NEWFOUNDLAND POWER INC.

MOBILE GAS TURBINE
PLANNED REFURBISHMENT 2003
PROJECT JUSTIFICATION

Prepared By:
Jack W. Casey P. Eng.

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Introduction

The Newfoundland Power Mobile Gas Turbine set consists of a fully packaged turbo-generator on one road trailer together with control systems and a power transformer on a second trailer. Hawker Siddeley Canada Limited, Orenda Division, originally supplied the unit. The unit was acceptance tested on site in Newfoundland in 1974. In 1990 the gas generator was replaced with a refurbished unit. In recent years the unit has been operating from Grand Bay substation in the Port Aux Basques area.

The basic trailer package is almost thirty years old and is in need of refurbishment. The gas generator, power turbine and alternator are in good condition and if maintained properly can operate for another ten or fifteen years. However the auxiliary systems, control systems and mechanical structure requires refurbishment to ensure reliable operations. The mobile nature of the unit introduces a unique set of operating conditions. Minor damage to the unit frequently happens during transport between sites, causing delays in unit preparation and ultimately leads to premature failure of some components. Recent inspections have identified items that require immediate attention.

Mobile Gas Turbine Applications

The Mobile Gas Turbine (MGT) fills a dual role at Newfoundland Power. Most frequently the unit is located at Grand Bay substation and is available to provide generation in the event of a loss of infeed from Newfoundland & Labrador Hydro. The MGT is also available for relocation to other sites for construction projects and emergency generation.

Construction Projects & Emergency Situations

The MGT consists of two trailers, one housing the turbo-generator and a second housing the control systems and the power transformer. A third trailer (fuel tanker) is available for transport with the MGT to other locations in the Province. Both Newfoundland Power and Newfoundland and Labrador Hydro use the MGT to provide local generation in support of construction projects where the normal connection to the power grid is unavailable. This allows both utilities to complete substation and transmission line projects without exposing the customer to prolonged power interruptions.

The other mobile application for the MGT is the supply of emergency generation to both Newfoundland Power and Newfoundland and Labrador Hydro customers in the event of catastrophic system failures. The harsh climate in Newfoundland causes severe damage to substation and transmission equipment. At 7 MW the MGT is the largest single piece of mobile generation equipment available within the Province.

Port Aux Basques

Newfoundland Power bases the MGT at Grand Bay substation in the Port Aux Basques area. The normal source of supply for customers in the Port Aux Basques area is through the infeed on Newfoundland and Labrador Hydro transmission line TL214/TL215. This is a 145 km long radial line from Bottom Brook substation and passes through the infamous Wreckhouse area in Western Newfoundland. TL214/TL215 require scheduled maintenance and experience frequent weather related outages. Transmission related outages in the Port Aux Basques area has accounted for below average customer outage statistics for SAIDI (5.4 hours) and SAIFI (4.0). As a result the MGT is used to support scheduled maintenance as well as to provide an emergency source of generation.

Role in Port Aux Basques

The introduction of the Rose Blanche Hydroelectric Development to the southwest coast power system has created some issues with respect to operating isolated from the interconnected grid. The MGT, being the unit with the ability to respond to load swings faster than either the GM diesel or Rose Blanche hydro plant, is operated as the lead machine on the network. The governor on the MGT must respond to load fluctuations in unison with Rose Blanche hydro plant. Delays in response, or an inability to maintain a reliable 60 Hz supply will cause instability in the system. These instabilities will result in load rejection at Rose Blanche hydro plant and customer interruptions will be experienced.

There is a documented problem transferring the MGT from Droop to Isochronous mode causing a “bump” on the power system. During this event Rose Blanche will typically respond by rejecting load, which in turn causes the system to slip in frequency. To overcome this problem Newfoundland Power has had to station personnel at the Rose Blanche hydro plant when running isolated. The travel time to get an operator to the plant causes additional delays when attempting to restore power to customers in the area. Replacing the governor with a digital device designed to operate in tandem with other generating units on this network, will improve operations significantly, and remove the requirement to man Rose Blanche plant during power outages.

Scope of Work

The 2003 Capital Budget project covers the refurbishment of the Mobile Gas Turbine generator set. The work identified in this document is the result of information provided by the local operators and a review of the most recent inspection reports (included in Appendix B). A summary of the operators log identifying failed starts is included in Appendix A.

It is Newfoundland Power's intention that the unit be transported to an appropriate facility where the refurbishment and subsequent acceptance testing be completed. The project Scope of Work includes the following:

Generator Protection and Control

Replace the existing hydraulic governor with programmable logic controller (PLC) based technology including a digital governor and incorporating the sequencing logic for the system. Included with the protection and control system will be an automatic synchronizer, digital voltage regulator and a digital generator protection relay. A digital differential protection relay will be required for the power transformer.

Included, as part of the PLC control system will be an LCD screen display and associated pushbuttons and switches necessary for operation of the system from the control panels in the trailer control room. Also a personal computer based Human Machine Interface for operating the system locally in the trailer control room, or remotely from an associated substation building will be provided.

Instrumentation

The existing instrumentation on the gas generator and power turbine will need to be modernized to provide reliable inputs to the control system. This includes replacing the vibration monitoring system (including sensors) on the generator and gas turbine shafts with a system designed for remote monitoring. Interference picked up in the cable harness between trailers has been the cause of many false trips on the unit. It should be noted that original equipment manufacturer Orenda recommended improvements to vibration monitoring in the 1998 inspection.

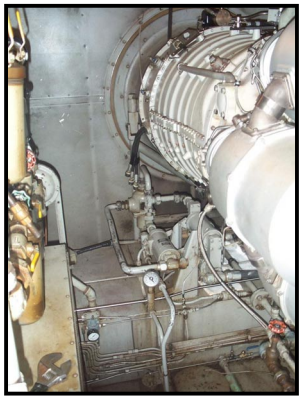
It is also necessary to replace the exhaust gas temperature thermocouples and wiring harness on gas generator. It has been our experience that poor quality signals from these older devices are not tolerated by the newer digital control systems. Failure of these devices in service will result in the loss of the MGT from service with delays in facilitating repairs, as the thermocouples are located in the hot exhaust path of the unit.

Power Cables

The system of power cables between output terminals of the generator and the generator breaker in the controls trailer is complex in design. There are a series of short cables, terminations and elbows that must be established whenever the unit is relocated. The fixed sections of these cables need a thorough inspection with repairs completed as required.

The interconnecting cables receive the most abuse during transport of the unit and are in the worst condition. At a minimum the replacement of the interconnecting power cables between the two trailers with new cables will be completed.

Fuel Control



The existing fuel system including AC and DC pumping units should be made more reliable. Transfers from DC to AC, and from station service AC to alternator AC occur at critical times during system run-up. For example, the transfer from station service AC to alternator AC occurs at the same time as the generator breaker is closed-in. This transfer has been the cause of numerous customer outages and unit trips. One option is to replace the existing fuel valve and install fuel flow meters to provide better and more timely information when problems occur. Another solution would be to consolidate the two pumps and fuel valve with a regulated fuel supply. The advantage of this alternate approach is a simplification of the system design and possibility the creation of some free space in the vicinity of the fuel day tank. To enhance the environmental conditions within the power trailer it will be necessary to modify the fuel day tank to include provision for containing a spill.

Power Transformer Maintenance

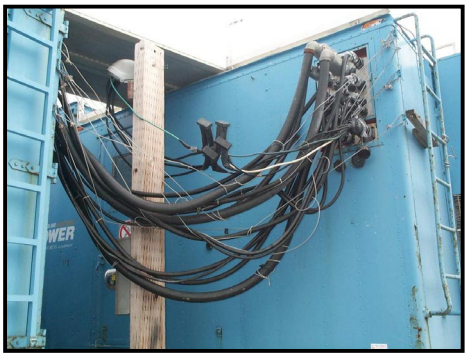
The power transformer is due for an inspection and overhaul. It is recommended that this work be completed while the unit is out of Province to take advantage of the time the unit is unavailable. Otherwise it would be necessary to schedule an additional outage once the unit has been returned to service. The additional work required includes the repair or replacing of valves and oil

flow indicators. The unit will also be painted, removing any rust that has developed on the equipment.

Miscellaneous Electrical

The electrical systems in the unit are largely original to the 1974 construction. The manual transfer switch used to connect the auxilary power unit (APU) to the electrical distribution system must be inspected and if necessary replaced with a modern design. This will ensure current safety codes are followed and spare parts are available in the future. Associated with the transfer switch is the Allan-Bradley Motor Control Center. This motor control center is original to the unit and should be modernized to ensure a supply of parts into the future. It may be possible to refurbish the existing contactors as opposed to replacing the entire Motor Control Center.

The work will also include replacing the existing auxiliary power cables between the two trailers. These cables as shown in the attached picture are deteriorated and require considerable effort to connect and disconnect. The system could be redesigned for quicker connection and disconnection to shorten preparation time when transporting the unit for emergency purposes.



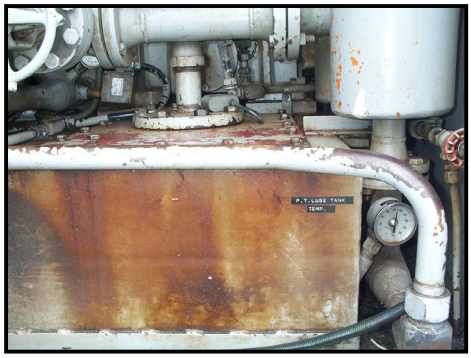
It will be important to ensure that the grounding system is reestablished after the unit has been refurbished. New 4/0 copper grounding will be installed for all new equipment enclosures.

There are some enhancements that will improve the utility of the MGT. The installation a SCADA Remote Terminal Unit (RTU) will allow the MGT to be monitored and controlled from the System Control Center. The SCADA RTU will interface with the PLC controller through a DNP communications link. The RTU will be used primarily to monitor the unit in stand-by or in operation.

The installation of a distribution feeder Recloser on the high voltage side of the power transformer will remove the requirement to transport a circuit breaker whenever the MGT is relocated. Once again the goal is to simplify the relocation of the MGT and reduce the preparation time in emergency situations. The Recloser will interface with the SCADA RTU through a DNP communications link.

Miscellaneous Mechanical

While the MGT is at the factory an opportunity exists to complete some necessary maintenance on the unit. The lubricating oil in the gas turbine will be replaced and the contractor will modify the existing lubricating oil heater system to provide a re-circulating oil flow. At present the stationary lubricating oil is heated and there is a resulting carbon buildup in the oil. The contractor will also modify the lube oil tank to include provision for spill containment to meet environmental guidelines.



Orenda recommended a new trailer leveling system be designed and installed in their 1998 inspection report. This work will be completed in the factory.

The contractor will replace the existing aluminum bolts used to secure the intake louvers with stainless steel fasteners. Orenda identified this item in the 1998 inspection. While the louvers are disassembled the contractor will repair or refurbish the motors in the air intake system and install a differential pressure switch in the louver. Orenda also identified this item in the 1998 inspection.

Orenda identified the front engine oil seal on the gas generator for replacement in the 1998 inspection. Work on this item has been deferred in anticipation of returning the trailer to the factory. The trailer structure does not provide a support system for moving the gas generator forward for access; therefore this work is better suited for the factory.

Damage to the combustion cans was identified in the 1998 inspection and these faults may have propagated to the point where further service may no longer be possible. This item will be investigated in the 2002 inspection and will be confirmed before the project goes to tender.

It will be necessary to refurbish the access doors to the filter house. Orenda identified this item in the 1998 inspection. Finally the contractor will check and repair cracks in the exhaust stack and remove all remaining asbestos on the exhaust stacks.

Alternatives

It has been Newfoundland Power's experience that there is a need for standby generation in the Port Aux Basques area. This has been proven by the number of times when the power system has been operated in isolation from the provincial grid.

A 7 MW mobile generating unit is ideally suited to match the load of nearly all of NP's rural feeders. Unfortunately, small gas turbines (suitable for mobile applications) are no longer commonly manufactured. The largest mobile gas turbines now fall into the 3-4 MW range. Two units in this size range would be required to replace the existing mobile gas turbine. This would have a negative impact on the utility of this generating package as the logistics of transporting the units becomes more complex as the number of trailers increases. In addition, a larger unit may have to be purchased to fully substitute for the existing mobile gas turbine. The expected life of a new unit is approximately 25 years, compared with the 15 years of remaining life estimated on the existing mobile gas turbine. A 1999 Request for Information issued to gas turbine suppliers by Newfoundland Power indicated that a new 4 MW unit would cost $3.5 to $4 million and therefore replacement of the full capacity with new would cost approximately $7.5 million.

More recent quotes for refurbished gas turbines indicate prices on the order of $500/kW. Therefore, the capacity necessary to replace the existing unit could be acquired for approximately $4 million. The expected life of a refurbished unit is approximately 20 years, compared with the 15 years remaining on the existing unit.

Appendix C provides a comparison of these various alternatives to the proposed rehabilitation of the mobile gas turbine. These analyses show that based on a 25 year project life, the annual cost of each of these 3 alternatives are as follows:

2 x 4.0 MW new mobile gas turbines	levelized annual cost = $935,000
2 x 3.8 MW refurbished gas turbines	levelized annual cost = $695,000
Proposed PAB MGT refurbishment	levelized annual cost = $505,000

Recommendation

Newfoundland Power should proceed with plans to refurbish the Mobile Gas Turbine in the summer of 2003. To ensure the integrity of those parts not scheduled for replacement, a thorough inspection of the MGT by the original equipment manufacturer is to be completed as soon as possible. This inspection is scheduled for October 2002. If the results of this external inspection confirm the information gathered in house, then tenders for the project should be called following Public Utilities Board approval for the project.

Appendix A
Mobile Gas Turbine Operators Log

Mobile Gas Turbine
Operators Log

April 18, 1997

- MGT failed to start due to governor problems. Diaphragm had to be replaced on suction of metering valve. The unit was very erratic when on line with large load, however, unit settle down after a short time.

October 1, 1997

- MGT would not pick-up more than 1.5 mw on black start. Unit had to shut down and restarted. Everything okay.

November 4, 1997

- Controller on governor had to be adjusted to get more load out of unit because the fuel valve was damaged. The fuel valve wasn't replaced (impact damage to the fuel valve port caused by fuel pump)

December 19, 1997

- MGT was very erratic when placed on line with a large load on unit, however, unit settled down after a short time and everything was okay.

