labrador Hydro operates a variety of hydraulic (water) turbine, steam turbine, gas turbine and diesel engine generating plants. These plants were all designed and constructed as state of the art facilities and are operated and maintained consistent with good utility practice. Like all man made facilities they have a finite life and when originally built their service lives were estimated based on the standards of the day. Three of these plants (Holyrood Generating Station, Hardwoods Gas Turbine, Stephenville Gas Turbine) are reaching the end of their lives. Hydro Management felt that these plants could provide many additional years of economic service, based on their current condition and the Company's maintenance practices and wished to assess the condition and usage of these three plants to attempt to quantify their useful lives. A study team was assembled to review the operating history, present condition and to predict the useful lives of these facilities, using a recognized methodology. This report contains the findings of the condition assessment.

METHODOLOGY

Utilities around the world are confronting a common problem, generating facilities which are approaching, or have reached, their service lives. Through their research and development agencies, utilities have developed methodologies for assessing the useful lives of generating plants. The field is generally referred to as life assessment or life extension. It is obvious that when a power plant is designed and constructed every component does not wear at the same rate and that it is therefore simplistic to designate a retirement date for a facility, at which point its service life can be considered to be expended. For financial purposes thermal generating plants, such as the Holyrood Generating Station have been considered to have a service life of 30 years. Similarly, gas turbine plants, such as Hardwoods or Stephenville, have been considered to have a service life of 25 years. This does not imply that when a plant reaches that age it is no longer viable, but rather indicates that upon completing that period of normal operation, maintenance costs can be expected to increase. Utility planners have realized that when a plant reaches a mature age, it is often more cost effective to extend its life than it is to decommission it and construct a new facility.

The life assessment and extension process was first addressed by the Electric Power Research Institute (EPRI) in the United States. (EPRI is a research institute established and funded mainly by North American utilities.) A three level process was developed, which is based on the gathering and analysis of data, to determine the condition and useful life of a thermal generating plant. The three levels are indicated in Table 1.

Characteristic	Level 1	Level 2	Level 3
Failure History	Plant Records	Plant Records	Plant Records
Dimensions	Design or Nominal	Measured or Nominal	Measured
Condition	Records or Nominal	Inspection	Detailed Inspection
Temperature and Pressure	Design or Operational	Operational or Measured	Measured
Stresses	Design or Operational	Simple Calculation	Refined Analysis
Material Properties	Minimum	Minimum	Actual material
Material Samples Required	No	No	Yes

TABLE 1 Life Assessment Programme

A Level 1 assessment is intended to quickly determine the basic condition of a power plant, to roughly assess its useful life and to identify components, systems or facilities which require attention. The Level 1 assessment also helps the utility to select which components require additional investigation, in the case of a full three level life assessment investigation, and assists personnel in selecting the sampling and testing methodologies to be used in Level 2 and 3 assessments. The failure history is established by reviewing maintenance record . Dimensional review is the comparison of the present dimensions with original dimensions of components subject to wear, erosion or creep (deformation which occurs due to prolonged high temperature and high stress operation). For a Level 1 assessment only the most cursory dimensional review is performed. The apparent condition of the plant is assessed by reviewing the adequacy of maintenance practices, major component repair and replacement records, and by an external inspection of the equipment. Internal inspections are not performed, unless equipment happens to be open for other purposes at the time of the inspection. Operating pressures and temperatures are reviewed to determine if material properties such as creep have been compromised by operation outside established normal operating limits. Material samples are not taken for the determination of properties and in situ tests are not performed. A Level 1 assessment results in a rough estimate of the useful life of a power plant. Within a life assessment /extension programme, this estimate is used by a utility to determine if the plant is a candidate for life extension. Within the context of this study, Level 1 assessments were used to evaluate the present condition of the plant equipment and to estimate the useful lives of the three plants.

A study team was assembled and members were assigned areas of responsibility as indicated in Table 2. The study team began its task with a start up meeting 98-09-16. During this meeting the intent, scope and methodology for the study were discussed and agreed. The EPRI Level 1 assessment methodology was reviewed and adopted and the format of reporting was established. It was agreed that all report sheets would be submitted to the report author by November 15.

Members of the study team visited the plants and reviewed the documentation for, and condition of, each plant. (Sample documentation is appended for the Stephenville Gas Turbine only, to illustrate the sort of records available for inspection by the study team. Hardwoods documentation is similar, as is that for Holyrood. Although Holyrood is a different sort of plant, its documentation is not appended because it would be voluminous, due to the size and complexity of the plant.)

The failure history for each plant is reported in the plant log, equipment histories and maintenance logs. Appendix I contains the equipment history for the Stephenville Gas Turbine.

Person	Holyrood Generating Station	Hardwoods Gas Turbine	Stephenville Gas Turbine
R. Jerrett, P. Eng. Senior Civil Engineer, Generation Engineering	Civil		
R. Kaushik, P. Eng. Senior Electrical Engineer, Generation Engineering	Electrical		
R. Leggo, P. Eng. Senior P&C Engineer, Generation Engineering	Protection, control, instrumentation		
G. Lundrigan, P. Eng. Senior Civil Engineer, Transmission and Rural Operations		Civil	Civil
J. Mallam, P. Eng. Senior Mechanical Engineer, Generation Engineering	Mechanical	Mechanical	Mechanical
D. Hicks, P. Eng. Electrical Engineer, Transmission and Rural Operations		Electrical	Electrical
C. Warren, P. Eng. P&C Engineer, Transmission and Rural Operations		Protection, control, instrumentation	Protection, control, instrumentation

TABLE 2 Study Team Members and responsibilities

Appendix II contains copies of the maintenance check sheets for the Stephenville Gas Turbine. These sheets are used by maintenance personnel to guide them through routine inspection and maintenance procedures.

Dimensional review of components is applicable only to high temperature base loaded equipment and therefore does not apply to the two gas turbine plants, which are used for peaking and emergencies only. Dimensional review will be discussed in the section on the Holyrood Generating Station.

Condition of the equipment in each plant was assessed by visually inspecting all equipment in each plant and by reviewing the maintenance records and equipment histories.

The operating temperature, pressure and stresses were given a cursory review. All three plants have operating limitations established by their manufacturers and Hydro has been careful to respect these limitations.

Material properties were reviewed in very general terms only. Many of the study team were, or are, involved in the design, operation, maintenance and modification of these three plants and are aware of the suitability of the materials from which the equipment was manufactured. It is sufficient to state that the equipment contained in these plants was manufactured from materials which were state of the art at that time. In some cases advances in material science and manufacturing have resulted in better quality components which offer significant improvements in performance or reduction in maintenance requirements. When justified, such new materials and components have been retrofitted to existing equipment. An example of this is the installation of new power turbine casings at both gas turbines, which permits the use of a faster machine loading rate. This is of great benefit when picking up load in an emergency situation. Some physical properties of materials can change with time and exposure to high temperature. This occurs at plants such as the Holyrood Generating Station, where components have been exposed to high temperatures for tens of thousands of hours. This will be discussed in the section on the Holyrood generating Station.

Material samples are not removed for analysis during a Level I assessment. However, as part of other activities, material samples have been removed from the Holyrood Generating Station and this will be discussed later in this report.

PLANT DESCRIPTIONS

Stephenville Gas Turbine

The Stephenville Gas Turbine was installed in 1975 as a peaking and emergency power plant. Fuel for this facility is of the diesel or furnace oil type and is stored in three large storage tanks. The fuel is supplied to two gas generators, which are modified jet engines. Each gas generator produces a stream of hot pressurized gas which is ducted into a power turbine. The power turbine converts the energy contained in the hot gas into rotary motion of its output shaft. The output shaft is connected to a clutch and each clutch to one end of a common alternator, which produces electrical energy. The fuel used at this facility is relatively expensive so the plant is used to produce energy only during peak demand periods and emergencies, which is why it has accumulated so few operating hours. It is also used as a synchronous condenser, to support voltage on the west coast of the Island. To operate as a synchronous condenser, one of the gas generators is started and accelerates the alternator to synchronous speed. The alternator is

synchronized to the system and the gas generator is shut down while the alternator is left connected to the electrical grid and operates as a motor. The voltage of the alternator can be adjusted using the exciter and the unit can then import or export reactive power for transmission voltage support, as required. While the alternator is operating as a synchronous condenser, both gas generators are shut down and no fuel is consumed.

Hardwoods Gas Turbine

The Hardwoods Gas Turbine is essentially identical to the Stephenville Gas Turbine, as is its mode of operation. For a description of this plant please refer to the previous section, Stephenville Gas Turbine. There are some small differences in the fuel and generator cooling systems but, for the purposes of this investigation, they are essentially identical units.

Holyrood Generating Station

The Holyrood Generating Station was constructed in two stages. The first stage, consisting of two 150 MW generators was completed in 1970. The second phase, consisting of an additional 150 MW generator was completed in 1980. The first two units were modified during the late 1980's to increase their capabilities to 170 MW each. Fuel for this facility is Bunker C (a very thick tar like oil produced as a by product from the oil refining process) which is stored in four large storage tanks.

The power production method at Holyrood is that of a conventional thermal generating plant. The fuel is heated and atomized by steam as it is introduced into the boiler, Units 1 and 2 boilers each have 12 burners and Unit 3 has nine burners. The fuel burns within the furnace section of the boiler then the hot gasses pass through the various heat exchange sections of the boiler and out the stack. Steam produced in the boiler is supplied to a turbine which converts the energy contained in the high pressure high temperature steam (1005 ^{0}F, 1900 pounds per square inch) into rotational energy which drives a generator. There are numerous auxiliary systems which support and control this process and which were evaluated as part of this exercise.

FINDINGS and DISCUSSION

Stephenville Gas Turbine

The Stephenville Gas Turbine was placed in service in 1975 and the operating history of this plant as of 98-09-24 is presented in Table 3.

Equipment	Statistics
Gas Generator/Power Turbine A Operating Hours	1,168
Gas Generator/Power Turbine A Starts	1,768
Gas Generator/Power Turbine B Operating Hours	2,042
Gas Generator/Power Turbine B Starts	1,607
Generator Operating Hours as a Generator	2,398
Generator Operating Hours as a Synchronous Condenser	22,172

TABLE 3 Stephenville Gas Turbine Operating Statistics

The Stephenville Gas Turbine was conceptually divided into its major components or operating systems to facilitate assessment. The equipment and systems are briefly described below:

Gas generator/power turbine/generator modules - the plant was constructed by the manufacturer in a modular fashion to facilitate transportation and assembly. These are the major generating equipment buildings

Storage building - small site warehouse

Main Building - contains the control room, repair shop, battery bank and remote/communications equipment

Pump house - contains the equipment for off loading and transferring fuel

Tank farm - the water tight storage area for fuel. Contains three fuel tanks in a lined earth dyke, designed to contain fuel in the case of a spill.

A End Module/B End Module - the plant has two gas generators and power turbines, one each contained in two modules, with auxiliary equipment

Air inlet system - the gas generator (jet engine) consumes large quantities of air which must be filtered to remove contaminants which could reduce performance. This system includes equipment and filters for removing water, snow and dust from the air

Compressed air - high pressure air system used to operate the starters on the gas generators

Fire protection equipment - the equipment is protected using a gas called Halon 1301

Fuel system - includes all equipment used to off load the fuel from tanker trucks, filter it, transfer it to the three storage tanks, withdraw it from the storage tanks, pressurize, filter and heat the fuel before being supplied to the two gas generators

Generator cooling - the internal components of the generator are cooled by air. This air is in turn cooled by a water/antifreeze mix which is pumped through an external radiator

Generator - the electrical generator and its auxiliary equipment

Lube oil system - the bearings of the power turbines and generator are cooled and lubricated by a common lubrication system consisting of storage, pumps, heaters, coolers and controls

Exhaust stacks - includes the exhaust stacks, silencers and rain/snow doors

AC MCC - the motor control centre which distributes power to and controls the operation of the numerous alternating current motors found in the plant (used for normal plant operation)

DC MCC - the motor control centre which distributes power to and controls the operation of the direct current motors found in the plant (used during emergency plant operation). This equipment is powered by batteries and is used to start the plant in the case of loss of power on the island grid system.

Main Transformer - raises the voltage of the power produced by the generator for connection to the island grid system

Switchgear - controls the flow of power from the generator to the main transformer

Control system - equipment used to control the operation of the plant, including the turbine gouvernors

Protective relays - equipment which monitors the operation of the plant and protects it

from unusual operating conditions or equipment failures which might otherwise cause extensive damage

Vibration monitoring system - equipment used to monitor the mechanical condition of the rotating equipment

Transducers, thermocouples, rtd's - used to monitor the condition of equipment and protect it from unusual operating conditions or equipment failures which might otherwise cause extensive damage

Inverter - used to convert direct current electricity from the battery bank to alternating current for use by the plant control systems

AVR - automatic voltage regulator; controls the voltage produced by the generator

Battery bank and charger - equipment used to store and supply power to the plant controls and other equipment required to start the plant in the case of a failure of the island grid

Exciter - device used to induce and control electric power production by the generator

The components of a gas turbine plant which are most sensitive to wear are the parts of the gas generator and power turbine exposed to the hot gases. The useful life of these components is determined by the operating hours, while the useful life of the balance of the parts of these two components is much longer. Most manufacturers require borescope inspections (a method of looking inside the hot sections of the gas path using a fibre optic system) every one to three years and a major inspection at a specified number of operating hours. The manufacturer's specified interval for the major inspection of the Stephenville machine is 8,000 hours. Minor repairs to some components (combustors, blades, nozzles) can be expected at that time. Replacement of some of these parts can be expected at 24,000 to 48,000 hours The fleet leader (the unit presently in service having the greatest number of operating hours) for this type of machine is located in Holland and has operated for 64,989 hours. Based on the hours accumulated to date and assuming that Hydro continues to operate the unit as it has in the past, the material life of the Stephenville Gas Turbine is theoretically almost infinite.

For the Stephenville plant the consideration which is likely to dictate its useful life is the availability of replacement parts. Replacement parts are readily available from the original manufacturers for all parts of all major equipment, except the power turbine. Parts for the power turbine are available from an after market supplier. Any auxiliary equipment (pumps, relays, switches, valves, etc.) which become obsolete in the future can be replaced with similar equipment from another manufacturer. The gas generators are Rolls Royce Olympus C units, of

which dozens exist in active service. There is no reason to think that Rolls Royce will discontinue support of these machines for many years into the future. Rolls Royce has an established record for providing long term support for its products. (As an example, numerous Rolls Royce Avon gas generator units, which first appeared in the early 1960's, are still in service and are actively supported by Rolls Royce). Rolls Royce has committed to supporting the Olympus units until at least 2015.

The Stephenville Gas Turbine condition assessment sheets are contained in Appendix III. The review of the Civil components and facilities (buildings, foundations, fuel storage area, etc.) indicates that all are in excellent condition and are well maintained. Maintenance programmes are in place and are rigorously followed. Civil components are estimated to have a useful life of 30 years. Similarly, the Mechanical equipment and systems and equipment was found to be in good condition and well maintained. The useful life of this equipment is estimated to be an additional 20 years. Similar comments and estimated remaining useful life apply to the electrical components. The protection and control systems were found to be in good condition, but the remaining useful lives of some components were evaluated to be less than for the Civil, Electrical and Mechanical components. The specific components of concern and their remaining useful lives are listed below:

Automatic Voltage Regulator (15 years)

Inverter (10 years)

Vibration Monitoring System (5 years)

Protective Relays (10 years)

Exciter (10 years).

The shorter remaining useful lives of these items does not create a concern because these are relatively low cost items. Also, advances in electronics technology may eliminate the need for some of the equipment. For instance, the function of the Vibration Monitoring System can be incorporated into the new control system which will be installed at Stephenville in 1999, minimal cost. This new control system will be of the DCS type (Distributed Control System, computer based) of the latest type which will electronically control all plant functions.

Considering the very few operating hours which this unit has accumulated, it can be conservatively estimated that the plant has a remaining useful life of 20 years.

Hardwoods Gas Turbine

The Hardwoods Gas Turbine is essentially identical to the Stephenville Gas Turbine. There are some small differences between some of the auxiliary systems of the two plants, but both units were designed, constructed and installed by the same manufacturer. The systems which differ significantly from the Stephenville Gas Turbine are described below:

Tank farm - the water tight storage area for fuel. Contains one fuel tank in a lined earth dyke, designed to contain fuel in the case of a spill.

Generator cooling - the internal components of the generator are cooled directly by filtered

For the Hardwoods Gas Turbine the consideration which is likely to dictate its useful life is the availability of replacement parts. Replacement parts are readily available from the original manufacturers for all parts of all equipment, except the power turbine. Parts for the power turbine are available from an after market supplier. Any pieces of auxiliary equipment (pumps, relays, switches, valves, etc.) which become obsolete in the future can be replaced. The gas generators are Rolls Royce Olympus C units, of which dozens exit in active service. There is no reason to think that Rolls Royce will discontinue support of these machines for many years into the future. (As an example, numerous Rolls Royce Avon gas generator units, which first appeared in the early 1960's, are still in service and are actively supported by Rolls Royce). Rolls Royce has committed to supporting the Olympus units until at least 2015.

The Hardwoods Gas Turbine condition assessment sheets are contained in Appendix IV. The review of the Civil components and facilities (buildings, foundations, fuel storage area, etc.) Indicates that all are in excellent condition and are well maintained. Maintenance programmes are in place and are rigorously followed. Civil components are estimated to have a remaining useful life of 30 years. Similarly, the Mechanical equipment and systems and equipment was found to be in good condition and well maintained. The remaining useful life of this equipment is estimated to be 20 years. Similar comments and estimated remaining useful life apply to the electrical components. The protection and control systems were found to be in good condition, but the remaining useful life of some components were evaluated to be less than for the Civil, Electrical and Mechanical components. The specific components of concern and their remaining useful lives are listed below:

Automatic Voltage Regulator (15 years)

Inverter (10 years)

Vibration Monitoring System (5 years)

Protective Relays (10 years)

Exciter (10 years).

The shorter remaining useful lives of these items does not create a concern because these are relatively low cost items. Also advances in electronics technology may eliminate the need for some of the equipment. For instance, the function of the Vibration Monitoring System can be incorporated into the new control system which was installed in 1998, at virtually no additional cost.

The Hardwoods Gas Turbine went into service in 1976. As of 98-10-05 the operating history of this plant was as presented in Table 4.

Equipment	Statistics
Gas Generator/Power Turbine A Operating Hours	3,494
Gas Generator/Power Turbine A Starts	2,636
Gas Generator/Power Turbine B Operating Hours	3,473
Gas Generator/Power Turbine B Starts	2,514
Generator Operating Hours as a Generator	6,441
Generator Operating Hours as a Synchronous Condenser	27,681

TABLE 4 Hardwoods Gas Turbine operating Statistics

The Hardwoods Gas Turbine condition assessment sheets are contained in Appendix IV.
The age of this facility is one year less than the Stephenville Gas Turbine. Although the high temperature components of this plant have seen approximately twice the number of operating hours as the Stephenville plant the number of operating hours is still very low, so it can be conservatively estimated that the plant has a remaining useful life of 20 years.

Holyrood Generating Station

The principal systems, equipment and facilities which were reviewed include:

Generator bus - high voltage, high current conductors which carry electricity from the generator to the step up transformers

Step up transformer - convert the electricity to high voltage for efficient transmission over long distance

Unit service transformer - provides power to the auxiliary equipment for one of the units

Station service transformer - provides power to the common auxiliary equipment

Switchgear - controls the distribution of electricity

Uninterruptable power supply (UPS) - provides a highly reliable source of power for plant control systems

DC system - provides reliable electrical power to the UPS

Warm air makeup - equipment which provides conditioned ventilation to the powerhouse

Sootblower controls - control system for equipment used to clean the steam generators (boilers) while they are operating

Feedwater system - supplies high pressure water to the boiler which is used to produce steam

Station service control - equipment used to control the flow of power to auxiliary equipment

Light oil fuel system - equipment used to receive, store and transfer light oil (diesel) which is used for starting the main boilers and operating the emergency generators

Bunker C fuel system - equipment used to receive, store and transfer heavy oil (Bunker C) which is used to fuel the three steam generators

Auxiliary steam - equipment used to provide intermediate pressure steam for fuel heating and atomizing, combustion air heating, sootblowing and plant heating

Chemical feed - equipment used to introduce chemicals into the boiler feedwater. The chemicals are required to control corrosion within the power plant equipment

Emergency diesels - used to shut down the plant under controlled conditions following a disturbance on the island grid and can be used to help start the plant following the loss of the island grid

Fire protection and detection - self explanatory

Fuel additive - equipment used to introduce a chemical into the Bunker C fuel to reduce fouling and corrosion of the boiler

General service cooling - cooling system which controls temperatures of auxiliary equipment

Ventilation and heating - self explanatory

Service air - compressed air equipment which provides air for general use throughout the plant

Instrument air - compressed air equipment which provides filtered dry air for use by controls and instrumentation

Raw water - system which supplies untreated fresh water for plant use

Water treatment plant - equipment used to treat raw water to produce highly purified water for use in the boilers

Reserve feedwater - system used to store purified water for use in the boilers

Wastewater treatment plant - equipment used to collect and treat waste water generated throughout the plant to a level of purity acceptable to environmental authorities, prior to discharge

Turbine Generator - the steam turbine, generator ans auxiliary equipment used to produce electricity

High temperature piping - the high pressure, high temperature piping systems used to convey steam between the boiler and turbine

Deaerator - a large storage tank and equipment used to remove air and oxygen from the boiler feedwater, to reduce corrosion

Circulating water - equipment which provides screened seawater to the plant for process cooling

Condenser - a large heat exchanger used to cool and condense the steam exiting the turbine, for reuse in the boiler

Bled steam - a system which extracts a small quantity of steam from the turbine to heat water being admitted to the boiler

Boiler vents drains and blowdown - a system used to remove air and contaminants from the boiler,

Steam generator and auxiliaries - the boiler and its auxiliary equipment

Generator protection - a system of instrumentation and relays used to protect the generator

Turbine controls - self explanatory

Turbine supervisory instrumentation - equipment used to monitor and control the turbine, especially during transient conditions

Boiler controls - self explanatory

Burner management - equipment which uses signals from the boiler controls to precisely control fuel input and distribution to the boiler

Overall controls - self explanatory

Logic cubicles - equipment used to control the plant equipment and store control commands

Synchronous condenser drive - a device used to start and control the operation of Unit 3 (only) as a synchronous (see the Stephenville Gas Turbine for a description of a synchronous condenser)

Motor control centre - equipment used to start, stop, and protect the numerous motors found in the plant

Excitation system - equipment used to control the generator voltage and power output

Civil structures - generally the civil structures require no explanation as their names are

quite descriptive. However, a few structures are described below because their function may not be obvious:

Pumphouse 1 and 2 - the steam turbine condensers are cooled using large quantities of seawater. These two buildings contain the pumps and screens for supplying this water, as well as fire pumps and other auxiliary equipment.

Waste water treatment basins - waste water is divided into two streams and held in these two basins for processing

Waste water treatment plant - contaminated waste water is processed in this building to render it safe for discharge to Conception Bay

Hydrogen storage - hydrogen is used to cool the electric generators. The gas is flammable is stored in this building, away from the powerhouse

Marine terminal - this is the wharf and shore arm, to which tankers tie up to deliver fuel

Quarry Brook Dam - the fresh water supply for the plant is obtained from Quarry Brook. The dam is a timber crib structure which includes a fishway

Site services - the miscellaneous civil structures at the site (pavement, roadways, fences, drainage, etc.)

Stack - each unit has a concrete smoke stack with an insulated steel liner

The Condition Assessment Sheets for the Holyrood Generating Station are contained in Appendices VI, VII, VIII and IX.

Generally, the Holyrood Generating Station is in excellent condition for its age. During its life some major system and equipment replacements and upgrades have been performed. These are listed below:

Direct current power supply systems (replacement)
Warm air makeup system (new equipment to improve plant ventilation)
Boiler controls (replacement)
Fire protection (additions)
General service cooling (replacement in progress)
Air compressors (replacement)
Waste water treatment plant (replacement and addition)
Units 1 and 2 capability increased

Boiler breeching (replacement)
Fishway at Quarry Brook Dam (addition)
Combustion air heaters on Units 1 and 2 (replacement and upgrade)
Station service control (replacement and upgrade)
Plant control system (replacement and upgrade)
Year 2000 compliance modifications and verifications in progress

Most equipment and facilities can be expected to operate reliability without requiring any extraordinary maintenance for many years. Many components can be expected to function reliably and economically for a much greater period. There are some specific areas of concern which will have to be addressed in the near future. The specific components of concern and their remaining useful lives are listed below:

Unit 3 exciter (10 years) - this equipment is expected to become obsolete

Low pressure feedwater heater level controls, all units (5 years) - these have proved troublesome and will be replaced within 5 years in a similar fashion as the high pressure feedwater heater level controls which were replaced over the past three years

Uninterruptable power supplies - by their nature, these have a life expectancy of 15 years from new. These will be replaced on the three units as required.

Overall unit instrumentation - this was replaced in 1987/88 on Units 1 and 2, while about 50% of Unit 3 instrumentation is original. Overall life expectancy of this equipment is 25 to 30 years and it will be replaced as required.

Units 1 and 2 turbine supervisory instrumentation - is now 7 years old and should last at least another 10 years, longer if the manufacturer continues to support it.

Units 1 and 2 turbine electro hydraulic controls - will be replaced on Unit 2 in 1999 and on Unit 1 in 2003

Units I and 2 generator protection - although these relays are 30 years old and rapidly becoming obsolete they function reliably. They will be replaced as required.

Units I and 2 boiler controls (10 years) - these can probably be easily upgraded by replacing the processors

Unit 3 synchronous condenser drive controller - will be replaced in 2000.

Unit 3 logic controls cubicle (10 years) - becoming difficult to maintain

Unit 3 turbine controls (5 - 10 years) - although this equipment is becoming obsolete it may not require replacement as it may be feasible to transfer its control functions to the plant control system (Westinghouse WDPF system)

Unity 3 generator protection (10 years or longer) - this is equipment is in good condition and operates reliably. Its remaining life will depend on how long the manufacturer continues to support it.

It is obvious from a quick perusal of this list that the equipment which will require replacement is all protection and control related. This is due to the rapid pace of advancement in the electronics field which renders equipment obsolete much more quickly than mechanical or electrical equipment. This is not as serious a problem as it might appear for two reasons. First, often the component which becomes obsolete is the main processor (motherboard) which is relatively easy and inexpensive to replace. The balance of the control system (relays, wiring, field devices) are often unaffected. Second, the cost of protection and control equipment is small compared to the mechanical and electrical equipment which comprise the major parts of the facility.

Dimensional review of components is applicable only to a Level 2 or 3 assessment. However, as part of the normal practice of maintenance and assessment of component condition during dismantling to perform routine maintenance, many components are measured or checked. This is to permit assessment of which components require replacement, adjustment or repair during a normal overhaul. It can be stated that no abnormal conditions have been detected which would indicate that replacement of components having significant costs are required.

Material samples are not removed for analysis during a Level I assessment. However, as part of other activities, material samples have been removed from the Holyrood Generating Station, particularly from the boiler. These have been removed to monitor the condition of boiler tubes and to assess the quantity of deposits on both the interior and exterior of the tubes. The condition of these components has been found to be excellent.

In the late 1980's the capability of Units 1 and 2 was increased from 150 MW to 170 MW. As part of the investigation of the feasibility of this project, the condition of the high energy pipework was investigated. Components such as high energy piping, which is operated at high temperature, is subject to a phenomenon known as creep. Creep is the tendency for a material to deform over time, a process which is accelerated by operation at high temperature. The piping was evaluated by examining the microstructure of the steel. No evidence of creep was detected. This indicates that the piping is capable of many more years of service

Deaerating feed water heaters have proved to be troublesome for other utilities. Evidence of cracking of the welds have been discovered in many plants. Holyrood has implemented a

programme whereby 20% of the welds in each deaerating heater are examined each year. This ensures the safety and integrity of the heater and provides an indication of the overall health of the equipment. Similar non destructive assessments are made of many components of the Holyrood Generating station at regular intervals, to continuously monitor the condition of the plant. No serious problems have been detected.

The history of the development of thermal power plants such as Holyrood has a great deal to do with the selection of a service life of 30 years for this type of power plant. The majority of thermal power plants presently in service were constructed after the second world war, but there are also plants still in service which date from before the war. During the period from the early part of this century to the 1970's, advances in technology and material science occurred so rapidly that the fuel efficiency of a new thermal plant was significantly better than that of one twenty or more years old. This fact, coupled with general obsolescence due to those same rapid technological advances meant that complete replacement of a thermal power plant after 30 years of service could be economically justified. This trend has diminished considerably as the rate of technological change has slowed to the extent that the fuel efficiency of thermal power plants built today is only very slightly better than that of the Holyrood Generating Station. Thus what was formerly the principal reason for retiring such a plant is no longer valid. Today the trend is to extend the life of thermal power plants for as long as possible, until the cost of maintaining the plant exceeds the cost of decommissioning and replacement. A recent survey indicated that many utilities are extending the useful lives of their thermal plants to as much as 60 years. (See Appendix V.) To assess the remaining useful life of the Holyrood Generating Station, we must first determine how much of its life has already been expended.

