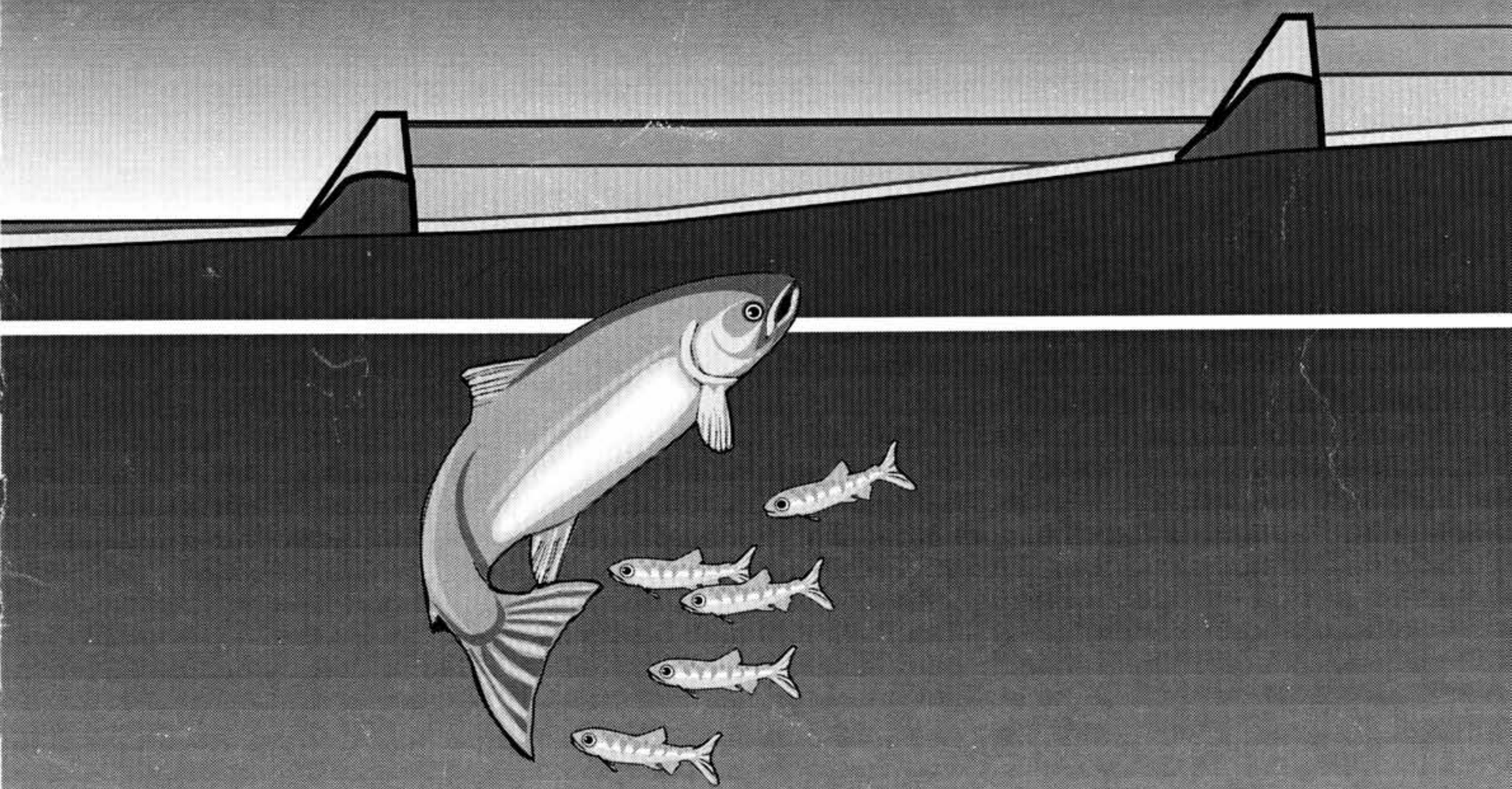
US Army Corps
of Engineers
Walla Walla District

1992 Reservoir Drawdown Test

Lower Granite and Little Goose Dams

Appendix G

Impact on Power Plant Operation



December 1993

APPENDIX G

LOWER SNAKE RESERVOIR DRAWDOWN IMPACT ON POWER PLANT OPERATION

1992 Reservoir Drawdown Test

Lower Granite and Little Goose Dams

Walla Walla District
U.S. Army Corps of Engineers

Note: The "pool lowering" report referred to in the attahed document is the System Configuration Study, a draft of which was completed in April 1994. Contact Planning Division, Walla Walla District, U.S. Army Corps of Engineers for further information.

ORC
APP_G3

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P.O. BOX 2870
PORTLAND, OREGON 97208-2870

REPLY TO
ATTENTION OF:

CENPD-PE-HD (1110)

JUN 3 1992

MEMORANDUM FOR Commander, Walla Walla District, ATTN: Chief, (CENPW-OP)

SUBJECT: Transmittal of Report on Powerhouse Monitoring Program During Pool Lowering Tests at Lower Granite and Little Goose.

1. Enclosed is one disk (WordPerfect) and one bound and one unbound copy of our final draft of the report on the Powerhouse Monitoring Program conducted during the pool lowering at Lower Granite and Little Goose. Comments in Mr. Paul Winborg's 19 May 92 memo and Mr. Charlie Krahenbuhl's 8 May 92 memo to HDC have been incorporated. We have also made some small additional changes as a result of our internal review.

2. This report is labeled as a draft because it is part of a larger Pool Lowering Report being written by your office. Final format and additional data may be included by District personnel as needed to meet the needs of the more comprehensive report. A disk copy of the report (file name=GRANITE) is enclosed as well as the original photographs. The graphs included as an Appendix originated from your office. Copies of the graphs and or files can be obtained from Rick Werner of your staff.

3. We appreciate the opportunity be of service and thank you for your support. If you need additional information or assistance, please contact Al Lewey or Brian Moentenich of my staff at (503) 326-3840.