July 29, 1998

- MGT tripped on low fuel pressure when the MGT-B was closed. There were problems with the H.P. fuel pump, repairs were competed and everything was okay.

July 30, 1998

- There was trouble with speed control switch (governor) on the MGT. Unit was okay after several adjustments was made to the speed control switch.

October 27, 1998

- MGT was very erratic when placed on line and unit had to be shut down. Unit was restarted and everything was okay.

January 26, 1999

- MGT was very erratic when place on line, however, the unit settled down after a short time and everything was okay.

June 15, 1999

- MGT would not start due to problems with DC power inverter. This unit had to be replaced before unit could be started.

July 27, 1999

- MGT would not start due to faulty fuel metering valve position or actuator motor loss. The relay for this valve had to be removed and cleaned because there were problems getting a replacement unit.

September 2, 1999

- MGT would not start because of problems with 18L relay. This relay had to jumpered out before the unit could be started.

April 25, 2000

- MGT would not start due to problems with DC power inverter. This unit had to replaced before the unit could be started.

May 6, 2000

- MGT was very erratic when placed on line with a large load. (4.0 MW) The unit was okay after on line for a short time.

December 25, 2000

- MGT tripped off line when a coil burnted out for the DC Fuel pump starter. This coil had to be replaced before the unit could be placed back on line.

January 22, 2001

- MGT would not start due to faulty circuit board in annunciator panel and had to be replaced before the unit could be started.

February 26, 2001

- MGT was very erratic when placed on line with large load. (4.2 MW). The unit was okay after on line for a short time.

March 28, 2001

- MGT tripped off line on G.G. Lube Pressure Low. This was caused when the relay for low lube oil pressure burnt out. This relay had to be replaced before the unit could be started.

December 7, 2001

- MGT was very erratic when placed on line with large load. The unit would not settle down and had to taken off line. A resister had to be replaced in the speed switch before the unit could be placed back on line.

January 24, 2002

- MGT tripped off line due to over speed. This was caused by a faulty speed switch and had to jumpered out until a replacement could be found.

January 28, 2002

- MGT tripped off line when 86-unit relay and unit control DC breaker tripped. This was caused when a coil for the liquid fuel valve burnt out. The coil had to be replaced before the unit could be restarted.

February 11, 2002

- MGT would not pick up more than 2.0 MW on black start and had to be shut down. More load had to dropped before the unit could be started a placed back on line. Also the power supply for the DC power inverter tripped and had to be reset before the unit could be started. The unit usually could pick up blocks of load of 3 MW, however the unit can now only pick up 2.0 MW on black start.

June 12 – 16, 2002

- MGT would not pick any load when MGT-G-B was closed and would trip on reverse power. A number of resisters had to be replaced for the governor's droop setting.

June 21, 2002

- MGT tripped off line when RBH tripped off line. The unit at Rose Blanche dropped approximately 2.5 MW, however, the MGT could not pick up the load and tripped off line.

August 28, 2002

- MGT tripped off line due to low fuel pressure. This was caused when the AC breaker burnt out on the 120 volt battery charger. The breaker in the battery charger had to be replaced before then could be started.

Appendix B
Inspection Reports

Orenda
Governor Inspection

Prepared By : John Budgell

01/03/30

Port Aux Basque Gas Turbine

The unit was started on March 28th as part of the regular scheduled test run.. The machine was synchronized and loaded to 3500 kw , operators were in the process of increasing the load when the unit tripped on GG low oil pressure . A motor run was performed and the GG oil pressure gauge and GG speed monitored .There was no evidence of any build up at GG speeds of 500 rpm, the unit should build up 1 or 2 psi with the pumps turning at low rpm. The GG lube oil pressure gauge was changed and another motor run check performed with the same result . The unit was shut down to inspect the GG lube oil pump , scavenge and aux scavenge oil pumps . The magnetic chip detector and screens were checked for signs of possible oil pump drive gear failure. The screens contained a small amount of non metallic debris , the chip detector was clean.

The pumping unit was removed from the engine carcass . The quill shaft was checked and found to be good condition with no evidence of wear on the tooth drive . The pump cover plates were removed from the oil , scavenge and auxiliary scavenge pumps . The quill shaft was inserted and the pumps manually rotated to check the pump drive gears. These checked ok , the pump was cleaned and the covers installed . The bevel drive was checked and the pump assembly was installed on the engine.

A pressure transducer was connected to the oil supply line and the engine speed and pressure were monitored with a data logger . the unit was motored to 700 rpm a small pressure increase noted prior to shutdown . A test run was preformed the unit tripped on GG low oil pressure , during the test, relay 63 GGL was chattering . The pressure switch contacts were checked ok . The relay coil at this point had failed open circuit , the relay was replaced and the unit re started. The unit was placed on line GG lube oil supply pressure 18 psi. There is no significant increase in lube oil pressure until the GG reached 1000 rpm . See the attached chart showing lube oil pressure vs GG speed.

During the test there were severe speed fluctuations during loading . This has been intermittent problem with the unit over the last couple of years .The chart labeled, Gas Generator Speed Oscillation, shows speed swings of 614 rpm during loading. Photo of the combustion can shows the heat damage to the combustor during a run in January when the machine was surging during online operation supplying local load .

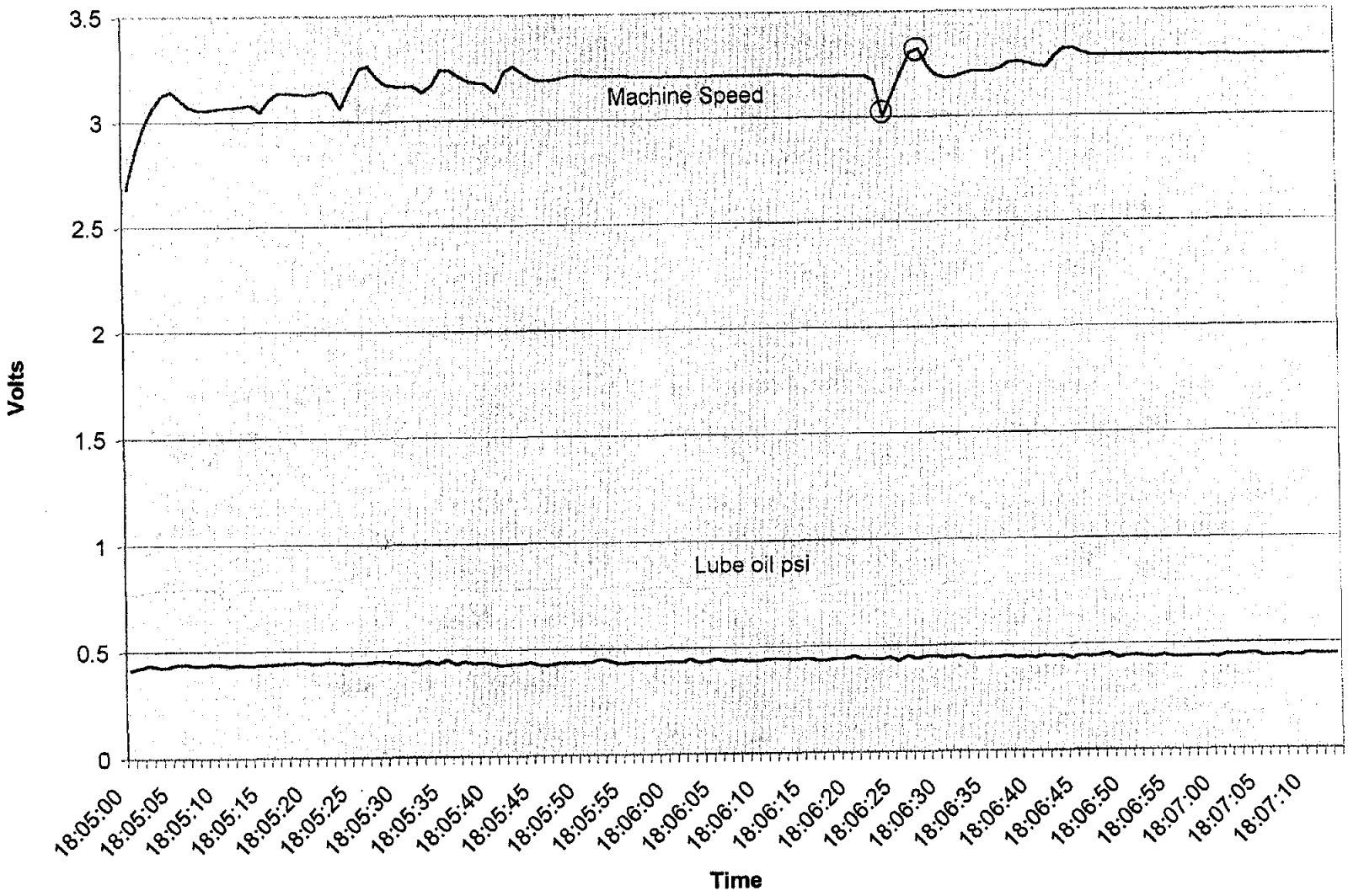
June 12th 2001
Modified the fuel drain system . The existing configuration had the distributor fuel bypass line connected to the combustion can drain lines and routed an external container under the power turbine trailer. See figure 3-2. The distributor bypass was re routed to the day tank. A ¼" NPT S/S nipple was welded in the day tank inspection cover to accept the distributor bypass line, and the flow divider capped off .

The day tank was inspected and found to be contaminated with rust and silt. Ran the unit on line to burn the majority of the fuel and pumped the remainder of the fuel into a waste oil drum. Monitored N1 & N2 speed channels during the run , 8.25 vdc & 4.35vdc respectively. See data sheet for on line values. The unit was taken out of service. The bottom of the tank was heavily pitted, most likely from condensation in the tank and or water in the fuel supply. Scraped the bottom of the tank and vacuumed out the tank. See photos 1 and 2. The day tank drain valve was replaced with a 2" brass ball valve and plug. The original valve and connecting pipe was plugged with silt and dirt.

Removed the power turbine speed pick up cover plates and inspected the wiring and locking nuts for possible loose connection . These checked out ok . Checked the interconnecting cable for the analog speed and EGT channels (connector D4). One pin was found to be shorter than the rest with pitting on the end of the pin, this turned out to be a thermocouple connection for the EGT on the right side of the stack. The remaining pins were soiled and tarnished , these were burnished and sprayed with contact cleaner. This may have been the source of the stability problem , a high impedance connection of the PT speed pick ups to the Woodward N2 amplifier would cause a malfunction of the governor speed control circuits.

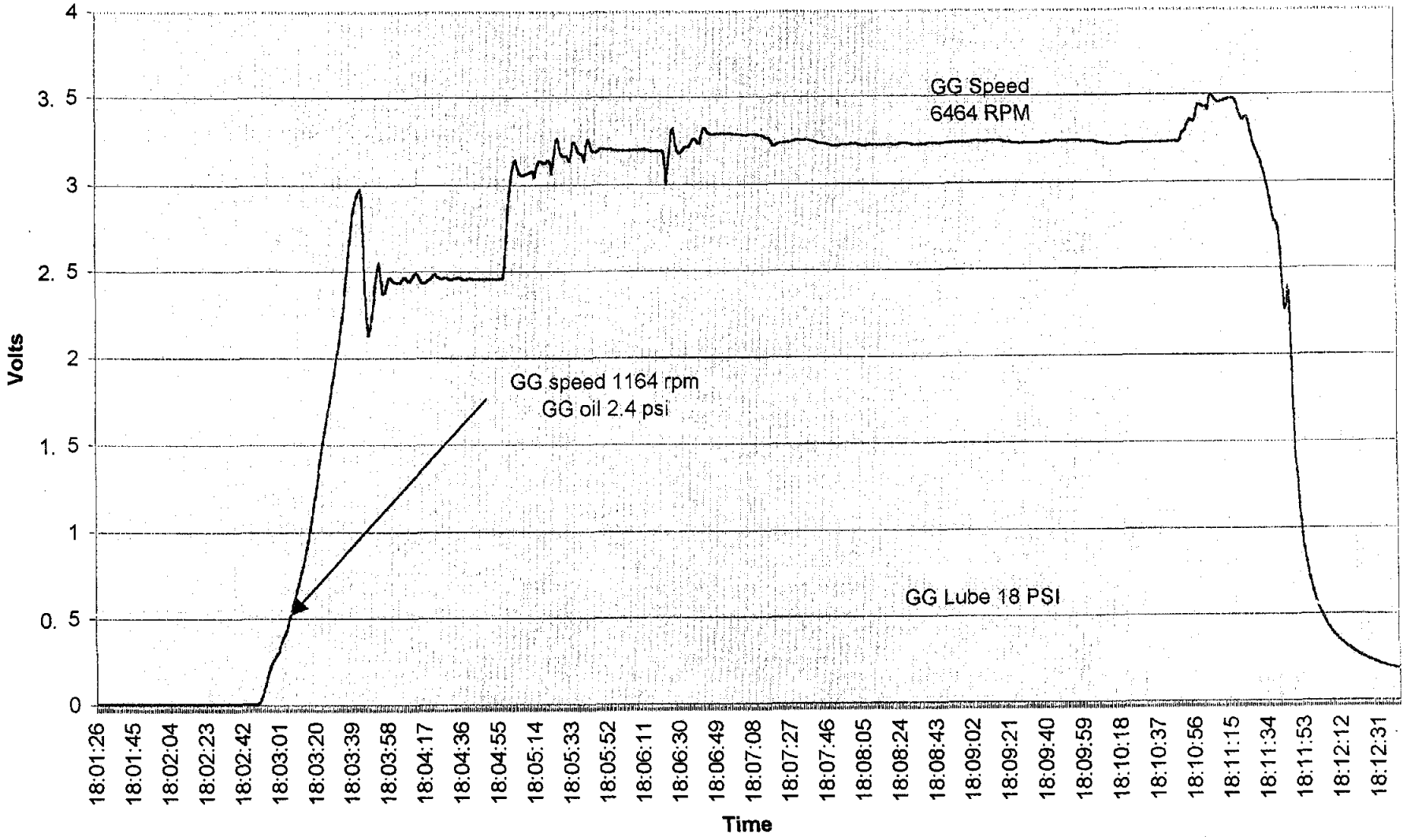
Test run, the unit started fine with cool light off temperature 407 degrees C . The unit was manually synchronized and loaded to 6000 kw in 1000kw increments, monitoring fuel angle , N1 ,N2 , and CDP engine parameters See data sheet and chart for details. The unit was started again the following day to check the governor operation , the unit started fine and loaded to full load with excellent speed regulation through out the entire load range.