Holyrood was designed in a manner consistent with all other large thermal plants. It was engineered to have a design life of at least 30 years when operating with an annual capacity factor of 70 to 90%. What this means is that over a 30 year period the total energy production of the plant should be equal to between 70% and 90% x 30 years x 8760 hours per year. This 70% to 90% range allows time for maintenance and accounts for periods when a plant is operating at less than maximum rated capability due to equipment problems or local system conditions. Only plants connected to very large electrical systems can achieve annual capacity factors near 90%. The Holyrood plant is connected to a relatively small electrical system (The isolated Newfoundland island system has a peak demand of about 1,500 MW, of which Holyrood's peak capability of 490 MW comprises 32%). The primary source of electrical energy on the island is hydraulic power and these units are operated in preference to Holyrood because they do not have an associated fuel cost. Holyrood is operated only when there is not enough power and energy available from hydraulic power plants. The decision to construct the Holyrood plant was based on the need to back up the Eastern end of the island grid and on long term projections of load growth. A combination of lower than expected load growth and greater than expected precipitation has resulted in Holyrood not being operated as much as was expected. In fact, the units have operated only about one half as much as would be expected for units of their age. For the majority of the time the system demand is much less then 1,500 MW and Holyrood must

operate at less than maximum capability. There are also lengthy periods each year when not all three units are in operation and there are some periods when all three units are shut down because system demand is so low that they are not required at all.

A conservative approach to use when assessing the life expended to date is to compare the accumulated operating hours to date with the number of hours such a unit could be expected to operate. This approach is conservative because such a large proportion of the Holyrood units' operating time is spent at part load, rather than at full load, for which the plant was designed. At part load the pressures and temperatures to which components are subjected are less than at full load and therefore less destructive. Industry practice and the operating characteristics of the Newfoundland island electrical grid indicate that these units are capable of operating at 75% annual capacity factors for 30 years and are therefore capable of 30 years x 8,760 hours per year x 0.75, or about 197,000 operating hours. Units 1 and 2 were placed in service in 1969 and Unit 3 in 1979. The accumulated operating hours on the Holyrood units as of the 1998 summer shut down are presented in Table 5

Unit	Hours
1	110,028
2	101,610
3	76,155
3 as a Synchronous Condenser	11,184

Table 5 Holyrood Generating Station Operating Statistics

On this basis, the useful life of the Holyrood plant can be said to be only half expended and another 20 to 25 years of economic operation can reasonably be expected. This statement is supported by the trend observed in other utilities which have older thermal plants that have operated at much higher annual load factors than Holyrood. These utilities begin to consider life assessment programmes at 150,000 to 200,000 hours and begin implementation of life extension programmes at 250,000 to 300,000 hours.

CONCLUSIONS

1. The Hardwoods Gas Turbine, Stephenville Gas Turbine and Holyrood Generating Station are all in good operating condition, given their respective ages.

2. The practices followed by these three plants are sound and thorough and are consistent with utility practice and manufacturers' recommendations.

3. Parts availability does not appear to be a problem for major equipment. Obsolescence of minor equipment and components can be accommodated by replacement when and as appropriate.

4. The Hardwoods and Stephenville Gas Turbines should be capable of a further period of reliable operation of at least 20 years.

5. The three units in the Holyrood Generating Station should be capable of reliable operation for a period of at least 20 years, if operated as they have in the past. If the annual operating hours are increased significantly in future years, this conservative estimate of remaining useful life should be reassessed. In practice, when the accumulated operating time on a unit nears 200,000 hours, Hydro should implement a more detailed life management/extension programme, as has been done by other utilities having mature power plants.

Appendix I

Stephenville Gas Turbine
Equipment History

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
1996-06-11	801-10-02 P.T.A.	CLEANED AND REPAINTED "A" P.T. BEARING ASSEMBLY AND FLOOR AREA.
1990-05-03	801-10-02	81-08-12 REMOVED AND INSPECTED THE REAR RADIAL AND THRUST BEARINGS.83-05-04 RE-ALIGNMENT BY C-W REP. CHECKED RUB STICKS.84-08-23 DISMANTLED FOR FIRST STAGE STATOR FRONT REFORMING LAND INSPECTION.84-10-11 REMOVED STATOR CASES & SHIPPED TO HWD.84-11-15 REWORK ON ROTATING SEAL - SIB #61, SEAL O.D. : 25,805.86-06-25 P.T STATOR CASES SHIPPED TO FERN, ENGLAND FOR REWORK.88-04-15 P.T STATOR CASES RETURNED (MODIFIED) DURING INSTALLATION. ALSO INSTALLED BALLS IN TURBINE SUPPORTS, AND AIR DEFLECTOR RINGS.90-05-20 INSPECTED P.T. AIR DEFLECTOR RINGS FOR DAMAGE, CHECKED OK.92-08-19 REPLACED THE AIR DEFLECTOR RINGS. COMPLETED DURING OUR ANNUAL INSPECTIONS (DW/GB).94-07-27 INSPECTED THE VOLUTE AREA, DIFFUSER & BLADES, DEFLECTOR RINGS, STACK, ETC. ENTERED THROUGH THE STACK MANHOLE. COMPLETED DURING THE ANNUAL MECHANICAL MAINT. (WB/RW).80-03-12 BELLOWS HRS = 570, NEW BELLOWS INSTALLED.81-08-14 BELLOWS VIBRATION CHECKS PERFORMED. (LF)93-04-02 BELLOWS HRS = 1025.3, BELLOWS INSPECTED BY ROLLS ROYCE CAN. (VM/AJ).83-08-19 BURNER ASS'Y REMOVED FOR BOROUGHSCOPE INSPECTION ON THE COMBUSTION CANS. CLEANED IN VARSOL. (R.R. REP. J. WHITEHILL).90-05-03 BURNER ASS'Y INSPECTED DURING THE HOT SECTION INSPECTION BY R.R. REP. (V. MOSS).

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
1995-08-23	801-11-01	AUGUST 22/95: ANALYSIS SHOWED A HIGH LEVEL OF TOTAL ACID. (2.45 MGKOH/G) ROLLS ROYCE REP., ALLAN JACOBS, SUGGESTED WE REPLACE THEOIL & HAVE ANOTHER TEST DONE AFTER A FEW RUNS.AUGUST 23/95: ALL REMAINING OIL IN THE RESERVOIR WITH NEW OIL. (D.W.)
1995-08-18	801-11-01	75-08-07 FINAL TEST COMPLETED & ACCEPTED FOR SERVICE. REFER TO THE UNIT LOG BOOK.77-11-18 HRS = 325, STARTS = 617. UNIT REMOVED FROM SERVICE DUE TO THE POWER TURBINE FAILURE. (CWC - WARRENTY JOB).78-03-29 HRS = 325, STARTS = 617. ENGINE SHIPPED TO CWC PLANT FOR #3 BEARING REPLACEMENT. (CWC - WARRENTY).78-09-22 HRS = 325, STARTS = 617. BOROSCOPE INSPECTED THE COMBUSTION AREA & ACCESSARY DRIVE. ALSO INSPECTED THE INLET GUIDE VANES. COMPLETED AN ENGINE WASH.79-02-08 HRS = 352, STARTS = 627. INSPECTED THE INLET GUIDE VANES & CHIP DETECTORS. 79-09-20 HRS = 456, STARTS = 701. CHANGED THE ENGINE OIL FILTER. CHECKED THE H.P.PUMP & SERVO PRESSURES.80-01-05 HRS = 473, STARTS = 730. CHANGED THE FUEL FILTER & ADJUSTED THE PRESSURE SWITCH.80-01-30 HRS = 487. INSPECTED THE INLET GUIDE VANES AGAIN.80-02-12 HRS = 496, STARTS = 745. INSPECTED THE CHIP DETECTORS & INSTALLED SNUBBERS IN LINE WITH THE PRESSURE SWITCHES. 80-05-22 HRS = 508, STARTS = 753. INSPECTED THE CHIP DETECTORS.80-08-20 HRS = 515, STARTS = 768. CHECKED THE SECURITY & INTERITY OF THE STARTER & ASSOCIATED GEARBOX. (SIB #50). 80-11-14 HRS = 522. INSTALLED A REDUCED ORFICE IN THE ANTI-ICING EQP. ORFICE REDUCED TO .835/.840" DIA. ALSO INSTALLED NEW IMPROVED COOLING COMBUSTION CANS. (OLYMPUS MOD.#OLP2949). (J.MICHELS).80-11-18 HRS = 522. INSTALLED LEANED ENTRY GUIDE VANES - CASE S/N 061 JD. (OLYMPUS MOD.#OLP3012). ALSO INSTALLED A NEW OIL JET FOR THE STARTER ROLLER BEARING. (OLYMPUS MOD.#OLP3545). (J.MICHELS).82-07-30 HRS = 615. HOT SECTION INSPECTION COMPLETED. FOUND CRACTS JUST BELOW THE MALE CROSSOVERS ON MOST CANS. HAD TO GET FRELCO TO WELD. DUE TO CWC PIB#1036, CHECKED THE ENGINE TURBINE ENTRY DUCT TABWASHERS. FOUND THEM TO BE TABBED PROPERLY & PROPERLY TORQUED. (J.MICHLES). PIB#1037 - DELETION OF HP TURBINE FIRST STAGE STATOR LOCATING BLOCKS. REMOVED 17. (J.MICHLES). 82-08-19 UNIT OUT OF SERVICE DUE TO EXCITER FAILURE & THE ALTERNATOR MODIFICATIONS.83-04-27 HRS = 615. INSPECTED THE FIRST STAGE LP COMPRESSOR STATOR VANES FOR SHROUD CRACKS. FOUND IN GOOD SHAPE. (W.MCINNIS).83-08-18 HRS = 615. BOROSCOPE INSPECTION CARRED OUT ON THE FLAME TUBES. FOUND #6 TUBE

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
		WELD NOT ATTACHED TO THE END OF FRONT COOLING RING. NOTED MODERATE CORROSION THROUGH. REMAINDER IN GOOD CONDITION. (J.WHITEHILL). 83-12-16 UNIT BACK IN SERVICE.84-12-06 HRS = 659. BOROSCOPED THE COMBUSTION AREA AGAIN. REFER TO ENGINE LOG BOOK. (J.WHITEHILL).85-11-29 HRS = 673. COMPLETED ENGINE WASH & INSPECTED CHIP DETECTORS.86-04-15 HRS = 685. INSPECTED THE INLET GUIDE VANES & FIRST STAGE COMP BLADES. ALSO INSPECTED THE CHIP DETECTORS & FOUND CLEAN. 86-10-08 HRS = 690. COMPLETED ENGINE WASH.87-06-11 HRS = 839. INSTALLED RERATED OIL PRESSURE SPRING & MODIFIED COMBUSTION CANS. REFER TO ENGINE LOG BOOK. (V.MOSS).87-11-17 HRS = 1760. COMPLETED ENGINE WASH.87-11-25 HRS = 1761. REPLACED THE VENT LINE BOOTH.89-05-09 HRS = 1793. REMOVED & INSPECTED ALL CHIP DETECTORS.91-06-06 HRS = 1927. STARTS = 1387. COMPLETED AN ENGINE WASH. (DW & GB).92-06-10 HRS = 1944, REMOVED THE LOW PRESSURE COMPRESSOR VANES & SHIPPED TO R.R. PLANT IN LACHINE, QUEBEC, FOR SERMETAL COATING. MOD.OLP2908.(RR REP V. MOSS HERE WITH WB & RW).92-07-16 HRS = 1944, INSTALLED NEW L.P. COMPRESSOR VANES. (PIB #1018-A). COMPLETED A SUCESSFUL TEST RUN AFTER. (RR REP V.MOSS WITH WB & RW).93-04-02 HRS = 1954, STARTS = 1477, ROLLS ROYCE SERVICE REPRESENTATIVES COMPLETED THE FOLLOWING INSPECTIONS ON GGB: 1. REMOVED THE COMBUSTION CHAMBER TOP & BOTTOM HALF CASINGS & INSPECTED ALL CANS, H.P. NOZZLE GUIDE VANES, TURBINES & ENTRY DUCTS. CAN #S 3,4, & 5 FEATURE EARLY STAGES OF EROSION. 2. REMOVED THE STARTER DRIVE GEAR BOX & INSPECTED THE STARTER PAUL & RATCHET ASSEMBLYS. 3. REMOVED ONE FUEL BURNER FOR INSPECTION & CLEANING. 4. BOBOSCOPED THE H.P. COMPRESSOR AREA & THE DELIVERY CASING H.P. COMP REAR BRG & FIRST STAGE TURBINE BRG DRAIN AREAS. NO OIL LEAKS DETECTED. 5. INSPECTED ALL THE METAL CHIP DETECTORS. THE ONLY DEFICIENCYS FOUND WERE THREE COMBUSTION CANS COOLING RINGS ARE STARTING TO BURN. DONNY & GRAHAM ASSISTED R.R. SERVICE REPS (VERNON MOSS & ALLAN JACOBS). REFER TO GGB LOG FOR DETAIL.95-08-18 HRS = 2001, STARTS = 1572. GGB SUPPORTS, VENT LINE, MODULE FLOOR, ETC. CLEANED & PAINTED. (RW/EC). OIL SAMPLE TAKEN FROM THE RESERVOIR & SENT TO IMPERIAL OIL RESEARCH DEPT. FOR ANALYSIS. (RESULTS IN FILE #106.89.30/1).

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
1996-06-11	801-11-02 P.T. (B)	CLEANED AND REPAINTED "B" P.T. BEARING SUPPORT AND FLOOR AREA.
1993-04-01	801-11-02	81-07-02 INSTALLED SHIMS AT P.T. ENTRY DUCT LUGS TO STOP LEAKS. C.W. RECOMMENDED THIS BUT WAS UNSUCCESSFUL. LEAKS PRESENT AT SEVERAL LOCATIONS. ALSO MEASURED RUB STICK CLEARANCES.82-06-03 REMOVED REAR, RADIAL & THRUST BEARINGS FOR INSPECTION.82-09-06 INSTALLED P.T. TO INLET HOUSING SEAL.83-12-16 POWER TURBINE COUPLING - INSTALLED 2 INSULATOR BUSHINGS IN P.T. FLANGE BOKS WITH 3 GRAM WEIGHT DIFFERENCE. PLACED AT 180 DEGREES AND MARKED.84-11-02 COUPLING REMOVED FOR P.T. SEAL MACHINING.84-11-27 COUPLING REPLACED AFTER SEAL MACHINING.84-11-16 MACHINED THE ROTATING SEALS TO 25.805 THOUGH (J. MICHELS) SIB #61 (BASE HRS. = 659).84-12-20 INSTALLED MODIFIED LAB SEALS & FRONT CENTERING RINGS. SIB #46A.86-01-10 INSPECTED LAB SEALS - FOUND IN ORIGINAL CONDITION. (BASE HRS = 673)88-04-15 INSTALLED NEW BALLS IN TURBINE SUPPORTS.88-05-26 INSTALLED NEW STATOR CASES. (BASE HRS = 1770).89-05-10 REPLACED THE DEFLECTOR AIR SEAL. (BASE HRS = 1793)90-11-29 REPLACED #8 THERMOCOUPLE. ALNOR READINGS HIGH (999) (BC) (BASE HRS = 1899).92-06-10 REPLACED BOTH AIR DEFLECTOR RINGS. RING #5054-26-1522P1. (BC). (BASE HRS. = 1944)92-08-18 FLOW DISTRIBUTOR - STARTS = 1435, HRS = 1945.2, REPLACED THE AIR STARTER LUBRICATING OIL. (DW/GB)81-08-14 BELLOWS - VIBRATION CHECKS PERFORMED. (LF)84-10-04 NEW BELLOWS INSTALLED. (BASE HRS = 658)93-04-01 BELLOWS - INSPECTED BY R.R. REPS (V. MOSS & A. JACKSON). (HRS. = 1954). (GB/WB).83-08-19 BURNER ASS'Y - REMOVED FOR BOROUGHSCOPE INSPECTION ON THE COMBUSTION CANS CLEANED IN VARSOL. (R.R. REP. J. WHITEHILL)84-12-04 BURNER ASS'Y - REMOVED FOR BOROUGHSCOPE INSPECTION. (R.R. REP. J. WHITEHILL)93-04-01 BURNER ASS'Y - CASINGS REMOVED & CANS VISUALLY INSPECTED & BOROUGHSCOPED CANS #3,4, & 5 FEATURE EARLY STAGES OF COOLING RING THERMAL EROSION & MINOR CRACKING. CONSIDERED SERVICEABLE FOR NOW. HRS. = 1954. (R.R. JACOBS).

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
1995-08-18	801-10-01	IMPERIAL OIL LTD. (TECHNICAL SUPPORT CENTRE) COMPLETED ANALYSISON AUGUST 18, 1995.
1995-08-18	801-10-01	75-06-30 FINAL TEST COMPLETED & THE UNIT ACCEPTED FOR SERVICE. REFER TO THE ENGINE LOG BOOK.77-10-24 REPLACED THE AIR STARTING REGULATOR DIAPHRAGAM. (CWC).77-11-18 HRS = 393. UNIT REMOVED FROM SERVICE DUE TO POWER TURBINE FAILURE. ALL CHIP DETECTORS INSPECTED OK. WARRANTY WORK BY CWC.78-09-22 HRS = 393. BOROSCOPE INSPECTED THE COMBUSTION AREA & CHECKED THE ACCESSORY DRIVE. (CWC WARRENTY).79-01-09 HRS = 431. CHECKED THE BELLOWS & CHIP DETECTORS.79-01-29 HRS = 431. SUPPLEMENTRY FUEL PUMP REPLACED DUE TO VIBRATION AND NOISE. 79-07-31 HRS = 520. INSPECTED THE IGNITORS & CHANGED THE FUEL FILTERS.79-08-24 HRS = 529. INSTALLED A NEW CHECK VALVE ON THE FUEL LINE & INSPECTED THE INLET GUIDE VANES. ADDED 40 LITERS OF OIL.79-09-20 HRS = 530. CHANGED THE ENGINE OIL FILTER & ADJUSTED PRESSURE SWITCH.79-10-10 HRS = 540. RE - ADJUSTED THE AIR STARTING REGULATOR TO 255PSI.80-01-05 HRS = 545. CHANGED THE FUEL FILTER & ADJUSTED THE PRESSURE SWITCH.80-03-25 HRS = 570. STARTS = 865. REPLACED THE BELLOW ASSEMBLY & INSPECTED THE CHIP DETECTORS.80-05-22 HRS = 577, STARTS = 874. REPLACED THE P.T. COOLING LINE GASKET AND INSPECTED THE CHIP DETECTORS.80-07-09 HRS = 577, STARTS = 875. COMPLETED A COMPRESSOR WASH.80-08-01 HRS = 582, STARTS = 882. COMPLETED A HOT SECTION INSPECTION. INSTALLED MODIFIED CANS & ENGINE CASE.80-08-20 HRS = 582, STARTS = 882. CHECKED THE STARTER ASSEMBLY AS PER SIB # 50.80-11-05 HRS = 582, STARTS = 882. R.R. MOD # OLP3145. REDUCED THE ANTI - ICING ORFICE TO .835/.840" DIA. COMPLETED THE FOLLOWING OLYMPUS MODIFICATIONS: # OLP3012, INSTALLED LEANED ENTRY GUIDE VANES. # OLP2949, INSTALLED A NEW SET OF COMBUSTION CANS. # OLP3545, INSTALLED A NEW OIL JET FOR THE STARTER ROLLER BEARING. (REFER TO THE ENGINE LOG BOOK FOR DETAILS ON THE ABOVE WORK. 81-05-13 HRS = 638, STARTS = 954, D.P. TEST STATOR CASES. INSPECT CHIP DETECTORS. CLEANED SUCTION OIL FILTERS, OBTAINED OIL SAMPLES FOR TEST. INSPECT INLET GUIDE VANES. (DW).81-12-07 INSPECTED CHIP DETECTORS AND INLET GUIDE VANES.81-12-11 HRS = 667, STARTS = 995. INSPECTED L.P. COMPRESSOR, STATOR VANES, AND NOSE BULLET. COMPRESSOR WASHED THE ENGINE.82-05-05 HRS = 701, STARTS = 1015, INSPECT CHIP DETECTORS & OBTAINED OIL SAMPLES.82-06-10 HRS = 709, STARTS = 1017, INSPECT CHIP DETECTORS & CLEANED THE

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED

AIR FILTER. R.R. REP INSPECTED THE INLET GUIDE VANES & FIRST STAGE STATOR & ROTOR.82-07-30 HRS = 713, STARTS = 1022, R.R.REP (J. MICHELS) COMPLETED HOT SECTION INSPECTION. REMOVED AND REPAIRED COMBUSTION CANS. INSPECTED THE TURBINE ENTRY DUCT TABWASHERS AS PER PIB #1036. REMOVED THE HP TURBINE FIRST STAGE STATOR LOCATING BLOCKS AS PER PIB #1037. (REFER TO THE ENGINE LOG BOOK FOR DETAILS.)83-04-27 HRS = 720, STARTS = 1030. INSPECTED THE LP STATOR VANES & BLADES. FOUND IN GOOD SHAPE. (W.MCINNIS, CWC).83-05-13 HRS = 724, STARTS = 1040. THE ENGINE WAS MOVED BACK TO CORRECT STRECHING OF THE BELLOWS. A COMPLETE REALIGNMENT OF THE POWERTRAIN WAS DONE. INLET GUIDE VANES & 1ST STAGE L.P. COMPRESSOR BLADES WERE INSPECTED AT THIS TIME AS WELL. (CWC REP W.MCINNIS).83-08-19 HRS = 726 START = 1063. BOROSCOPE INSPECTION DONE ON THE COMBUSTION AREA. FOUND IN SATISFACTORY CONDITION. (J.W. RRC). 84-09-07 SET T6 LIMIT TO 1325 F & 1390 F TRIP.84-10-11 HRS = 744, STARTS = 1140. GGA REMOVED AND SENT TO HWD.85-11-00 GGA BACK ON SITE, INSTALLED ENGINE INHIBITOR WD-40.86-02-00 GGA SENT TO HWD AGAIN.87-09-25 L.P. COMPRESSOR STATOR BLADES INSPECTED AND SERMETAL COATED BY ROLLS ROYCE.88-05-04 HRS = 750, STARTS = 1152. ENGINE BACK IN SERVICE.90-03-28 HRS = 892, STARTS = 1380, R.R REP (V. MOSS) ATTEMPTED TO REPLACE THE 8 COMBUSTION CANS AND STRAPS. COULD NOT COMPLETE DUE TO SEIZED CASING DOWELS. 90-04-30 HRS = 893, STARTS = 1386, R.R REP (V. MOSS) HERE AGAIN START REPLACING COMBUSTION CANS. REMOVED ALL BOLTS AROUND ENGINE REAR FLANGES AND THE BELLOWS TO OBTAIN CLEARANCE TO REMOVE CHAMBER CASES. DOWELS STILL STUCK.90-05-03 GGA CAN JOB COMPLETED. EIGHT MODIFIED CANS INSTALLED. THE HOT SECTION SHOWED NO SIGNS OF THERMAL OR MECHANICAL STRESS. (GB & WB WITH R.R. REP V.MOSS).91-06-06 HRS = 972, STARTS = 1511, COMPLETED AN ENGINE WASH. (DW & GB). REFER TO FILE #106.83.11/8 FOR ANNUAL WASHES. 93-03-31 HRS = 1024, STARTS = 1580, ROLLS ROYCE SERVICE REPS (VERNON MOSS & ALLAN JACOBS) COMPLETED THE FOLLOWING INSPECTIONS. 1. REMOVED THE L.P. COMPRESSOR TOP HALF CASING & INSPECTED THE L.P. COMP & STATOR ASSEMBLIES.

2. BOROSCOPED THE FOLLOWING AREAS: H.P. COMPRESSOR, H.P. H.P. NOZZLE GUIDE VANES, THE H.P. & L.P. TURBINES, THE DELIVERY CASING H.P.COMP REAR BRG & FIRST STAGE TURBINE BRG DRAIN AREAS FOR OIL LEAKS AS FOUND IN GGB AT HWDS.

3. CHECKED & CLEANED ALL FUEL BURNERS. #6 SHROUD NUT

COMP.DATE	EQNUM	ACTUAL WORK PERFORMED
		FOUND TO BE SLIGHTLY LOOSE. RE-TABBED THE LOCK TABS. 4. INSPECTED THE NOSE BULLET & INLET GUIDE VANES. 5. REMOVED THE STARTER DRIVE GEAR BOX & INSPECTED THE STARTER PAUL & RATCHET ASSEMBLYS. 6. INSPECTED ALL MAGNETIC CHIP DETECTORS. THE ONLY DEFICIENCY FOUND DURING THIS INSPECTION WAS A LOOSE NOZZLE ON #6 BURNER WHICH WAS CLEANED & TIGHTENED. DONNY & GRAHAM ASSISTED ROLLS ROYCE REPS. REFER TO GGA LOG BOOK FOR DETAILS. 95-08-18 HRS=1102, STARTS=1710. GGA SUPPORTS,VENT LINE,MODULE FLOOR, ETC.CLEANED & PAINTED. (RW/EC). OIL SAMPLE TAKEN FROM THE RESERVOIR & SENT TO IMPERIAL OIL RESEARCH DEPT. FOR ANALYSIS. (RESULTS IN FILE #106.89.30/1).

Appendix II

Stephenville Gas Turbine
Maintenance Check Sheets

STATION BATTERY - FORM 1

DATE: _____ INSP. BY _____ STATION: SGT

I2 INSPECTION

_____

CLEANLINESS
JUMPERS & CONNECTIONS
CASES
CHARGER & METERS

TYPE: LEAD ACID 230 VOLT BANK

CHARGING VOLTS _____ AMPS_____

POSITION FOUND: FLOAT _____ EQUALIZE _____

PILOT CELL: NO. _____ VOLTAGE:_____

ROOM TEMPETATURE: _____

BATTERY CONDITION _____

TYPE: LEAD ACID 125 VOLT BANK

CHARGING VOLTS _____ AMPS_____

POSITION FOUND: FLOAT _____ EQUALIZE _____

PILOT CELL: NO. _____ VOLTAGE:_____

ROOM TEMPETATURE: _____

BATTERY CONDITION _____

NOTE: THIS SHEET MUST BE GIVEN TO THE SGT SUPERVISOR.

EMERGENCY LIGHTING:
FUNCTION TEST : _____

REMARKS: _____

_____

STATION BATTERY - FORM II

Station _____ Inspected By _____ Date _____

MFG: _____ Cat. No. _____ Type Electrolyte _____

Charging Condition Found: Float _____ Equalize _____ Volts ____ Amps _____

Pilot Cell: No. _____ (Found) Sp. Gr. _____ Volts _____ Temp _____ C

Water Added: Yes _____ No _____ Equalize Charge: Volts ____ Amps ____ Hr.____

Bank Cleaned _____ Terminations Scanned _____ Alarm Tested _____

Record All Cells: New Pilot Cell: No. _____ Sp. Gr. _____

	SP. GR.	VOLTS	TEMP.		SP. GR.	VOLTS	TEMP.		SP.GR.	VOLTS	TEMP.
1.				21.				41.			
2.				22.				42.			
3.				23.				43.			
4.				24.				44.			
5.				25.				45.			
6.				26.				46.			
7.				27.				47.			
8.				28.				48.			
9.				29.				49.			
10.				30.				50.			
11.				31.				51.			
12.				32.				52.			
13.				33.				53.			
14.				34.				54.			
15.				35.				55.			
16.				36.				56.			
17.				37.				57.			
18.				38.				58.			
19.				39.				59.			
20.				40.				60.			

ONLY IF INSTRUCTED:

Clean & Lubricate Connections _____ Check Accuracy of Charger Meters ____

Complete Amp/Hr. Discharge Test:

1. Discharge: Amps _____ Hrs. _____ Temp. _____
   Charge: Amps _____ Hrs. _____ Temp. _____

2. Discharge: Amps _____ Hrs. _____ Temp. _____
   Charge: Amps _____ Hrs. _____ Temp. _____

CAUTION: AVOID EXCESS GASSING AND TEMPERATURE.