FOR THE COMMANDER:

Glenn R. Meloy

GLENN R. MELOY, P.E.
Chief, Hydroelectric Design Center

3 Encls
1. WordPerfect disk
2. Bound Copy (1)
3. Unbound Copy (1)

CF (w/o encls):
CENPD-PE-ER (Jim Athearn)
CENPD-CO-OP (Vern Parry)
CENPD-CO-OP (Karl Bryan)
CENPD-PE-HD (Turbine Section File)
CENPW-OP-PO (Rick Werner)
CENPW-OP-PO (J.D. Morrow)

ORC
APP-G-1

DRAFT

(This will become part of a larger "Pool Lowering" Report)

POWERHOUSE MONITORING PROGRAM

PURPOSE

A powerhouse montoring program was instituted during the Snake River March 1992 pool lowering test. The purpose of the powerhouse monitoring program was two fold; first, to insure safe operation of the generating units as pool elevations were lowered and second, to determine what modifications (if any) may be required for long term operation at lower pools.

The monitoring program was structured so that baseline operating characteristics could be established and monitored for significant change as the head and submergence[1] conditions changed. The measurement points considered to be critical to the safe operation of the unit were evaluated daily while those of lesser importance were stored for evaluation and use at a later date.

INTRODUCTION

The generating units at Lower Granite Powerhouse (rather than Little Goose) were selected for monitoring. This was because the Lower Granite Project would be exposed to more severe (lower forebay and tailwater levels and heads) operating conditions than would Little Goose.

Lower Granite Powerhouse has six generating units. All six units have 135 Megawatt[2] (Mw), 90 RPM generators driven by 212,400 hp, six-blade Kaplan turbines. Though rated at 135 Mw all six generators can operate continuously at outputs up to 155 Mw. The turbines and generators of Units 1-3 were manufactured by Baldwin Lima Hamilton (BLH) and Westinghouse respectively. Likewise, the turbines and generators of Units 4-6 were manufactured by Allis Chalmers (AC) and General Electric (GE) respectively.

Each turbine was designed to operate over a head range of 76 to 105 feet. Rated power of 212,400 horsepower is produced at a head of 93 feet. Maximum design power output at these heads range from 158,500 hp (118 Mw) to 212,400 hp (155 Mw) respectively. Minimum design power outputs range from 56,500 hp (41 Mw) to 77,400 hp (56.5 Mw). Minimum design tailwater elevations ranged from 633 feet mean sea level (fmsl) at a net head of 105 feet to 648 fmsl at a net head of 76 feet.

---

[1]distance between runner centerline and tailwater elevation.

[2]135 Megawatt nameplate rating, 155 Megawatt continuous duty.

ORC APP-65

Units 1-4 and 6 had standard length (20') submerged traveling fish screens installed. Unit 5 had simulated extended length (40') screens installed. This unit was instrumented specifically to determine if extended length screens would cause the turbine to behave differently than units with standard length screens.

The ideal condition would have been to have all these instrumented units on line continuously. However, low reservoir inflow prohibited this because there was not enough water to operate 2 units continuously. Therefore, the data had significant gaps and irregular readings. The gaps in data were due to the units being shut down. Irregular data, primarily stator and bearing temperatures, was due to the units being started and stopped and therefore, not being at a stabilized temperature when the data was recorded.

It was expected that the generating units would operate satisfactorily during the drawdown test. Kaplan turbines can typically operate over head ranges of 2:1 or more without a problem. Cavitation data (sigma) from the turbine model test for Units 4-6 verified that design safety margins would not be exceeded.

The units at Lower Granite are identical to other units at Lower Monumental and Little Goose on the Lower Snake river. Any conclusions arrived at by the measurements and observations at Lower Granite can be applied to these units operating under similar conditions.

RESULTS

General - Units 3, 4, & 5 were instrumented for monitoring during the test period.

Unit 3 was operated almost continuously throughout the test period. Unit 4 was operated almost continuously at first. However, because of decreasing inflow to the reservoir, Unit 4 operated less frequently than Unit 3. Unit 5 was operated intermittently throughout the test period. Therefore, a contiguous set of data is not available to evaluate them.

No adverse effects were observed during the periods that the unit was in operation. Extended length screens do not appear to significantly change the roughness (vibration) or cavitation of the turbine when operating at lower pool elevations, gross heads, or tailwater elevations.

During the test period, Unit 3 exhibited a more pronounced tendency for increasing shaft runout as the head was decreased as compared to Units 4 and 5. This observation of differences between the two turbine models involved was verified when Units 1 and 2 were operated for short periods during the test.

Units 4 and 5 exhibited a more pronounced tendency for increasing vibration as the tailwater level was lowered as compared to Unit 3.

Bearing and stator temperatures - Changes in bearing and stator temperatures were expected. Cooling water flow rates will decrease and cooling water inlet temperatures will increase as the forebay elevation drops, which, by themselves, tend to produce higher bearing and stator temperatures. However, power output and hydraulic down thrust decreases as head decreases which would tend to result in lower bearing and stator temperatures. As a result, it could not be predicted if temperatures would rise or fall during the pool lowering.

The normal range of operation for bearing temperatures is 75° - 85°C. The upper limit is 105°C. Actual bearing temperatures decreased as the head dropped. The maximum temperature during the drawdown was 80°C.

Stator temperatures followed the same trend as the bearing temperatures. They decreased as the pool elevations were lowered. The maximum temperature of 85°C occurred during the first few days of monitoring while at normal pool elevations. Normal temperatures are 80° - 85°C with a maximum limit of 100°C.

Cooling water flow and temperature - Generator cooling water flow rates for Unit 3 decreased from 1450 GPM at a forebay elevation of 734 feet to 1250 GPM at an elevation of 699 feet. A similar reduction in flow rates (800 GPM to 600 GPM) occurred for Units 4 and 5. This drop was expected because the cooling water is gravity fed and flow rate is a function of the forebay elevation.