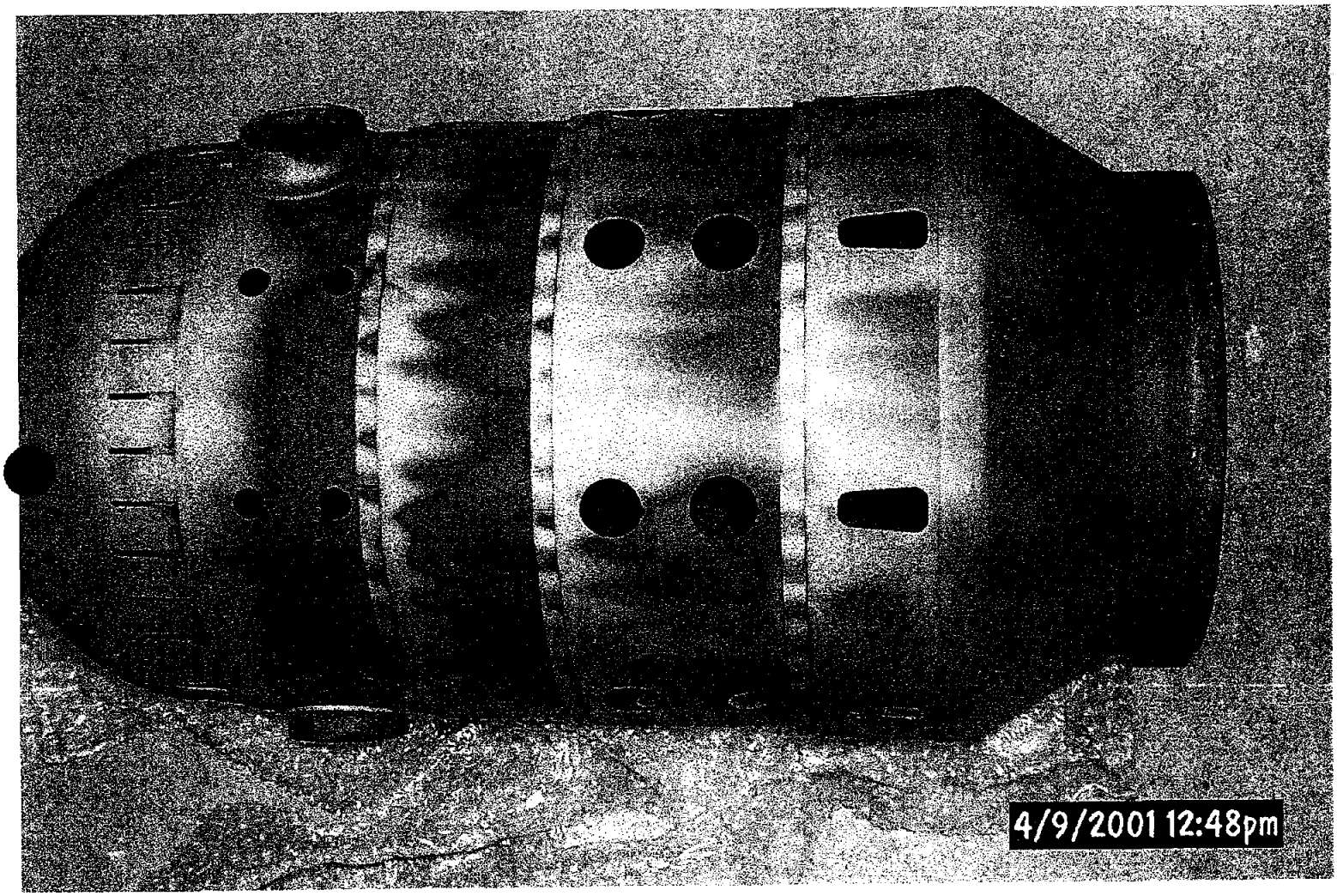
Gas Generator Speed Oscillation



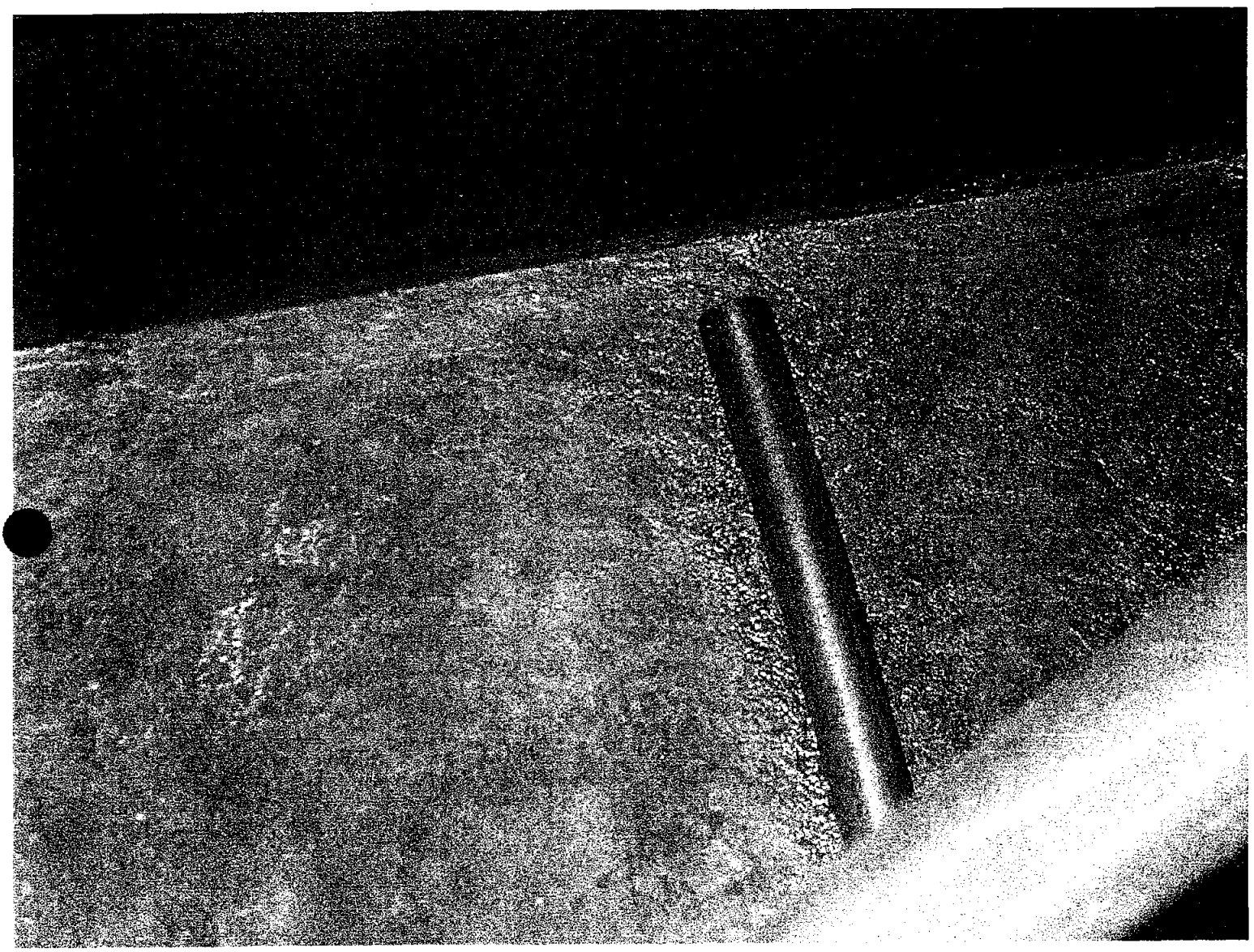
614 RPM pk to pk

Gas Generator Lube Oil Pressure & GG Speed



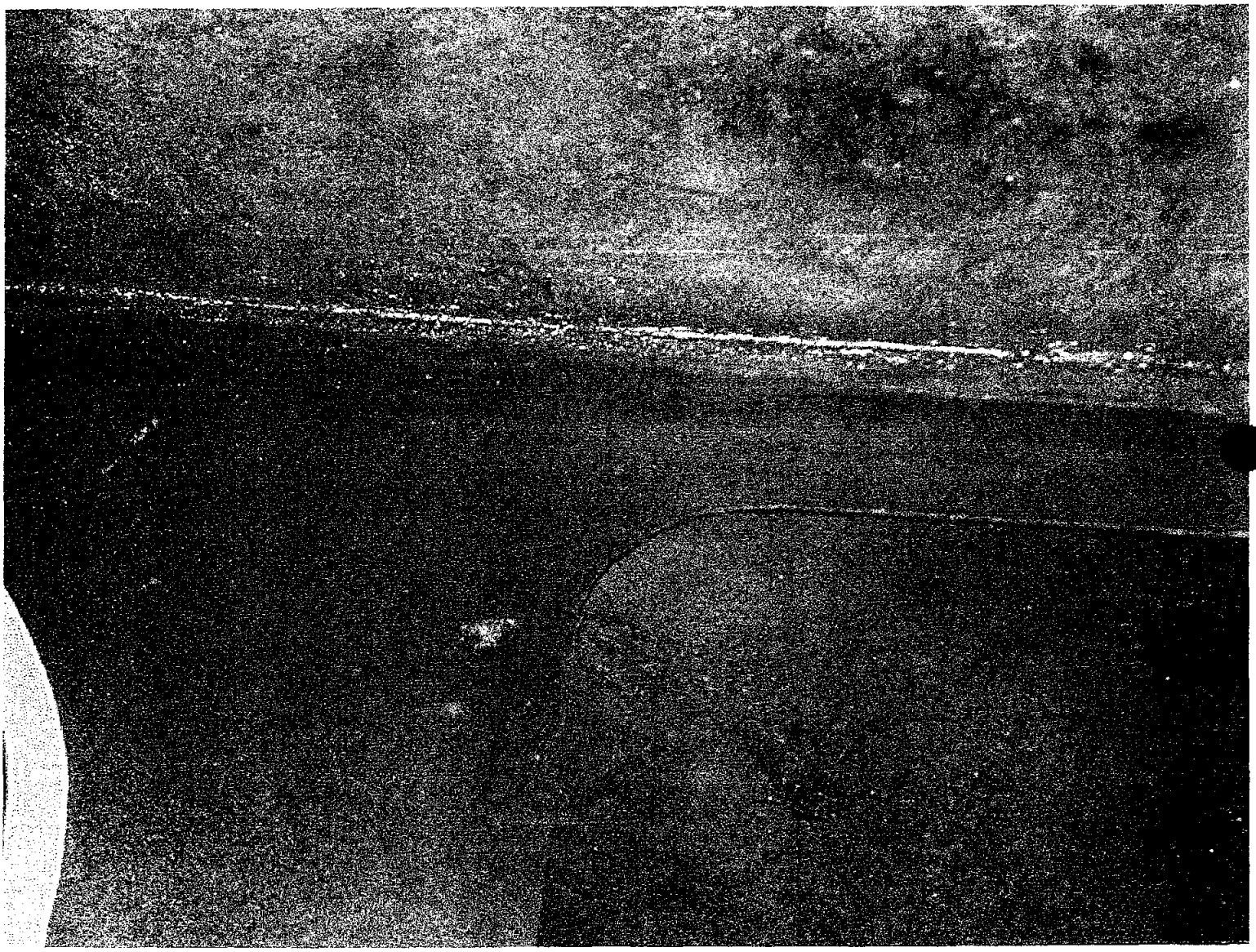


Overheating of the combustion can due to surging on the governor



Portable G.T. Day Tank

Rust & Scale cleaned from the bottom of tank



			CDP & FUEL VALVE ANGLE		
LOAD	N1 VDC	N2 VDC	CDP GAUGE	CDP VDC	FUEL ANGLE
			PSI		
0	8.24	7.11	0	0.5	5
1000	8.25	1.87	25	0.91	4.91
2000	8.26	2.99	31	1.03	4.79
3000	8.26	3.91	37.5	1.14	4.7
4000	8.26	4.49	43	1.24	4.66
5000	8.25	4.95	47	1.33	4.61
6000	8.25	5.91	52	1.42	4.56
5000	8.26	5.04	49	1.33	4.59
4000	8.26	4.39	44.5	1.23	4.66
3000	8.26	4	40	1.15	4.2
2000	8.26	3.09	34	1.03	4.81
1000	8.27	2.05	26.5	0.92	4.91
Note: Light off 407 deg C					
Ambient 22 deg C					
Fuel Angle 5 vdc to 4.5 vdc Minimum fuel to maximum fuel					
CDP Transducer 0 to 300 psi 0.5 vdc to 5 vdc					