HYDRO

Revision Date: 96-02-29

File #106.83.11/13

STEPHENVILLE GAS TURBINE
MOTOR LOAD & SOUND LEVEL ANNUAL INSPECTION

DATE _____ *INSPECTED BY* _____

MOTOR/ HEATER NO.	APPLICATION	SOUND LEVEL db (C)	RATING	LOAD A PH	LOAD B PH	LOAD C PH
1.C.	MLO Main Pump (Run for 20 Sec. Before Checking)		50 HP			
1.D.	Oil Service Vent Fan		6 HP			
2.C.	Evacuator Fan		5 HP			
2.H.	Demister		1 HP			
3.B.	Fuel Unloading Pump		20 HP			
3.F.	Alt. Glycol Main Pump		75 HP			
3.J.	Alt. Glycol Aux. Pump		75 HP			
4.C.	MLO Aux. Pump (Run for 20 Sec. Before Checking)		50 HP			
5.C	Turbine/Generator Lube Oil Heating		24 KW			
5.D.	MLO Heat Exch. Fan		5 HP			
5.F.	Alt. Heat Exch. Fan		20 HP			
5.H.	Alt. Heat Exch. Fan		20 HP			
5.J.	MLO Glycol Pump		10 HP			
6.A.	MLO Heat Exch. Fan		5 HP			
6.F.	Fuel Forwarding Pump		10 HP			
7.A	Switch Gear Heaters		2 KW			
7.C.	Unit A Enclosure Fan		20 HP			
7.D.	Unit A Enclosure Fan		20 HP			
7.F.	Fuel Forwarding Aux. Pump		10 HP			
7.H	Generator Heaters		33 KW			
8.A.	Unit B Enclosure Fan		20 HP			
8.C.	Unit B Enclosure Fan		20 HP			
9.	Supplement Pump - Unit A (Fuel forwarding pump must be on)		25 HP			
10.	Supplement Pump - Unit B (Fuel forwarding pump must be on)		25 HP			
1766 Wire	Bus Duct Heaters		1 KW			

INSPECTION GUIDE

1. *Couplings (check wear)*
2. *Guards*
3. *General Condition (cleanliness)*
4. *Check Belt Tension*
5. *Contactors (check & clean contacts)*
6. *MCC Wiring (check connections)*

REMARKS:

Appendix III

Stephenville Gas Turbine
Condition Assessment Sheets

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Gas Generator/ Power Turbine /Generator Modules**	
Prepared by:	G. Lundrigan
Date:	98-11-13
Description	Metal enclosures /concrete foundations
Reliability History	Good
Maintenance Requirements	Routine cleaning & painting
Major Repair/Upgrade History	There is an on-going painting program with selected sections of the enclosures are cleaned of corrosion and painted each year.
Condition	Good
Spare Parts Availability	-
Comments	
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Storage Building**	
Prepared by:	G. Lundrigan
Date:	98-11-13
Description	Vinyl Clad Wooden Structure
Reliability History	Good
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	-
Condition	Good
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Main Building**	
Prepared by:	G. Lundrigan
Date:	98-11-13
Description	Includes Control, Communication, Compressor and Stock Rooms as well as Workshop
Reliability History	Excellent
Maintenance Requirements	Routine Cleaning & Painting
Major Repair/Upgrade History	Exterior of roof was painted within the last 5 years.
Condition	Good
Spare Parts Availability	N/A
Comments	Building is a pre-engineered metal type. Concrete Foundations.
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Pumphouse**	
Prepared by:	G. Lundrigan
Date:	98-11-13
Description	Building structure including walls, roof, and foundations
Reliability History	Excellent
Maintenance Requirements	Routine Cleaning & Painting
Major Repair/Upgrade History	N/A
Condition	Good
Spare Parts Availability	N/A
Comments	Building is a pre-engineered metal type
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Tank Farm (Excluding Tanks)**	
Prepared by:	G. Lundrigan
Date:	98-11-13
Description	Hyplon Lined Earthen Dyke
Reliability History	Good
Maintenance Requirements	Patching of liner as required
Major Repair/Upgrade History	There have been no major repairs / upgrade to date but dyke liner may have to be replaced within the next year to comply with GAP regulations
Condition	The earthen dyke itself is in good shape but the liner has a number of holes which require patching. Also to meet existing GAP regulations the tank farm will have to be upgraded by extending existing liner or placing a new liner under fuel tanks. Another option would be to install a vacuum sealed double bottom with monitoring devices in the tanks, thus eliminating the need to install liner under tanks.
Spare Parts Availability	Good
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: A End Module**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Gas generator, power turbine, clutch
Reliability History	Fair to good. Problems with cracking of power turbine casing in early years. Problems associated with control system will be eliminated when new control system is installed in 1999/2000
Maintenance Requirements	Regularly scheduled maintenance and inspections by Hydro and manufacturers personnel
Major Repair/Upgrade History	GG/PT bellows replaced 1981 Power turbine casing replaced 1988 Combustion cans replaced 1990 Clutch dismantled 1991 to correct problem with incorrect phasing of gears.
Condition	Good
Spare Parts Availability	Good. Original manufacturer no longer in business but after market manufacturers provide spare parts and service.
Comments	Units accumulate very few operating hours annually.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Air Inlet System**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Air intake hoods, screens and emergency vacuum relief, dynamic air filters, static air filters, silencers
Reliability History	Good
Maintenance Requirements	Replacement of filters as required
Major Repair/Upgrade History	Dynavane inertial filters removed 1995 and replaced by prefilters
Condition	Good. No evidence of rust on baskets or anywhere else
Spare Parts Availability	Good
Comments	Filters replaced every 5 years or as indicated by pressure differential
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: B End Module**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Inlet air filter, gas generator, power turbine, clutch
Reliability History	Fair to good. Problems with cracking of power turbine casing in early years. Problems associated with control system will be eliminated when new control system is installed in 1999/2000
Maintenance Requirements	Regularly scheduled maintenance and inspections by Hydro and manufacturers personnel
Major Repair/Upgrade History	Power turbine casings replaced 1988 Combustion cans replaced 1980 New LP compressor vanes installed 1992
Condition	Good
Spare Parts Availability	Good. Original manufacturer no longer in business but after market manufacturers provide spare parts and service.
Comments	Units accumulate very few operating hours annually.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Compressed Air**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Air compressors, receivers, valves, controls
Reliability History	Good
Maintenance Requirements	Routine maintenance all components
Major Repair/Upgrade History	Air dryer added 1991 Both compressors replaced 1993 Air receivers inspected internally and cleaned 1993
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Fire Protection Equipment**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Halon fire suppression system
Reliability History	Good, although there have been false discharges
Maintenance Requirements	Periodic inspection and testing by service technicians
Major Repair/Upgrade History	Rewired to correct faulty wiring, which caused false alarms.
Condition	Good
Spare Parts Availability	Good. Replacement Halon is becoming scarce and expensive
Comments	System will be replaced within 5 years to eliminate Halon
Minimum Life Expectancy	5 years, 30 years with replacement of Halon

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Fuel System**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Receiving pump and filter, three storage tanks, forwarding pumps, filter and heater, piping, valves
Reliability History	Good
Maintenance Requirements	Routine maintenance all components
Major Repair/Upgrade History	Fuel meter replaced Tank farm liner installed
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Generator Cooling**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Air/glycol cooler, circulating pumps, piping and valves
Reliability History	Good
Maintenance Requirements	Routine maintenance of components
Major Repair/Upgrade History	One cooling pump rebuilt.
Condition	Good
Spare Parts Availability	Good
Comments	Simple, low maintenance equipment.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Generator**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Generator, exciter
Reliability History	Early problems with exciter, otherwise good.
Maintenance Requirements	Routine maintenance and inspections
Major Repair/Upgrade History	Exciter repaired and modified in 1983 and 1985.
Condition	Good
Spare Parts Availability	Good
Comments	Generator has a closed cooling system which renders it immune from the contamination problems which have occurred at Hardwoods.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Lube oil System**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Lube oil/glycol cooler, glycol/air cooler, circulating pumps, filters, heater, sump tank, valves, piping
Reliability History	Good
Maintenance Requirements	Routine maintenance of all components. Painting of structural steel as required.
Major Repair/Upgrade History	None
Condition	Good
Spare Parts Availability	Good
Comments	Conventional equipment with parts/replacements readily available
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Exhaust Stacks**	
Prepared by:	John Mallam
Date:	98-10-05
Description	Exhaust volute, stacks, silencers, snow hoods
Reliability History	Good
Maintenance Requirements	Routine maintenance of snow hoods and operating mechanism. Inspections and minor repairs to silencers and liner as required
Major Repair/Upgrade History	Stacks, silencers and snow doors replaced 1990
Condition	Good
Spare Parts Availability	Good
Comments	Low maintenance equipment
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: AC MCC**	
Prepared by:	Dave Hicks
Reliability History	This has been a very reliable system, with very minor repairs required.
Maintenance Requirements	No regular maintenance is required on this MCC.
Major Repair/Upgrade History	Have replaced some contacts and relays, mostly of a minor nature.
Condition	This is in good condition. It is kept in clean, heated control room environment and requires very little maintenance.
Spare Parts Availability	There are some spare relays on site but most components are readily available from the manufacturer.
Comments	
Minimum Life Expectancy	System should be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Air Start System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Both turbines are have air start systems with two 7.5 Hp, 600 Volt AC air compressors. Those are not necessarily redundant systems as they both feed the air receiver which in turn provides air to the units. There are no electrical components involved, a desiccant pack is used to dry the air.
Reliability History	Good
Maintenance Requirements	Regular checks requiring minor adjustments to compressor drive belts.
Major Repair/Upgrade History	Both air compressors, motors included, were replaced in 1993 as well as the air lines valves etc. in addition to a new control panel.
Condition	Good
Spare Parts Availability	Some spare parts are kept on site in Hardwoods, most are readily available from manufacturers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Air Supply/ Coolant System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The air coolant system has been Turbine Inlet Filters with two blowers on A and two on B, all AC motors, which are used to draw air into the enclosure. Plus there are enclosure fans two on A and two on B, AC as well.
Reliability History	Good.
Maintenance Requirements	Routine checks.
Major Repair/Upgrade History	There have not been any major repairs required on this system
Condition	Good
Spare Parts Availability	Some spare parts are maintained in Hardwoods but most are readily accessible from the suppliers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant:Stephenville Gas Turbine **Component: Alternator**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	This is the generator coupled to the A and B power turbines. There are approximately 12 heaters 33kW each on the generator.
Reliability History	This has been a fairly reliable system. There was a problem with the terminal bushings on two separate occasions. There was also a problem with a heater failure which has since been modified tied into the monitoring system.
Maintenance Requirements	Annual meggar of: rotor, exciter armature winding, and exciter field winding plus checks on all other associated components.
Major Repair/Upgrade History	Two of the high voltage bushing have been replaced since its installation. One in the 70's and one in 1997.
Condition	Good
Spare Parts Availability	There are two spare bushings on order to be kept on site at Stephenville. There are some other parts in inventory in Hardwoods but the list would have to be reviewed to know which parts applicable to the generator were kept on hand.
Comments	

Plant:Stephenville Gas Turbine **Component: Alternator**	
Minimum Life Expectancy	According to Brush Electric the life expectancy from startup for this unit is approximately 45 years, when maintained properly and operated in a clean environment, with the minimum number of starts. Not all our maintenance records are complete, there has been fairly clean environment surrounding the units in the past, and there have been a significant number of starts on the units, especially Hardwoods GT. Brush could not comment for certain, as to the remaining life expectancy without doing a physical assessment themselves, but suspect it may be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant:Stephenville Gas Turbine **Component: DC MCC**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Westinghouse SO# 37B4276, Class II-350, 600 Volts, 3 Phase.
Reliability History	This has been a fairly reliable system not requiring any repairs.
Maintenance Requirements	No regular maintenance is required on this MCC.
Major Repair/Upgrade History	None since it was installed.
Condition	This is in good condition. It is kept in clean, heated control room environment and requires very little maintenance.
Spare Parts Availability	There are some spare parts on hand but most components are readily available from the manufacturer.
Comments	
Minimum Life Expectancy	System should be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant:Stephenville Gas Turbine **Component: Exhaust System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	There are two snow doors on the exhaust stacks which have DC solenoids operated from the DC MCC. Those solenoids must first be released before the air system can open the SnoDoors using air style pistons.
Reliability History	Good
Maintenance Requirements	Routine physical inspection.
Major Repair/Upgrade History	The air style pistons were installed a few years ago as replacement for DC solenoids which were problematic.????
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the snow doors.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant:Stephenville Gas Turbine **Component: Generator Lube Oil System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Each turbine has a generator lube oil system which is driven from the unit. Each has a heater as well. Those are located adjacent to the turbine units.
Reliability History	Good
Maintenance Requirements	Routine inspection
Major Repair/Upgrade History	None have been done since it was installed.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the generator lube oil system.
Comments	
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Water/Glycol Coolant System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	This is a closed water and glycol system interfaced with a heat exchanger to remove heat from oil lubrication system. There is one glycol AC pump in this system as well as two AC fans installed on the cooling rads through which the coolant circulates. Those are both 600 Volts fed from the AC MCC.
Reliability History	Good
Maintenance Requirements	Routine maintenance and inspection
Major Repair/Upgrade History	Several belts were replaced over its period in service.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the Water / Glycol coolant system. Most components are readily available from suppliers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Halon Fire Systems**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	There are Halon Fire Systems on each compartment which are supplied with DC fed solenoids.
Reliability History	Good
Maintenance Requirements	Routine Inspection of system.
Major Repair/Upgrade History	Completely rewired the Stephenville system in 1997, as a result of burn marks found on the wires in the conduits. Maintenance records were incomplete for Whitbourne.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the Halon fire system. This is a fairly common system and spare parts are readily available from local suppliers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Liquid Fuel Supply System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The electrical aspects of this system consists of three off loading pumps, 2 AC and 1 DC, which are fed from NFLD Power source; three fuel forwarding pumps 2 AC and 1 DC and two supplementary pumps 1 on GTA and 1 on GTB which are used to bring the fuel to a higher pressure. There is also a 100 kW, 600 volt heater on this system.
Reliability History	Good
Maintenance Requirements	Routine inspection and maintenance.
Major Repair/Upgrade History	The heater was replaced on the Hardwoods system.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the liquid fuel supply system.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Main Lube Oil System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The Main Lube Oil is located in the Auxiliary Module. It consists of two DC pumps, one main AC pump and one Auxiliary AC pump. There is one Demister. There is one vapour extractor. There are two heaters on the main lube oil system to maintain the temperature at a certain level for viscosity reasons, they are 25 kW each, at 600 volt. There are two DC jacking pumps which are used in a hydraulic style system used to lift the main bearings and force oil around them prior to start up. (Axial piston constant displacement type - one pump per alternator bearing)
Reliability History	Good
Maintenance Requirements	Routine maintenance and inspection.
Major Repair/Upgrade History	None have been done.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the main lube oil system.
Comments	
Minimum Life Expectancy	20 years

Plant: Stephenville Gas Turbine **Component: Main Lube Oil System**	

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Main Transformer**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Westinghouse, 45 MVA, 13.8 V delta/ 66 kV Wye gnd, oct 1975
Reliability History	Good
Maintenance Requirements	Routine Maintenance and inspection. Annual oil sampling and gas analysis.
Major Repair/Upgrade History	None have been done.
Condition	Good
Spare Parts Availability	Spare bushings are kept in Bishop's Falls for both the high and low side. Other external components are kept in Bishop's Falls as well.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Switchgear**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	13.8 V switchgear associated with the gas turbine consists of all buswork leading from the alternator to the breaker, auxiliary transformer, PT's, CT's and buswork up to the step up transformer.
Reliability History	There has been a history of problems associated with the switchgear in Stephenville for several years since 1983 culminating in flashover failure of the buswork and support insulators in 1993. A decision has been made to replace all the switchgear in 1998 with a complete new system.
Maintenance Requirements	
Major Repair/Upgrade History	See reliability history.
Condition	To be replaced.
Spare Parts Availability	New system will have spare parts readily available from the manufacturer.
Comments	
Minimum Life Expectancy	New switchgear will have a minimum life expectancy of 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Control System**	
Prepared by:	Craig Warren
Date:	Oct. 20 / 1998
Description	Curtiss-Wright Electromechanical Relay/Timer based Controls (sequencer). Woodward Governor Control (fuel control).
Reliability History	Timing problems with sequencer have been numerous in the past. Relays have failed and required replacement. Determining identity of a failed relay is difficult and time consuming with no way of knowing if any relay failed prior to starting of gas turbine.
Maintenance Requirements	None. Replacements made on failure only.
Major Repair/Upgrade History	Upgrade to a new digital control system (sequencer and governor functions) scheduled for 1999.
Condition	Working.
Spare Parts Availability	Relays, timers and governor cards stocked at site.
Comments	Control System upgrade planned for mid 1999 (April - June). A state-of-the-art digital control system is to replace the existing relays and timers.
Minimum Life Expectancy	Not applicable due to upgrade. New controls should have 15+ years minimum life expectancy.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Protective Relays**	
Prepared by:	Craig Warren
Date:	Oct. 21 / 1998
Description	Relays: - Underpower Relay (37) - Underfrequency Relay (81G) - Overcurrent Relay - Aux. Transformer (51AT) - Loss of Excitation Relay (40G) - Undervoltage Relay (dead bus) (27DB) - Differential Relay (87G) - Undervoltage Relay (27G) - Reverse Power relay (32) - Negative Phase Sequence Relay (46) - Voltage Restraint Relay (51V) - Overvoltage Relay (59G) * - Bus Ground Protection Relay (64B) - Stator Ground Protection (64F) Meters: - AB-40 style Wattmeter - AB-40 style Varmeter - AB-40 style Voltmeter - AB-40 style Ammeter - AB-40 style Synchroscope * - new as of 1994.
Reliability History	No problems to date.

Plant: Stephenville Gas Turbine **Component: Protective Relays**	
Maintenance Requirements	Periodic function checks are performed on the relays by P&C technicians (once every 3 years) using Doble relay test equipment.
Major Repair/Upgrade History	All relays are original (as of 1972). Costs to upgrade any or all relays is minimal. New technologies combine many functions into one package thereby reducing upgrade cost and space allocation.
Condition	Good.
Spare Parts Availability	Some spare devices in Bishop's Fall area office. In the event of relay failure and like model not in stock or considered obsolete, it would be most economical to upgrade any relay to a digital model.
Comments	
Minimum Life Expectancy	Estimated additional 10 years minimum.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Vibration Monitoring System**	
Prepared by:	Craig Warren
Date:	Oct. 20 / 1998
Description	IRD Mechanalysis Machine Monitor - Model 5806 Signal Conditioner - Model SP95C Vibration Pickups - Model 544M
Reliability History	Minor problems with some input cards in machine monitor over the years but otherwise working good.
Maintenance Requirements	IRD personnel periodically checks unit and calibrates where necessary (approx. every 4 - 5 years).
Major Repair/Upgrade History	Filtering cards installed on some channels of machine monitor in 1989. In 1993, Channels 1 and 2 control cards replaced and recelebrated, all nine channels were tested using pickup tester model 421 and IRD representative Gilles Lanthier tested vibration monitor.
Condition	Good.
Spare Parts Availability	Some spares stocked in Stephenville.
Comments	Not original equipment - vibration monitoring system installed in 1986.
Minimum Life Expectancy	Estimated additional 5 years minimum. There is a redundant monitoring method, so this may not be replaced.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Transducers, Thermocouples, RTD's**	
Prepared by:	Craig Warren
Date:	Oct. 22 / 1998
Description	Signal transducers, thermocouples and RTD's - various manufacturers.
Reliability History	No major problems.
Maintenance Requirements	None. Replaced on failure only.
Major Repair/Upgrade History	All thermocouples have been replaced on engine EGT. Stator RTD's are original. Speed pickups are original. Transducers replaced over the years. All cabling will be replaced during controls upgrade in 1999 - none of the existing control, thermocouple or RTD cabling has adequate shielding.
Condition	Good. These devices do not have a long life but are minimal cost and easy to install.
Spare Parts Availability	Yes, cable stocked in Bishops Falls, transducers are easily acquired.
Comments	
Minimum Life Expectancy	Estimated additional 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Inverter**	
Prepared by:	Craig Warren
Date:	Oct. 19 / 1998
Description	Single phase power inverter - CTS of Canada, Ltd.
Reliability History	Good. No major problems since 1987. Minor grounding related problems resulting from lightning strikes and switchyard flashovers - resolved.
Maintenance Requirements	Monthly general check. Annual comprehensive check.
Major Repair/Upgrade History	Inverter removed from service in 1987, some cards replaced and recelebration done by manufacturer representative.
Condition	Good.
Spare Parts Availability	None. Manufacturer would have to contacted in the event of problem.
Comments	
Minimum Life Expectancy	Estimated additional 5 - 10 years minimum.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: AVR**	
Prepared by:	Craig Warren
Date:	Oct. 21 / 1998
Description	Automatic Voltage Regulator - Brush Electric
Reliability History	No major problems. This unit has been performing well over the years.
Maintenance Requirements	Setting test every 3 years.
Major Repair/Upgrade History	Some diodes and one rheostat replacement. No major work.
Condition	Good. Consistently energized.
Spare Parts Availability	Diodes and rheostats stocked. Manufacturer to be contacted in the event of a complete loss of any one circuit board.
Comments	
Minimum Life Expectancy	Estimated additional 15 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Battery Bank & Charger**	
Prepared by:	Craig Warren
Date:	Oct. 20 / 1998
Description	GNB Batteries, CIGENTEC Battery Charger
Reliability History	No problems. Charger has been performing well over the past years. Battery Bank is new - excellent condition.
Maintenance Requirements	Monthly (general) and annual (comprehensive) inspections. Batteries are maintenance-free type.
Major Repair/Upgrade History	Old battery bank replaced with in 1992. Charger is original equipment.
Condition	Excellent.
Spare Parts Availability	None. Manufacturer would have to contacted in the event of battery cell or charger failure.
Comments	
Minimum Life Expectancy	Estimated additional 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Stephenville Gas Turbine **Component: Exciter**	
Prepared by:	Craig Warren
Date:	Oct. 22 / 1998
Description	Brushless Exciter - Brush Electric.
Reliability History	No problems since exciter replacement in 1984.
Maintenance Requirements	Monthly (general) and annual (comprehensive) inspections.
Major Repair/Upgrade History	Major failure of exciter occurred in 1982 - armature replaced. Failure of diode carrier and replacement armature occurred in 1984 (Dec.) - repaired. Unit on-line 1985 (Aug.). Report on file detailing the failure and subsequent replacement. No major problems since then.
Condition	Good.
Spare Parts Availability	None. Brush Electric (UK) to be contacted in the event of major failure.
Comments	
Minimum Life Expectancy	Estimated additional 10+ years.

Appendix IV

Hardwoods Gas Turbine
Condition Assessment Sheets

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Gas Generator/ Power Turbine /Generator Modules**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Cladding, Concrete Foundations
Reliability History	Good
Maintenance Requirements	Routine Cleaning & Painting and Repairing of leaks
Major Repair/Upgrade History	There is an on-going painting program with selected sections of the modules are cleaned of corrosion and painted on a revolving basis.
Condition	Good. Overall condition is good although there is evidence of leaking at the turbine end of both gas generator modules. There is some rusting of the metal screens immediately above the unit at these points. I would suggest that an extensive effort be made to locate these leaks during a shut down period which is scheduled in 1999.
Spare Parts Availability	Good
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Maintenance Building**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Building, Concrete Foundations
Reliability History	Good
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	None
Condition	Good, with the exception of some rusting at base.
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Fuel Storage Tank Farm (excluding tank)**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Lined Earthen Dyke XR-5 Geomembrane from Seaman Corp.
Reliability History	Good
Maintenance Requirements	Keep liner covered with gravel and patch liner when required.
Major Repair/Upgrade History	New liner was installed under tank and throughout dyked area in 1996.
Condition	Excellent
Spare Parts Availability	Replacement liner and patching kits available.
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Auxiliary Module**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Includes coolers, lube oil, glycol and compressed air system
Reliability History	Good
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	N/A
Condition	Good
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Switchgear Module**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Clad Enclosure, Concrete Foundations
Reliability History	Good
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	N/A
Condition	Good
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Control Module**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Building, Concrete Foundations
Reliability History	Excellent
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	-
Condition	Excellent
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

☐ NOISE ☐ VIBRATION

ANALYSIS OF: *MAIN LUBE OIL PUMP AND MOTOR* (1C)

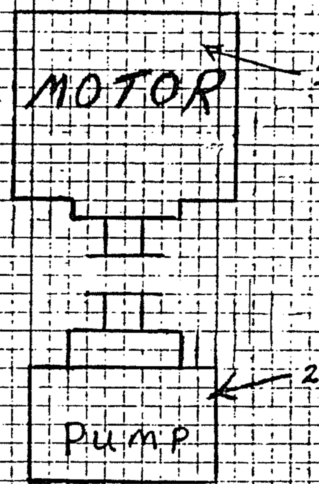
FOR: *STEPHENVILLE*
GAS TURBINE

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY: ____________

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

TEST CONDITIONS:



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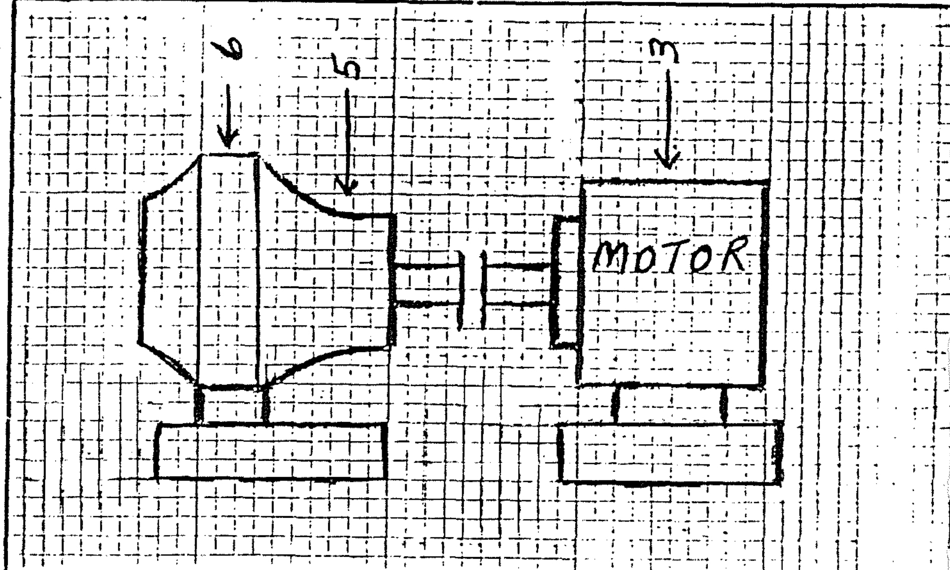
IRD MECHANALYSIS, INC. DATA SHEET DATE

☐ NOISE ☐ VIBRATION ANALYSIS OF: *FUEL UNLOADING PUMP AND MOTOR* (3B)

FOR: *STEPHENVILLE GAS TURBINE*

TEST CONDITIONS:



MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY:

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

PICKUP		FILTER OUT											
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IRD MECHANALYSIS, INC. DATA SHEET DATE

☐ NOISE ☐ VIBRATION

ANALYSIS OF: *MAIN GENERATOR GLYCOL PUMP AND MOTOR (3F)*

FOR: *STEPHENVILLE GAS TURBINE*

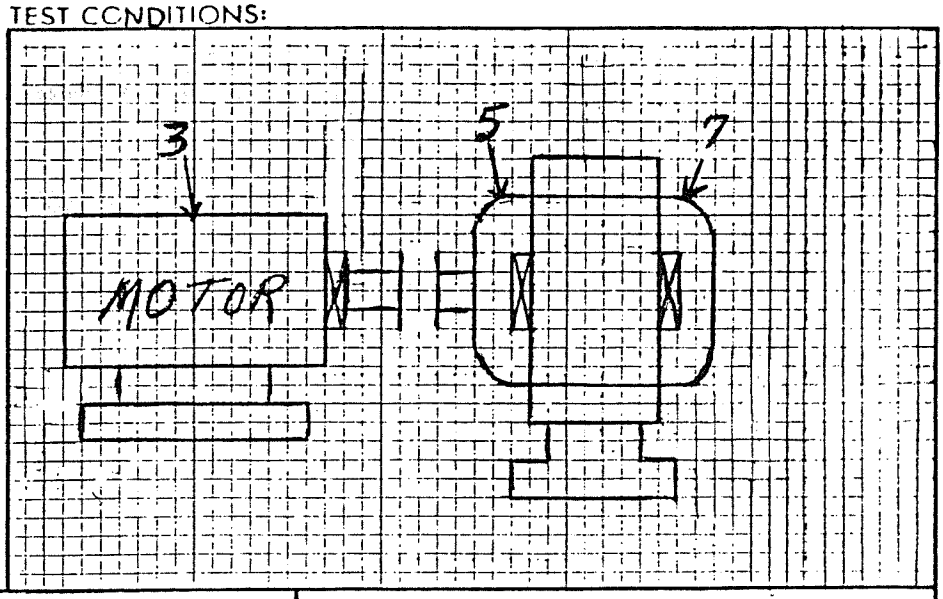
TEST CONDITIONS:

MECHANALYSIS EQUIPMENT USED:

IRD - MODEL 308

PERFORMED BY:

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊠ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING



PICKUP		FILTER OUT											
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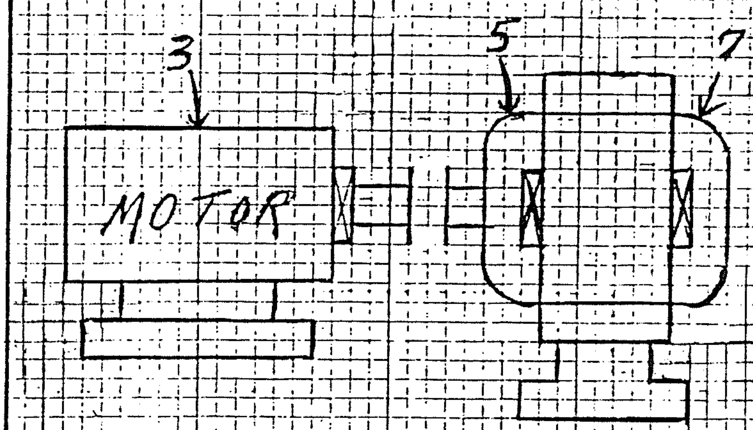
IRD MECHANALYSIS, INC. DATA SHEET DATE

☐ NOISE ☐ VIBRATION ANALYSIS OF: *BACKUP GENERATOR GLYCOL PUMP AND MOTOR* (3J

FOR: *STEPHENVILLE GAS TURBINE*

TEST CONDITIONS:



MECHANALYSIS EQUIPMENT USED:

IRD - MODEL 308

PERFORMED BY:

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊠ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

PICKUP		FILTER OUT											
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IRD MECHANALYSIS, INC. **DATA SHEET** DATE ____________

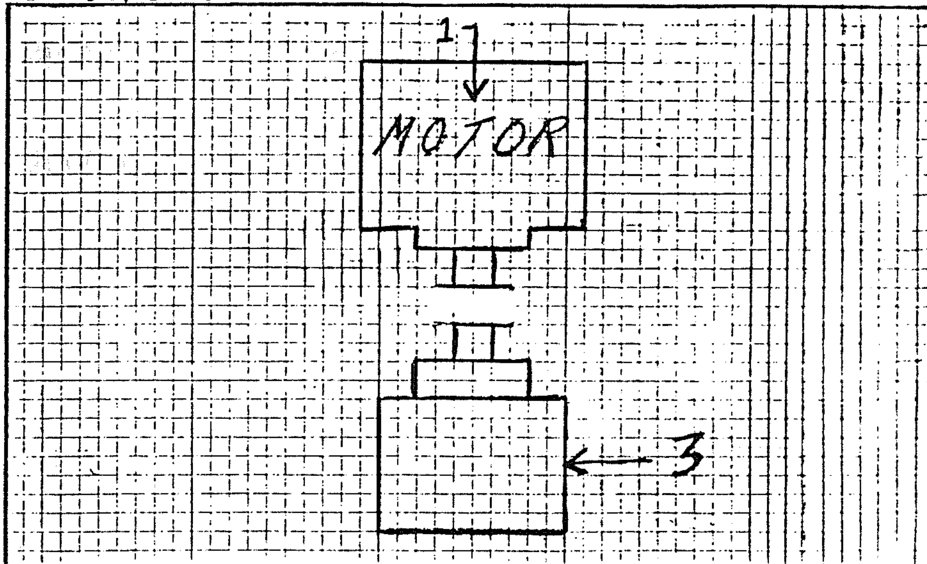
☐ NOISE ☐ VIBRATION ANALYSIS OF: *BACKUP LUBE OIL PUMP* *(4C)*

FOR: *STEPHENVILLE GAS TURBINE*

MECHANALYSIS EQUIPMENT USED: *IRD - MODEL 308*

PERFORMED BY: ____________

TEST CONDITIONS:



LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

PICKUP		FILTER OUT		DISPL.		VELOCITY							
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IRD MECHANALYSIS, INC. **DATA SHEET** DATE ____________

☐ NOISE ☐ VIBRATION

ANALYSIS OF: MLO HEAT EXCHANGER FAN NO. (5D)

FOR: STEPHENVILLE GAS TURBINE

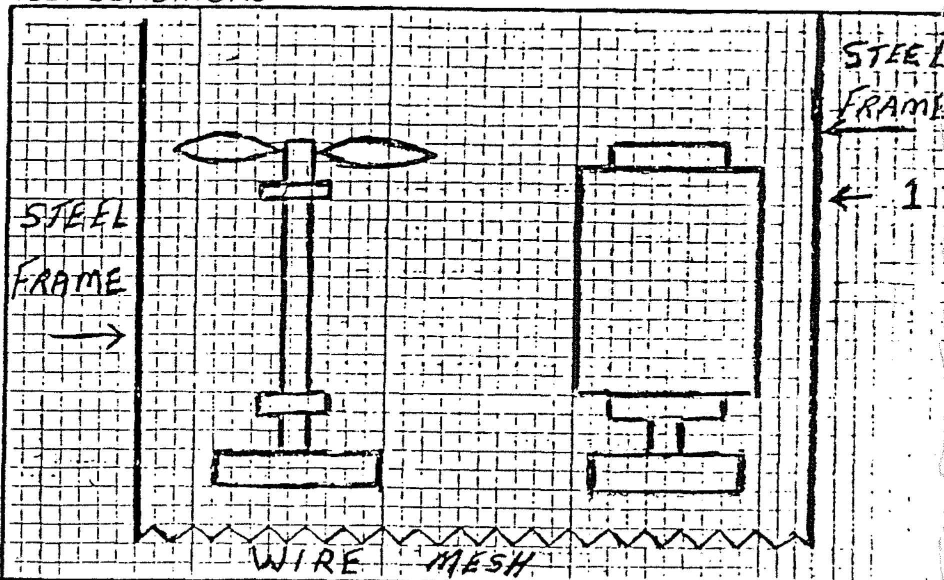
MECHANALYSIS EQUIPMENT USED:

IRD - MODEL 308

PERFORMED BY: ____________

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

TEST CONDITIONS:



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IRD MECHANALYSIS, INC. **DATA SHEET** DATE ____________

☐ NOISE ☐ VIBRATION ANALYSIS OF: *ALt.* HEAT EXCHANGER FAN NO. (5F)

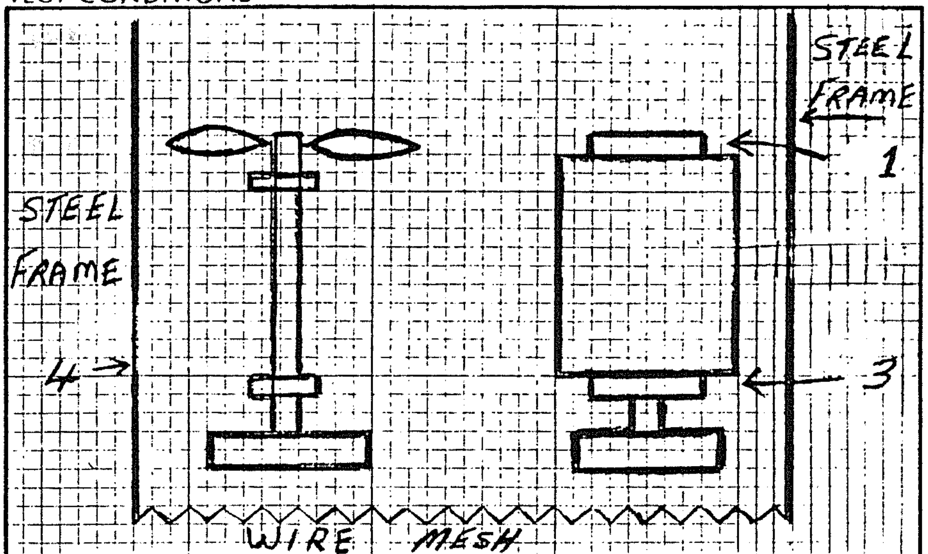
FOR: STEPHENVILLE GAS TURBINE

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY: ____________

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

TEST CONDITIONS:



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IRD MECHANALYSIS, INC.

DATA SHEET

DATE ____________________

☐ NOISE ☐ VIBRATION

ANALYSIS OF: ALt. HEAT EXCHANGER FAN NO. (5H)

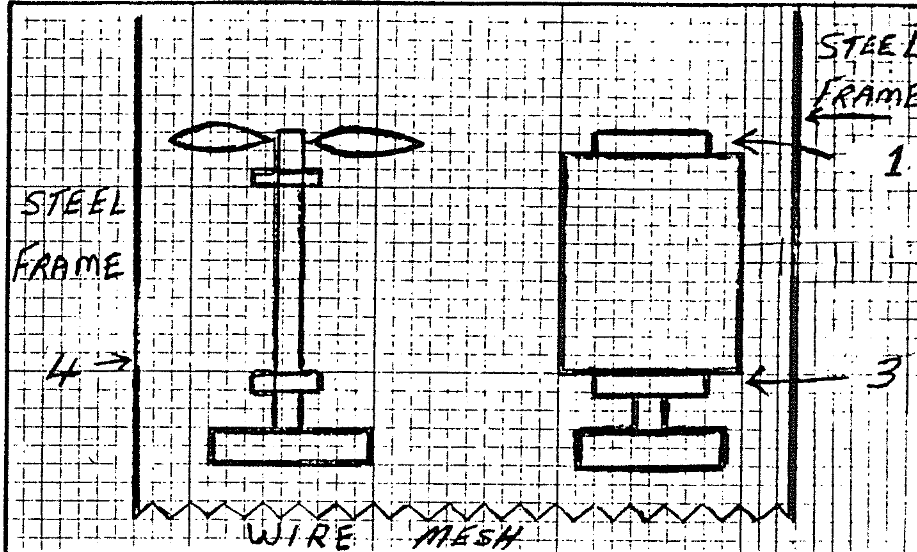
FOR: STEPHENVILLE GAS TURBINE

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY: ____________________

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

TEST CONDITIONS:



PICKUP		FILTER OUT											
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IRD MECHANALYSIS, INC. DATA SHEET DATE

☐ NOISE ☐ VIBRATION ANALYSIS OF: M&O GLYCOL PUMP (5J)

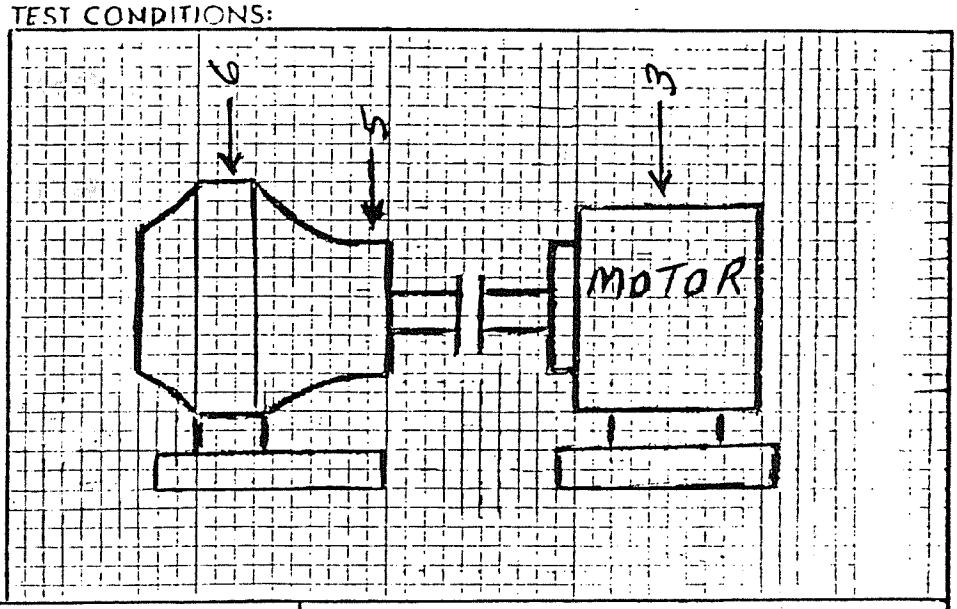
FOR: STEPHENVILLE GAS TURBINE

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY:

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

TEST CONDITIONS:



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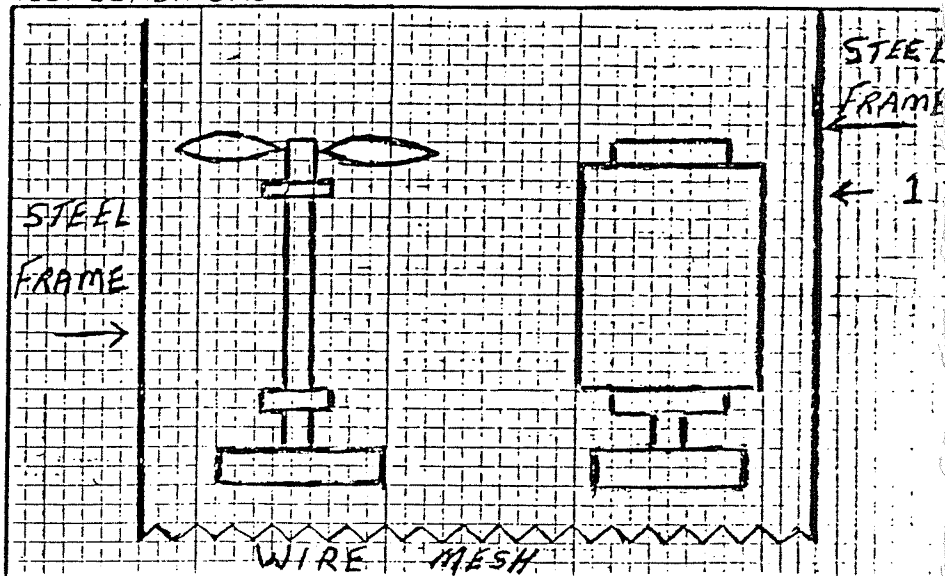
IRD MECHANALYSIS, INC. **DATA SHEET** DATE ______

☐ NOISE ☐ VIBRATION

ANALYSIS OF: MLO HEAT EXCHANGER FAN NO. (6A

FOR: STEPHENVILLE GAS TURBINE

TEST CONDITIONS:



MECHANALYSIS EQUIPMENT USED: IRD - MODEL 308

PERFORMED BY: ______

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

PICKUP		FILTER OUT											
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IRD MECHANALYSIS, INC. — DATA SHEET

DATE ______

☐ NOISE ☐ VIBRATION ANALYSIS OF: *MAIN FUEL FORWARDING PUMP* (6F)

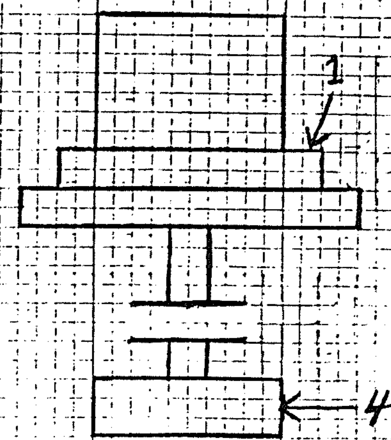
FOR: *STEPHENVILLE GAS TURBINE*

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY: ______

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

TEST CONDITIONS:



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IRD MECHANALYSIS, INC. **DATA SHEET** DATE ____________

☐ NOISE ☐ VIBRATION

ANALYSIS OF: *BACKUP FUEL FORWARDING PUMP* *(7F)*

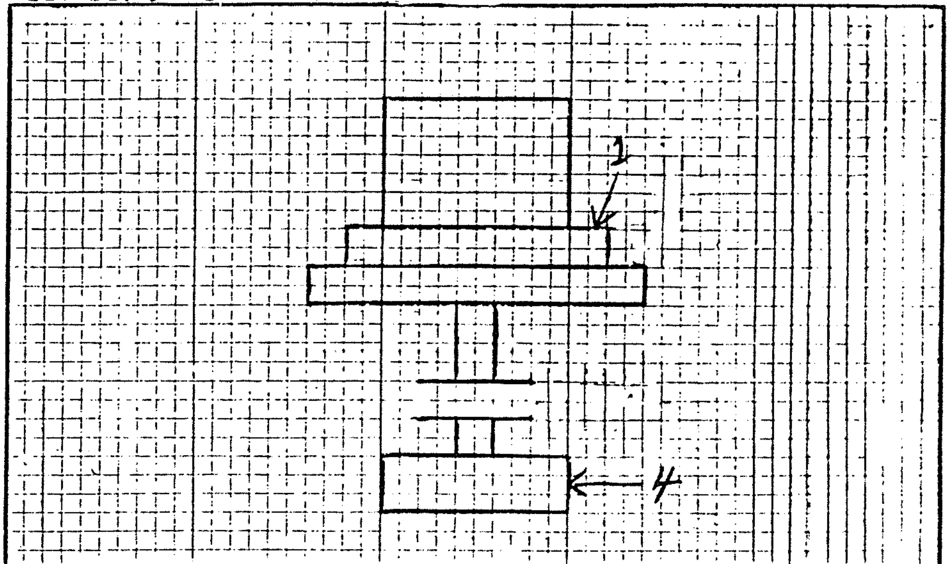
FOR: *STEPHENVILLE GAS TURBINE*

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY: ____________

LEGEND:
- → PICKUP POINT
- X PLAIN BEARING
- ⊗ ANTI-FRICTION BEARING
- ⊣⊢ COUPLING

TEST CONDITIONS:



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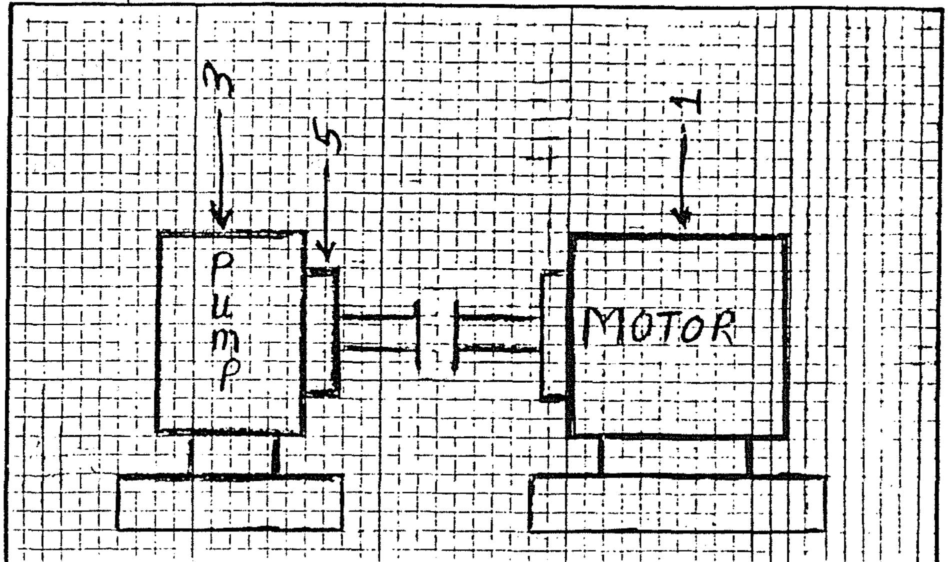
☐ NOISE ☐ VIBRATION ANALYSIS OF: *SUPPLEMENTARY FUEL PUMP, A UNIT* (9)

FOR: *STEPHENVILLE GAS TURBINE*

TEST CONDITIONS:



MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY:

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

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IRD MECHANALYSIS, INC. DATA SHEET DATE

☐ NOISE ☐ VIBRATION

ANALYSIS OF: *SUPPLEMENTARY FUEL PUMP, B UNIT* (10)

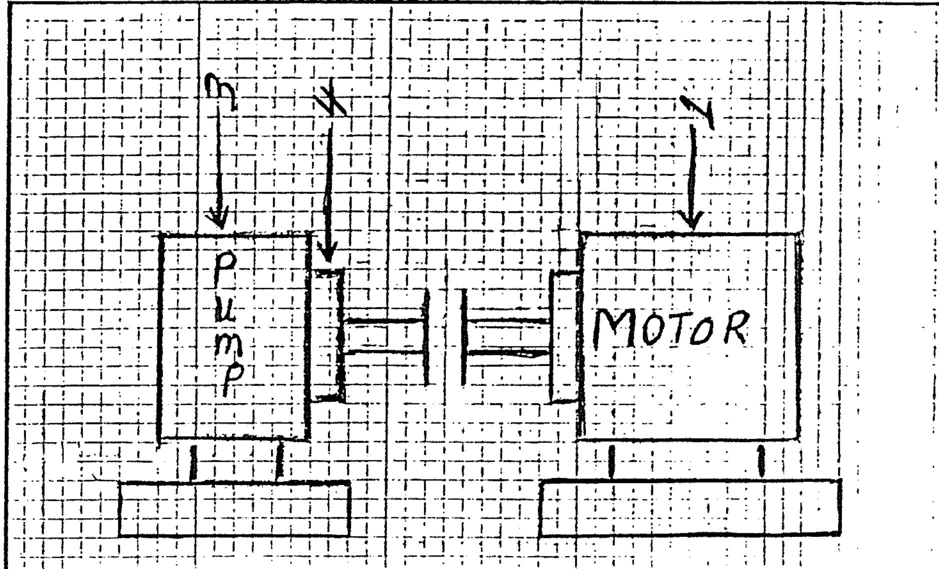
FOR: *STEPHENVILLE GAS TURBINE*

MECHANALYSIS EQUIPMENT USED:
IRD - MODEL 308

PERFORMED BY:

LEGEND:
→ PICKUP POINT
X PLAIN BEARING
⊗ ANTI-FRICTION BEARING
⊣⊢ COUPLING

TEST CONDITIONS:



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(File #106.83.11/4)
Rev. (94-12-15)

STEPHENVILLE GAS TURBINE
UNIT & ASSOCIATED EQUIPMENT MONTHLY INSPECTIONS

DATE: _____ INSPECTED BY: _____

UNIT A

Gas Generator A:

. Inspect combustion chamber outer casing general condition. Also inspect the engine to power turbine bellows for dents, distortion, hot spots, etc.
Remarks: _____

2. Check lube oil tank level using the dipstick level indicator. Top up as required.
Remarks: _____

. Check that drainage hole is clear and free. Check level of exterior sump and check level switch operation. Reset alarm in the control room.
Remarks: _____

Power Turbine A:

1. Inspect Exhaust volute general conditions, mount supports, insulation blankets, stator case bolts, etc.
Remarks: _____

. Inspect thrust bearing supports for oil seepage at cover surfaces, etc.
Remarks: _____

Exhaust Stack A:

.. Check the Snow Door phuomatic system for leaks, etc.
Remarks: _____

.. Inspect the condition of the snow door accessory equipment. (Air Cylinders, Door Stops, Flex Hoses & Lines, etc.)
Remarks: _____

3. Grease and Oil all moving snow door parts. (Cylinder rams, bearing sleeves, limit switches, etc.)
   Remarks: _____

Inlet Plenum A:

1. Check condition of filters and filter boxes.
   Remarks: _____

2. Check the plenum building for leaks, damage, rust, loose paint, etc. Also check ladders for security.
   Remarks: _____

UNIT B

Gas Generator B:

1. Inspect combustion chamber outer casing general condition. Also inspect the engine to power turbine bellows for dents, distortion, hot spots, etc.
   Remarks: _____

2. Check lube oil tank level using the dipstick level indicator. Top up as required.
   Remarks: _____

3. Check that drainage hole is clear and free.
   Remarks: _____

Power Turbine B:

1. Inspect exhaust volute general conditions, mount supports and insulation blankets, stator case bolts, etc.
   Remarks: _____

2. Inspect thrust bearing supports for oil seepage at cover surfaces, etc.
   Remarks: _____

xhaust Stack B:

. Check the snow door phuomatic system for leaks, etc.
Remarks: _____

. Inspect the condition of the snow door accessory equipment. (Air Cylinders, Door Stops, Flex Hoses & Lines, etc.)
Remarks: _____

3. Grease and Oil all moving snow door parts. (Cylinder rams, bearing sleeves, limit switches, etc.)
Remarks: _____

ınlet Plenum B:

. Check condition of filters and filter boxes.
Remarks: _____

2. Check the plenum building for leaks, damage, rust, loose paint, etc. Also check ladders for security.
Remarks: _____

MAIN LUBE OIL SYSTEM

Evacuator:

1. Check for oil leaks around evacuator. Check bolt tightness on evacuator and motor.
Remarks: _____

Demister:

. Check hose, hose connection & drain line for leaks. Check bolt tightness, etc.
Remarks: _____

Main Oil Tanks:

1. Check oil levels and add as required.
   Remarks: _____

2. Check the general condition of the main lube oil filter chamber. Check pressure across filters.
   Remarks: _____

Jacking Pumps:

1. Check pump and fittings for leaks.
   Remarks: _____

GLYCOL SYSTEMS

Main Lube Oil Glycol System:

1. Oil and grease all manual valves, flow control valve, etc.
   Remarks: _____

2. Inspect piping insulation and check for excessive corrosion on pipes, cooling towers, etc.
   Remarks: _____

3. Check the flow control valve thermostat element is secure and tubing is unkinked.
   Remarks: _____

Alternator Glycol System:

1. Oil and grease all manual valves, flow control valve, butterfly valves, etc.
   Remarks: _____

2. Inspect piping insulation and check for excessive corrosion on pipes, cooling towers, etc.
   Remarks: _____

3. Check the flow control valve thermostatic element is secure and tubing is unkinked.
   Remarks: _____

FUEL SYSTEM

ank Farm:

. Check the level of water in tank farm and drain off if required.
Remarks: _____

. Check condition of tank farm liners (cracks, cuts, etc.) and repair as required.
Remarks: _____

ump House:

. Check the filter vessels, heater vessels, etc. for fuel leaks.
Note: Fuel temperature and pressure.
Remarks: _____

HAYLON FIRE SYSTEM VISUAL INSPECTION

nit A:

1. Serial #F30 - 1913 Pressure = _____
2. Serial #F30 - 1950 Pressure = _____

nit B:

1. Serial #F30 - 1253 Pressure = _____
2. Serial #F30 - 1529 Pressure = _____

xciter Module:

1. Serial #F30 - 1784 Pressure = _____

Pumphouse:

1. Serial #140 - 955 Pressure = _____
2. Serial #140 - 2306 Pressure = _____

HYDRO

File #106.83.11/3

STEPHENVILLE GAS TURBINE
UNIT & ASSOCIATED EQUIPMENT DAILY INSPECTIONS

DATE: _____ *INSPECTED BY:* _____

NOTE: The following areas and associated items must be visually inspected each day:

A & B MODULES:

Gas Generator:

__ *Fuel leaks*
__ *Oil leaks*
__ *Air leaks*
__ *Snow door pneumatic systems*
__ *GG oil level*
__ *Electrical connections*
__ *Drain sump*
__ *Halon fire systems*

Power Turbine:

__ *Bellows*
__ *Thermocouples*
__ *Volute area*
__ *Clutch box*
__ *Bearing supports*
__ *Blankets*
__ *Stack*
__ *Oil leaks*

ALTERNATOR & EXCITER MODULES:

__ *Pressure switches & gauges*
__ *MLO systems*
__ *Pumps*
__ *Jacking pumps*
__ *Exciter area*
__ *Clutch box*
__ *Demister*
__ *Evacuator*
__ *Halon fire systems*
__ *Oil leaks*

SWITCH GEAR & BUS DUCTS:

__ *Exterior condition*
__ *Weatherproof (leaks)*
__ *Air circulation (condensation)*
__ *Heaters working*
__ *H.V. arcing*
__ *S.S. transformer temperature*

COOLING SYSTEMS:

__ *Glycol leaks*
__ *Fans*
__ *Glycol temperature*
__ *Belts*
__ *Guards*
__ *Regulators*

PUMPHOUSE:

__ *Fuel leaks*
__ *Pumps*
__ *Building condition*
__ *Halon fire system*
__ *Valves*
__ *Filter assemblies*
__ *Security system*
__ *Fuel pressures & temperatures*

TANK FARM:

__ *Fuel leaks*
__ *Liners*
__ *Sump level*
__ *Water level (drain off)*
__ *Tank levels*

CONTROL BUILDING:

Unit Control Room:

__ *Indicating lights*
__ *Data logger (check data)*
__ *Battery chargers*
__ *Inverter*
__ *Recorders*
__ *Alarms*
__ *AVR*
__ *Air conditioners*

Main Control Room:

__ *Fuel tank levels*
__ *405L export kwh meter*
__ *Building water supply*
__ *Building general condition*

Compressor Room:

__ *Air leaks*
__ *Oil leaks*
__ *Water trap*
__ *Indicating lights*
__ *Air dryer (purge pressure)*
__ *Air receivers*

Note: This form must be dropped off at the Stephenville Gas Turbine supervisor's office.