Throttling valves in the generator air housings are part of the cooling water system. The valves are adjusted to control flows at an optimal rate to maintain desirable temperatures. The valves were unchanged during most of the test period. At the lowest forebay elevation (699 fmsl), the valves were fully opened to determine maximum flows available. Flow rates through the air coolers in Unit 3 increased from 1280 GPM to 1900 GPM. Flow rates for Unit 4 increased from 600 GPM to 1260 GPM.

Cooling water temperatures increase as the forebay elevation decreases. This also was expected since the warmer surface water will be closer to the inlets as the reservoir drops. Actual inlet temperatures ranged from 6°C at a forebay elevation of 734 fmsl to 10°C at elevation 699. Outlet temperatures followed the same general trend.

Shaft runout - Runout of the turbine shaft was used as an indicator of rough operation. Normal shaft runout for both types of units is 4-6 mils (.004"-.006"). A maximum safe limit of 15 and 22 mils for the BLH and AC turbines respectively was chosen. This was based on a value of 80% of the design bearing clearance. Shaft runout on the AC units remained within the normal range as the pool elevation and gross head reached their minimums. Unit 3, however, exhibited an increase in runout from 4 mils at 99 feet of head to 10 mils at 68 feet of head. This increase, although outside of the normal range of operation, is still within allowable limits.

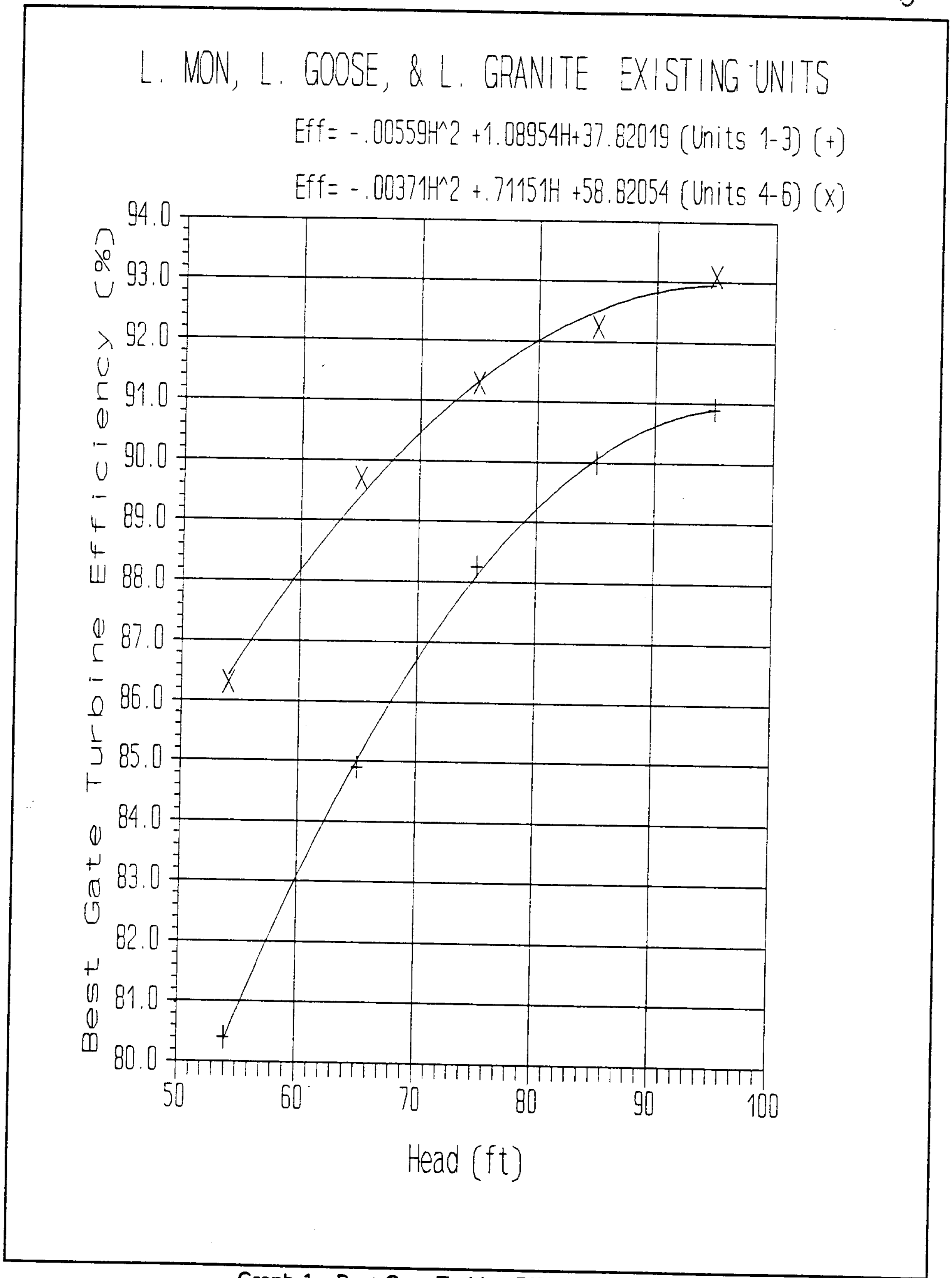
OPC APP G

Noise and vibration - Noise and vibration data was used as indicators of rough operation and cavitation. There were no preset limits for noise and vibration. These measurements were obtained to monitor trends at the various heads. Noise and vibration levels increased by 3 to 5 dbA at lower heads and higher power outputs. It should be noted that doubling the sound power causes a 3 db increase in sound pressure. Although the rise indicates that roughness and cavitation intensity may be increasing as the head drops, the actual amount of damage and efficiency drop cannot be determined from these tests. Evaluation of damage after extended operation at the lower heads will be required to determine actual increases in the rate of accumulation of damage.