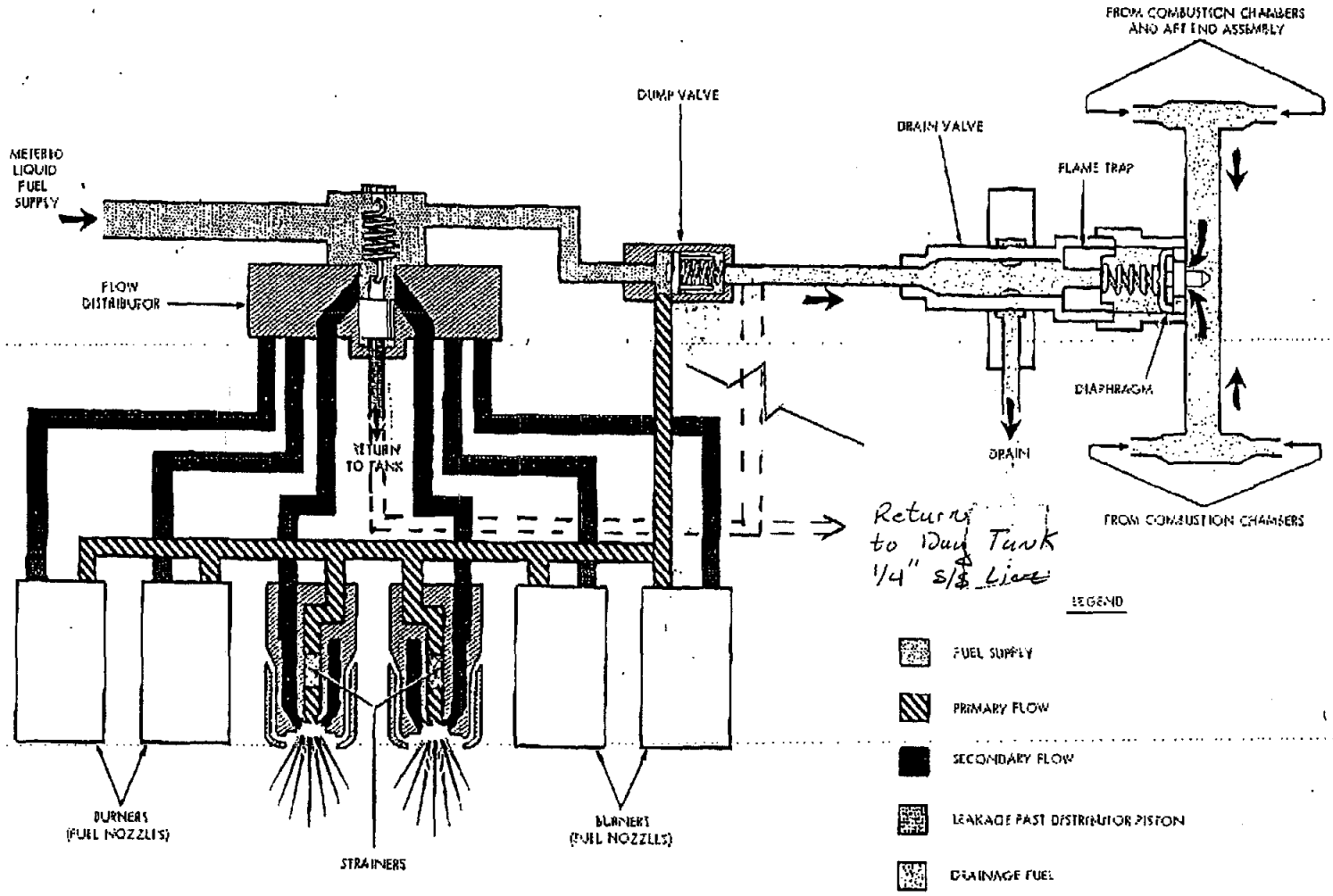
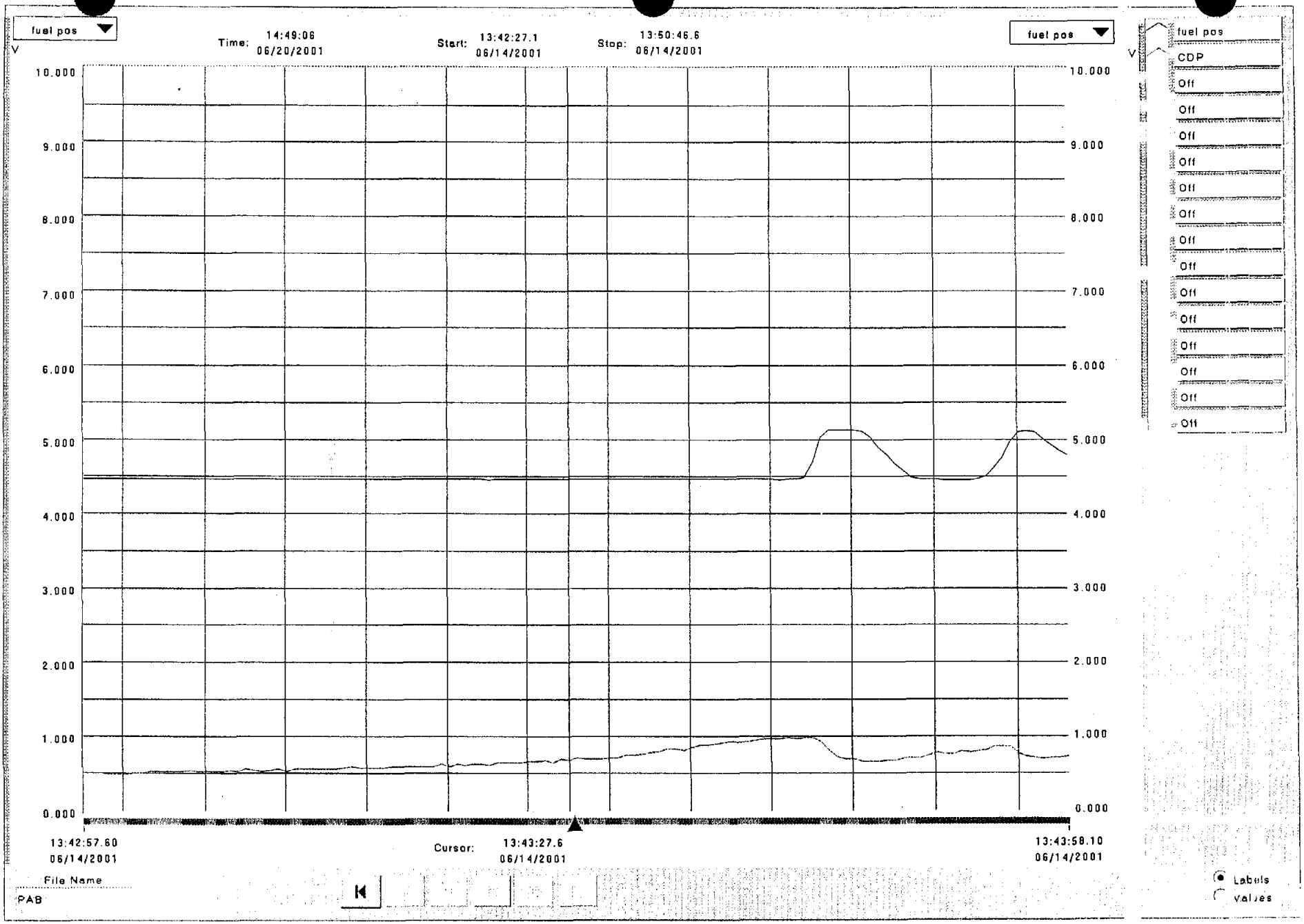
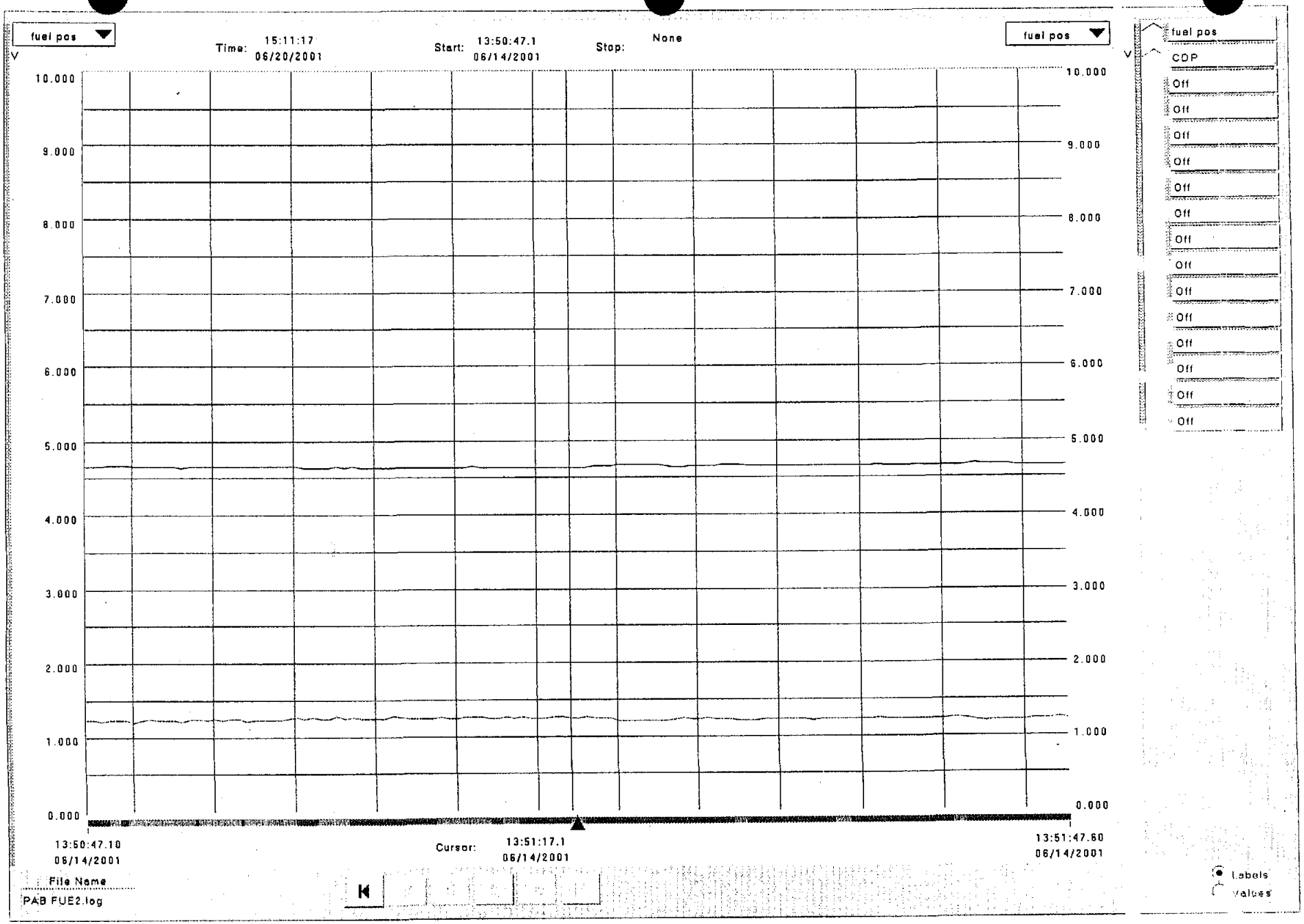
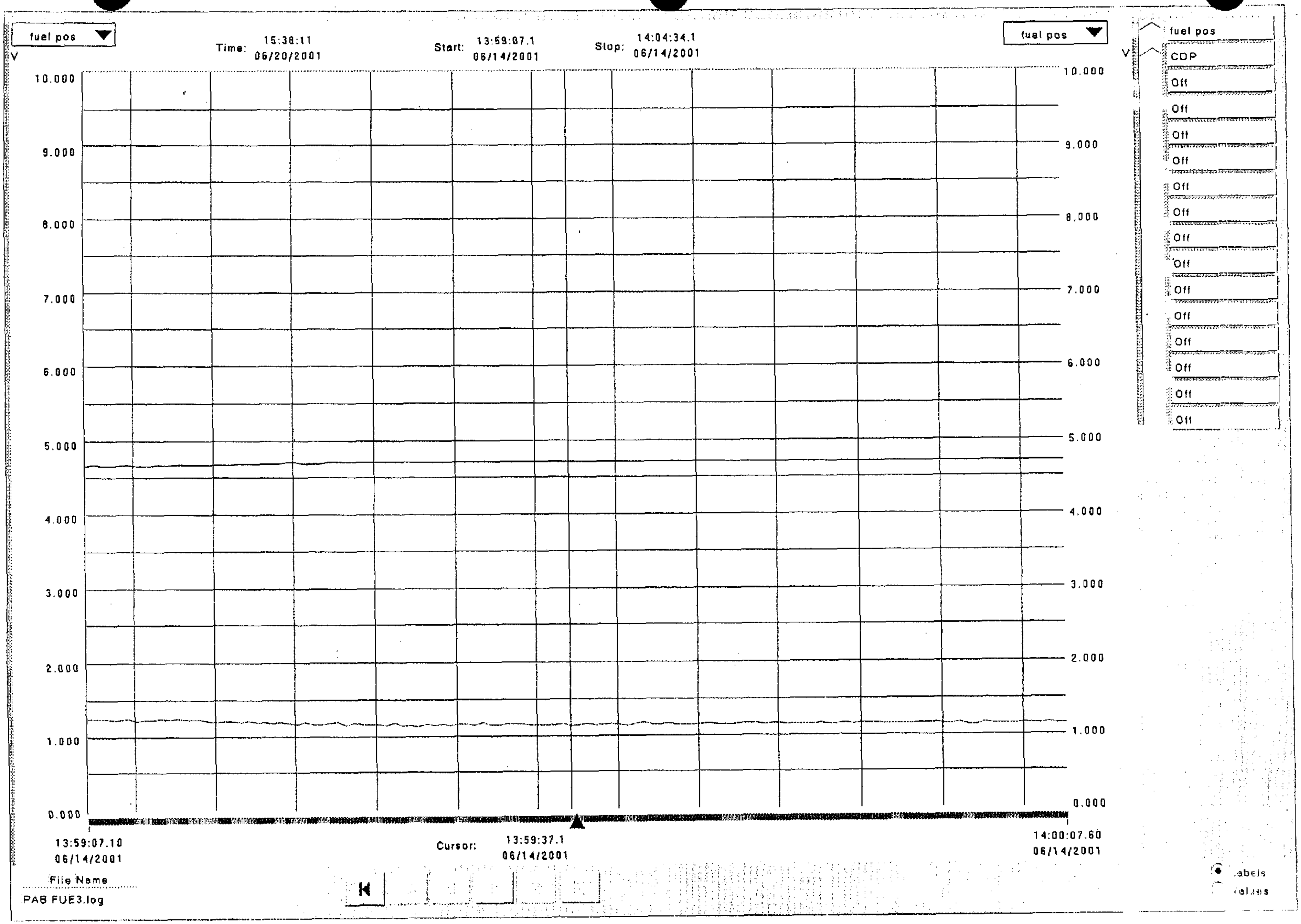


Figure 3-2 Gas Generator - Liquid Fuel System Schematic

ATT/ JOHN BUDGELL
The line coming from the center of the fuel distributor valve is tied into the drain valve instead of going back to the tank


fuel pos
V
Time: 14:49:06
06/20/2001
Start: 13:42:27.1
06/14/2001
Stop: 13:50:46.6
06/14/2001
fuel pos
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
13:42:57.60
06/14/2001
Cursor: 13:43:27.6
06/14/2001
13:43:58.10
06/14/2001
File Name
PAB
fuel pos
CDP
Off
Labels
Values


fuel pos
V
Time: 15:11:17
06/20/2001
Start: 13:50:47.1
06/14/2001
Stop: None
fuel pos
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
13:50:47.10
06/14/2001
Cursor: 13:51:17.1
06/14/2001
13:51:47.60
06/14/2001
File Name
PAB FUE2.log
fuel pos
CDP
Off
Labels
Values


fuel pos
Time: 15:38:11 06/20/2001
Start: 13:59:07.1 06/14/2001
Stop: 14:04:34.1 06/14/2001
fuel pos
V
10.000
9.000
8.000
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0.000
fuel pos
CDP
Off
13:59:07.10 06/14/2001
Cursor: 13:59:37.1 06/14/2001
14:00:07.60 06/14/2001
File Name
PAB FUE3.log

Port Aux Basque
Gas Turbine
Inspection
File # 401.01.01.48.04

Prepared By: John Budgell

Oct 30, 2000

Met with representatives from, Orenda Aerospace, Herb Phillips & Martyn Hexter. Reviewed the operating history of the unit and discussed several recent operating concerns. One being the excessive amount of fuel discharging from the combustor drains during operation.