Revision Date: 95-08-16

STEPHENVILLE GAS TURBINE
P.M. PROGRAM
MAXIMO DRIVEN

EQUIPMENT I.D. #	WORK ORDER JOB DESCRIPTION	W.O GO TO	PRESENT HOURS	FREQUENCY
802-03-00	Complete IRD Annual Analysis.	Terms. Supv.	N/A	Jan. 1st, each year
802-03-00	Complete Motor Load & Sound Level Maintenance.	Terms. Supv.	N/A	Jan. 1st each year
803-04	Complete Halon Fire System Inspection.	SGT Supv.	N/A	April 1st each year
801	Complete Unit & Ass. Equipment Annual Inspection.	SGT Supv.	N/A	May 1st each year
801-07-01	Doble Test the Alternator (G1).	P & C Supv.	N/A	2000-05-01 + every 3 years after.
802-05-00	Doble Test the 13.8 kv Bus & Ass. Equipment.	P & C Supv.	N/A	2000-05-01 + every 3 years after.
802-05-01	Doble Test Breaker (G1T1).	P & C Supv.	N/A	2000-05-01 + every 3 years after.
802-05-01	Complete Breaker (G1T1) Regular Maintenance.	SGT Supv.	N/A	2000-05-01 + every 3 years after.
801-10-01	Complete GGA Hot Section Inspection.	SGT Supv.	1154	2025, 4025, 6025, 8025
801-11-01	Complete GGB Hot Section Inspection.	SGT Supv.	2030	4000, 6000, 8000, 10,000
801-01	Complete GG Oil Analysis.	SGT Supv.	N/A	98-06-01 + every 3 years after.
801-02	Complete GG Oil Analysis.	SGT Supv.	N/A	98-06-01 + every 3 years after.
801-12	Complete Main Lube Oil Analysis.	SGT Supv.	N/A	98-06-01 + every 3 years after.

EQUIPMENT I.D. #	*WORK ORDER JOB DESCRIPTION*	*W.O. GO TO*	*PRESENT HOURS*	*FREQUENCY*
801-08-05	*Replace A Inlet Air Filters.*	*SGT Supv.*	*N/A*	*2000-05-01 + every 5 years after.*
801-09-05	*Replace B Inlet Air Filters.*	*SGT Supv.*	*N/A*	*2000-05-01 + everty 5 years after.*
801-12-12	*Replace Main Lube Oil & Actuator Filter.*	*SGT Supv.*	*N/A*	*2000-05-01 + every 5 years after.*
803-02-10	*Replace Fuel Oil Coaleser Filters.*	*SGT Supv.*	*N/A*	*2001-05-01 + every 5 years after.*
803-02-11	*Replace Fuel Oil Pre-Filters.*	*SGT Supv.*	*N/A*	*2001-05-01 + every 5 years after.*
802-04-01	*A Governor Over Speed & Over Temperature Test.*	*P & C Supv.*	*N/A*	*1998-05-01 + every 3 years after.*
802-04-02	*B Governor Over Speed & Over Temperature Test.*	*P & C Supv.*	*N/A*	*1998-05-01 + every 3 years after.*
802-04-00	*IRD Vibration Monitor Input Test.*	*P & C Supv.*	*N/A*	*1997-05-01 + every 3 years after.*
802-04-00	*Multipoint Recorder/Logger Alarm & Trip Test.*	*P & C Supv.*	*N/A*	*1997-05-01 + every 3 years after.*
802-04-00	*AVR Setting Test.*	*P & C Supv.*	*N/A*	*1998-05-01 + every 3 years after.*

(File #106.83.11/1)
(REVISED 93-09-28)

STEPHENVILLE GENERATING STATION
PREVENTATIVE MAINTENANCE SCHEDULE

YEAR 1998

COMPLETED ( )

EQUIPMENT	JAN.	FEB.	MAR.	APR	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	REMARKS
MONTHLY INSPECTIONS:													
1. Unit & Ass. Equip.	✓	✓	✓	✓	✓	✓	✓	✓					
2. Battery Banks	✓	✓	✓	✓		✓	✓		✓				
3. Compressed Air System	✓		✓	✓			✓	✓					
4. Switchgear	✓	✓	✓	✓		✓	✓		✓				
ANNUAL INSPECTIONS:													
1. Unit & Ass. Equip.													
2. Battery Banks													
3. Compressed Air System			✓										
4. IRD Analysis Readings													
5. Halon Fire Systems													
6. Motor Load & Sound Levels.													

SGT Switchgear Inspection Report

Date: _____ Inspected By: _____

Switchgear and Associated Bus Ducts

RECORD	VISUAL INSPECTION
Switchgear Heater Amps A: ____ B: ____ C: ____	Bldg. Exterior Condition _____
Bus Duct Heater Amps: _____	Weatherproof (leaks) _____
Station Service Tfr Temp. _____	Signs Of Arching _____
	Condensation _____

REMARKS _____

Breaker G1T1

RECORD	VISUAL INSPECTION
Counter Operations _____	Housing Condition _____
	Secondary Connnections _____
	Signs Of Arching _____
	Condensation _____

REMARKS _____

NOTE: THIS REPORT MUST BE DROPPED OFF AT THE SGT SUPERVISORS OFFICE.

COMPRESSOR/DRYER/AIR SYSTEM FORM 1

DATE: _____ INSP. BY: _____ STATION: _____

INSPECTION _____

ASE OIL _____

GUARDS/COUPLERS _____

OIL SEALS/LEAKS _____

ELIEF VALVES _____

PRESSURE GAUGES _____

NLOADER
OPERATING & CLEAN #1___ #2___

HECK VALVES _____

FLEX CONNECTIONS _____

IBRATIONS _____

AIR/FLUID LEAKS_____

FLOW SWITCH OPERATION _____

)RYER HEATER _____

THERMOSTATS _____

)ONTROLS,
COMPRESSOR/DRYER _____

FILTERS _____

BLOWERS: OIL LEVEL/BELTS ____

RECIEVERS/DISCHARGE
MOISTURE _____

)EW POINT TEST,RECORD _____

COMP./DRYER FUNCTION TEST ___

SYSTEM KPA HP _____ LP _____

PURGE PRESSURE _____

AMBIENT TEMP. _____

)RIVE BELT TENSION _____

COMPRESSOR NO: ____ COUNTER: _____

BASE OIL LEVEL NORMAL___ OIL ADDED___

MOTOR AMPS: _____

OPERATING POSITION LEAD _____ LAG _____

REMARKS: _____

_____

COMPRESSOR NO: ____ COUNTER: _____

BASE OIL LEVEL NORMAL___ OIL ADDED___

MOTOR AMPS: _____

OPERATING POSITION LEAD _____ LAG _____

REMARKS: _____

_____

DRYER NO:_____ COUNTER: _____

BLOWER MTR AMPS _____

HEATER AMPS: A_____ B_____ C_____

DRYER DUMP VALVES OPERATIONAL Y/N _____

CIRCUIT BREAKER: COMPRESSOR #

BASE OIL LEVEL: NORMAL _____ OIL ADDED _____

UNLOADER CLEANED _____

MOTOR AMPS _____ COUNTER _____

OPERATING KPA CUT IN _____ CUT OUT _____

CHECK DRIVE BELT _____

CHECK HEATER NEAR COMPRESSOR _____

*NOTE: ANY FORM FOR SGT GIVE TO SGT SUPERVISOR.

HYDRO

TRO WESTERN REGION
STANDARD TASK PROCEDURE/PRACTICE

Complete Unit & Associated Equipment Annual Inspections (STP #7).
TASK

S'Ville Gas Turbine — *DEPARTMENT*

Mechanic — *OCCUPATION*

TASK PURPOSE AND IMPORTANCE

The purpose of this procedure is to complete annual inspection on the unit and associated equipment as safely as possible and prevent employee accidents and equipment damage.

The major steps are outlined in their proper order. Follow each job step. All steps and key points must be followed in sequence to achieve maximum efficiency and avoid loss.

TOOLS & EQUIPMENT

- *Extension Light*
- *Extension Cord (three prong)*
- *Test Mirror*
- *Gas generator lubricating oil (Imperial #2380)*
- *Rags*
- *Can lubricating oil and dow grease*
- *Digital thermometer*
- *250ml measuring cup*
- *Dial indicator and associated mounting hardware*
- *Grease gun and bearing grease*
- *Safety Goggles*
- *Rubber Gloves*
- *Mask (Respirator)*
- *Coveralls/Apron*

SAFETY SUMMARY:

- *Contact the Local Controlling Authority & establish work protection.*
- *Ensure that the control switch 43S-GT is turned off and tagged.*
  NOTE: Extra isolation may be required in certain segments of this procedure. Use of red tag work protection may be employed again.
- *Refer to STP #2 for the gas generator compressor washes.*
- *Ensure that all PPE is worn. Note: Goggles, gloves, mask, & coveralls must be worn when handling Clenvex Ice.*

UNIT A

Gas Generator A:

1. *Inspect the five chip detectors for metallic deposits (refer to C.W. Manual, Volume III, 7.2.1.2/14).*
   Remarks: _____

2. *Check for cracks in nose bullet.*
   Remarks: _____

3. *Clean entry guide vanes and inspect with extension light and mirror. If indication of cracks, investigate using dye penetrant procedure. Also, inspect the first stage compressor shrouded stators (refer to C.W. Manual, Volume III, 7.2.1.2/1 to 3).*
   Remarks: _____

4. *Drain and refill the air starter with 150 cc of clean gas generator lubricating oil.*
   Remarks: _____

5. *Inspect the ignition unit and igniter plugs. Check for security of connections and physical damage.*
   Remarks: _____

   Check all fuel, oil and air lines for condition and security of connections.
   Remarks: _____

7. *Inspect and lubricate the fuel pressure regulator (LF-4) shaft and check for leaks.*
   Remarks: _____

8. *Inspect liquid fuel valve and actuator for loose bolts, oil leaks, wear, binding and security of mounting.*
   Remarks: _____

9. *Remove the air system strainer screen (ST-CA-1). Inspect and clean. Also, check the air regulating system components for leaks, cleanliness, etc.*
   Remarks: _____

10. *Check all junction boxes for security of terminals, tidiness, overheading, etc.*
    Remarks: _____

11. *Check the security of the supplementary fuel pump/motor assembly. Check the supplementary fuel filter indicator. Clean the filter as required.*
    Remarks: _____

12. *Grease and oil the fuel fire valve plunger rod to assure freedom of operation.*
    Remarks: _____

13. *Compressor wash the jet engine (refer to Mechanic Standard Task Procedure #2).*

er Turbine A:

1. *Check security of thermocouple terminations, etc.*
   Remarks: _____

2. *Inspect the power turbine cover blankets for general condition.*
   Remarks: _____

3. *Check the vibration detectors security of pickup and connections.*
   Remarks: _____

4. *Inspect front and rear bearing supports for oil seepage at covers. Also, check all hold down bolts, etc.*
   Remarks: _____

5. *Inspect exhaust volute general conditions, mount supports, and load reference indication (refer to C.W. Operation and Maintenance Manual, Section 2.2.2.2.)*
   Remarks: _____

6. *Inspect the inside of power turbine volute for falling objects, cracks, etc. (refer to C.W. Manual, 7.2.11).*
   Remarks: _____

7. *Check the exhaust stack inside wall panels for security of insulation, plates, etc.*
   Remarks: _____

8. *Check the snow door cylinders for ease of operation, grease and oil as required. Also, check operation of limit switches, wiring, etc.*
   Remarks: _____

9. *Check the clutch box base hold down bolts. Also, inspect the grounding brush.*
   Remarks: _____

Inlet Plenum A:

1. *Check condition of bird screens, plenum floor, walls, etc.*
   Remarks: _____

2. *Inspect and check operation of blow-in-doors for freedom of movement and operation of alarm limit switches.*
   Remarks: _____

3. *Check the inlet silencer baffles for cracks and security of support blankets.*
   Remarks: _____

Check the inlet compartment for loose objects and foreign material and the outside doors are sealed with no leaks.
Remarks: _____

5. *Check the inlet temperature thermocouple reading on data logger with digital thermometer held next to the thermocouple probe.*
Remarks: _____

UNIT B

Gas Generator B:

1. *Inspect the five chip detectors for metallic deposits (refer to C.W. Manual, Volume III, 7.2.1.2/14).*
Remarks: _____

2. *Check for cracks in nose bullet.*
Remarks: _____

3. *Clean entry guide vanes and inspect with extension light and mirror. If indication of cracks, investigate using dye penetrant procedure. Also, inspect the first stage compressor shrouded stators (refer to C.W. Manual, Volume III, 7.2.1.2/1 to 3).*
Remarks: _____

4. *Drain and refill the air starter with 150 cc of clean gas generator lubricating oil.*
Remarks: _____

5. *Inspect the ignition unit and igniter plugs. Check for security of connections and physical damage.*
Remarks: _____

6. *Check all fuel, oil and air lines for condition and security of connections.*
Remarks: _____

7. *Inspect and lubricate the fuel pressure regulator (LF-4) shaft and check for leaks.*
Remarks: _____

8. *Inspect fuel valve and actuator for loose bolts, oil leaks, wear, binding and security of mounting.*
Remarks: _____

9. *Remove the air system strainer screen (ST-CA-1). Inspect and clean. Also, check the air regulating system components for leaks, cleanliness, etc.*
Remarks: _____

Check all junction boxes for security of terminals, tidiness, overheading, etc.
Remarks: _____

Check the security of the supplementary fuel pump/motor assembly. Check the supplementary fuel filter indicator. Clean the filter as required.
Remarks: _____

12. *Grease and oil the fuel fire valve plunger rod to assure freedom of operation. Check valve operation and note alarm on annunciator in building.*
Remarks: _____

13. *Compressor wash the jet engine. (Refer to Mechanics Standard Task Procedure #2.)*
Remarks: _____

Power Turbine B:

1. *Check security of thermocouple terminations, etc.*
Remarks: _____

2. *Inspect the power turbine cover blankets for general condition.*
Remarks: _____

3. *Check the vibration detectors security of pickup and connections.*
Remarks: _____

Inspect front and rear bearing supports for oil seepage at covers. Also, check all hold down bolts, etc.
Remarks: _____

5. *Inspect exhaust volute general conditions, mount supports and load reference indication (refer to C.W. Operation and Maintenance Manual, Section 2.2.2.2.)*
Remarks: _____

6. *Inspect the inside of power turbine volute for falling objects, cracks, etc.*
Remarks: _____

7. *Check the exhaust stack inside wall panels for security of insulation, plates, etc.*
Remarks: _____

8. *Check the snow door cylinders for ease of operation, grease and oil as required. Also, check operation of limit switches, wiring, etc.*
Remarks: _____

9. *Check the clutch box base hold down bolts. Also, inspect the grounding brush.*
Remarks: _____

Inlet Plenum B:

Check condition of bird screens plenum floors, walls, etc.
Remarks: _____

Inspect and check operation of blow-in-doors for freedom of movement and operation of alarm limit switches.
Remarks: _____

3. *Check the inlet silencer baffles for cracks and security of support blankets.*
Remarks: _____

4. *Check the inlet compartment for loose objects and foreign material and the outside doors are sealed with no leaks.*
Remarks: _____

5. *Check the inlet temperature thermocouple reading on data logger with digital thermometer held next to the thermocouple probe.*
Remarks: _____

FUEL SYSTEM

Tank Farm:

1. *Check the level of fluid in sump tank and pump out if required. Check integrity of pump structure.*
Remarks: _____

2. *Check the three fuel tank drain valves for water and dirt contaminants.*
Remarks: _____

3. *Grease all fuel valve stems and associated equipment.*
Remarks: _____

4. *Check tank ladders for security, etc.*
Remarks: _____

5. *Check the tank walls, roof and associated piping for excessive rust, etc.*
Remarks: _____

Pump House:

1. *Grease all motorized valve stems are required. Also, grease all associated fuel valve stems in pump house.*
Remarks: _____

2. *Clean or replace fuel strainer elements as required.*
Remarks: _____

MAIN LUBE OIL SYSTEM

Demister:

1. *Inspect mounting hardware. Check for oil leaks, vibration, etc.*
   Remarks: _____

Vent Fan - Motor Assembly:

1. *Check mounting bolts, fan, fan coupling, etc.*
   Remarks: _____

Jacking Pump:

1. *Check pump and fittings for leaks. Check hold down bolts and grease motor bearings. Also, check operation pressures and shaft lift with a dial indicator. (Note: The following motors must be on prior to performing this test - Evacuator, Demister, MLO pump & Jacking Pump A or B.)*
   Remarks: _____

Main Oil Pumps:

1. *Grease motor bearings as required. Check for oil leaks and general condition.*
   Remarks: _____

Main Oil Tanks:

1. *Drain condensation from main tanks. (Use drain at the bottom rear side of large tank.)*
   Remarks: _____

GLYCOL SYSTEMS

Main Lube Oil Glycol System:

1. *Check the cooling fans pitch angle settings and general condition of fan blades.*
   Remarks: _____

2. *Check tightness and condition of fan belts.*
   Remarks: _____

3. *Check expansion tank glycol level. Make note of tank level. Check low level alarm switch.*
   Remarks: _____

Drain off some glycol and check contamination control in strainer # ST-GA-1.
Remarks: _____

5. *Grease motor bearings as required. Check for glycol leaks and general condition.*
Remarks: _____

Alternator Glycol Systems:

1. *Check the cooling fan pitch angle settings and general condition of fan blades.*
Remarks: _____

2. *Check tightness and condition of fan belts.*
Remarks: _____

3. *Check expansion tank glycol level. Make note of tank level. Check low level alarm switch condition.*
Remarks: _____

4. *Drain off some glycol and check contamination content in Strainer No. ST-GA-1.*
Remarks: _____

5. *Check the heat exchanger cooling tubes and vanes for leaks, rust, etc. (HE-GA-1/2/3).*
Remarks: _____

6. *Check the operation of three-way thermostat #GA-9. (Oil all moving parts.)*
Remarks: _____

7. *Grease motor bearings as required. Check for glycol leaks and general condition.*
Remarks: _____

- *Contact the Local Controlling Authority and surrender the work protection. Ensure that the control switch 43S-GT is returned to the original position and tag removed.*

STANDARD TASK PROCEDURE

I have received this Standard Job Procedure and the importance of following it has been stressed.

RECEIVED BY: _____

_____ _____

DATE *SUPERVISOR*

HYDRO

STP #2

STANDARD TASK PROCEDURE

Compressor Wash - Jet Engine
TASK

Stephenville Gas Turbine — *DEPARTMENT*

Mechanic — *OCCUPATION*

TASK PURPOSE AND IMPORTANCE

The purpose of this procedure is to prevent damage to equipment and ensure safety of employees.

The major steps are outlined in their proper order. Follow each job step. All steps and key points must be followed in sequence to achieve maximum efficiency and avoid losses.

TOOLS AND EQUIPMENT

- *Gas generator liquid wash rig.*
- *Water hose.*
- *20 litres (5 gallons) Castrol Cleavex #1CD177 (premixed).*
- *Tap water.*
- *PC10A work protection tags.*

SAFETY SUMMARY

- *Obtain permit from local controlling authority prior to starting this task (red tag permit).*
- *Wear goggles or safety glasses and rubber (P.V.C.) gloves while handling the cleaning solution.*
- *Refer to attached drawing (Figure #1).*

PROCEDURE STEPS

1. *Isolate the gas generator you are going to wash by putting the "Unit Ready Switch" in the proper position (A or B not ready). Obtain Red Tag Permit from the local controlling authority.*

2. *Position the liquid wash rig and ensure both tank drain valves are off.*

3. *Pour 23 litres (5 gallons) premix castrol cleavex solution into the detergent tank. (Wear goggles and rubber gloves).*

4. *Fill the rinse tank with tap water.*

HYDRO

5. *Place the end of the discharge hose into the detergent tank and open the detergent tank drain valve.*

6. *Plug the centrifugal pump cord into a 115 volt A.C. outlet.*

7. *Start up pump and regulate the delivery pressure to 16 PSI via needle valve.*

8. *Shut down the pump and connect the discharge hose to the fitting on the side of the gas generator module.*

9. *Using the gas generator starter switch (143ST or 243ST) in the sequencer, run the starter at low then high. Allow for speed stabilization (about 30 seconds), immediately after the starter is cut inject the 20 litres of cleaning solution maintaining 16 PSI (approximately two minutes).*

10. *Leave the gas generator to soak for 30 minutes.*

11. *Close the drain valve on the detergent tank and open the rinse tank valve.*

12. *Run the gas generator starter again for 30 seconds and after the starter is cut inject water for two minutes at 16 PSI.*

13. *Allow the gas generator to drain for ten minutes.*

14. *Remove the discharge hose from module and replace plug.*

15. *Dry the gas generator through a purge cycle.*

16. *Thoroughly rinse the detergent tank with clear water and empty prior to storing (also empty the rinse tank).*

17. *Restore the "Unit Ready Switch" to its original position. Remove tags and notify the local controlling authority.*

STANDARD TASK PROCEDURE

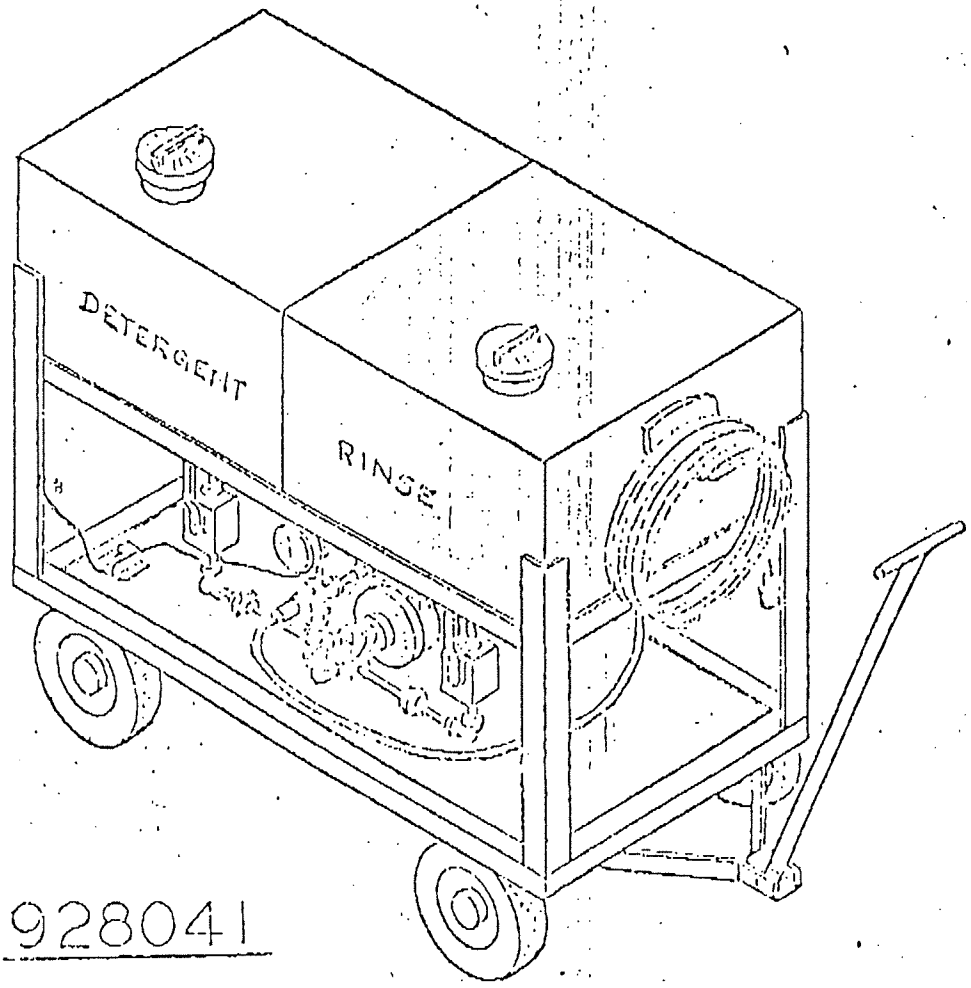
have received this Standard Job Procedure/Practice and the importance of following it has been stressed.

RECEIVED BY: _____

_____ _____

DATE *SUPERVISOR*

HYDRO



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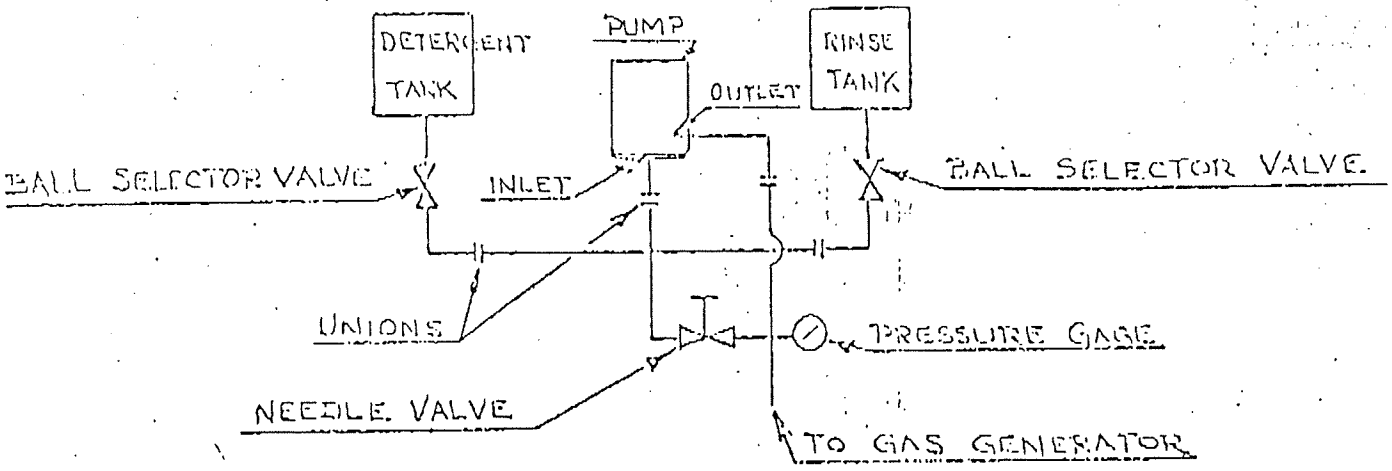

PLUMBING SCHEMATIC
LIQUID WASH - GAS GENERATOR COMPRESSOR
CLEANING RIG

FIGURE NO. 1

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Fuel Off-Loading Module**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Building, Concrete Foundations
Reliability History	Excellent
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	Waste Oil Tank was removed in 1997. Dyke around tanker connection points was raised to meet containment requirements.
Condition	Good
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Fuel Forwarding Module**	
Prepared by:	G. Lundrigan
Date:	98-11-17
Description	Metal Building, Concrete Foundations
Reliability History	Excellent
Maintenance Requirements	Routine Painting
Major Repair/Upgrade History	N/A
Condition	Excellent
Spare Parts Availability	N/A
Comments	-
Minimum Life Expectancy	30 Years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: A End Module**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Inlet air filter, gas generator, power turbine, clutch, auxiliaries
Reliability History	Fair to good. Problems with cracking of power turbine casing in early years. Cured by installing new casings of modified design Problems associated with control system have been eliminated by installation of new control system this year.
Maintenance Requirements	Regularly scheduled maintenance and inspections by Hydro and manufacturers personnel
Major Repair/Upgrade History	New power turbine casings installed 1988 New control system installed 1998 New air filtration installed in 1998 GG/PT expansion joint modified
Condition	Good
Spare Parts Availability	Good. Original manufacturer no longer in business but after market manufacturers provide spare parts and service.
Comments	Units accumulate very few operating hours annually. Slight lack of power to be investigated 1998/99
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: B End Module**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Inlet air filter, gas generator, power turbine, clutch, auxiliaries
Reliability History	Fair to good. Problems with cracking of power turbine casing in early years. Cured by installing new casings of modified design Problems associated with control system have been eliminated by installation of new control system this year.
Maintenance Requirements	Regularly scheduled maintenance and inspections by Hydro and manufacturers personnel
Major Repair/Upgrade History	New power turbine casings installed 1988 New control system installed 1998 GG/PT expansion joint modified New air filtration system will be installed in 1999
Condition	Good
Spare Parts Availability	Good. Original manufacturer no longer in business but after market manufacturers provide spare parts and service.
Comments	Units accumulate very few operating hours annually.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Compressed Air**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Air compressors, receivers, valves, controls
Reliability History	Good
Maintenance Requirements	Routine maintenance all components
Major Repair/Upgrade History	None
Condition	Good, but compressors are beginning to show signs of age. Will be replaced within 5 years
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Emergency Diesel**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Emergency diesel generator
Reliability History	Good
Maintenance Requirements	Routine maintenance
Major Repair/Upgrade History	Diesel was added to plant in 1985
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Fire Protection Equipment**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Halon fire suppression system
Reliability History	Good, although there have been several false discharges
Maintenance Requirements	Periodic inspection and testing by technicians
Major Repair/Upgrade History	None
Condition	Good
Spare Parts Availability	Good. Replacement Halon gas is becoming scarce and expensive
Comments	System will be replaced within 5 years to eliminate Halon gas
Minimum Life Expectancy	5 years, 30 years with replacement of Halon