Use of draft tube stoplogs - During the preparations for drawdown, there was concern that unacceptable cavitation would require discontinuing unit operation before the end of the drawdown test. Precautions were taken to enable the units to continue to operate in the event cavitation became unacceptably servere. Each draft tube bulkhead set is made of three segments stacked on top of one another. Draft tubes need two bulkhead sets for a total of six segments. One segment of a draft tube bulkhead set was on hand to install in each of the 12 draft tube bulkhead slots. Blocking the lower third of the draft tube area would induce hydraulic losses (the draft tube segment acts as a weir) and thereby impose a higher effective tailwater on the turbine. This would reduce cavitation. Sometimes this is done at plants in Europe to permit high discharges without generation. There would be a loss of head and associated increase in loading on the stoplog slots in the reverse (i.e. downstream) direction. It was determined that there was sufficient reinforcement in the concrete in the vicinity of the stoplog slots to safely resist the loads. The need for installation of the stoplogs in the draft tube bulkhead slots never materialized.

Loss of generation - During the drawdown test, generation at the Lower Granite and Little Goose powerhouses would have been 163,200 Mwh and 165,100 Mwh respectively had the pool levels remained at their normal levels. Actual output was 116,500 Mwh at Lower Granite and 155,800 Mwh at Little Goose. Total loss of generation during March was 56,000 Mwh. The economic value of this loss is discussed in the conclusions. It should be noted that the flows through the powerhouses were much lower than normal.

Lower turbine efficiency - Both the BLH and the AC turbines operate at highest efficiency at highest head. As the head decreases, so too does the peak efficiency attainable. Graph 1 shows the relationship of the peak turbine efficiency attainable to head. At the minimum test head of 67 feet, the peak efficiency of Units 1-3 decreased from 90.9% to 85.8%. The peak efficiency of Units 4-6 decreased from 93.0% to 89.9%.



Graph 1 - Best Gate Turbine Efficiency vs Head

CONCLUSIONS

The design turbine operating head range is 76 to 105 feet. The monitoring program shows that the units can operate safely to a minimum head of 67 feet without modification. The units could probably be operated at heads as low as 55 feet without significant problems. With the exception of shaft runout, unit performance was within normal operating limits at all times. Although shaft runout was outside of normal limits it was well within allowable limits for safe operation. No modification should be required to provide adequate cooling water capacity at low reservoir elevations, regardless of the time of year.

Although the units can be operated safely without modification, they cannot operate without detrimental effects. An increase in maintenance (addtional equipment outages, manpower requirements and higher maintenance cost) will result due to the increase in cavitation, shaft runout, and vibration. Actual inspection and repair frequencies as well as the associated cost can be identified only after the first few years of operation at lower heads.

Since Units 4-6 run smoother and are more efficient at lower head, preference should be given to operating those units first when the available head is lower. The operating range (power output) of the units at low heads is expected to be quite small. From the limited data taken, at best it would be between the "mean" and "lower" values in Table 1 for Units 4-6. If Units 1-3 are operated, they should be run between the "mean" and "upper" output settings where they run the smoothest. Operating experience may indicate that block (constant) load operation will be required.

The loss in energy production for the test period was 56,000 Mwh. This is 17% of normal energy production. A longer drawdown period would yield higher losses because the percent of time spent at the minimum level would be higher. At 20 mils per Kw-hr (the price BPA paid for replacement power during this period), value of the lost generation amounts to $1.1 Million. River flow during March was 53 % of the average flow during March[3]. Therefore, had the test been performed during an average year, the cost of lost generation would have been $2.1 million.

[3]Average inflow for March is 56,000 cfs. Actual inflow during the March test was 30,000 cfs.

TABLE 1. - Power Output at various heads to maintain one percent of best efficiency

UNITS 1-3

GROSS GENERATION OUTPUT			
Head (ft)	(MW) Lower	Middle	Upper
59	49.7	59.9	70.1
60	50.8	61.3	71.8
61	52.0	62.8	73.6
62	53.1	64.2	75.3
63	54.1	65.6	77.0
64	55.2	66.9	78.6
65	56.3	68.3	80.3
66	57.3	69.6	81.9
67	58.3	70.9	83.5
68	59.3	72.2	85.1
69	60.3	73.5	86.6
70	61.3	74.7	88.2
71	62.2	75.9	89.7
72	63.2	77.2	91.2
73	64.1	78.4	92.6
74	65.0	79.5	94.1
75	65.9	80.7	95.5
76	66.8	81.8	96.9
77	67.7	83.0	98.3
78	68.5	84.1	99.7
79	69.4	85.2	101.0
80	70.2	86.3	102.3
81	71.0	87.4	103.7
82	71.9	88.4	105.0
83	72.7	89.5	106.2
84	73.5	90.5	107.5
85	74.3	91.5	108.7
86	75.1	92.5	110.0
87	75.9	93.5	111.2
88	76.7	94.5	112.4
89	77.5	95.5	113.6
90	78.2	96.5	114.7
91	79.0	97.4	115.9
92	79.8	98.4	117.0
93	80.5	99.3	118.2
94	81.3	100.3	119.3
95	82.1	101.2	120.4
96	82.8	102.1	121.5
97	83.6	103.1	122.5
98	84.4	104.4	124.5
99	85.1	106.0	126.9
100	85.9	107.6	129.3
101	86.8	109.1	131.4
102	87.4	109.6	131.8
103	88.3	110.3	132.2
104	88.7	111.5	134.3
105	89.3	112.7	136.1