Engine History:	Unit # 5055 Engine # 5907
Original Engine	replaced on Nov 22 1990
Number of starts	1171
Original Engine Elapsed Time	1096 hrs
Number of starts On new engine	698
New Engine Elapsed Time	868 hrs

Preformed a motoring run to check oil consumption prior to starting the unit. Excessive starter clutch slippage was evident during the motor run and engine test. The unit was placed on line and loaded to 5500 kW. Ran the unit for I hour and measured the fuel discharge from the combustor drains to be approximately 1 gallon. The oil consumption was measured at 2 quarts the unit ran fine, smooth acceleration and cool light off temperature of 384 degrees c. The engine data was recorded see test data 00/10/30. The interconnectors & combustor sealing rings were checked for leaks. The GG lube oil thermo bulb gasket was leaking, new gaskets ordered

The unit was taken out of service for inspect. The combustion cans were removed for inspection. The casings were dismantled and visually inspected for buckling, cracking, and general wear of components. The balance pipes and suspension tubes were inspected for fretting and cracking at the root of the slots. The combustion liners were inspected with particular attention given to the, front section around the balance pipe & suspension tube bosses, the swirlers and the snout sections. The following is a breakdown of the general condition of each combustor.

#1
Casing in good condition no signs of discoloration around the balance tubes or split line gaskets
Flame tube in good condition, no visual signs of cracking or buckling.
The balance pipes and suspension tubes are in good condition
Reassembled with all new gaskets

#2
The casing is in good condition, some slight discoloration around the split line gasket
Irregularities in coating thickness on the mating flanges filed true
Flame tube had several cracks around the balance pipe exceeding the recommended allowable limits of ¼". There were several cracks around this area see attached sketch and photo.
The tube was marked for repair / replacement.
The balance pipe and suspension tubes are in good condition
Reassembled with an aero derivative flame tube on loan from Orenda

#3
The casing is in good condition, slight discoloration around the split line. The flanges were filed true.
Flame tube had one crack in the wiggle strip above the balance pipe boss 3/16" long.
The balance pipe and suspension tube are in good condition
Reassembled with all new gaskets.

#4
The casing is in good condition, no signs of discoloration
The flame tube has 2 cracks in the window section, one $3/16^{th}$ of an inch long, one $1/8^{th}$ of an inch long. Tube is serviceable
The balance pipe and the suspension tube are in good condition.
Reassembled with all new gaskets

5
The casing is in good condition, slight discoloration around the split line gasket
The flame tube is in good condition no visible signs of cracking.
The balance pipe and suspension tube are in good condition
Reassembled with all new gaskets

#6
The casing is in good condition no discoloration
The flame tube has two cracks, one in the window section $1/16^{th}$ of an inch long and one in the wiggle strip $1/16^{th}$ of an inch long. The tube is serviceable.
The balance pipe and suspension tube are in good condition
Reassembled with all new gaskets

The transition ducts were inspected for fretting and cracking, evidence of minor fretting around the bottom of the power turbine transition ducts, no visual signs of cracking. There was evidence of trace oil found on the bottom of the GG transition duct #1 combustion can. See photo. This is most likely coming from the front engine seal. The magnetic chip detector was checked ok. The fuel and oil filters were replaced. The starter was replaced with a reconditioned unit from Orenda and the original sent back for repair. New gaskets installed in the thermo bulb well. The burners were inspected and were found to be in serviceable condition. Small amount of carbon deposits.
The igniters were inspected and are serviceable.
The combustion cans were installed and the unit returned to service. The fuel drains from the combustors; distributor and the relief valve were individually piped to an external container to determine the origin of the fuel leak. The distributor is bypassing fuel when the unit is operating. Orenda to send a replacement distributor along with the repaired flame tube at a later date. The oil level in the replacement starter was checked and the unit was installed on the engine & torqued to 50 ft/lbs.

A motoring run was preformed to check oil consumption and an audible check of the new starter. The unit was started and the gas generator cleaned with walnut shell to remove any residue from exhaust recirculation .Engine parameters were recorded see attached data sheet 00/11/03. Vibration signatures were taken on the GG , PT , & the reduction gear box. See attached sheets for details.

October [redacted]000
TEST DATA

																		GAS GENERATOR								POWER TURBINE							
TIME	KW	KVAR	BUS		GEN		EX	HZ	STATOR					REAR	HP PUMP	PRI	PUMP	HP FUEL	LUBE	LUBE	LUBE	COMP	INLET	10TH	GG	EGT	SPEED	LUBE	LUBE	LUBE GG	COOLER	LUBE	LUBE	REAR	THRUST
			VOLTS	AMPS	VOLTS	AMPS	AMPS		1	2	3	4	5	BEARING	INLET	FUEL	DELIVERY	INLET	SUPPLY	TEMP	DRAIN	DELIVERY	FILTER	STAGE	SPEED	TEMP		SUPPLY	PUMP	TEMP	OUTPUT	TANK	FILTER	BEARING	BEARING
1500	5700	0	4160		4160	780	4	60	63	63	64	66	65	121	13	840	960	64	18.2	96	202	51	25.1	17.5	7500	496	7450	49	71	68	43	125	54	114	112
1600	5500	400	4160		4160	750	4.2	60	73	74	73	75	74	123	14.5	830	970	65	18	100	210	51	25	16.8	7500	496	7450	49	70	70	44	133	54	117	115

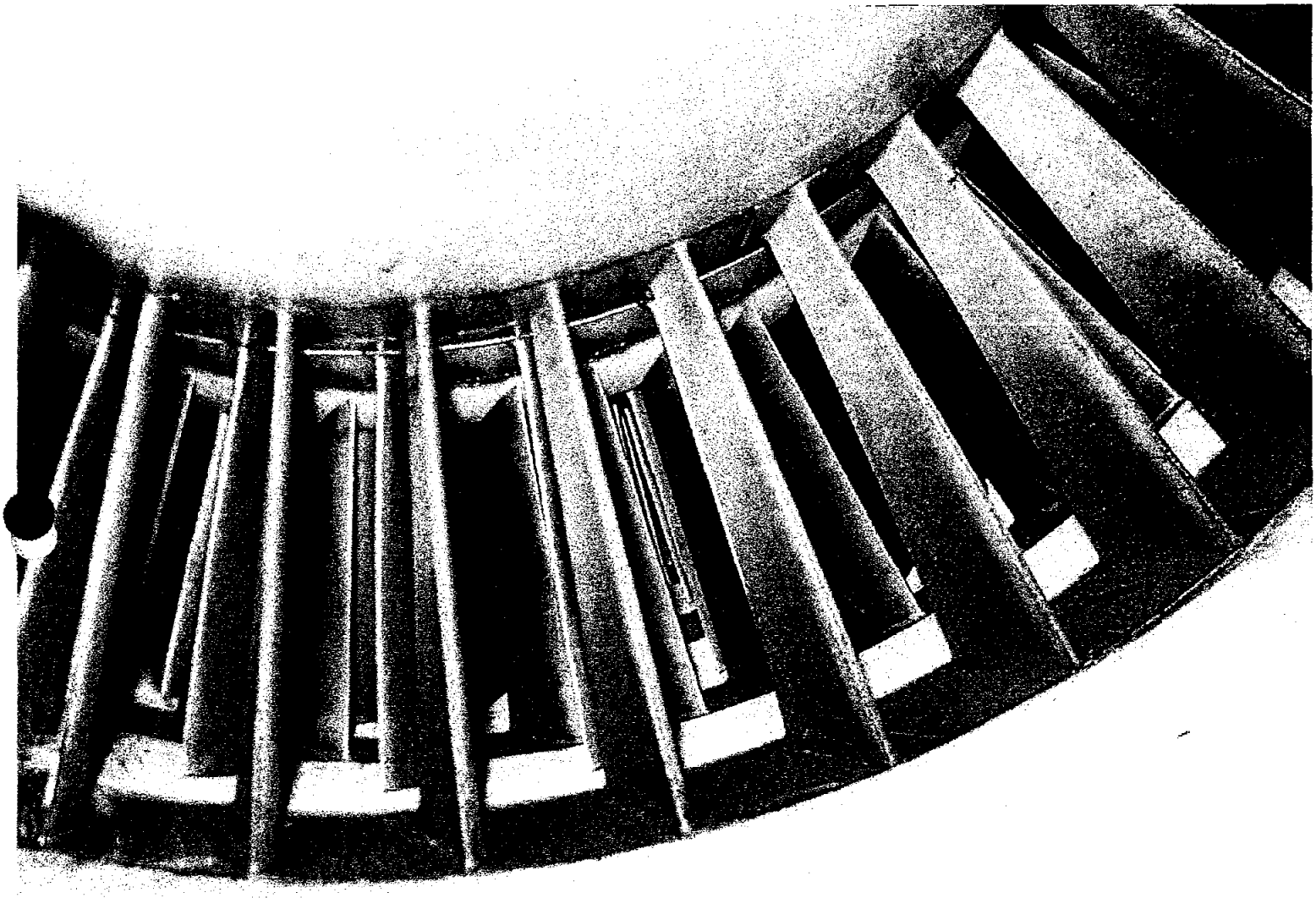
November 3,2000
TEST DATA

																			GAS GENERATOR								POWER TURBINE								
TIME	KW	KVAR	BUS		GEN		EX	HZ	STATOR					REAR	HP PUMP	PRI	PUMP	HP FUEL	LUBE	LUBE	LUBE	COMP	INLET	10TH	GG	EGT	SPEED	LUBE	LUBE	LUBE GG	COOLER	LUBE	LUBE	REAR	THRUST
			VOLTS	AMPS	VOLTS	AMPS	AMPS		1	2	3	4	5	BEARING	INLET	FUEL	DELIVERY	INLET	SUPPLY	TEMP	DRAIN	DELIVERY	FILTER	STAGE	SPEED	TEMP		SUPPLY	PUMP	TEMP	OUTPUT	TANK	FILTER	BEARING	BEARING
1500	5000	-200	4180		4170	690	3.7	60	64	64	65	67	66	120	13	820	960	84	16	95	200	48	25	16	7350	475	7450	49	71	72	44	125	55	116	114
1600	5000	0	4180		4190	710	3.8	60	69	70	69	70	71	124	14	820	950	83	18	97	204	48.5	25	16	7400	480	7450	49	71	74	45	132	55	116	118