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Fuel System**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Off loading pump and filter, storage, forwarding pumps, filter, heater, piping, valves
Reliability History	Good
Maintenance Requirements	Routine maintenance all components
Major Repair/Upgrade History	Fuel storage modified in 1997. One tank removed and the remaining tank reconstructed and dyke rebuilt to ensure containment of spills.
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Generator**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Generator, exciter
Reliability History	Good. Some problems associated with inadequate air filtration
Maintenance Requirements	Routine maintenance and inspections
Major Repair/Upgrade History	Rotor overhauled in 1997 New air filtration system will be installed in 1999 Exciter repaired and modified in 1986
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Lube oil System**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Lube oil/glycol cooler, glycol/air cooler, circulating pumps, filters, heater, sump tank, valves, piping
Reliability History	Good
Maintenance Requirements	Routine maintenance of all components
Major Repair/Upgrade History	Heaters replaced 1997
Condition	Good
Spare Parts Availability	Good
Comments	Conventional equipment with parts/replacements readily available. Lube oil will be replaced in near future
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Exhaust Stacks**	
Prepared by:	John Mallam
Date:	98-12-02
Description	Exhaust volute, stacks, silencers, snow doors
Reliability History	Good
Maintenance Requirements	Routine maintenance of snow hoods and operating mechanism
Major Repair/Upgrade History	Stacks and silencers repaired mid 1980's Snow door operators changed from electric to pneumatic
Condition	Good
Spare Parts Availability	Good
Comments	Low maintenance equipment
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: AC MCC**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Cutler Hammer, CAT F500, No. 817853, 600 Volt Horizontal Bus , 600 Volt Vertical Bus, 600 Amp. See dwg. 182009
Reliability History	Good. This equipment has required very little maintenance.
Maintenance Requirements	No regular maintenance is required on this MCC.
Major Repair/Upgrade History	Have replaced some contacts and relays, mostly of a minor nature.
Condition	This is in good condition. It is kept in a clean, heated control room environment and requires very little maintenance.
Spare Parts Availability	There are some spare relays on site but most components are readily available from the manufacturer.
Comments	
Minimum Life Expectancy	System should be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Air Start System**	
Prepared by:	Dave Hicks
Date:	98/11/02
Description	Both turbines are air start systems with two 7.5 Hp, 600 Volt AC air compressors. Those are not necessarily redundant systems as they both feed the air receiver which in turn supplies the units. There is a desiccant pack which is used to dry the air with no electrical components involved.
Reliability History	Good
Maintenance Requirements	Regular checks requiring minor adjustments to compressor drive belts.
Major Repair/Upgrade History	Both air compressors were replaced in 1993 as well as the air lines valves etc. in addition to a new control panel.
Condition	Good
Spare Parts Availability	Some spare parts are kept on site in Hardwoods, most are readily available from manufacturers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Air Supply/ Coolant System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The air coolant system has Turbine inlet filters with two blowers on A side and two blowers on B side, all AC motors which are used to draw air into the enclosure. Plus there are enclosure fans, two on A and two on B, AC as well.
Reliability History	The fans were not used at Hardwoods, but a new system has been installed.
Maintenance Requirements	Regular checks as per AC motor requirements.
Major Repair/Upgrade History	The air coolant system at Hardwoods has been modified in the fall of 1998 with the installation of inertia filters to compensate for increased dust, salt contamination, and ice spray expected from the adjacent roadway modifications. The Turbine Inlet Filters have two blowers on A and two on B, all AC motors, which are used to draw the contaminated incoming air out of the plenum. Those motors were replaced as the existing motors had not been used for an extended period of time. There are enclosure fans two on A and two on B, AC as well which were replaced.
Condition	Good , all new.
Spare Parts Availability	Readily available from suppliers.
Comments	

Plant: Hardwoods Gas Turbine **Component: Air Supply/ Coolant System**	
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Alternator**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	This is the generator coupled to the A and B power turbines. There are approximately 12 heaters 33kW each on the generator.
Reliability History	This has been a fairly reliable system. There was a problem with the terminal bushings on two separate occasions. There was also a problem with a heater failure which has since been modified tied into the monitoring system.
Maintenance Requirements	Annual meggar of: rotor, exciter armature winding, and exciter field winding plus checks on all other associated components
Major Repair/Upgrade History	Two of the high voltage bushing have been replaced since its installation. One in the 70's and one in 1997.
Condition	Good
Spare Parts Availability	There are two spare bushings on order to be kept on site at Stephenville. There are some other parts in inventory in Hardwoods but the list would have to be reviewed to know which parts applicable to the generator were kept on hand.
Comments	

Plant: Hardwoods Gas Turbine **Component: Alternator**	
Minimum Life Expectancy	According to Brush Electric the life expectancy form startup for this unit is approximately 45 years, when maintained properly and operated in a clean environment, with the minimum number of starts. Not all our maintenance records are complete, there has been fairly clean environment surrounding the units in the past, and there have been a significant number of starts on the units, especially Hardwoods GT. Brush could not comment for certain, as to the remaining life expectancy without doing a physical assessment themselves, but suspect it may be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: DC MCC**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Cutler Hammer, CAT F500, No. 817852, 600 Amp Horizontal Bus , 600 500 Amp Vertical Bus, 600 Volt Maximum. See dog. 182010
Reliability History	This has been a fairly reliable system not requiring any repairs.
Maintenance Requirements	No regular maintenance is required on this MCC.
Major Repair/Upgrade History	None since it was installed.
Condition	This is in good condition. It is kept in clean, heated control room environment and requires very little maintenance.
Spare Parts Availability	There are some spare parts on hand but most components are readily available from the manufacturer.
Comments	
Minimum Life Expectancy	System should be good for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Exhaust System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	There are two Snow doors on the exhaust stacks which have DC solenoids operated from the DC MCC. Those solenoids must first be released before the air system can open the Snow doors using air style pistons.
Reliability History	Good
Maintenance Requirements	Regular checks, physical inspection.
Major Repair/Upgrade History	The DC solenoids on the Snow doors were changed out a few years ago in place of air system pistons.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the snow doors.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Generator Lube Oil System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Each turbine has a generator lube oil system which is driven from the unit. Each has a heater as well. Those are located adjacent to the turbine units.
Reliability History	Good
Maintenance Requirements	Routine inspection
Major Repair/Upgrade History	None have been done since it was installed.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the generator lube oil system.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Halon Fire Systems**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	There are Halon Fire Systems on each compartment which are supplied with DC fed solenoids.
Reliability History	Good
Maintenance Requirements	Routine Inspection of system.
Major Repair/Upgrade History	Completely rewired the Stephenville system in 1997, as a result of burn marks found on the wires in the conduits. Maintenance records were incomplete for Hardwoods.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the Halon fire system. This is a fairly common system and spare parts are readily available from local suppliers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Liquid Fuel Supply System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The electrical aspects of this system consists of three off loading pumps, 2 AC and 1 DC, which are fed from NFLD Power source; three fuel forwarding pumps 2 AC and 1 DC and two supplementary pumps 1 on GTA and 1 on GTB which are used to bring the fuel to a higher pressure. There is also a 100kW, 600 volt heater on this system.
Reliability History	Good
Maintenance Requirements	Routine inspection and maintenance.
Major Repair/Upgrade History	The heater was replaced on the Hardwoods system.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the liquid fuel supply system.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Main Lube Oil System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	The Main Lube Oil is located in the Auxiliary Module. It consists of two DC pumps, one main AC pump and one Auxiliary AC pump. There is one Demister. There is one vapour extractor. There are two heaters on the main lube oil system to maintain the temperature at a certain level for viscosity reasons, they are 25 kW each, at 600 volt. There are two DC jacking pumps which are hydraulic style devices used to lift the main bearings and force oil around them prior to start up. (Axial piston constant displacement type- one pump per alternator bearing)
Reliability History	Good
Maintenance Requirements	Routine maintenance and inspection.
Major Repair/Upgrade History	None have been done
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the main lube oil system.
Comments	

Plant: Hardwoods Gas Turbine **Component: Main Lube Oil System**	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Main Transformer**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	Westinghouse, 45 MVA, 13.8 kV delta/ 66 kV Wye Gnd, Oct.1976
Reliability History	Good
Maintenance Requirements	Routine Maintenance and inspection. Annual oil sampling and gas analysis.
Major Repair & Upgrade History	None have been done.
Condition	Good
Spare Parts Availability	Spare bushings are kept in Bishop's Falls for both the high and low side. Other external components are kept in Bishop's Falls as well.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Switchgear**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	13.8 V switchgear associated with the gas turbine consists of all buswork leading from the alternator to the breaker, auxiliary transformer, PT's, CT's and buswork up to the step up transformer.
Reliability History	There has been a reliable service history associated with the switchgear in Hardwoods which is expected due in part to the enclosure and associated heaters within it. The terminal box where the bus connects to the generator terminals has been a cause for some concern in recent years. The switchgear will not be replaced in Hardwoods.
Maintenance Requirements	Routine inspection and maintenance.
Major Repair/Upgrade History	Lightning arresters have been upgraded and additional ones have been added to other auxiliary transformer. New surge capacitors were installed as well, all in 1994
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the switchgear. The suitable components of the switchgear which is being removed from Stephenville will be kept as spares for Hardwoods as well.
Comments	

Plant: Hardwoods Gas Turbine **Component: Switchgear**	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Water/Glycol Coolant System**	
Prepared by:	Dave Hicks
Date:	1998-11-04
Description	This is a closed water and glycol system interfaced with a heat exchanger to remove heat from oil lubrication system. There is one glycol AC pump in this system as well as two AC fans installed on the cooling rads through which the coolant circulates. Those are both 600 Volts fed from the AC MCC.
Reliability History	Good
Maintenance Requirements	Routine maintenance and inspection
Major Repair/Upgrade History	One Fan motor and several belts were replaced over its period in service.
Condition	Good
Spare Parts Availability	Some spare parts are maintained but the list would have to be reviewed to confirm the availability of parts associated with the Water / Glycol coolant system. Most components are readily available from suppliers.
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Control System**	
Prepared by:	Craig Warren
Date:	Oct. 6 / 1998
Description	Bailey INFI-90 Distributed Control System (DCS)
Reliability History	This new control system has performed satisfactorily over the past year. Minor modifications were made to the logic with success.
Maintenance Requirements	No maintenance required with the exception of general dust removal. It is advisable to download module configurations to diskette for backup on a monthly basis.
Major Repair/Upgrade History	The installation of the DCS was part of the upgrade to the existing control system. Twenty year old electro-mechanical relay/timer based controls were retired and replace with state of the art digital controls.
Condition	Installed and operational as of Dec. 4, 1997.
Spare Parts Availability	Spare DCS components were purchased and are at site. Most components are available from Elsag-Bailey Dartmouth office.
Comments	Advanced self-diagnostics, trending capabilities, sequence of events monitoring and comprehensive, straightforward software logic of DCS installations allow maintenance and engineering forces to more efficiently troubleshoot problems and expand system.
Minimum Life Expectancy	Estimated 15+ years expected. Controls manufacturer will support hardware for 10 years past point of obsolescence of any particular component.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Protective Relay & Meters**	
Prepared by:	Craig Warren
Date:	Oct. 6 / 1998
Description	Relays: - Underpower Relay (37) - Underfrequency Relay (81G) - Overcurrent Relay - Aux. Transformer (51AT) - Loss of Excitation Relay (40G) - Undervoltage Relay (dead bus) (27DB) - Differential Relay (87G) * - Undervoltage Relay (27G) - Reverse Power relay (32) - Negative Phase Sequence Relay (46) - Voltage Restraint Relay (51V) - Overvoltage Relay (59G) - Bus Ground Protection Relay (64B) * - Stator Ground Protection (64F) Meters: - AB-40 style Wattmeter - AB-40 style Varmeter - AB-40 style Voltmeter - AB-40 style Ammeter - AB-40 style Synchroscope * - see *Major Repair/Upgrade History* below.
Reliability History	No problems to date.

Plant: Hardwoods Gas Turbine **Component: Protective Relay & Meters**	
Maintenance Requirements	Periodic function checks are performed on the relays by P&C technicians (once every 3 - 4 years). Doble relay test equipment is used to verify operation of relays.
Major Repair/Upgrade History	All relays, with the exception of the 27G and 64F relays which were installed in 1993, are original (as of 1972). Costs to upgrade any or all relays is minimal. New technologies combine many functions into one package thereby reducing upgrade cost and space allocation.
Condition	Good working order.
Spare Parts Availability	Some spare devices in Bishop's Fall area office. In the event of relay failure and like model not in stock or considered obsolete, it would be most economical to upgrade any relay to a digital model.
Comments	
Minimum Life Expectancy	Estimated additional 10 years minimum.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Vibration Monitoring System**	
Prepared by:	Craig Warren
Date:	Oct. 16 / 1998
Description	IRD Mechanalysis Machine Monitor - Model 5806 Signal Conditioner - Model SP95C Vibration Pickups - Model 544M
Reliability History	Since installation, there have been no problems with unit.
Maintenance Requirements	IRD personnel periodically check unit and calibrate (approx. every 4-5 years). Calibration was performed with use of shaker table during recent controls upgrade during October/November of 1997.
Major Repair/Upgrade History	This is not original equipment. This device was installed in October 1986.
Condition	Device in good working order, no operational problems. Option exists to extend DCS topology to include vibration monitoring should present device fail to operate and require replacement.
Spare Parts Availability	Spare components are stocked in Stephenville office.
Comments	
Minimum Life Expectancy	Estimated additional 5 years minimum.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Transducers, Thermocouples, RTD's**	
Prepared by:	Craig Warren
Date:	Oct. 16 / 1998
Description	Signal transducers, thermocouples and RTD's - various manufacturers.
Reliability History	No major problems.
Maintenance Requirements	None required - replace on failure only.
Major Repair/Upgrade History	None of the transducers are original as a result of either the EMS project or the control system upgrade. Stator RTD's are original. Exhaust gas temperature thermocouples are new as of DCS installation.
Condition	Good.
Spare Parts Availability	Yes. Devices are low cost and easily acquired.
Comments	
Minimum Life Expectancy	Estimated additional 5 - 10 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Inverter**	
Prepared by:	Craig Warren
Date:	Oct. 21 / 1998
Description	Single phase power inverter - CTS of Canada, Ltd.
Reliability History	No major problems.
Maintenance Requirements	General inspection.
Major Repair/Upgrade History	Few problems, nothing serious. No major equipment failures. Some card replacements in recent years.
Condition	Good.
Spare Parts Availability	None. Manufacturer would have to contacted in the event of problem.
Comments	Planned replacement of unit within next two years.
Minimum Life Expectancy	Estimated additional 5 - 10 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: AVR**	
Prepared by:	Craig Warren
Date:	Oct. 21 / 1998
Description	Automatic Voltage Regulator - Brush Electric
Reliability History	No major problems.
Maintenance Requirements	Settings are checked every 3 years.
Major Repair/Upgrade History	None.
Condition	Good. No operational problems.
Spare Parts Availability	Some diodes and rheostats. Manufacturer to be contacted in the event of major circuit board failure.
Comments	
Minimum Life Expectancy	Estimated additional 5 - 10 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Battery Bank and Charger**	
Prepared by:	Craig Warren
Date:	Oct. 21 / 1998
Description	GNB Batteries, CIGENTEC Charger.
Reliability History	Good. Since it is a new system, not much history exists.
Maintenance Requirements	Monthly inspections. Batteries are maintenance-free type.
Major Repair/Upgrade History	Old charger and battery bank replaced with new system in 1996.
Condition	Excellent.
Spare Parts Availability	None. Manufacturer to be contacted in the event of battery cell failure or charger failure.
Comments	
Minimum Life Expectancy	Estimated additional 15+ years.

PLANT CONDITION ASSESSMENT 1998

Plant: Hardwoods Gas Turbine **Component: Exciter**	
Prepared by:	Craig Warren
Date:	Oct. 22 / 1998
Description	Brushless Exciter - Brush Electric.
Reliability History	No major problems since modifications in 1982.
Maintenance Requirements	None routinely in place. Inspected approximately 4-5 years ago.
Major Repair/Upgrade History	Major failure resulting in full replacement in 1982. Report on file detailing the failure and subsequent replacement. No major problems since then.
Condition	Good.
Spare Parts Availability	None. Some minor parts at site. Brush Electric (UK) to be contacted in the event of major failure.
Comments	
Minimum Life Expectancy	Estimated additional 10+ years.

Appendix V

Survey of Expected Thermal Plant Life

Keith / Greg
FYI + give a copy to J Malone please
AB

MEMORANDUM

FILE 102.81.00

TO: G. Dlugosch

FROM: A. MacNeill

SUBJECT: Practical Life Expectancy for Holyrood

DATE: 1998, February 2nd

Holyrood Units 1 and 2 were commissioned in 1970, 28 years ago. Since that time the units have had approximately 100,000 hours running time, an equivalent of 134 continuous months or 11 years of running time. Unit 3 was commissioned in 1980, 18 years ago. Since that time Unit 3 has had approximately 70,000 hours of running time, the equivalent of 94 months or 8 years.

Most utilities have designed the units and financed them for a 30 year life span. This is mirrored in a FOMIS report dated October 1996 where almost every plant indicated this was their original design life. However, most responses in this report from older plants indicate that their companies have reconsidered the life expectancy, sometimes by a factor of two, but at the least the decision is based on replace/repair costs compared to new replacement generation.

PLANT NAME	ORIGINAL DESIGN LIFE	REVISED PRACTICAL LIFE SPAN
[redacted]	30	Studying remaining life
[redacted]	30	60
[redacted]	25	40
[redacted]	30	Study life extension
[redacted]	30	Replace/repair economics
[redacted]	35	50 with no degradation of effiency & availability
[redacted]	40-44	none
[redacted]	35	50-75
[redacted]	30	50
[redacted]	40	50-55
[redacted]	30	Ageless
[redacted]	35	Depends upon condition
[redacted]	30	none
[redacted]	25-30	As long as possible.
[redacted]	40	Operating Costs vs New Generation Options
[redacted]	40	Economic decision
[redacted]	40	Economic cost/benefit
[redacted]	30	60
[redacted]	40	none
[redacted]	35	Economic study
[redacted]	45	Economic

Holyrood has not been operated as hard as most plants have, in fact units 1 and 2 are only about half as old in operating hours as they appear based on their in-service date. Based on this alone, we should expect another 15 years of hard running (75% operating factor), for a total operating time of 200,000 hours (23 years at 50% operating factor). Unit 3 has approximately 130,000 operating hours left, 20 years at 75% operating factor and 30 years at 50% operating factor. This will only use up the original intended design life of the units. Based upon what can be seen in the chart above, most companies plan to be running the plant past the design life until it is too expensive to repair (based upon the cost of replacement generation).

To follow the example of some of the stations above, we can safely plan on operating the units for as long as 300,000 hours each or 50% longer than the designed life. Efficiency and availability should be able to be maintained but maintenence costs are sure increase as the plant ages. Maintenence cost increases could be limited by accepting reduced efficiency and availability. A full fledged Life Extension program will probably extend the viability of the plant longer than 300,000 operating hours, but at a high cost.

A. MacNeill Manager, Thermal Plant Operations

Appendix VI

Holyrood Generating Station
Condition Assessment Sheets
Common Equipment

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Generator Bus Units 1,2& 3**	
Prepared by:	Raj Kaushik
Date:	November 25,98
Description	Isolate phase buses from generator terminal to step-up transformers.
Reliability History	Excellent. Have not experienced any problem with these buses..
Maintenance Requirements	Routine inspection & testing every year. These are almost maintenance free items.
Major Repair/Upgrade History	None
Condition	General overall condition is excellent.
Spare Parts Availability	N/A
Comments	Buses are cleaned as required, if the megger readings are low.
Minimum Life Expectancy	Another 30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: STEP-UP TRANSFORMER UNITS 1,2&3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	Unit 1: Trafo Union 16/230 kV,180MVA, OFAF Unit 2: Federal Pioneer 16/230 KV,190MVA,OFAF Unit 3: General Electric,16/230 KV,170 MVA.OFAF
Reliability History	Reliability if these units have been very good.
Maintenance Requirements	These units go through a Meggar,TTR,Doble,DGA and oil test every 5 years.
Major Repair/Upgrade History	Radiators & Fan Motors have been replaced for units 1&3.
Condition	Overall condition of these transformers is excellent.
Spare Parts Availability	Spare high & low voltage bushings are available for these units
Comments	Unit 2 may require radiators & fan motors replacement in about 5 years. Spare parts from Trafo Union requires long lead time.
Minimum Life Expectancy	Based on their present condition & duty cycle these transformers should last for another 30-40 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: UNIT SERVICE TRANSFORMERS FOR UNITS 1,2&3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	Unit 1: Pioneer Electric 16/4.16 KV,10 MVA, ONAN Unit 2: Pioneer Electric 16/4.16 KV,10 MVA, ONAN Unit 3: Pioneer Electric 16/4.16 KV, 10 MVA, ONAN
Reliability History	Reliability of these units have been very good.
Maintenance Requirements	These units go through a Meggar,TTR,Doble,DGA and oil test every 5 years.
Major Repair/Upgrade History	Grounding resistor boxes were rebuilt and radiators replaced for unit 1&2. Unit 2 tapchanger was rebuilt twice.
Condition	Overall condition of these transformers is excellent.
Spare Parts Availability	Spare parts for tap changers & bushings are available for these units.
Comments	Due to their location, all of these units have tank rust problem & have been painted several times.
Minimum Life Expectancy	Based on their present condition & duty cycle these transformers should last for another 25-35 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: STATION SERVICE TRANSFORMERS SST1-2 SST3-4**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	SST1-2: Pioneer Electric 69/4.16 KV, 14 MVA, ONAF SST3-4: Westinghouse 69/4.16 KV ,14 MVA, ONAF
Reliability History	Reliability of these units have been very good.
Maintenance Requirements	These units go through a Meggar,TTR,Doble,DGA and oil test every 5 years.
Major Repair/Upgrade History	Radiators & fan motors have been changed for sst1-2.
Condition	Overall condition of these transformers is excellent.
Spare Parts Availability	Spare parts for tap changers & bushings are available for these units.
Comments	Due to their location, all of these units have tank rust problem & have been painted several times.
Minimum Life Expectancy	Based on their present condition & duty cycle these transformers should last for another 30-40 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: 4160 V SWITCHGEAR FOR UNITS 1,2&3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	4160 v switchgear for unit service and station service boards for units 1,2 &3 supplied by ITE.
Reliability History	Reliability of these switchgear has been very good.
Maintenance Requirements	Routine maintenance i.e. general cleaning & contact resistance test, is performed on 8 most used switchgear every year for each unit. Every five year each unit is totally dismantled & rebuilt.
Major Repair/Upgrade History	Nothing outside of what is mentioned under maintenance requirements.
Condition	Overall condition of these switchgear is excellent.
Spare Parts Availability	Spare parts are available to rebuild one complete unit.
Comments	
Minimum Life Expectancy	Based on their present condition & Hydro's maintenance practice, these Switchgear should last for another 20-30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: DC SYSTEMS FOR UNITS 1,2&3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	DC batteries & chargers to supply critical loads for units 1,2&3.
Reliability History	Reliability of these systems has been good.
Maintenance Requirements	Routine maintenance i.e. general cleaning ,inspection & testing of cell voltage is performed on each dc system periodically.
Major Repair/Upgrade History	All three of 258 v dc systems have been replaced during last year and one half. 129 v system was replaced in 1989.
Condition	Overall condition of these dc systems is excellent.
Spare Parts Availability	None
Comments	Replacement batteries have a minimum of 20 years life.
Minimum Life Expectancy	Based on their present condition 258 v dc systems should last for another 20 years. However,129 v system will require replacement in 10 years time.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood **Component: Warm Air Makeup**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Warm air makeup cabinet including programmable logic controller (PLC) and field instrumentation
Reliability History	Good
Maintenance Requirements	Annual inspection
Major Repair/Upgrade History	Temperature switches in enclosures to be replaced in 1999 with thermocouples and digital indicators.
Condition	Good
Spare Parts Availability	Readily available
Comments	
Minimum Life Expectancy	10 years; can be easily upgraded by replacing processor

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood **Component: Units 1,2 & 3 Sootblower Controls**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Programmable logic controller (PLC) and other control equipment for sootblowers
Reliability History	Good
Maintenance Requirements	Annual inspection.
Major Repair/Upgrade History	Replaced on all units over last 10 years. All transmitters and valves have been replaced.
Condition	Good
Spare Parts Availability	Available on site at the warehouse
Comments	
Minimum Life Expectancy	15 years; can be easily upgraded by replacing processor

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood **Component: Units 1,2 & 3 LP Feedwater Controls**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Controls and level switches on all units
Reliability History	Lower than needed
Maintenance Requirements	Annual; level controls and valves are removed and overhauled
Major Repair/Upgrade History	
Condition	Fair
Spare Parts Availability	Available for controls and valves but not for the level switches
Comments	Propose to upgrade as was done for the HP feedwater heaters
Minimum Life Expectancy	10 years for controls; switches will be replaced in near future

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood **Component: Units 1,2 & 3 HP Feedwater Heaters**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Transmitters and Aquarian probes
Reliability History	Good
Maintenance Requirements	Annual inspection; operating plant so problems are fixed as they occur
Major Repair/Upgrade History	Controls on Units 1 & 2 were replaced in 1996 and Unit 3 controls was replaced in 1997. The original local level controllers were replaced with transmitters and Aquarians replaced the level switches.
Condition	Good
Spare Parts Availability	Available on site at the warehouse
Comments	
Minimum Life Expectancy	15 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood **Component: Station Service Control**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Station Service Distributed Control System(DCS) and operator consoles supplied by Westinghouse
Reliability History	Good; system is well supported by vendor; software can be upgraded
Maintenance Requirements	Changing faulty boards; annual cleaning, inspection, power supply testing; on-going throughout the year as testing after problems
Major Repair/Upgrade History	System was upgraded for Year 2000 compliance
Condition	Excellent
Spare Parts Availability	Stocked in warehouse; available from vendor or repaired by vendor
Comments	The system was installed in 1994. It is well maintained and the technicians are well trained.
Minimum Life Expectancy	Dependent on support from Westinghouse; it may be possible to upgrade processors and cards as the system ages. Estimate 15 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Light Oil Fuel System**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Fuel off loading equipment, pipeline to tanks, two storage tanks, fuel line to plant, three pumping sets.
Reliability History	Good.
Maintenance Requirements	Routine maintenance of pumps, valves and equipment.
Major Repair/Upgrade History	Two light oil storage tanks in tank farm are in the process of being decommissioned and replaced by two self dyking tanks located nearer the plant.
Condition	Good. Piping has been reviewed for compliance with environmental legislation.
Spare Parts Availability	Good
Comments	No indication of abnormal wear or corrosion
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Bunker C Fuel System**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Fuel off loading equipment at marine terminal, pipeline to tank farm, four storage tanks, fuel line to day tank, day tank, three pumping and heating sets.
Reliability History	Good.
Maintenance Requirements	Routine maintenance of heat tracing, pumps, valves and other equipment.
Major Repair/Upgrade History	Pipeline supports from dock to tanks have been repaired to correct sagging caused by settling. Emergency shut off valves added in line from dock to tank farm. A section of the pipeline from tank farm to plant has been replaced due to presence of corrosion Fuel pumps have been upgraded on all three units to accommodate low API fuels.
Condition	Good. Fuel tanks 1 and 2 have been inspected internally and were found to be in good condition. Piping has been tested to comply with environmental legislation.
Spare Parts Availability	Good
Comments	No signs of abnormal wear or corrosion
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Auxiliary Steam System**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Auxiliary steam system, including pressure reducing stations, condensate return
Reliability History	Good
Maintenance Requirements	Routine maintenance on pumps, valves, hangers, traps and other piping components as required.
Major Repair/Upgrade History	Steam trap survey has been performed to assess condition of traps. Replacement programme in effect
Condition	Good
Spare Parts Availability	Good. Parts/replacements for all components available from several manufacturers.
Comments	System life can be extended almost to infinity by routine maintenance and replacement programme. System comprised of numerous small components any of which could be provided by several manufacturers. Some sections of piping are subject to erosion and corrosion and are replaced as required
Minimum Life Expectancy	20 years..