UNITS 3-4

GROSS GENERATION OUTPUT			
Head (ft)	(MW) Lower	Middle	Upper
59	58.8	65.9	72.9
60	60.0	67.1	74.2
61	61.2	68.4	75.6
62	62.4	69.7	77.0
63	63.5	71.0	78.5
64	64.6	72.4	80.1
65	65.7	73.7	81.8
66	66.7	75.1	83.6
67	67.8	76.6	85.4
68	68.8	78.0	87.3
69	69.8	79.5	89.2
70	70.8	81.0	91.2
71	71.8	82.5	93.2
72	72.7	84.0	95.2
73	73.7	85.5	97.3
74	74.7	87.0	99.4
75	75.6	88.6	101.6
76	76.6	90.1	103.7
77	77.5	91.7	105.9
78	78.4	93.3	108.1
79	79.4	94.8	110.3
80	80.3	96.4	112.4
81	81.3	98.0	114.6
82	82.2	99.5	116.8
83	83.2	101.1	118.9
84	84.2	102.6	121.1
85	85.2	104.2	123.2
86	86.2	105.7	125.3
87	87.2	107.2	127.3
88	88.2	108.7	129.3
89	89.2	110.2	131.3
90	90.3	111.7	133.2
91	91.3	113.2	135.0
92	92.4	114.6	136.8
93	93.6	116.0	138.5
94	94.7	117.5	140.2
95	95.9	118.8	141.8
96	97.1	120.2	143.3
97	98.3	121.5	144.7
98	99.5	122.4	145.2
99	101.8	123.9	146.0
100	103.2	125.1	147.0
101	105.3	126.4	147.4
102	106.3	126.9	147.5
103	107.4	127.6	147.7
104	108.7	128.9	149.0
105	110.0	130.5	151.0

g-1-pg 11

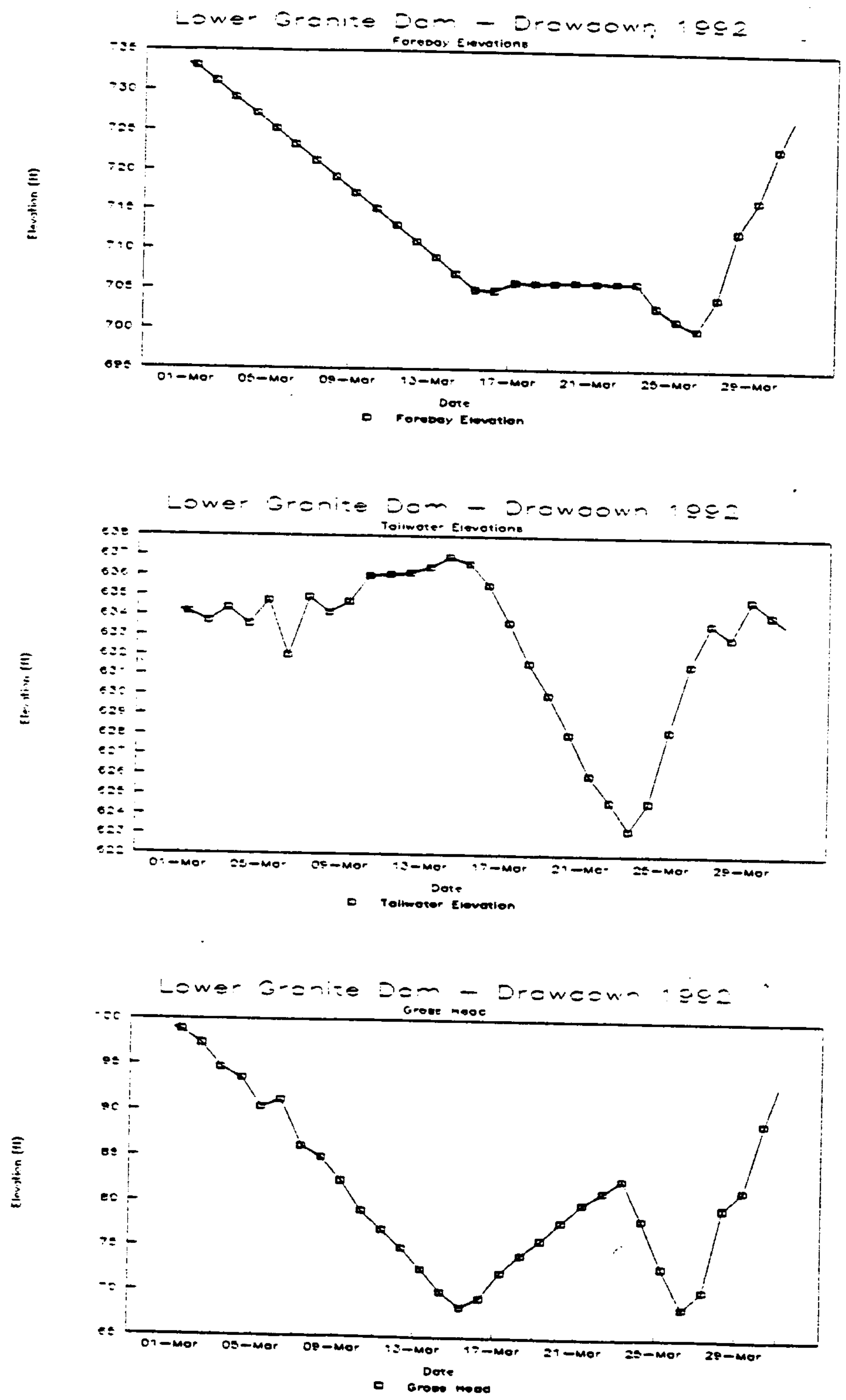


Figure 1. - Forebay, tailwater and gross head at Lower Granite.