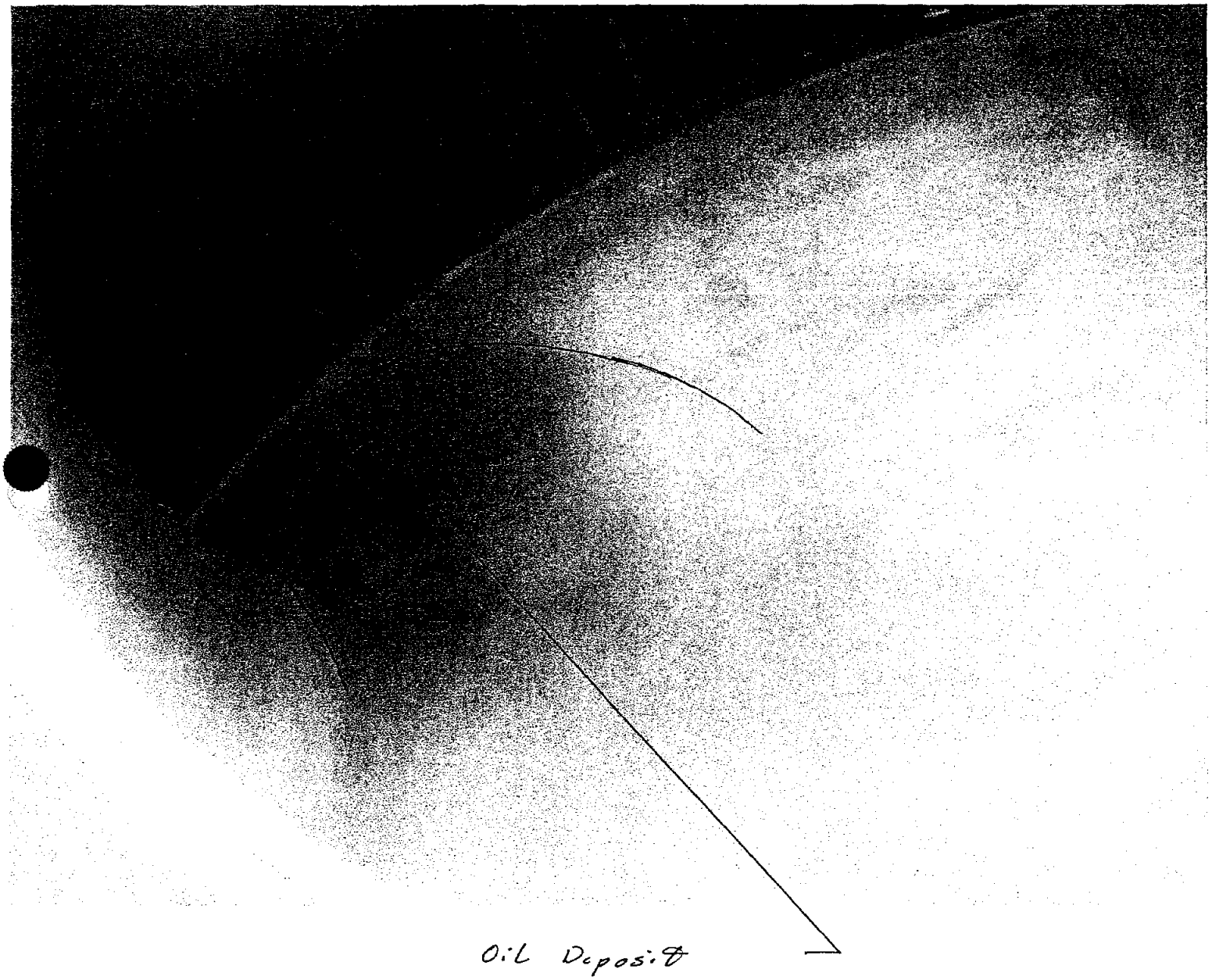
Damage to front section

Number 2 combustion car

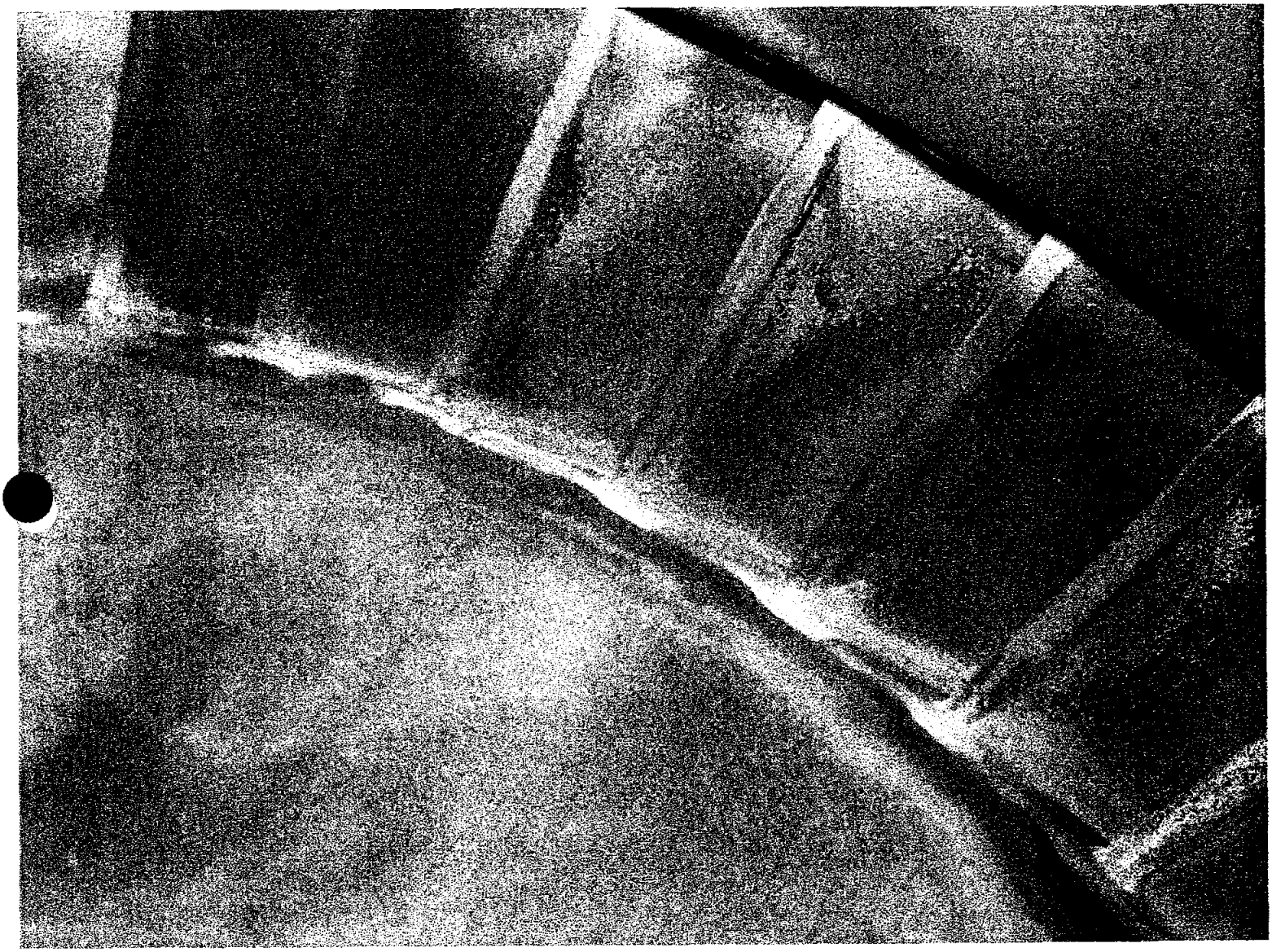
Gas Generator 1st Stage



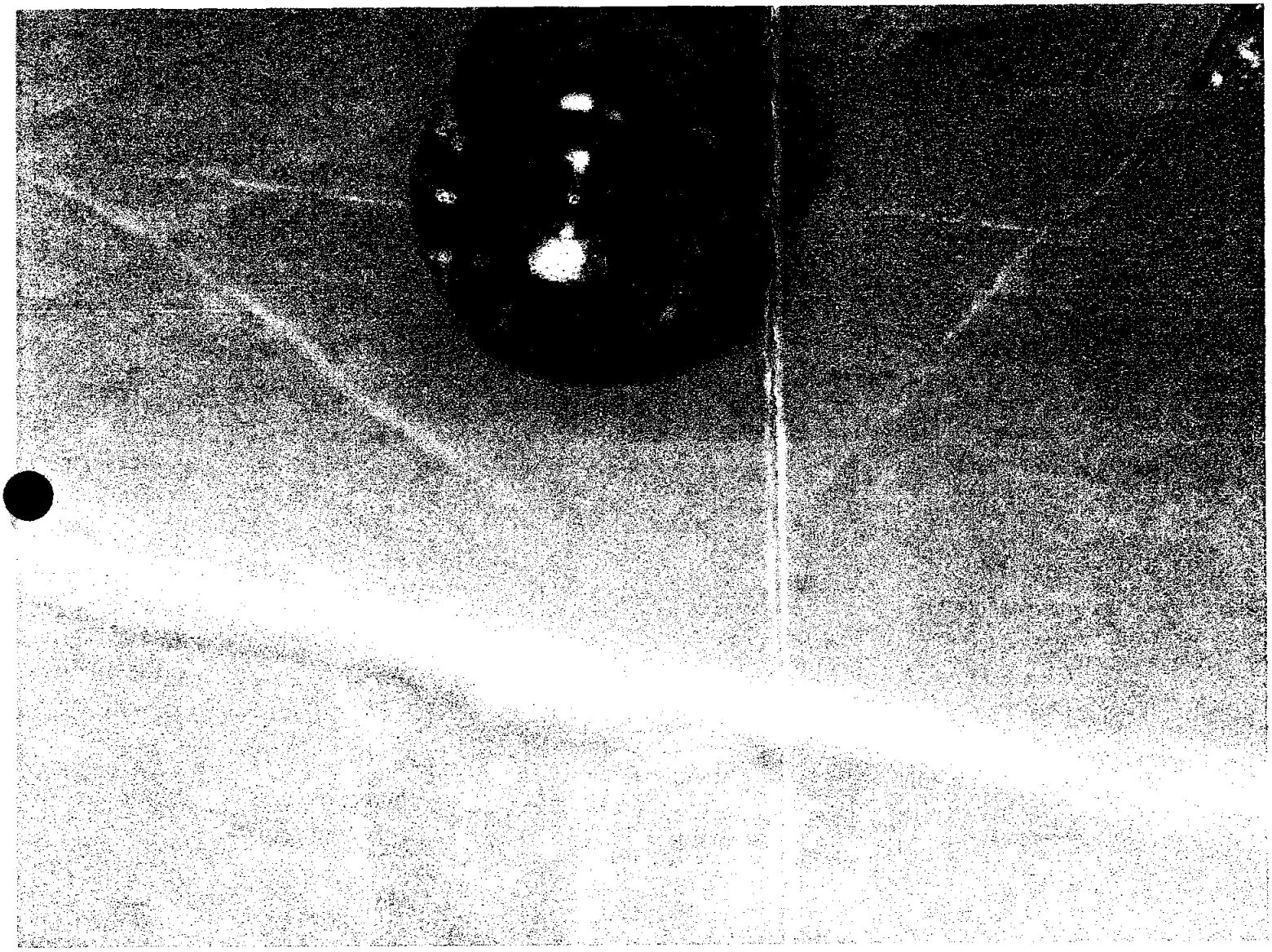
Gas Generator 10th Stage

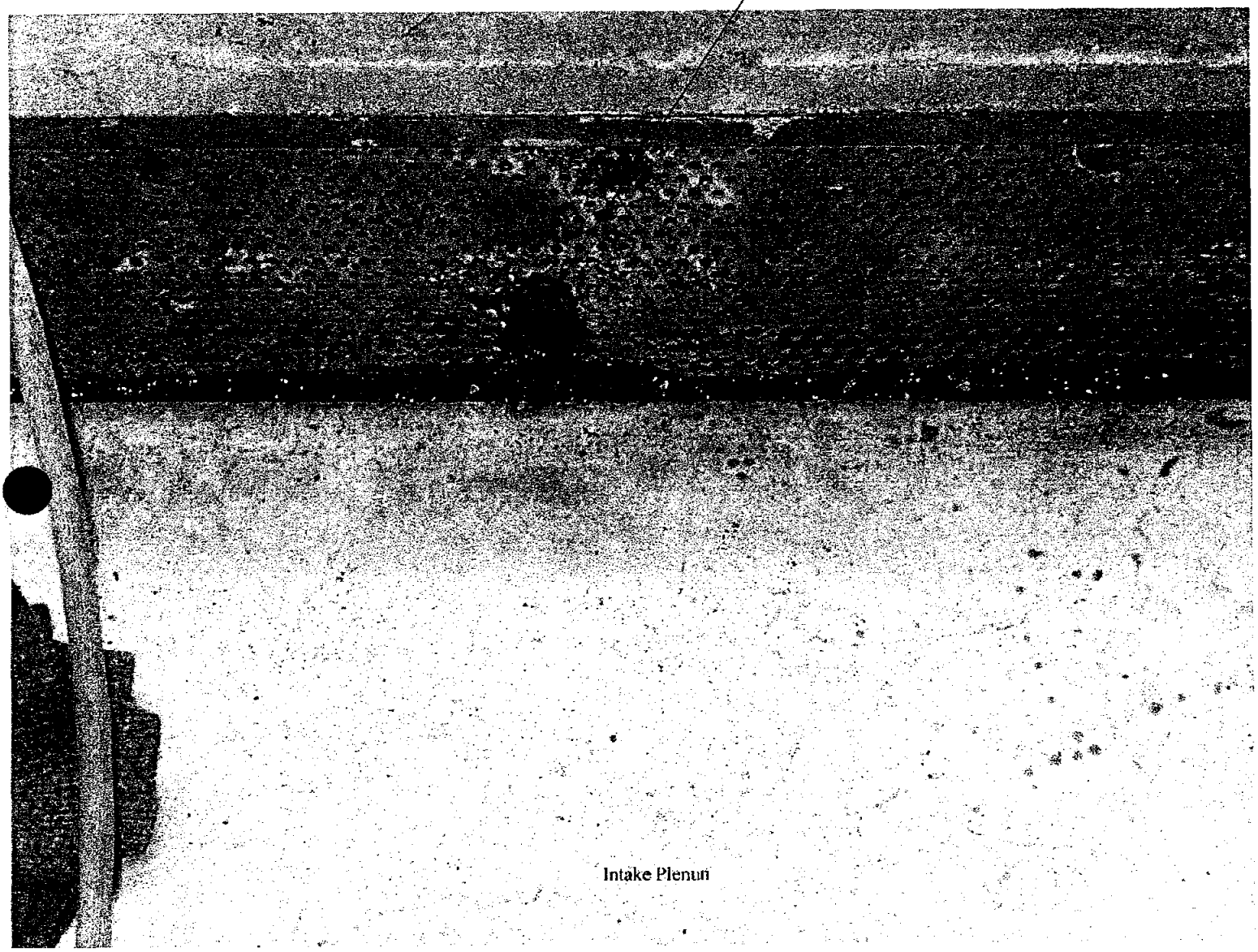


Power Turbine 1st Stage



Burner Nozzles





Intake Plenum

Orenda

September 30, 1998

John Budgell
Supervisor, Power Plant Maintenance
Newfoundland Power
1076 Topsail Road
PO Box 8910
St. John's, Newfoundland
A1B 3P6

Re.: Orenda OT3-390 Gas Turbine Engine

Dear John,

Please find attached a copy of Field Report for our visit in July this year.

If you would have any questions or comments please do not hesitate to contact me.

Best regards,

George Michniewicz
Engineering Supervisor
Industrial Turbines

ORENDA AEROSPACE CORPORATION
3160 Derry Road East, Mississauga, Ontario, Canada L4T 1A9 Tel: (905) 677-3250 Fax: (905) 678-1538
A Fleet Aerospace Company

Orenda Aerospace Corporation
3160 Derry Rd., MISSISSAUGA,
Ontario, L4T 1A9

Field Report

Customer:	Newfoundland Power
Location:	Port-aux-Basques
Unit:	Orenda OT3-390 Model 2C, GG-S/N 5907, PT-S/N 5055
Customer Representatives:	John Budgell, Wayne Green
Orenda Representatives:	Jerzy Michniewicz, Herb Phillips

The purpose of this visit was to do a periodic inspection and routine servicing of the Gas Turbine Unit. The guiding document for this work was 226KSB-20.

The customer brought to our attention the following problems:

1. Instantaneous fuel pressure drop, from 22 psig to around 9 to 9.5 psig, at the high pressure fuel pump (DC/AC) inlet, is observed each time when the circuit breaker is closed.
2. From time to time an unstable operation of the engine is noticed. Power fluctuates without operator involvement. The fluctuation range goes up to around 1.5 MW.
3. High oil consumption of 3 to 6 liters per hour. This high oil consumption is mainly noticed during frequent starts and when there are problems with the power stability.

Orenda was advised that some time ago the HP fuel pump was overhauled. There is no record what was done to that pump.

HISTORY.

The Gas Producer S/N 5907 was installed on November 22, 1990 after an overhaul. Since then the turbine has accumulated:

Fired hours:	550
Number of starts:	602

Every week the Unit is started to check its readiness, and every month the Unit is put on line generating power.

The vibration pickups were changed. The new sensors were installed 3 or 4 years ago and since new they never worked properly. The customer suspects that 60 Hz noise is contributing to the system malfunctions. To solve the problem the customer has a plan to change the location of the high voltage wires around the gas turbine.
The operator is not familiar with the Gas Generator Restricted Speed Range Chart. The restriction zone is interpreted to be between 1 and 2 MW.