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Chemical Feed**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Hydrazine, ammonia, phosphate feed systems, including storage, feed pumps and piping
Reliability History	Good
Maintenance Requirements	Routine maintenance on pumps and valves
Major Repair/Upgrade History	Ammonia and hydrazine storage and metering equipment was replaced in 1996. This equipment will be automated during the winter of 98/99.
Condition	Good.
Spare Parts Availability	Good. Piping and valves available from numerous manufacturers and hydrazine and ammonia pumps are new. Parts available for phosphate pumps.
Comments	Generally, system requires low maintenance.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Emergency Diesel Generators**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Two emergency diesel generator sets and fuel storage
Reliability History	Good
Maintenance Requirements	Routine maintenance as recommended by manufacturer Regular testing (exercising) of diesel generator sets
Major Repair/Upgrade History	Overhauls to diesels as required by accumulated operating hours. Self dyking fuel day tanks added 1997. Synchronizing capabilities added to permit on line load testing.
Condition	Good
Spare Parts Availability	Good
Comments	Diesels operate infrequently for test purposes only and have accumulated few operating hours.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Fire Protection and Detection**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Facility fire detection and extinguishing systems
Reliability History	Good
Maintenance Requirements	Routine maintenance on equipment. Regular pressure/flow testing of piping and equipment by Hydro personnel and insurance company representatives.
Major Repair/Upgrade History	Numerous upgrades and extension of coverage by automatic sprinkler protection as recommended by insurance company. Additional coverage recently added to boiler fronts and windboxes.
Condition	Good
Spare Parts Availability	Good
Comments	Frequently inspected and tested
Minimum Life Expectancy	40 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment Component: Fuel Additive System	
Prepared by:	John Mallam
Date:	98-11-10
Description	Fuel additive storage tank, transfer piping and metering pumps
Reliability History	Troublesome in past; system redesigned and rebuilt in 1996 and reliability has improved markedly
Maintenance Requirements	Basic maintenance requirements for pumps and valves. System has had a history of line blockage.
Major Repair/Upgrade History	Major renovations to system in 1996 to correct chronic problems with line blockage.
Condition	Good (to be verified after several operating seasons)
Spare Parts Availability	Good
Comments	Further modifications (if any) to be determined following several seasons of operation with new configuration. Experience with modifications to date has been encouraging.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: General Service Cooling System**	
Prepared by:	John Mallam
Date:	98-11-10
Description	General service cooling system for three units and common equipment, from raw water sump, including pumps, piping, valves, heat exchangers, clarified water tank and discharge piping.
Reliability History	Good to poor. System has experienced numerous incidents of pipe fouling/plugging.
Maintenance Requirements	Routine maintenance on all equipment and frequent chemical cleaning/replacement of piping to remove deposits
Major Repair/Upgrade History	A significant quantity of piping has been replaced due to corrosion/plugging. Considerable funds expended annually on chemical cleaning.
Condition	Fair to good
Spare Parts Availability	Good
Comments	A study of the complete system is in progress and will be completed during the winter of 1998/99 to determine the best method to bring the fouling/plugging problem under control. Modifications to achieve this will begin in 1999.
Minimum Life Expectancy	20 years, with modifications to be implemented in 1999.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Ventilation and Heating**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Building ventilation equipment, including wall louvres, exhaust fans, warm air makeup equipment, office block heat/ventilation system, various air conditioning systems
Reliability History	Good
Maintenance Requirements	Routine equipment maintenance and filter replacement
Major Repair/Upgrade History	Building warm air makeup equipment added 1993 to improve air quality and control air infiltration.
Condition	Good.
Spare Parts Availability	Good
Comments	Some deterioration of wall louvres and wall exhaust fans
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Instrument Air**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Compressors, dryer, air receivers, distribution piping.
Reliability History	Good. Problems with moisture in air have been rectified by installation of a new dryer in 1995
Maintenance Requirements	Routine maintenance on compressors, dryer and valves.
Major Repair/Upgrade History	New dryer and compressor added in 1995. During the past 10 years all original compressors have been replaced by centrifugal oil free units
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Raw Water**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Raw water sump, pumps, piping.
Reliability History	Good
Maintenance Requirements	Routine maintenance on pumps and valves
Major Repair/Upgrade History	Sections of deteriorated raw water piping from dam to plant replaced 1996
Condition	Good
Spare Parts Availability	Good
Comments	Relatively simple, low maintenance system
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Reserve Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Reserve feedwater including demin water booster pumps, reserve feedwater tanks, pumps and piping
Reliability History	Good
Maintenance Requirements	Routine maintenance on pumps and valves
Major Repair/Upgrade History	Demin water booster pumps added 1979
Condition	Good
Spare Parts Availability	Good
Comments	Generally low maintenance
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Service Air**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Compressors, air receivers distribution piping.
Reliability History	Good.
Maintenance Requirements	Routine maintenance on compressors and valves.
Major Repair/Upgrade History	During the past 10 years all original compressors have been replaced by centrifugal oil free units
Condition	Good
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Water Treatment Plant**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Water treatment plant from raw water inlet to clarifier, clarifier, sand filters, demineralization equipment, regeneration equipment, chemical storage, demineralized water storage tanks, laboratory
Reliability History	Fair to good. Original demineralization equipment had deteriorated to point where much manual intervention was required by chemists.
Maintenance Requirements	Routine maintenance of equipment
Major Repair/Upgrade History	Replacement of demineralization equipment, laboratory and general upgrading of complete facility performed in 1997/98. Renovation of chemical storage area in 1992
Condition	Good
Spare Parts Availability	Good
Comments	Sand filters and clarifier inspected 1994. Minor defects identified and corrected in subsequent years. Replacement of demineralization equipment and laboratory in and other general renovations 1997/98 created an essentially new water treatment plant.
Minimum Life Expectancy	25 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Common Equipment **Component: Waste Water Treatment Plant**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Drain piping from plant to oil separators, oil separators, piping to basins, basins, waste water processing equipment
Reliability History	Good
Maintenance Requirements	Routine maintenance on process equipment. Replacement of resins every 5 years (approx). Occasional removal of sludge from periodic basin
Major Repair/Upgrade History	Original leeching pit and grease/oil traps replaced in 1992 with oil/water separators and a two basin treatment system
Condition	Good
Spare Parts Availability	Good
Comments	System being expanded in 1999 to contain solid wastes on site and to collect and treat runoff from solid waste disposal site. Problem with generation of fog from periodic basin being addressed.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Pumphouse # 1**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding on structural steel frame
Reliability History	Good
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	Built-up roof replaced within last 2 years; metal siding replaced or epoxy coated within the last 5 years; some rusted structural steel (20%) was coated in recent years.
Condition	Overall - good condition.
Spare Parts Availability	n/a
Comments	Trashracks are scheduled to be replaced within the next 3 years. Coating of the exterior handrails is scheduled within the next 2 years; diving inspection is done annually. Some concrete repair & re-coating of st steel may be appropriate in next few years.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Pumphouse # 2**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding on structural steel frame.
Reliability History	Good
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	
Condition	Good Some surface rusting of structural steel within the 1st 5 m of the floor on the east, west & north elevations.
Spare Parts Availability	n/a
Comments	Floor grating is scheduled to be replaced in 1999; Trashracks are scheduled to be replaced over the next 4 years; diving inspection is done annually. Consider re-coating of some st steel in next several years.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Waste Water Treatment Plant (building)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding (pvc coated) over structural steel.
Reliability History	Good. Building constructed in 1992.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	Epoxy coating applied to roof in 1992.
Condition	Good.
Spare Parts Availability	n/a
Comments	Some minor rusting in small areas at the bottom of the liner panels & some st steel.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Waste Water Treatment Plant (basins)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding (pvc coated) over (epoxy coated) structural steel.
Reliability History	Good. Building constructed in 1992.
Maintenance Requirements	Routine inspection & annual general maintenance.
Major Repair/Upgrade History	
Condition	Good Some surface rusting of structural steel. Some areas of the floor coating has lifted.
Spare Parts Availability	n/a
Comments	High humidity inside continuously. Solutions being investigated.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Chemical Storage Building**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding (pvc coated) on structural steel frame.
Reliability History	Good. Building constructed in 1996.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	
Condition	Good Building heated. Walls coated with fire retardant paint.
Spare Parts Availability	n/a
Comments	Consider coating metal roof against corrosion from stack fallout.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Warehouse/pipeshop**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding (pvc coated) on structural steel.
Reliability History	Good. Building constructed in 1968.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	The new pvc coated siding was added to the existing structure in 1995.
Condition	Good The metal roof was coated in 1998. The building is heated & sprinkler protected. There is some surface rusting on the structural steel.
Spare Parts Availability	n/a
Comments	Good.. Consider insulating the overhead doors.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Warehouse/Training Centre**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding on structural steel frame.
Reliability History	Good. Building constructed in 1968.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	50% of metal roof replaced in 1998. Coating of the metal siding & roofing was done in 1998.
Condition	Good. Overhead door is insulated. Building is heated & sprinkler protected. There is some surface rusting on the structural steel.
Spare Parts Availability	n/a
Comments	
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Main Warehouse Building**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding on structural steel frame.
Reliability History	Good. Building constructed in 1968.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	Coating of exterior cladding & roofing was completed in 1998. The overhead door was replaced in recent years. Some of the metal roofing was replaced in recent years.
Condition	Good. The building is heated & sprinkler protected. The concrete floor was painted recently.
Spare Parts Availability	n/a
Comments	
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Warehouse (Shawmont Bldg)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Metal cladding (not insulated) on structural steel frame.
Reliability History	Good. Building constructed in 1976.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	
Condition	Good. Building heated & sprinkler protected. Several locations of surface rust on metal siding.
Spare Parts Availability	n/a
Comments	Consider coating of metal siding & roof.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Hydrogen Storage Building**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Metal cladding (not insulated) on structural steel frame.
Reliability History	Good. Building constructed in 1978.
Maintenance Requirements	Routine inspection & regular annual maintenance.
Major Repair/Upgrade History	Coating of exterior cladding & roofing was completed in 1998. The structural steel was painted in recent years.
Condition	Good. The building is unheated. Some surface rusting is occurring on the (horizontal) beams on the perimeter walls.
Spare Parts Availability	n/a
Comments	
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Main Powerhouse Building**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Insulated metal cladding on structural steel frame.
Reliability History	Good.
Maintenance Requirements	Routine inspection & regular maintenance.
Major Repair/Upgrade History	Several additions were made since unit # 1& 2 in 1968 ie unit 3 in 1976; workshop & enclosure bldgs in 1992; water treatment plant ext in 1997.
Condition	Good
Spare Parts Availability	n/a
Comments	All siding has been re-coated with epoxy paint or replaced with new pvc coated siding within the last 5 years; a significant amount of re-roofing has been done in last few years; coating of some of the concrete floors has been done in last couple of years
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Marine Terminal (Wharf)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Concrete approach & berthing structure on steel piles (approx 100); small bldg on wharf & bollards on shore;
Reliability History	Good.
Maintenance Requirements	Routine inspection & annual regular maintenance.
Major Repair/Upgrade History	The approach was repaired due to ship collision several years ago; the piles were epoxy coated several years ago; the timber facing on the fenders were replaced (partial success) a few years ago; 2 fenders are pushed back & stuck in position;
Condition	Overall - good. 20 % of the piles were re-coated in 1998.
Spare Parts Availability	n/a
Comments	The balance of the piles are to be re-coated within the next 2 years; fender repair is scheduled in 1999.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Main Tank Farm**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Earth dyke structure (including pipe supports & 4 small bldgs)
Reliability History	Good
Maintenance Requirements	Routine inspection & annual regular maintenance.
Major Repair/Upgrade History	A portion of the dyke & the interior road surfaces were repaired within the last few years; a portion of the dyke was repaired in 1998; the pipe supports have been insulated against frost action.
Condition	Good
Spare Parts Availability	
Comments	Each of the main 4 tanks are to be re-coated within the next 4 years. The light oil tanks will be removed in 1999.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Concrete Stacks**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	3 concrete exhaust stacks (to max height of 115 m)
Reliability History	Good.
Maintenance Requirements	Routine inspection & annual regular maintenance.
Major Repair/Upgrade History	Each of the stacks have been re-coated in recent years. Inspection of the interior of all stacks was done in 1998 & repairs were done as necessary. Replacement of some of the grating was done in 1997.
Condition	Good
Spare Parts Availability	n/a
Comments	2 of the stacks are scheduled to be re-coated within the next 5 years; annual inspection of the interior liners is planned; repair is to be done as necessary; replacement of the grating on the upper platform of stack # 1 & 2 is planned for 1999.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Quarry Brook Dam**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Wood crib structure (with o/f spillway, fishway & fencing)
Reliability History	Good
Maintenance Requirements	Routine inspection & annual regular maintenance.
Major Repair/Upgrade History	The fishway was constructed within the last 5 years; the fencing was replaced within the last few years.
Condition	Good
Spare Parts Availability	n/a
Comments	
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Main Water Supply**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Buried 16 in dia asbestos cement pipeline from Q.B.Dam
Reliability History	Reasonable.
Maintenance Requirements	Continue to monitor.
Major Repair/Upgrade History	A portion (approx 65 m) was replaced near the warehouse in 1996 because it was suspected of leaking; a portion was exposed & repaired near pump house # 1 in 1992.
Condition	Reasonably good.
Spare Parts Availability	2 collars & a section of plastic pipe in stock
Comments	The line was installed in 1968.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Sewer (disposal system)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Buried 4 & 6 in a.c. pipe to lift station &disposal field.
Reliability History	Reasonable.
Maintenance Requirements	
Major Repair/Upgrade History	The disposal field was upgraded within the last 10 years. A new manhole was installed & a portion of 4 in line was replaced in 1996.
Condition	Reasonably good.
Spare Parts Availability	n/a
Comments	No reported problems.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Guardhouse**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Wood frame construction; sloped roof. Heated.
Reliability History	
Maintenance Requirements	
Major Repair/Upgrade History	Roof was replaced within last 5 years. The waterline was replaced in 1997.
Condition	Good
Spare Parts Availability	n/a
Comments	
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Site Services (fencing, paving, grading etc.)**	
Prepared by:	B. Jerrett
Date:	98-11-03
Description	Perimeter fencing, site grading & paving
Reliability History	Good.
Maintenance Requirements	Routine inspection & annual regular maintenance.
Major Repair/Upgrade History	
Condition	Good
Spare Parts Availability	n/a
Comments	Normal maintenance is scheduled in the 5 year plan.
Minimum Life Expectancy	25 years based on existing conditions & continuation of regular maintenance.

Appendix VII

Holyrood Generating Station
Condition Assessment Sheets
Unit 1

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Generator Unit 1**	
Prepared by:	Raj Kaushik
Date:	November 25,98
Description	Stator & Rotor Windings
Reliability History	V. Good. Unit 1 has operated for 110,000 hours without any problem.
Maintenance Requirements	Routine inspection & testing every year with rotor in and every 6th year with rotor out.
Major Repair/Upgrade History	Hydrogen cooling system was upgraded to match the units uprating. Retaining rings have been replaced with in last six years. Both stators were rewedged with in last ten years.
Condition	General overall condition is very good.
Spare Parts Availability	No spare available.
Comments	PDA-condition monitoring equipment will be installed on both units over the next couple of years to monitor the stator windings of these units.
Minimum Life Expectancy	Based on the present condition , considering Hydro's operating & maintenance practices and life expectancy of similar other units, these generators should provide normal service for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION SYSTEM Unit 1**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	GE static excitation system for unit 1
Reliability History	Acceptable
Maintenance Requirements	Annual routine inspection, testing & maintenance of all components.
Major Repair/Upgrade History	Power supplies replaced. The replacement power supplies were re-engineered and, thus, were quite expensive.
Condition	Overall condition of these exciter units is fair.
Spare Parts Availability	It is very difficult to obtain spare parts for these units. Product support from the manufacturer is also from limited to non-existent.
Comments	Unit 1 is scheduled for replacement in 2000
Minimum Life Expectancy	Present units in their current condition should provide normal service for another 2-3 years. Subsequent to replacement, new units should last for another 30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION TRANSFORMERS Unit 1**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	General Electric oil filled units.
Reliability History	V. Good.
Maintenance Requirements	Annual routine inspection & 5kV meggar test.
Major Repair/Upgrade History	The original oil in these transformers was PCB contaminated. Has been re-processed & retro filled & at present are going through a non-pcb certification process.
Condition	Overall condition of transformer is very good.
Spare Parts Availability	N/A
Comments	Non-PCB certification may take another three years.
Minimum Life Expectancy	Based on their present condition & operation these transformers should last for another 25-30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: 600 V MOTOR CONTROL CENTRES FOR Unit 1**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	600 motor control centres supplied by General Electric.
Reliability History	Reliability of these MCCs has been very good.
Maintenance Requirements	Routine maintenance i.e. general cleaning ,inspection & testing is performed on each breaker every six years.
Major Repair/Upgrade History	Most of 600 v GE breakers have been overhauled & refitted with new overload relays and the rest are scheduled for the same during next year.
Condition	Overall condition of these breakers is very good.
Spare Parts Availability	Two complete breakers are available as spares.
Comments	
Minimum Life Expectancy	Based on their present condition & Hydro's maintenance practice, these MCCs should last for another 20-30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1&2 Boiler Controls**	
Prepared by:	R.Leggo
Date:	98-10-28
Description	Boiler control electronics, I/O cards, operator consoles, engineering console, Historian and data logger supplied by Westinghouse
Reliability History	Good; system is well supported by vendor; software can be upgraded
Maintenance Requirements	Changing faulty boards; annual cleaning, inspection, power supply testing; on-going throughout the year such as testing after failures
Major Repair/Upgrade History	All operator console monitors were replaced due to screen burn-in. This is normal and replacement monitors were easily found. Systems were upgraded for Year 2000 compliancy.
Condition	Excellent
Spare Parts Availability	Stocked in warehouse; available from vendor or repaired by vendor
Comments	Unit 1 was installed in 1987. The systems are well maintained and the technicians are well trained. These systems have not caused any major outages.
Minimum Life Expectancy	Dependent on support from Westinghouse; it may be possible to upgrade the processors and cards as the systems age; estimate 10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1 Uninterruptible Power Supply (UPS)**	
Prepared by:	R.Leggo
Date:	98-11-02
Description:	Exide model PWP50 UPS
Reliability History	Good
Maintenance Requirements	Annual maintenance done by manufacturer
Major Repair/Upgrade History	Unit 1 UPS was replaced in 1997.
Condition	Excellent
Spare Parts Availability	Good
Comments	This equipment has worked quite well.
Minimum Life Expectancy	10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1&2 Overall Instrumentation**	
Prepared by:	R.Leggo
Date:	98-11-02
Description	Instrumentation not included in other systems
Reliability History	Good
Maintenance Requirements	Yearly on all field equipment; operating plant so problems are fixed as they occur
Major Repair/Upgrade History	All transmitters were replaced during the controls upgrade in 1987/88. The drives and actuators are original.
Condition	Good
Spare Parts Availability	Readily available.
Comments	
Minimum Life Expectancy	10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1 Turbine Board**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Turbine Control Board in Control Room
Reliability History	Good but some devices should be replaced.
Maintenance Requirements	Annual inspection
Major Repair/Upgrade History	Relays that control the logic for the turning gear should be replaced. Some of the controls should be transferred to the Westinghouse DCS.
Condition	Fair
Spare Parts Availability	No parts available on site but replacement devices should be possible.
Comments	Some of this equipment may be replaced if the EHC change out goes ahead.
Minimum Life Expectancy	2 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1 Burner Management**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Burner management programmable logic controller (PLC) and operator consoles; valves, solenoids & other equipment on burner front maintained by instrument shop
Reliability History	Good for PLC & operator consoles; valve seals wear out on the burner front
Maintenance Requirements	Changing faulty cards; annual inspection & cleaning; on-going throughout the year such as testing after problems occur Valves on the burner front are overhauled yearly
Major Repair/Upgrade History	The PLC processor was upgraded from a Modicon model 884 to a 984 in 1995. The I/O cards were not changed. The operator consoles were replaced with PC based ones in 1995.
Condition	Good-PLC & operator consoles; burner front good with upgrading
Spare Parts Availability	Readily available
Comments	
Minimum Life Expectancy	10 years; can be easily upgraded by replacing processor

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1 Turbine Supervisory Instrumentation System**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	TSI monitoring system and turbine mounted probes supplied by Bently Nevada
Reliability History	Good
Maintenance Requirements	Some checks done annually; probes and calibrations are done during major outages
Major Repair/Upgrade History	The TSI was replaced on Unit 1 in 1990 . The software and hardware for analysis is being upgraded and made Year 2000 compliant.
Condition	Good
Spare Parts Availability	Readily available
Comments	
Minimum Life Expectancy	Dependent on support from Bently Nevada; estimate 10 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Units 1 Electro hydraulic Controls (EHC)**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Electronic portion and applicable equipment in front standard
Reliability History	The electronic portion has been very good. There have been failed solenoids and relays in the front standard. Future reliability is reduced because if a card fails and there isn't one available in the warehouse, it will take GE a week to provide if they have one available and a month if they have to repair it.
Maintenance Requirements	Annual maintenance involves a cleaning of the cabinet, cards, fans and filters; checking power supply voltages; checking all settings
Major Repair/Upgrade History	PMG in front standard changed to different type.
Condition	The system is 30 years old and it has limited support from GE. The equipment in the front standard is very dirty and oily. It is difficult to troubleshoot.
Spare Parts Availability	Spare parts in the warehouse are 30 years old and they have never been tested. It is not known if these parts will work if needed. GE gave up selling these boards in January/97. They have an exchange program and a repair & return program. GE do not guarantee that all boards will be available for exchange.
Comments	The electrical portion of this system is in the capital budget for replacement in 2003.

Plant: Holyrood Generating Station Unit 1 Component: Units 1 Electro hydraulic Controls (EHC)	
Minimum Life Expectancy	2 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 Component: Units 1 Generator Protection	
Prepared by:	R.Leggo
Date:	98-11-25
Description	Relays for protection of the units
Reliability History	Good
Maintenance Requirements	Cleaning and testing every 2 years
Major Repair/Upgrade History	None
Condition	Good; original equipment but no problems reported
Spare Parts Availability	Some spare relays available; some of the relays are no longer manufactured; replacements would be of a more modern design
Comments	Individual relays will be replaced as needed; no plans to replace all of the relays with a modern multifunction type
Minimum Life Expectancy	5 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Steam Generator and Auxiliaries**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Oil fired steam generator, steam air heaters, air/air heater, combustion air equipment, breeching
Reliability History	Good.
Maintenance Requirements	Routine overhaul/repairs, cleaning and adjustments annually and as required during operating season. Periodic air heater washes and boiler ash removal.
Major Repair/Upgrade History	Major overhaul every 6 years. Breeching replaced 1990. Steam coil air heaters replaced 1992 Boiler was modified in 1990 to increase capability to 175 MW.
Condition	Good. Boiler tube failure rate less than national average.
Spare Parts Availability	Original manufacturer maintains stock of materials and all design/manufacturing information is available.
Comments	Boiler tube samples taken regularly to monitor corrosion rates. Boiler is inspected annually.
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Boiler Vents, Drains and Blowdown**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Valves, piping and hangers from connections on boiler to entry points of building drainage system, vent stacks, flash tank and blowdown tank, including flash tank and blowdown tank and its drain system and safety valves on boiler.
Reliability History	Good.
Maintenance Requirements	Valves require routine maintenance/repair/replacement due to their severe service conditions. Safety valves require regular maintenance, inspection and testing.
Major Repair/Upgrade History	Drains piping from all blowdown tanks to plant drainage system have been replaced. Closer attention being paid to valve condition in recent years as part of energy conservation practices.
Condition	Good. Flash and blowdown tanks and safety valves inspected regularly.
Spare Parts Availability	Good. Piping. Valves and other components available from many manufacturers.
Comments	Safety valves inspected and tested regularly be certified technicians. Periodic NDT to check piping wall thickness and to schedule replacement.
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Bled Steam**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Bled steam piping from connections on turbine to connections on feedwater heaters, including valves, supports and other appurtenances
Reliability History	Good
Maintenance Requirements	Routine inspection and maintenance of valves and hangers. Due to relatively low operating temperatures and pressures, piping is essentially maintenance free.
Major Repair/Upgrade History	None
Condition	Good
Spare Parts Availability	Good. Replacement parts and components are available from many manufacturers.
Comments	Piping and components not subject to significant wear or deterioration.
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Condenser**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Condenser and vacuum pumps
Reliability History	Good. Early problems with tube failures were eliminated by implementing a programme of ferrous sulphate dosing.
Maintenance Requirements	Annual cleaning of tubes/water boxes. Repair of water box coatings as required. Routine maintenance of vacuum pumps
Major Repair/Upgrade History	Eddy current test performed 1997. Condition of tubes good. Condenser tube bundles stiffened in 1990 by inserting synthetic braces, to accommodate higher steam flows resulting from capacity increase from 150 to 175 MW.
Condition	Good
Spare Parts Availability	Good. Tubes available from several sources. Vacuum pump parts available.
Comments	Not a high wear component
Minimum Life Expectancy	20 years minimum.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Circulating Water**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Intake trash racks, travelling screens, pumps, valves, piping from Indian Pond to condenser and from condenser through seal pit to discharge to Conception Bay, including ball cleaning equipment.
Reliability History	Good
Maintenance Requirements	Regular cleaning of trash racks; annual maintenance of travelling screens. Routine maintenance of pumps and valves.
Major Repair/Upgrade History	Pump discharge elbows replaced 1996. Unit 1 condenser discharge pipes replaced 1997. Travelling screen covers have been replaced. Travelling screens overhauled when required. Ferrous Sulphate dosing systems added in 1996 to replace manual dosing method.
Condition	Good
Spare Parts Availability	Good
Comments	Travelling screen require frequent attention due to operation in salt water.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Deaerator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Deaerator heater and storage tank
Reliability History	Good
Maintenance Requirements	Minimal. Regular inspection/testing of safety valve
Major Repair/Upgrade History	Storage tank welds inspected following failure of several deaerators elsewhere. Minor repairs effected
Condition	Good
Spare Parts Availability	Good
Comments	20% of welds checked annually
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: High energy Piping**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Main steam, hot reheat, cold reheat piping
Reliability History	Good
Maintenance Requirements	Minimal. Hangers are inspected and adjusted periodically.
Major Repair/Upgrade History	No significant repairs. As part of the uprate of this unit from 150 to 175 MW in 1990 the piping was examined for longitudinal weld seams (none found) and creep (none found).
Condition	Good
Spare Parts Availability	Good. Tube available from several manufacturers. Hanger parts and replacements readily available.
Comments	Low wear/low maintenance component.
Minimum Life Expectancy	20 years minimum. Typical life expectancy before any concerns arise regarding creep damage is 300,000 + operating hours. This unit has accumulated 110,028 hours.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: High Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	High pressure feedwater piping, heaters, heater drains, boiler feed pumps
Reliability History	Good
Maintenance Requirements	Routine annual maintenance on equipment Periodic assessment of feedwater heater condition.
Major Repair/Upgrade History	High pressure feedwater heaters were replaced in 1986. Boiler feed pumps were upgraded in 1990. Heater drains were upgraded in 1990, but continue to operate inadequately Orifices added to boiler feed pumps in 1998 to prevent excessive flow Motors replaced 1996
Condition	Good.
Spare Parts Availability	Good
Comments	Performance of heater drains system is under review and modifications are expected, to improve performance. Occasional failure of feedwater pumps has been traced to excessive flow under occasional extreme operating conditions. Modifications to pumps in 1998 should eliminate problem.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Low Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Low pressure feedwater extraction pumps, piping to feedwater heaters, feedwater heaters, vents and drains, piping to Deaerator, condensate polishers.
Reliability History	Good Condition of extraction pumps is under review
Maintenance Requirements	Routine annual maintenance on pumps, valves and equipment. Extraction pumps have required frequent attention and their performance/condition is under review.
Major Repair/Upgrade History	Regeneration skid for condensate polisher overhauled 1998 Acid feed line to regeneration skid replaced 1998. Feedwater heater drains piping modified 1998
Condition	Good.
Spare Parts Availability	Good
Comments	Operation of heater drains pump is under review and modifications are expected in 1999/2000.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 1 **Component: Turbine - Generator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Steam turbine, generator, lube oil system, EHC(mechanical), stop and throttle valves
Reliability History	Good
Maintenance Requirements	Major overhaul every 6 years. Routine maintenance and repairs annually. Minor adjustments during operating season.
Major Repair/Upgrade History	High pressure/intermediate pressure rotor replaced 1990 to increase capability to 175 MW. Complete internal inspection by GE service engineer at that time. Additional bearing instrumentation added 1996 Rotor retaining rings replaced 1997 Valves overhauled every three years
Condition	Good
Spare Parts Availability	Good. Spare parts available from manufacturer and a number of after market manufacturers.
Comments	Turbine carefully maintained by OEM under a partnership agreement, contractors, plant staff. Condition excellent.
Minimum Life Expectancy	20 years.