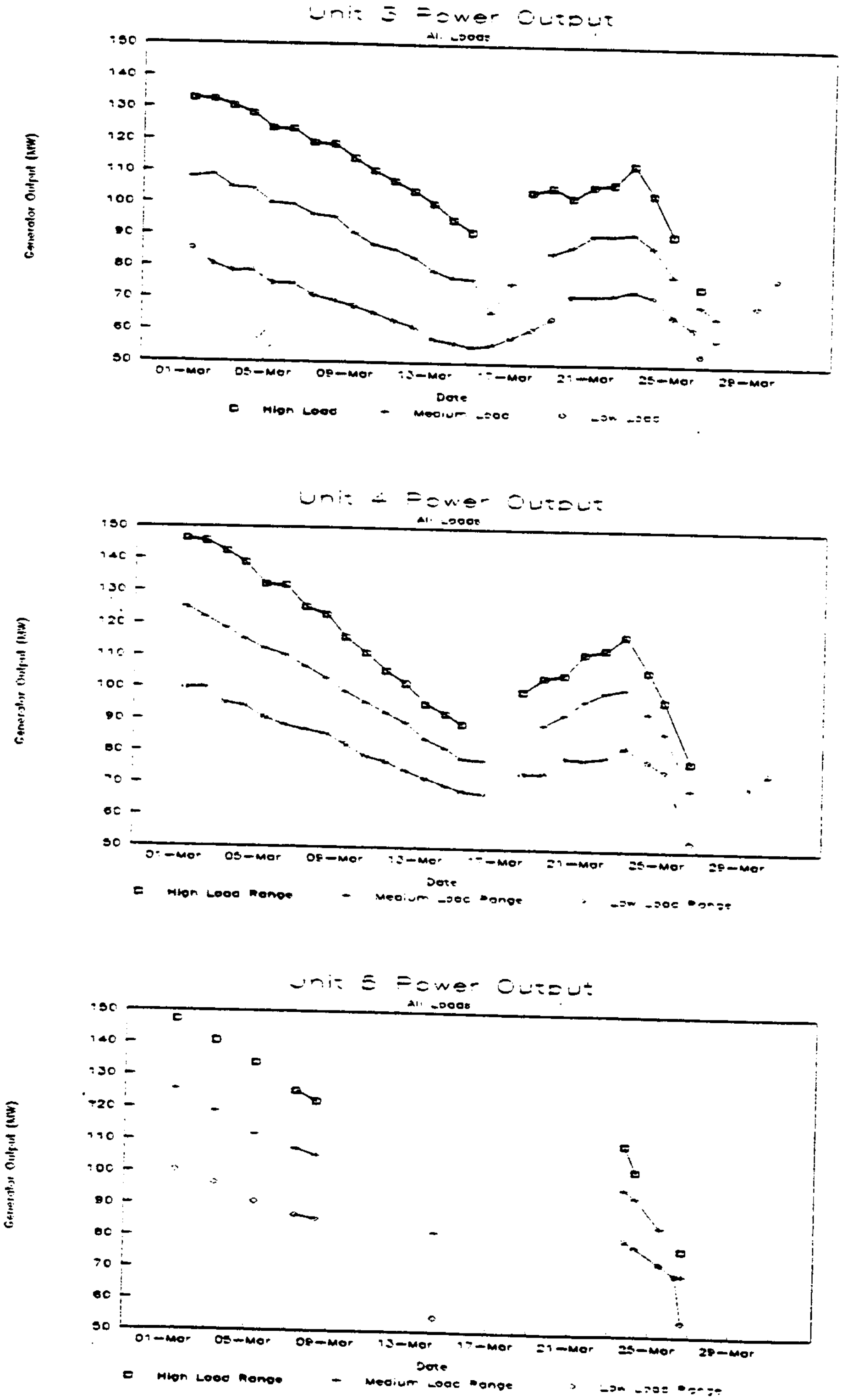


Figure 2. - Power output for Units 3, 4 and 5 during test period.

ORL APP GR

POWERHOUSE DATA COLLECTION PLAN

General

The generator temperature is affected by changes in power output, cooling water flow and water temperature. However, most of the effects of operating at lower pool elevations will be experienced by the turbine. Increased turbine shaft runout, cavitation and vibration are more likely at the lower heads than at the more efficient rated head of 93 feet. Reductions in cooling water flows can be expected since the system is gravity fed and is a function of the forebay elevation. Cooling water inflow temperatures can be expected to rise. As the reservoir elevation drops the cooling water inlet will be closer to the water surface and as such warmer waters will be used for cooling purposes. Most of these conditions will effect the turbine more than the generator. Therefore the test program has been structured predominately around the turbine. Observation and measurements was established for the following types of data.

(1) Operational data - This data establishes the conditions under which the unit is operating. They are largely the independent variables of the test. They include upper and lower water surface elevations, wicket gate position and blade angle. This data is used as the common points of reference when evaluating the data. Power output and discharge were also included in this type of data. Although, dependent on the previously listed elements, they do not indicate safe operation of the unit.

(2) Performance data - This data reflects the operating and performance characteristics of the unit as it pertains to the safe and reliable operation of the unit. Their magnitudes depend largely on the operational conditions under which the unit is operating. They include shaft runout, vibration, noise, cooling water flows and temperatures, stator and main shaft bearing temperatures, head cover pressures and inlet surface vortexing.

Shaft runout, bearing temperature, inlet vortexing, cooling water flows and vibration at the head cover and draft tube mandoor were considered the predominate or major indicators of safe operation of the unit. These measurements were evaluated daily for trends or sudden changes that would indicate the onset of unsafe operation. All other measurements were stored for future use.

Units 3 and 4 were selected as the representative units. Standard length submerged traveling fish screens were installed in the intakes to the turbines of both units. In addition to monitoring one unit of each type with standard length screens, Unit 5 was fitted with a set of simulated extended length screens to determine if there would be any differences in turbine performance due to screen type.

All turbines were operated within one percent of the best efficiency available for the head at which they were operating. The test units were to be the first units on line and the last units off line. At the beginning of each day, the available test units would be set at specific load settings (lower, mean, and upper) and data recorded. The "lower" and "upper" loads corresponded to the minimum and maximum power output which was within 1% of peak efficiency (See Table 1). The "mean" load was the mean of the lower and upper loads. The recorded data was used to establish the trends throughout the test period.