INSPECTION.

Since there was a problem with high oil consumption Orenda decided to look into this issue first.

Power supply to the Unit was cut off and work started.

The third stage air supply line, on the left side of the engine, was disconnected and inspected. Inside this line black, greasy traces of oil were found.

The next area where the traces of oil leakage were checked was the front frame. To do this inspection it was necessary to take off the starter cover, starter and the front fairing of the intake volute. While doing this work it was noticed that at the front of the starter cover one, of three, tube of the compressor cleaning system, was missing. This tube was found and will be reattached by the customer when the proper fittings have been arranged.

Looking from the front of the engine a black, sticky, oily deposit was noticed at the bottom of the IGV, between the front frame and the compressor casing, on the first stage compressor blades, and first stage stationary blades.

To further investigate the oil leak problem Orenda decided to remove the No.2 combustor and to open the hand hole on the left side of the back bone.

At the bottom of the backbone oil was found. Orenda explained that the oil leak was coming from the front bearing oil seal.

1. FUEL SYSTEM

The fuel nozzles were found with a small carbon deposit.

The HP fuel filter P/N 263K01369 element P/N 65561-2 was found damaged. At site there were filter elements which could not be identified. They were purchased by the customer from Purolator, MISSISSAUGA, ON.

For temporary use the element available at site was installed.

The LP fuel filter P/N 263K02181 element was replaced. The bowl and the original element were found clean.

2. LUBRICATION SYSTEM

Oil pump gearbox.
The magnetic pick-up was found clean. Very fine magnetic particles were found in the oil strainer of the oil pump gearbox.

Auxiliary scavenge pump.
In both strainers of the center bearing and the rear bearing lines fine magnetic particles were found together with crushed gasket materials.

Main oil and scavenge pump.
In the strainer of the flex coupling crushed gasket materials were found.

The main oil filter and its bowl were found clean. Filter TF-2F was replaced and bowls were cleaned in varsol.

The PT filters and bowls were found clean. The elements were replaced, and bowls were cleaned in varsol.

The LP fuel filter and its bowl were found clean. The element was replaced and bowl was cleaned in varsol.

3. ELECTRICAL SYSTEM

The igniters and ignition box were found in good condition.

The starter was taken off and inspected. The commutator and brushes were dry and in good condition. The clutch rod was found in good condition. Oil level was checked. It is recommended that the oil be replaced as soon as possible. Since a new gasket for the starter was not available, the old one with Hylamar blue joint compound was reinstalled.

4. COMBUSTION SYSTEM

Flame Tube #1.
The #1 flame tube was found in good condition without defects.

Flame Tube #2.
The flame tube was inspected without disassembly from the expansion chamber and the outer casing. Two cracks of around 1/16" long were found at the joint of the front and the center section of the flame tube. They were accepted for further service.

Two lugs on the outer casing were found with the cracks in the weld area. One of 3/8" and second of ½" long. It was decided to replace the outer casing.

Flame Tube #3.

The #3 flame tube was found with 2 cracks in the front section, around the balance pipe port. These cracks were propagating one against the other. There was another crack around a spot weld. Looking at the possible metal separation during operation it was decided to replace this flame tube.

Flame Tube #4.

The #4 flame tube was found in good condition with two small cracks, around 1/16" long at the center section.

Flame Tube #5.

The #5 combustor was disassembled and the flame tube was inspected. Four cracks of around 1/16" were found at the joint of the front and the center section and one ¾"long crack was discovered under the balance pipe port. This crack gave an indication that the cracked piece could break off during operation. Decision was made to replace this flame tube.

Flame Tube #6.

The #6 flame tube was found in good condition with one crack 1/16" long at the center section.

Since two flame tubes and one outer casing were ordered to be shipped from Orenda, we decided to install fame tube #1 into 3rd combustor to continue work.

5. TURBINE AND COMPRESSOR ASSEMBLIES

The back end of the compressor, transition ducts, 1st stage turbine nozzles, 1st stage turbine blades were found in good condition.

6. MISCELLANEOUS

The asbestos had been removed from the exhaust vaned elbows.

The intake compartment has replaced floor. On the internal walls of the intake compartment, around the intake volute, a brown, abrasive dust was found.

The intake filter house P/N 318K00045, type AAF R2-60186, was found in "untouched" condition since new. The dust louvers were not cleaned for at least 12 years. The studs around the access doors are heavily corroded.
On the ground, under the hood of the filter intake, there is a mixture of gravel and fine stones.

The measuring system for the air pressure drop across the filter house is not working. The pressure switch, P/N 318K00190, condition is unknown. The air line to the engine inlet is disconnected, and the second line to the front of the filter house can not be inspected without having the access doors to the filter house refurbished.

It was found that the two centering blocks, P/N 226C00047, to center the front end of the PT were missing. These blocks were found, cleaned and reinstalled with 0.003" clearance against the centering member.

Customer brought to us their problems with the trailer alignment. The original vertical levels, installed inside the ports, along the trailer beams have lost fluid and can not be used.

7. REPLACEMENT OF THE FRONT OIL SEAL

Looking at a possible front oil seal replacement detailed inspection was done around the trailer.

This trailer has no beam installed under the roof. The roof is of light construction and it would be difficult to attach any additional support for the lifting device without destroying some existing elements. The engine has no supports under the center frame.

To replace the front seal the front frame must be detached and moved toward the intake bulkhead. To do this work it is necessary to support the engine under the compressor casing, and to install support for the center frame at the trunion ports. Inside the trailer the internal supports should be placed to attach a small lifting device for the front frame. These supports would be used for the beam, which would run along the engine under the trailer roof.

These internal supports would have one pair of diagonal beams, "lying" against the intake bulkhead, and the second pair located around the flanges between GG and PT. At the top these diagonal "legs" would be bolted together using rectangular steel plate. The horizontal long beam would be bolted to these plates at both ends. This type of construction would allow the work to be done, and will not interfere with the existing structure of the trailer.

8. TEST OF THE ENGINE.

Orenda was advised that the customer always starts the engine without a motoring run.

This time the motoring run was done. The run down time, counted from 500 RPM to the moment when the annunciating light "Engine ready for start" went "ON" was 3 min 53 seconds. Oil was topped up in the oil tank.

The next two starts failed, the engine tripped on Low Fuel Supply Pressure. It was found that an "air lock" caused the problem.

The next start was successful. The results of three runs are shown in Attachment No.1.
Run No.1 was unstable with power fluctuations.
The ambient temperature should be measured close to the filter house inlet. Recorded ambient temperature for Run # 3 is questionable.

Comments:

When engine speed stabilized at 5200 RPM the operator closed the circuit breaker after manual synchronizing. Instantaneously the fuel pressure at HP inlet dropped from 22 psig to 10 psig. During the power raise it was noticed that the operator has a problem to control the engine. At around 1.8 MW power fluctuations were noticeable. Power was increasing to around 3.2 MW and falling down shortly after to around 1.8 MW. This cycling was repeating without any involvement from the operator. During these fluctuations the GG speed was varying from 6700 to 6950 RPM and the EGT was oscillating around 850°F.

The lube oil consumption during that unstable operation was 6 liters per hour.

9. SPARE PARTS

Orenda provided spare parts as per 226SB-20-document requirement – Shipping Order 74853 and send to the station the additional parts – Shipping Order No. 74866.

The following parts were brought back:

1. Nose Cone Tool
2. Locking wire H51520
3. Swagelock Fitting H54963
4. Gasket 226C00231
5. Filter element 226C06570
6. "O" Ring H54025

The copies of the Shipping Orders are attached to this report.

10. RECOMMENDATIONS

1. Bring back to operation the vibration monitoring system as soon as possible. The possibility of using a noise filter should be contemplated before any rewiring work.
2. Consider training for the OT3 Gas Turbine operator at Orenda.
3. Since proper cleaning and inspection of the fuel nozzles can not be done at site, the customer should consider sending their set of nozzles to Orenda for cleaning, inspection and calibration. As a guide, burner cleaning is recommended every 300 hours.
4. As soon as possible the proper HP filter elements P/N 63560-02 should be ordered.
5. The spare igniters at site should be returned to Orenda for inspection and testing. There are indications that their tips were cleaned with a wire brush, which is strictly prohibited.
6. The customer should consider purchasing a spare starter to have it available at site. During engine starting operation this starter was audible. From Orenda experience the audibility is expected after a high number of starts.
7. Clean the gas turbine compressor.
8. Bring back to operation the monitoring system of the pressure drop across the intake filter.

9. Refurbish the access doors to the filter house. Inspect filters and clean the dust louvers.
10. Together with Orenda develop a new, reliable system for the trailer leveling, or recommission the existing system.
11. Replace the corroded foot under the front right power trailer support.
12. Adjust the 10th Stage Cavity Pressure after the compressor has been cleaned satisfactorily.

It was a pleasure to work with the Newfoundland Power crew.

Jerzy Michniewicz
Herb Phillips

cc. J. Barber
V. Lupandin
H. Phillips
B. Martin
Originator
File

NEWFOUNDLAND POWER
OT3-390 MODEL 2C
GG S/N 5907

ATTACHMENT No. 1

DATE 16 JULY 1998
RUN #1

PARAMETERS	POWER					
	IDLE	1 [MW]	2 [MW]	3[MW]	4 [MW]	5[MW]
PRIMARY FUEL NOZZLE PRESSURE [PSIG]	580					
GG LUBE SUPPLY PRESSURE [PSIG]	16					
CDP [PSIG]	17					
PT LUBE SUPPLY PRESSURE [PSIG]	49					
FUEL PUMP DELIVERY PRESSURE [PSIG]	600					
GG LUBE FILTER INLET PRESSURE [PSIG]	20.5					
10TH STAGE CAVITY PRESSURE [PSIG]	4.5					
PT LUBE PUMP DELIVERY PRESSURE [PSIG]	74					
HP FUEL PUMP INLET PRESSURE [PSIG]	22					
EGT MAX @ START [F]	800					
EGT [F]	800					
GG SPEED [RPM]	5200					
PT SPEED [RPM]	7300					
OIL CONSUMPTION [L/HR]	9					
AMBIENT TEMPERATURE [F]	76					

NOTE: **POWER FLUCTUATION FROM 1.8 TO 3.2 MW; EGT OSCILLATIONS AROUND 850F**
GG SPEED 6700 TO 6950 RPM; PT SPEED 7500 RPM
UNSTABLE RUN

NEWFOUNDLAND POWER
OT3-390 MODEL 2C
GG S/N 5907

ATTACHMENT No. 1

DATE 16 JULY 1998
RUN #2

PARAMETERS	POWER					
	IDLE	1 [MW]	2 [MW]	3[MW]	4.2 [MW]	5[MW]
PRIMARY FUEL NOZZLE PRESSURE [PSIG]	580		700	750	825	
GG LUBE SUPPLY PRESSURE [PSIG]	15.5		17.1	17.5	18.2	
CDP [PSIG]	17		32	37.5	47	
PT LUBE SUPPLY PRESSURE [PSIG]	48		51	50.5	49	
FUEL PUMP DELIVERY PRESSURE [PSIG]	610		710	770	850	
GG LUBE FILTER INLET PRESSURE [PSIG]	19.5		23	24	25	
10TH STAGE CAVITY PRESSURE [PSIG]	4.5		10	11.8	14	
PT LUBE PUMP DELIVERY PRESSURE [PSIG]	74		75	73.5	70.5	
HP FUEL PUMP INLET PRESSURE [PSIG]	22.5		11.5	11.5	12	
EGT MAX @ START [F]	880					
EGT [F]	775		815	865	960	
GG SPEED [RPM]	5300		6550	6900	7500	
PT SPEED [RPM]	7300		7500	7500	7500	
OIL CONSUMPTION [L/HR]						
AMBIENT TEMPERATURE [F]	76					

NOTE: 4.2 MW WAS A MAX POWER FOR PARTICULAR AMBIENT TEMPERATURE
OIL LEVEL DID NOT CHANGED
STABLE RUN

NEWFOUNDLAND POWER
OT3-390 MODEL 2C
GG S/N 5907

ATTACHMENT No. 1

DATE 17 JULY 1998
RUN #3

PARAMETERS	POWER						
	IDLE	1 [MW]	2 [MW]	3[MW]	4 [MW]	5[MW]	5.45[MW]
PRIMARY FUEL NOZZLE PRESSURE [PSIG]	585	650	690	750	800	825	840
GG LUBE SUPPLY PRESSURE [PSIG]	15.5	16.8	17.2	17.8	18	18.2	18.2
CDP [PSIG]	17.4	27	32	38	43	47.5	49
PT LUBE SUPPLY PRESSURE [PSIG]	48	51	51	50	49.5	49.5	49.5
FUEL PUMP DELIVERY PRESSURE [PSIG]	610	670	740	775	830	860	875
GG LUBE FILTER INLET PRESSURE [PSIG]	20	22.2	23.8	24.5	25	25.5	25.5
10TH STAGE CAVITY PRESSURE [PSIG]	4.8	7.5	9.8	11.5	13.5	14.5	15
PT LUBE PUMP DELIVERY PRESSURE [PSIG]	74	75	74.2	73	71	72	71
HP FUEL PUMP INLET PRESSURE [PSIG]	22	9	10	10	11	11	11
EGT MAX @ START [F]	812						
EGT [F]	775	795	810	855	900	940	955
GG SPEED [RPM]	5200	6100	6600	6900	7200	7450	7500
PT SPEED [RPM]	6350	7400	7400	7450	7500	7450	7500
OIL CONSUMPTION [L/HR]	1.5						
AMBIENT TEMPERATURE [F]	74						

NOTE: 10TH STAGE AIR LINE WAS CLEANED
VERY STABLE RUN
SPEED INDICATORS ARE NOT DIGITAL

MATERIAL LOCATION: Industrial Stores | INV.: Now | SEC.:

SHIPPING ORDER

44D 74853

Orenda
ORENDA AEROSPACE CORPORATION
3160 DERRY ROAD EAST
MISSISSAUGA, ONTARIO
L4T 1A9
PHONE: (905) 673-3250
FAX: (905) 673-3896

DATE: July 8 1998
CONSIGNEE'S ORDER NO.:
OUR ORDER NO.: S4X65/022
WORK ORDER NO.: S4965-0-0022
SHIP VIA: J. Michniewicz
DATE SHIPPED: PPD. ☐ COLL. ☐

SHIP TO:
Newfoundland Light & Power Co.
Port Aux Basques
Newfoundland

REASON FOR SHIPMENT: Field Service
REQUESTED BY: J. McGill
AUTHORIZED BY:

ITEM	DESCRIPTION	QUANTITY ORDERED	BACK ORDERED	QUANTITY SHIPPED	UNIT PRICE	AMOUNT
1	Inspection Kit Consisting of the following:	1				
	H50629 "O" Ring	4				
02	H53847 "O" Ring ✓	18				
03	H53823 "O" Ring ✓	12				
04	226C06372 O Ring ✓	6				
05	226C06570 Filter Element ✓ —	1				
06	H51520 Locking Wire ✓ —	1				
07	226C00231 Gasket ✓ —	6				
08	226C06629 Gasket ✓	1				
09	226C05282 Sealing Ring ✓ —	6				
10	H54025 "O" Ring ✓	1				
11	226C06261 'C' Ring ✓	12				
12	226C06576 Sealing Washer ✓	6				
13	226C06630 Gasket ✓	1				
14	AN9018C Gasket	8				
15	226C06625 Gasket ✓	2				
16	226C06621 Gasket ✓	6				
	226C06620 Gasket ✓ +	6				
1	263K02186 Element ✓	1				
19	Nose Cone Tool ✓ —	1				
20	Flame Tube Covers ✓	6				
21	H54505 Hylamar ✓	1				

INSPECTED BY	CARTONS-CASES-BUNDLES-SKIDS	GROSS WEIGHT	SHIPPER	WAYBILL NO.
	1	11#	R.P.	