Appendix VIII

Holyrood Generating Station
Condition Assessment Sheets
Unit 2

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Generator Unit 2**	
Prepared by:	Raj Kaushik
Date:	November 25,98
Description	Stator & Rotor Windings
Reliability History	V. Good. Unit 2 had some teething problem with stator windings; however, since 1973 it has operated without any problems for approximately 100,000 hours.
Maintenance Requirements	Routine inspection & testing every year with rotor in and every 6th year with rotor out.
Major Repair/Upgrade History	Hydrogen cooling system was upgraded to match the units uprating. Retaining rings have been replaced with in last six years. Stator was rewedged within last ten years.
Condition	General overall condition is very good.
Spare Parts Availability	No spare available.
Comments	PDA-condition monitoring equipment will be installed over the next couple of years to monitor the stator windings
Minimum Life Expectancy	Based on the present condition , considering Hydro's operating & maintenance practices and life expectancy of similar other units, these generators should provide normal service for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION SYSTEM Unit 2**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	GE static excitation system for unit 2
Reliability History	Acceptable
Maintenance Requirements	Annual routine inspection, testing & maintenance of all components.
Major Repair/Upgrade History	Power supplies replaced. The replacement power supplies were re-engineered and, thus, were quite expensive.
Condition	Overall condition of these exciter units is fair.
Spare Parts Availability	It is very difficult to obtain spare parts for these units. Product support from the manufacturer is also from limited to non-existent.
Comments	Scheduled for replacement in 1999
Minimum Life Expectancy	Present units in their current condition should provide normal service for another 2-3 years. Subsequent to replacement, new units should last for another 30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION TRANSFORMERS Unit 2**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	General Electric oil filled units.
Reliability History	V. Good.
Maintenance Requirements	Annual routine inspection & 5kV meggar test.
Major Repair/Upgrade History	The original oil in the transformer is PCB contaminated. Has been re-processed & retro filled & at present is going through a non-pcb certification process.
Condition	Overall condition is very good.
Spare Parts Availability	N/A
Comments	Non-PCB certification may take another three years.
Minimum Life Expectancy	Based on present condition & operation , should last for another 25-30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: 600 V MOTOR CONTROL CENTRES FOR Unit 2**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	600 motor control centres supplied by General Electric.
Reliability History	Reliability of these MCCs has been very good.
Maintenance Requirements	Routine maintenance i.e. general cleaning ,inspection & testing is performed on each breaker every six years.
Major Repair/Upgrade History	Most of 600 v GE breakers have been overhauled & refitted with new overload relays and the rest are scheduled for the same during next year.
Condition	Overall condition of these breakers is very good.
Spare Parts Availability	Two complete breakers are available as spares.
Comments	
Minimum Life Expectancy	Based on their present condition & Hydro's maintenance practice, these MCCs should last for another 20-30 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Boiler Controls**	
Prepared by:	R.Leggo
Date:	98-10-28
Description	Boiler control electronics, I/O cards, operator consoles, engineering console, Historian and data logger supplied by Westinghouse
Reliability History	Good; system is well supported by vendor; software can be upgraded
Maintenance Requirements	Changing faulty boards; annual cleaning, inspection, power supply testing; on-going throughout the year such as testing after failures
Major Repair/Upgrade History	All operator console monitors were replaced due to screen burn-in. This is normal and replacement monitors were easily found. Systems were upgraded for Year 2000 compliancy.
Condition	Excellent
Spare Parts Availability	Stocked in warehouse; available from vendor or repaired by vendor
Comments	Unit 2 boiler controls were replaced in 1988. The systems are well maintained and the technicians are well trained. These systems have not caused any major outages.
Minimum Life Expectancy	Dependent on support from Westinghouse; it may be possible to easily upgrade the processors and cards as the systems age; estimate 10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Uninterruptible Power Supply (UPS)**	
Prepared by:	R.Leggo
Date:	98-11-02
Description:	Exide model PWP50 UPS
Reliability History	Good
Maintenance Requirements	Annual maintenance done by manufacturer
Major Repair/Upgrade History	Unit 2 UPS was replaced in 1996.
Condition	Excellent
Spare Parts Availability	Good
Comments	This equipment has worked quite well.
Minimum Life Expectancy	10 - 15 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Overall Instrumentation**	
Prepared by:	R.Leggo
Date:	98-11-02
Description	Instrumentation not included in other systems
Reliability History	Good
Maintenance Requirements	Yearly on all field equipment; operating plant so problems are fixed as they occur
Major Repair/Upgrade History	All transmitters were replaced during the controls upgrade in 1987/88. The drives and actuators are original.
Condition	Good
Spare Parts Availability	Readily available.
Comments	
Minimum Life Expectancy	10 - 15 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Turbine Board**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Turbine Control Board in Control Room
Reliability History	Good but some devices should be replaced.
Maintenance Requirements	Annual inspection
Major Repair/Upgrade History	Relays that control the logic for the turning gear should be replaced. Some of the controls should be transferred to the Westinghouse DCS.
Condition	Fair
Spare Parts Availability	No parts available on site but replacement devices should be possible.
Comments	Some of this equipment may be replaced if the EHC change out goes ahead.
Minimum Life Expectancy	2 years; will be replaced in 1999

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Burner Management**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Burner management programmable logic controller (PLC) and operator consoles; valves, solenoids & other equipment on burner front maintained by instrument shop
Reliability History	Good for PLC & operator consoles; valve seals wear out on the burner front
Maintenance Requirements	Changing faulty cards; annual inspection & cleaning; on-going throughout the year such as testing after problems occur Valves on the burner front are overhauled yearly
Major Repair/Upgrade History	The PLC processor was upgraded from a Modicon model 884 to a 984 in 1995. The I/O cards were not changed. The operator consoles were replaced with PC based ones in 1995.
Condition	Good-PLC & operator consoles; burner front good with upgrading
Spare Parts Availability	Readily available
Comments	
Minimum Life Expectancy	10 years; can be easily upgraded by replacing processor

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Turbine Supervisory Instrumentation System**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	TSI monitoring system and turbine mounted probes supplied by Bently Nevada
Reliability History	Good
Maintenance Requirements	Some checks done annually; probes and calibrations are done during major outages
Major Repair/Upgrade History	The TSI was replaced in 1991. The software and hardware for analysis is being upgraded and made Year 2000 compliant.
Condition	Good
Spare Parts Availability	Readily available
Comments	
Minimum Life Expectancy	Dependent on support from Bently Nevada; estimate 10 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 2 Electro hydraulic Controls (EHC)**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Electronic portion and applicable equipment in front standard
Reliability History	The electronic portion has been very good. There have been failed solenoids and relays in the front standard. Future reliability is reduced because if a card fails and there isn't one available in the warehouse, it will take GE a week to provide if they have one available and a month if they have to repair it.
Maintenance Requirements	Annual maintenance involves a cleaning of the cabinet, cards, fans and filters; checking power supply voltages; checking all settings
Major Repair/Upgrade History	PMG in front standard changed to different type.
Condition	The system is 30 years old and it has limited support from GE. The equipment in the front standard is very dirty and oily. It is difficult to troubleshoot.
Spare Parts Availability	Spare parts in the warehouse are 30 years old and they have never been tested. It is not known if these parts will work if needed. GE gave up selling these boards in January/97. They have an exchange program and a repair & return program. GE do not guarantee that all boards will be available for exchange.
Comments	The electrical portion of this system is in the capital budget for replacement in 2000 for Unit 2.

Plant: Holyrood Generating Station Component: Unit 2 Electro hydraulic Controls (EHC)	
Minimum Life Expectancy	2 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Component: Unit 2 Generator Protection	
Prepared by:	R.Leggo
Date:	98-11-25
Description	Relays for protection of the units
Reliability History	Good
Maintenance Requirements	Cleaning and testing every 2 years
Major Repair/Upgrade History	None
Condition	Good; original equipment but no problems reported
Spare Parts Availability	Some spare relays available; some of the relays are no longer manufactured; replacements would be of a more modern design
Comments	Individual relays will be replaced as needed; no plans to replace all of the relays with a modern multifunction type
Minimum Life Expectancy	5 years, or as long as parts are available

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Steam Generator and Auxiliaries**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Oil fired steam generator, steam air heaters, air/air heater, combustion air equipment, breeching
Reliability History	Good.
Maintenance Requirements	Routine overhaul/repairs, cleaning and adjustments annually and as required during operating season. Periodic air heater washes and boiler ash removal.
Major Repair/Upgrade History	Major overhaul every 6 years. Breeching replaced 1991. Steam coil air heaters replaced 1992 Boiler was modified in 1991 to increase capability to 175 MW.
Condition	Good. Boiler tube failure rate less than national average.
Spare Parts Availability	Original manufacturer maintains stock of materials and all design/manufacturing information is available.
Comments	Boiler tube samples taken regularly to monitor corrosion rates. Boiler is inspected annually.
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Boiler Vents, Drains and Blowdown**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Valves, piping and hangers from connections on boiler to entry points of building drainage system, vent stacks, flash tank and blowdown tank, including flash tank and blowdown tank and its drain system and safety valves on boiler.
Reliability History	Good.
Maintenance Requirements	Valves require routine maintenance/repair/replacement due to their severe service conditions. Safety valves require regular maintenance, inspection and testing.
Major Repair/Upgrade History	Drains piping from all blowdown tank to plant drainage system has been replaced. Closer attention being paid to valve condition in recent years as part of energy conservation practices.
Condition	Good. Flash and blowdown tanks and safety valves inspected regularly.
Spare Parts Availability	Good. Piping. Valves and other components available from many manufacturers.
Comments	Safety valves inspected and tested regularly be certified technicians. Periodic NDT to check piping wall thickness and to schedule replacement.
Minimum Life Expectancy	20 years. Repair and replacement programme can extend the life indefinitely.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Bled Steam**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Bled steam piping from connections on turbine to connections on feedwater heaters, including valves, supports and other appurtenances
Reliability History	Good
Maintenance Requirements	Routine inspection and maintenance of valves and hangers. Due to relatively low operating temperatures and pressures, piping is essentially maintenance free.
Major Repair/Upgrade History	None
Condition	Good
Spare Parts Availability	Good. Replacement parts and components are available from many manufacturers.
Comments	Piping and components not subject to significant wear or deterioration.
Minimum Life Expectancy	20 years. Life can be extended almost indefinitely.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Condenser**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Condenser and vacuum pumps
Reliability History	Good. Early problems with tube failures were eliminated by implementing a programme of ferrous sulphate dosing.
Maintenance Requirements	Annual cleaning of tubes/water boxes. Repair of water box coatings as required. Routine maintenance of vacuum pumps
Major Repair/Upgrade History	Eddy current test performed 1998. Condition of tubes good. Condenser tube bundles stiffened in 1991 by inserting synthetic braces, to accommodate higher steam flows resulting from capacity increase from 150 to 175 MW.
Condition	Good
Spare Parts Availability	Good. Tubes available from numerous sources. Vacuum pump parts available.
Comments	Not a high wear component
Minimum Life Expectancy	20 years minimum. Life is almost infinite, as long as good maintenance practices are followed.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Circulating Water**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Intake trash racks, travelling screens, pumps, piping, valves from Indian Pond to condenser and from condenser through seal pit to discharge to Conception Bay, including ball cleaning equipment.
Reliability History	Good
Maintenance Requirements	Regular cleaning of trash racks; annual maintenance of travelling screens. Routine maintenance of pumps and valves.
Major Repair/Upgrade History	Pump discharge elbows replaced 1996. Unit 1 condenser discharge pipes replaced 1997. Travelling screen covers have been replaced. Travelling screens overhauled when required Ferrous Sulphate dosing systems added in 1996 to replace manual dosing method.
Condition	Good
Spare Parts Availability	Good
Comments	Travelling screen require frequent attention due to operation in salt water.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Deaerator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Deaerator heater and storage tank
Reliability History	Good
Maintenance Requirements	Minimal. Regular inspection/testing of safety valve
Major Repair/Upgrade History	Storage tank welds inspected following failure of several deaerators elsewhere. Minor repairs effected
Condition	Good
Spare Parts Availability	Good
Comments	20% of welds checked every year
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: High Pressure Piping**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Main steam, hot reheat, cold reheat piping
Reliability History	Good
Maintenance Requirements	Virtually nil. Hangers are inspected and adjusted periodically.
Major Repair/Upgrade History	No significant repairs. As part of the uprate of this unit from 150 to 175 MW in 1991 the piping was examined for longitudinal weld seams (none found) and creep (none found).
Condition	Good
Spare Parts Availability	Good. Tube available from several manufacturers. Hanger parts and replacements readily available.
Comments	Low wear/low maintenance component.
Minimum Life Expectancy	20 years minimum. Typical life expectancy before any concerns arise regarding creep damage is 300,000 operating hours. This unit has accumulated 101,610 hours.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: High Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	High pressure feedwater piping, heaters, heater drains, boiler feed pumps
Reliability History	Good
Maintenance Requirements	Routine annual maintenance on equipment Periodic assessment of feedwater heater condition.
Major Repair/Upgrade History	High pressure feedwater heaters were replaced in 1989. Boiler feed pumps were upgraded in 1989. Heater drains were upgraded in 1989, but continue to operate inadequately Orifices added to boiler feed pumps in 1998 to prevent excessive flow Motors replaced 1994
Condition	Good.
Spare Parts Availability	Good
Comments	Performance of heater drains system is under review and modifications are expected, to improve performance. Occasional failure of feedwater pumps has been traced to excessive flow under occasional extreme operating conditions. Modifications to pumps in 1998 should eliminate problem.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Low Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Low pressure feedwater extraction pumps, piping to feedwater heaters, feedwater heaters, vents and drains, piping to Deaerator, condensate polishers.
Reliability History	Good Condition of extraction pumps is under review
Maintenance Requirements	Routine annual maintenance on pumps, valves and equipment. One feedwater heater replaced Extraction pumps have required frequent attention and their performance/condition is under review.
Major Repair/Upgrade History	Regeneration skid for condensate polisher overhauled 1997 Acid feed line to regeneration skid replaced 1998. Feedwater heater drains piping modified 1998
Condition	Good.
Spare Parts Availability	Good
Comments	Operation of heater drains pump is under review and modifications are expected in 1999/2000. Condition of extraction pumps to be assessed.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 2 **Component: Turbine/Generator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Steam turbine, generator, lube oil system, EHC(mechanical), stop and throttle valves
Reliability History	Good
Maintenance Requirements	Major overhaul every x years. Routine maintenance and repairs annually. Minor adjustments during operating season.
Major Repair/Upgrade History	High pressure/intermediate pressure rotor replaced 1992 to increase capability to 175 MW. Complete internal inspection by GE service engineer at that time. Additional bearing instrumentation added 1996 Rotor retaining rings replaced 1994 Valves overhauled every three years
Condition	Good
Spare Parts Availability	Good. Spare parts available from manufacturer and a number of after market manufacturers.
Comments	Turbine carefully maintained by OEM under a partnership agreement, contractors, plant staff. Condition excellent.
Minimum Life Expectancy	20 years.

Appendix IX

Holyrood Generating Station
Condition Assessment Sheets
Unit 3

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Generator unit 3**	
Prepared by:	Raj Kaushik
Date:	November 25,98
Description	Stator & Rotor Windings
Reliability History	V. Good. Unit 3 have operated over 76,000 hours in generation mode and over 11,000 hours in sync condenser mode without any problem with stator or rotor windings.
Maintenance Requirements	Routine inspection & testing every year with rotor in and every 6^{th} year with rotor out.
Major Repair/Upgrade History	Stator was rewedged in 1985. Retaining rings are scheduled to be replaced in the year 2001.
Condition	General overall condition is very good.
Spare Parts Availability	No spare bars are available.
Comments	PDA-condition monitoring equipment will be installed on this unit in 2001 to monitor the stator windings .
Minimum Life Expectancy	Based on the present condition , considering Hydro's operating & maintenance practices and life expectancy of similar other units, this generator should provide normal service for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION SYSTEM UNIT 3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	Westinghouse static excitation system for unit 1&2
Reliability History	Good.
Maintenance Requirements	Annual routine inspection, testing & maintenance of all components. Moveable motorized pots drift a lot.
Major Repair/Upgrade History	Power supplies were re-engineered & replaced in 1991.
Condition	Overall condition of this exciter unit is good.
Spare Parts Availability	Most critical spare parts are either in store or readily available from the manufacturer.
Comments	May have to be replaced due to obsolescence.
Minimum Life Expectancy	This unit is expected to last another 10 years before replacement.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: EXCITATION TRANSFORMERS UNIT 3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	Westinghouse dry type unit.
Reliability History	V. Good.
Maintenance Requirements	Annual routine inspection & 5kV meggar test.
Major Repair/Upgrade History	None.
Condition	Overall condition of this transformer is very good.
Spare Parts Availability	N/A
Comments	.
Minimum Life Expectancy	Based on its present condition & operation this transformer should last for another 30-35 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: 600 V MOTOR CONTROL CENTRES FOR UNIT 3**	
Prepared by:	Raj Kaushik
Date:	NOVEMBER 30,98
Description	600 motor control centres for unit 3 supplied by FPE.
Reliability History	Reliability of these MCCs has been acceptable.
Maintenance Requirements	Routine maintenance i.e. general cleaning ,inspection & testing is performed on each breaker every six years.
Major Repair/Upgrade History	All of these breakers either have gone through or are scheduled for a major overhaul.
Condition	Overall condition of these breakers is good.
Spare Parts Availability	One complete breaker is available as spare.
Comments	Contacts of these breakers require more than normal replacement.
Minimum Life Expectancy	Based on their present condition & Hydro's maintenance practice, these MCCs should last for another 20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Synchronous Condenser Controller**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Synchronous Condenser Drive Controller Model Mark V by Philadelphia Gear Corporation
Reliability History	It does not work properly during start-up. This can cause delays in getting the unit up to speed.
Maintenance Requirements	Only used for part of the year. A technician is often needed to run-up the unit manually from the local control panel.
Major Repair/Upgrade History	The controller is scheduled to be replaced in 1999.
Condition	It works but does not give the operator all of the control he needs.
Spare Parts Availability	No longer available from manufacturer
Comments	Report has been written on need to replace.
Minimum Life Expectancy	Will be replaced in 2000

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit # 3 Logic Cubicles**	
Prepared by:	R.Leggo
Date:	98-11-02
Description	Three cubicles of relays for control of Unit 3 equipment in the plant. They are also used as junction boxes between plant equipment and the boiler controls cabinets.
Reliability History	The cubicles are congested with a great amount of wiring. A condition report from the plant (97-11-21) says that "plant reliability seriously jeopardized with the condition of the panels especially when troubleshooting ".
Maintenance Requirements	Little maintenance done. Faulty relays or terminations fixed during troubleshooting.
Major Repair/Upgrade History	Approximately 75 relays and timers were removed and 20-30 cables were added during the boiler controls upgrade.
Condition	Limited space to work; bases of the cubicles are covered with wiring; poor wire labelling
Spare Parts Availability	Not applicable
Comments	The plant issued a report about the condition and it had possible solutions listed. They suggested a capital budget for 2001 but it was not prepared by GET.
Minimum Life Expectancy	Estimate 10 years if not replaced for safety or maintenance reasons.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Uninterruptible Power Supply (UPS)**	
Prepared by:	R.Leggo
Date:	98-11-02
Description	CTS UPS
Reliability History	Good
Maintenance Requirements	Yearly inspection; settings checked and corrected, if needed
Major Repair/Upgrade History	No major repairs; some card replacements; PCB capacitors replaced
Condition	Good
Spare Parts Availability	Good supply of parts in warehouse
Comments	UPS in capital budget for replacement in 2001.
Minimum Life Expectancy	Will be replaced within 5 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Overall Instrumentation**	
Prepared by:	R.Leggo
Date:	98-11-03
Description	Instrumentation not included in other systems
Reliability History	Good
Maintenance Requirements	Yearly on all field equipment; operating plant so problems are fixed as they occur
Major Repair/Upgrade History	The turbine has original Hitachi transmitters in many areas. Approximately 50% of transmitters have been replaced on the boiler. The drives such as on fan dampers are original.
Condition	Good
Spare Parts Availability	Good; some parts can be supplied by manufacturers other than the original.
Comments	
Minimum Life Expectancy	10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Boiler Controls**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Boiler control system electronics, I/O cards, operator consoles, engineering console, Historian and data logger supplied by Westinghouse
Reliability History	Good; system is well supported by vendor; software can be upgraded
Maintenance Requirements	Changing faulty boards; annual cleaning, inspection, power supply testing; on-going throughout the year such as testing after problems
Major Repair/Upgrade History	System was upgraded for Year 2000 compliance.
Condition	Excellent
Spare Parts Availability	Stocked in warehouse; available from vendor or repaired by vendor
Comments	The system was installed in 1994.It is well maintained and the technicians are well trained.
Minimum Life Expectancy	Dependent on support from Westinghouse; it may be possible to upgrade processors and cards as the system ages; estimate 15 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Burner Management**	
Prepared by:	R. Leggo
Date:	998-10-29
Description	Burner management system electronics, I/O cards, operator consoles
Reliability History	Good, system is well supported by vendor; software can be upgraded
Maintenance Requirements	Changing faulty boards; annual cleaning, inspection, power supply testing; on-going throughout the year such as testing after problems
Major Repair/Upgrade History	System was upgraded for Year 2000 compliance
Condition	Excellent
Spare Parts Availability	Stocked in warehouse; available from vendor or repaired by vendor
Comments	This is a Westinghouse DCS that was installed in 1994. It is well maintained and the technicians are well trained.
Minimum Life Expectancy	Dependent on support from Westinghouse; it may be possible to upgrade processors and cards as the system ages; estimate 15 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Turbine Supervisory Instrumentation**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	TSI monitoring system and turbine mounted probes supplied by Bently Nevada
Reliability History	Good
Maintenance Requirements	Some checks done annually; probes and calibrations are done during major outages.
Major Repair/Upgrade History	The TSI was replaced in 1994. The software and hardware for analysis is being upgraded and made Year 2000 compliant.
Condition	Good
Spare Parts Availability	readily available
Comments	
Minimum Life Expectancy	Dependent on support from Bently Nevada; estimate 15 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Turbine Control**	
Prepared by:	R.Leggo
Date:	98-10-29
Description	Indicators and DC motors to interface with front standard flyball governor
Reliability History	Good
Maintenance Requirements	Replacement of indicators when necessary
Major Repair/Upgrade History	An indicator was replaced.
Condition	Good; indicators should be replaced
Spare Parts Availability	Available in warehouse; if needed from Hitachi (Japan) there is a 1 year delivery
Comments	The governor is integral to the turbine and the only parts under P&C are the DC motors and indicators.
Minimum Life Expectancy	5 - 10 years; may transfer function to Westinghouse WDPF system

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station **Component: Unit 3 Generator Protection**	
Prepared by:	R.Leggo
Date:	98-11-25
Description	Relays for protection of the unit
Reliability History	Good
Maintenance Requirements	Cleaning and testing every 2 years
Major Repair/Upgrade History	None
Condition	Good; original equipment but no problems reported
Spare Parts Availability	Some spare relays available; some of the relays are no longer manufactured; replacements would be of a more modern design
Comments	Individual relays will be replaced as needed; no plans to replace all of the relays with a modern multifunction type
Minimum Life Expectancy	10 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Steam Generator and Auxiliaries**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Oil fired steam generator, steam air heaters, air/air heater, combustion air equipment, breeching
Reliability History	Good.
Maintenance Requirements	Routine overhaul/repairs, cleaning and adjustments annually and as required during operating season. Periodic air heater washes and boiler ash removal.
Major Repair/Upgrade History	Major overhaul every 6 years. Sections of reheater tubing and supports damaged and require replacement within 5 years. Breeching and expansion joints replaced Fuel pumps being replaced this year Internal tube deposits indicate that an internal chemical cleaning will be required within 5 years.
Condition	Good. Boiler tube failure rate less than national average.
Spare Parts Availability	Original manufacturer maintains stock of raw materials and all design/manufacturing information is available.
Comments	Boiler tube samples taken regularly to monitor corrosion rates. Boiler is inspected annually.
Minimum Life Expectancy	20 years.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Boiler Vents, Drains and Blowdown**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Valves, piping and hangers from connections on boiler to entry points of building drainage system, vent stacks, flash tank and blowdown tank, including flash tank and blowdown tank and its drain system and safety valves on boiler.
Reliability History	Good.
Maintenance Requirements	Valves require routine maintenance/repair/replacement due to their severe service conditions. Safety valves require regular maintenance, inspection and testing.
Major Repair/Upgrade History	Drains piping from all blowdown tank to plant drainage system has been replaced. Closer attention being paid to valve condition in recent years as part of energy conservation practices.
Condition	Good. Flash and blowdown tanks and safety valves inspected regularly.
Spare Parts Availability	Good. Piping. Valves and other components available from many manufacturers.
Comments	Safety valves inspected and tested regularly be certified technicians. Periodic NDT to check piping wall thickness and to schedule replacement.
Minimum Life Expectancy	20 years. Repair and replacement programme can extend the life indefinitely.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Bled Steam**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Bled steam piping from connections on turbine to connections on feedwater heaters, including valves, supports and other appurtenances
Reliability History	Good
Maintenance Requirements	Routine inspection and maintenance of valves and hangers. Due to relatively low operating temperatures and pressures, piping is essentially maintenance free.
Major Repair/Upgrade History	None
Condition	Good
Spare Parts Availability	Good. Replacement parts and components are available from many manufacturers.
Comments	Piping and components not subject to significant wear or deterioration.
Minimum Life Expectancy	20 years. Life can be extended almost indefinitely.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Condenser**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Condenser and vacuum pumps
Reliability History	Good.
Maintenance Requirements	Annual cleaning of tubes/water boxes. Repair of water box coatings as required. Routine maintenance of vacuum pumps
Major Repair/Upgrade History	Condenser partially retubed 1982(3). A recent Eddy current test indicated that the condition of the tubes is good. Water box lining replaced 1996
Condition	Good
Spare Parts Availability	Good. Tubes available from numerous sources. Vacuum pump parts available.
Comments	Not a high wear component
Minimum Life Expectancy	20 years minimum. Life is almost infinite, as long as good maintenance practices are followed.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Circulating Water**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Intake trash racks, travelling screens, pumps, piping, valves from Indian Pond to condenser and from condenser through seal pit to discharge to Conception Bay, including ball cleaning equipment.
Reliability History	Good
Maintenance Requirements	Regular cleaning of trash racks; annual maintenance of travelling screens. Routine maintenance of pumps and valves.
Major Repair/Upgrade History	Travelling screens overhauled when required. Ferrous Sulphate dosing systems added in 1996 to replace manual dosing method.
Condition	Good
Spare Parts Availability	Good
Comments	Travelling screen require frequent attention due to operation in salt water.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Deaerator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Deaerator heater and storage tank
Reliability History	Good
Maintenance Requirements	Minimal. Regular inspection/testing of safety valve
Major Repair/Upgrade History	Storage tank welds inspected following failure of several deaerators elsewhere. Minor repairs effected
Condition	Good
Spare Parts Availability	Good
Comments	20% of welds checked every year
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: High Temperature Piping**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Main steam, hot reheat, cold reheat piping
Reliability History	Good
Maintenance Requirements	Virtually nil. Hangers are inspected and adjusted periodically.
Major Repair/Upgrade History	No significant repairs. examined for longitudinal weld seams (none found) and creep (none found).
Condition	Good
Spare Parts Availability	Good. Tube available from several manufacturers. Hanger parts and replacements readily available.
Comments	Low wear/low maintenance component. Periodic surface replication to check for creep planned.
Minimum Life Expectancy	20 years minimum. Typical life expectancy before any concerns arise regarding creep damage is 300,000 operating hours. This unit has accumulated 76,155 hours.

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: High Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	High pressure feedwater piping, heaters, heater drains, boiler feed pumps
Reliability History	Good
Maintenance Requirements	Routine annual maintenance on equipment Periodic assessment of feedwater heater condition.
Major Repair/Upgrade History	High pressure feedwater heaters were replaced in 1997. Feed pump recirculation valves will be replaced in 1998/99
Condition	Good.
Spare Parts Availability	Good
Comments	
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Low Pressure Feedwater**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Low pressure feedwater extraction pumps, piping to feedwater heaters, feedwater heaters, vents and drains, piping to Deaerator, condensate polishers.
Reliability History	Good
Maintenance Requirements	Routine annual maintenance on pumps, valves and equipment.
Major Repair/Upgrade History	Regeneration skid for condensate polisher overhauled 1997 Acid feed line to regeneration skid replaced 1998. Feedwater heater drains piping modified 1998
Condition	Good.
Spare Parts Availability	Good
Comments	Operation of heater drains pump is under review and modifications are expected in 1999/2000.
Minimum Life Expectancy	20 years

PLANT CONDITION ASSESSMENT 1998

Plant: Holyrood Generating Station Unit 3 **Component: Turbine/Generator**	
Prepared by:	John Mallam
Date:	98-11-10
Description	Steam turbine, generator, lube oil system, EHC(mechanical), stop and throttle valves
Reliability History	Good
Maintenance Requirements	Major overhaul every 6 years. Routine maintenance and repairs annually. Minor adjustments during operating season. Valves overhauled every three years
Major Repair/Upgrade History	Additional bearing instrumentation added 1996(?). Rotor retaining rings will be replaced in 2001
Condition	Good. First IP stage blade erosion problem requires blade replacement every 8 - 10 years
Spare Parts Availability	Good. Spare parts available from manufacturer and a number of after market manufacturers.
Comments	Turbine carefully maintained by OEM, contractors, plant staff. Condition excellent.
Minimum Life Expectancy	20 years.