Three methods of obtaining data was used. The first method was through available plant instrumentation and the DACS system. The second method was by tape recorder connected to transducers. This data was evaluated by a spectrum analyzer immediately after the acquisition process was completed. The third method was by hand held instrumentation and visual observations.

Data obtained through the DACS was recorded at 15 minute intervals throughout the test period. Samples of the data were taken each day (usually between 6 AM and 9 AM) at each of the loads and used as part of this report.

Water surface elevations

The existing plant instrumentation for measuring upper water surface (forebay) and lower water surface (tailwater) elevations was not capable of operating throughout the ranges to be expected during the test. Therefore, temporary stilling wells with pressure transducers were installed to accommodate the extended ranges. One stilling well and transducer was placed at the southeast corner of the Lower Granite intake deck (See photograph No. 1). This transducer was used to measure Forebay elevation. A second transducer was located on the south retaining wall about 200 feet downstream of the tailrace deck (See photograph No. 2). This transducer was used for measuring tailwater elevation.

Photo No 1 - Upper water surface elevation using pressure transducer. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Both stilling wells were 6 inches in diameter with several holes drilled in the base to provide reservoir pressure into the well. However, too many holes were drilled, negating the stilling effect of the well. To remedy this problem, a 2 inch PVC sleeve was inserted into both wells to dampen the effects of the water surface fluctuations.

The transducers were calibrated in place setting the transducers at several levels of submergence and recording the transducer output at each level. A straight line curve fit of the output versus submergence was developed for each transducer. An electric contact gage was used to determine actual water level with respect to

Photo No 2 - Lower water surface using pressure transducer. NEMA enclosure and conduit is part of temporary instrumentation. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

the transducer. Temporary bench marks were surveyed in to the top of each stilling well for determining the actual setting of the transducers.

Servomotor stroke

Servomotor stroke was measured with displacement transducers (See photograph No. 3). The transducer was mounted above the servomotor. A machinist scale with 1/64" divisions was also mounted on the servomotor for calibration of the transducers and for check readings during the test. No attempt was made to correlate servomotor stroke with wicket gate opening. Design data from the turbine drawings was used to convert inches of servomotor travel to percent of gate opening.

Blade angle

Blade angle was measured using rotary digital encoders mounted on the oil head of each unit (See photograph No. 4). The encoders were connected to an extension of the governor blade restoring system shaft that rotates the pointers for the brass scale on each oil head. No attempt was made to correlate pointer rotation with actual blade angle. Calibration was performed by placing a paper scale with finer graduations over the brass scale and correlating transducer output to the pointer reading on the scale.

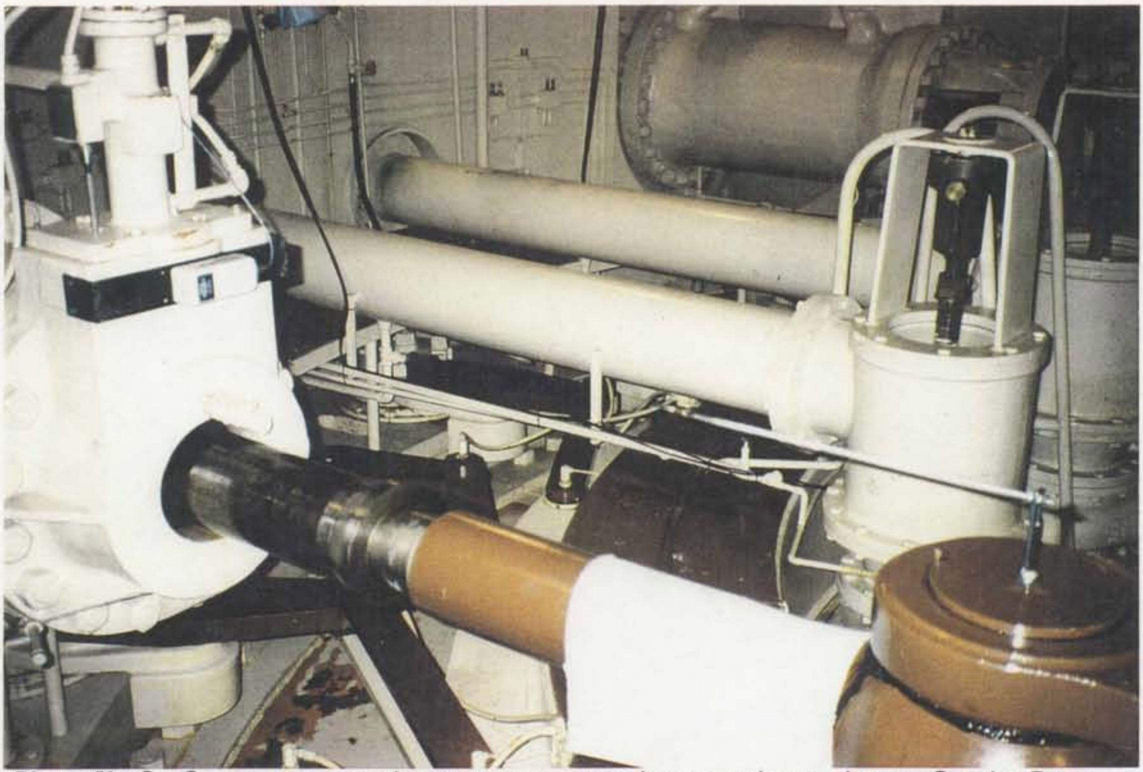


Photo No 3 - Servo motor stroke measurement string transducer. -Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