MATERIAL LOCATION	INV.	SEC.

SHIPPING ORDER

44D 74866

Orenda
ORENDA AEROSPACE CORPORATION
3160 DERRY ROAD EAST
MISSISSAUGA, ONTARIO
L4T 1A9
PHONE: (905) 673-3250
FAX: (905) 673-3896

DATE: July 15, 1998
CONSIGNEE'S ORDER NO.: 27090
OUR ORDER NO.: S4X85 / 022
WORK ORDER NO.: X S496500022
SHIP VIA:
DATE SHIPPED: 07-15-98 PPD. COLL.

SHIP TO

Newfoundland Light and Power Co.
XXXXX Port Aux Basques
Newfoundland

HOLD AT STEPHENVILLE AIRPORT FOR PICK_UP

REASON FOR SHIPMENT	REQUESTED BY	AUTHORIZED BY

ITEM	DESCRIPTION		QUANTITY ORDERED	BACK ORDERED	QUANTITY SHIPPED	UNIT PRICE	AMOUNT
1	"O" Ring	226C06371	6		6		
2	Self Locking Nut	XXX AN363-1032	6		6		
3	Starter Gasket	226C06539	1		1		
4	"O" Ring	226C84555-906	15		15		
5	"O" Ring	226C84555-110	15		15		
6	"O" Ring	226C84555-112	15		15		
7	Outer Casing (#2 Can)	226C06661	1		1		
8	#3 Flame Tube (Aero can on loan)	XXXXX 75192	1		1		
9	#5 Flame Tube (Aero can on loan)	75195	1		1		
10	Swagelock Fitting	H54963	1		1		

For use in inspect and build exercise at the Port Aux Basques station OT-3.

INSPECTED BY	CARTONS-CASES-BUNDLES-SKIDS	GROSS WEIGHT	SHIPPER	WAYBILL NO.
	4	58		

PACKING SLIP

OL 67-292-1 REV 03/98

44D 74866

Appendix C
Project Estimate

Portable Gas Turbine Refurbishment
Total Project

Description	Labour	Estimate Non Labour	Total
Governor			
Turbine Control Panel		$ 183,211.00	$ 183,211.00
Fuel System		$ 35,000.00	$ 35,000.00
Protection & Control			
Synchronizing Panel		$ 108,500.00	$ 108,500.00
Motor Control Centers		$ 120,745.00	$ 120,745.00
User Interace			
PC Based HMI		$ 27,125.00	$ 27,125.00
Miscellaneous			
Trailer Leveling System		$ 10,000.00	$ 10,000.00
Lube Oil Recirculating System		$ 15,000.00	$ 15,000.00
Transformer maintenance		$ 15,000.00	$ 15,000.00
Nulec Recloser	$ 7,000.00	$ 35,000.00	$ 42,000.00
Power Cables		$ 50,000.00	$ 50,000.00
SCADA RTU	$ 5,000.00	$ 25,000.00	$ 30,000.00
Air Intake Filter Housing	$ 10,000.00	$ 60,000.00	$ 70,000.00
Exhaust Gas Temp Harness		$ 15,000.00	$ 15,000.00
Minor Engine Repairs		$ 30,000.00	$ 30,000.00
Fuel Flow Meters		$ 7,000.00	$ 7,000.00
Grounding		$ 3,000.00	$ 3,000.00
Shipping		$ 27,600.00	$ 27,600.00
Engineering			
Project Engineering - Supplier		$ 80,000.00	$ 80,000.00
Project Engineering - NP	$ 25,000.00		$ 25,000.00
Training	$ 5,000.00	$ 22,475.00	$ 27,475.00
Testing & Commissioning	$ 24,000.00	$ 21,000.00	$ 45,000.00
Documentation	$ 5,000.00	$ 3,410.00	$ 8,410.00
Totals	**$ 81,000.00**	**$ 894,066.00**	**$ 975,066.00**

Appendix D
Present Worth Analyses

Present Worth Analysis - Refurbish Existing Orenda Mobile GT

Weighted Average Incremental Cost of Capital		**6.52%**
Escalation Rate		**2%**
PW Year	**2002**	

CAPITAL EXPENDITURE IN YEAR BY ASSET TYPE

YEAR	Generation Thermal 24.39 yrs 4% CCA	Generation Hydro 49.50 yrs 4% CCA	Generation Thermal 28.19 yrs 30% CCA	Generation Hydro 49.5 30% CCA	Generation CRCE 49.5 100% CCA	Transmission 29.59 yrs 4% CCA	Substation 36.36 yrs 4% CCA	Distribution 29.59 yrs 4% CCA	Telecommunication 12.90 yrs 20% CCA	Capital Revenue Requirement	Operating Costs	Operating Benefits	Net Benefit Gwh 0 $/Kwh	Present Worth Benefit	Cumulative Present Worth Benefit		
2003	**975,000**									150,053	**100,000**		0 -250,053	-234,747	-234,747	($6,246,998.11)	$505,057.40
2004										135,823	102,000		0 -237,823	-209,601	-444,348		
2005										132,498	104,040		0 -236,538	-195,707	-640,055		
2006										129,139	106,121		0 -235,260	-182,735	-822,790		
2007										125,748	108,243		0 -233,992	-170,626	-993,416		
2008										122,328	110,408		0 -232,736	-159,322	-1,152,738		
2009										118,878	112,616		0 -231,494	-148,772	-1,301,510		
2010										115,400	114,869		0 -230,268	-138,927	-1,440,437		
2011										111,895	117,166		0 -229,061	-129,739	-1,570,176		
2012										108,365	119,509		0 -227,874	-121,167	-1,691,343		
2013										104,810	121,899		0 -226,709	-113,169	-1,804,511		
2014										101,231	124,337		0 -225,568	-105,707	-1,910,218		
2015										97,629	126,824		0 -224,453	-98,746	-2,008,964		
2016										94,005	129,361		0 -223,366	-92,253	-2,101,217		
2017										90,360	131,948		0 -222,308	-86,196	-2,187,414		
2018										86,696	134,587		0 -221,282	-80,547	-2,267,960		
2019	**10100000**									1,986,354	137,279		0 -2,123,633	-725,688	-2,993,648		
2020										1,406,992	140,024		0 -1,547,016	-496,288	-3,489,936		
2021										1,372,539	142,825		0 -1,515,364	-456,378	-3,946,315		
2022										1,337,746	145,681		0 -1,483,427	-419,414	-4,365,729		
2023										1,302,625	148,595		0 -1,451,219	-385,193	-4,750,922		
2024										1,267,189	151,567		0 -1,418,756	-353,527	-5,104,448		
2025										1,231,452	154,598		0 -1,386,050	-324,237	-5,428,685		
2026										1,195,425	157,690		0 -1,353,115	-297,158	-5,725,843		
2027										1,159,120	160,844		0 -1,319,964	-272,134	-5,997,977		
2028										1,122,548	164,061		0 -1,286,608	-249,021	-6,246,998		

Present Worth Analysis - Purchase 2 Refurbished Mobile GTs

Weighted Average Incremental Cost of Capital 6.52%
Escalation Rate 2%
PW Year 2002

	CAPITAL EXPENDITURE IN YEAR BY ASSET TYPE									Capital Revenue Requirement	Operating Costs	Operating Benefits	Net Benefit	Present Worth Benefit	Cumulative Present Worth		
	Generation Thermal	Generation Hydro	Generation Thermal	Generation Hydro	Generation CRCE	Transmission	Substation	Distribution	Telecommunication				Gwh 0 $/Kwh		Benefit		
	24.39 yrs	49.50 yrs	28.19 yrs	49.5	49.5	29.59 yrs	36.36 yrs	29.59 yrs	12.90 yrs								
	4% CCA	4% CCA	30% CCA	30% CCA	100% CCA	4% CCA	4% CCA	4% CCA	20% CCA								
YEAR																	
2003	4,000,000									615,600	100,000	0	-715,600	-671,799	-671,799	($8,579,007.62)	$693,595.74
2004										557,224	102,000	0	-659,224	-580,993	-1,252,792		
2005										543,580	104,040	0	-647,620	-535,830	-1,788,622		
2006										529,800	106,121	0	-635,921	-493,945	-2,282,566		
2007										515,891	108,243	0	-624,134	-455,116	-2,737,683		
2008										501,857	110,408	0	-612,265	-419,134	-3,156,816		
2009										487,704	112,616	0	-600,320	-385,802	-3,542,618		
2010										473,436	114,869	0	-588,304	-354,938	-3,897,557		
2011										459,057	117,166	0	-576,223	-326,370	-4,223,927		
2012										444,573	119,509	0	-564,083	-299,938	-4,523,864		
2013										429,988	121,899	0	-551,887	-275,491	-4,799,356		
2014										415,305	124,337	0	-539,642	-252,890	-5,052,246		
2015										400,528	126,824	0	-527,353	-232,004	-5,284,250		
2016										385,662	129,361	0	-515,023	-212,711	-5,496,961		
2017										370,710	131,948	0	-502,657	-194,897	-5,691,858		
2018										355,674	134,587	0	-490,261	-178,455	-5,870,313		
2019										340,560	137,279	0	-477,838	-163,287	-6,033,600		
2020										325,369	140,024	0	-465,393	-149,300	-6,182,900		
2021										310,104	142,825	0	-452,929	-136,407	-6,319,307		
2022										294,770	145,681	0	-440,451	-124,530	-6,443,837		
2023										279,368	148,595	0	-427,962	-113,593	-6,557,430		
2024	11200000									2,261,205	151,567	0	-2,412,772	-601,216	-7,158,646		
2025										1,560,228	154,598	0	-1,714,826	-401,147	-7,559,793		
2026										1,522,024	157,690	0	-1,679,714	-368,882	-7,928,675		
2027										1,483,441	160,844	0	-1,644,284	-338,999	-8,267,674		
2028										1,444,495	164,061	0	-1,608,555	-311,333	-8,579,008		

Present Worth Analysis - Purchase 2 New Mobile GTs

Weighted Average Incremental Cost of Capital 6.52%
Escalation Rate 2%
PW Year 2002

CAPITAL EXPENDITURE IN YEAR BY ASSET TYPE

YEAR	Generation Thermal 24.39 yrs 4% CCA	Generation Hydro 49.50 yrs 4% CCA	Generation Thermal 28.19 yrs 30% CCA	Generation Hydro 49.5 30% CCA	Generation CRCE 49.5 100% CCA	Transmission 29.59 yrs 4% CCA	Substation 36.36 yrs 4% CCA	Distribution 29.59 yrs 4% CCA	Telecommunication 12.90 yrs 20% CCA	*Capital* Revenue Requirement	Operating Costs	Operating Benefits	Net Benefit Gwh 0 $/Kwh	Present Worth Benefit	Cumulative Present Worth Benefit		
2003	7,500,000									1,154,250	100,000	0	-1,254,250	-1,177,479	-1,177,479	($11,562,744.53)	$934,824.95
2004										1,044,796	102,000	0	-1,146,796	-1,010,704	-2,188,182		
2005										1,019,212	104,040	0	-1,123,252	-929,360	-3,117,542		
2006										993,375	106,121	0	-1,099,496	-854,022	-3,971,564		
2007										967,295	108,243	0	-1,075,539	-784,278	-4,755,842		
2008										940,982	110,408	0	-1,051,390	-719,742	-5,475,584		
2009										914,444	112,616	0	-1,027,061	-660,052	-6,135,636		
2010										887,692	114,869	0	-1,002,560	-604,869	-6,740,505		
2011										860,733	117,166	0	-977,899	-553,877	-7,294,382		
2012										833,575	119,509	0	-953,084	-506,780	-7,801,162		
2013										806,227	121,899	0	-928,127	-463,302	-8,264,465		
2014										778,697	124,337	0	-903,034	-423,185	-8,687,650		
2015										750,991	126,824	0	-877,815	-386,187	-9,073,837		
2016										723,117	129,361	0	-852,477	-352,084	-9,425,921		
2017										695,081	131,948	0	-827,028	-320,666	-9,746,588		
2018										666,889	134,587	0	-801,476	-291,737	-10,038,325		
2019										638,549	137,279	0	-775,828	-265,116	-10,303,441		
2020										610,066	140,024	0	-750,090	-240,632	-10,544,072		
2021										581,445	142,825	0	-724,270	-218,127	-10,762,199		
2022										552,693	145,681	0	-698,374	-197,454	-10,959,652		
2023										523,814	148,595	0	-672,409	-178,476	-11,138,128		
2024										494,814	151,567	0	-646,381	-161,066	-11,299,194		
2025										465,697	154,598	0	-620,295	-145,105	-11,444,298		
2026										436,468	157,690	0	-594,158	-130,483	-11,574,782		
2027										-373,247	160,844	0	212,403	43,791	-11,530,991		
2028										0	164,061	0	-164,061	-31,754	-11,562,745		