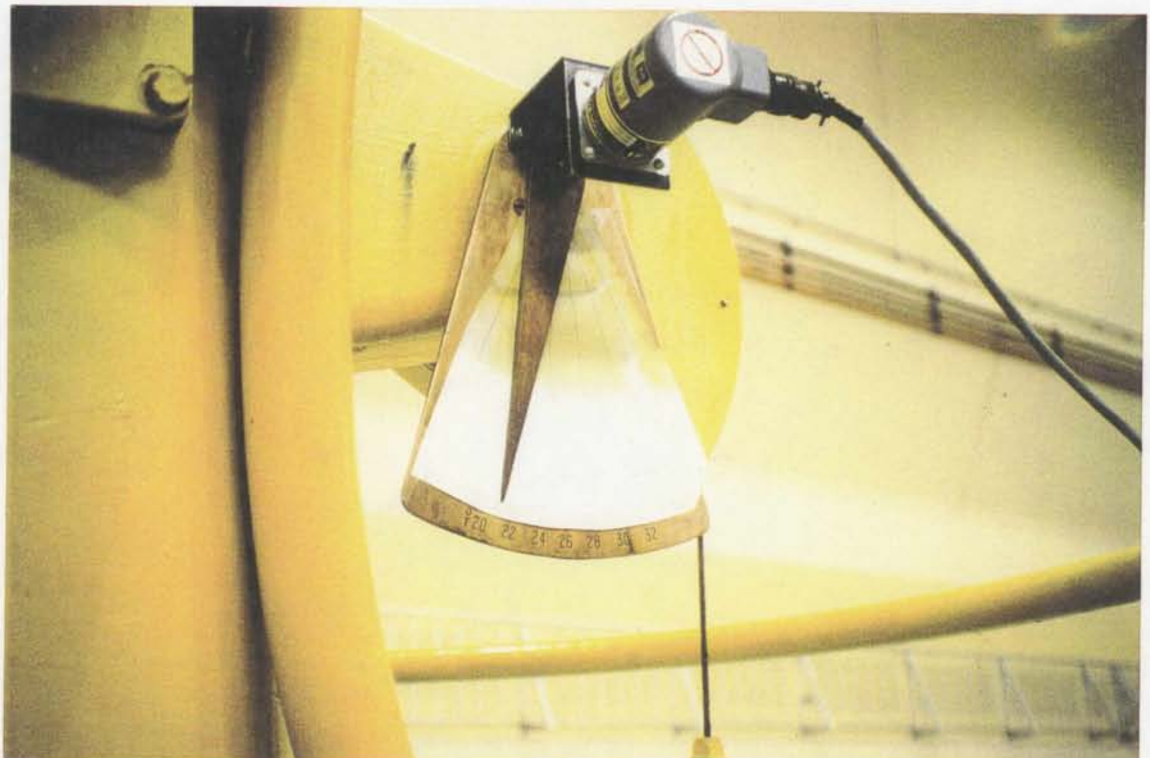


Photo No 4 - Blade angle measurement using rotary encoder. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Power output

Power output was read directly from the existing plant metering. No additional calibration was performed.

Winter-Kennedy

Discharge measurements were made using the Winter-Kennedy[3] (W-K) method of index testing. This method of measurement is a relative measurement of discharge and does not measure actual discharge unless the W-K readings are calibrated against an absolute method of measurement. The basic theory behind W-K measurement is that total energy remains constant across a radial cross section for flow around a bend. Therefore, the velocity will be lower (and the corresponding velocity head will be higher) on the outside radius of a bend as compared to the inside radius. By placing piezometer taps at the inside and outside radius and measuring the difference in velocity head, a relative index or measurement of the discharge can be made.

The spiral case for all units at Lower Granite have four piezometer taps, one on the outside radius and three on the inside radius. The difference in velocity head was measured across the C7-C10 taps. The transducer was connected to the these taps (See photograph No. 5).

Shaft runout

Shaft runout was measured at the turbine and intermediate guide bearing (See photograph No. 6). Lateral and longitudinal measurements were made at each bearing . Proximity probes were used for these measurements. These measurements were recorded on tape, once each day on those units that were running. Data was analyzed later with a Hewlett Packard Model ___ spectrum analyzer. Calibration was performed by using dial indicators.

---

[3]Ireal A. Winter. Improved Type of Flow Meter for Hydraulic Turbines, ASCE Proceedings, volume 59, No. 4, Part 1, pages 565-584, 1 April 1933.

Photo No 5 - Shaft runout measurement using proximity probe. -Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Photo No 6 Winter-Kennedy measure using differential pressure transducer. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Vibration

Head cover (vertical) and draft tube mandoor (horizontal) vibrations were measured during the test (See photograph Nos. 7 and 8). The measurements were taken on top of flanges on the inner most portion of the intermediate head cover and in the center of the draft tube mandoor. Manual readings were recorded using a hand held vibration meter. Accelerometers were also mounted to the head cover and draft tube mandoor. The frequency analyzer was used to record readings from these transducers.

Photo No 7 - Head cover vibration using IRD vibration meter. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Head cover pressure

Piezometer measurements were made in the turbine head cover (See photograph No. 9). These measurements were recorded on a regular interval by DACS. The location of the measurements were at the hand holes in the intermediate head cover.

Photo No 8 - Noise level readings at draft tube mandoor using hand held meter. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Photo No 9 - Head cover pressure using pressure transducer. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Noise

Noise in the turbine pit and in front of the draft tube mandoor was measured once each day with a hand held sound level meter (See photograph No. 10). In the turbine pit, the observer stood at the base of the access stair next to the pit liner. At the draft tube mandoor, he stood at the entrance to the access adit.

Photo No 10 - Noise level readings in turbine pit using hand held meter. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Cooling water flow rates and temperatures

Cooling water flow rates were measured with differential pressure transducers (See photograph No. 11). The transducers were connected to the Barton indicating flow switches. The Barton gages were used to calibrate the transducers.. They were recorded on regular intervals by DACS.

Vortexing

The forebay water surface was visually observed daily for the presence of vortexes. Occasional small swirls (6" or less in diameter) similar to that observed during normal operation, was observed on an infrequent basis. The swirling occurred at times when the upper reservoir was smooth and undisturbed by debris or windy conditions. Additional or increased vortexing solely attributed to lower forebay water surface elevations was not observed.

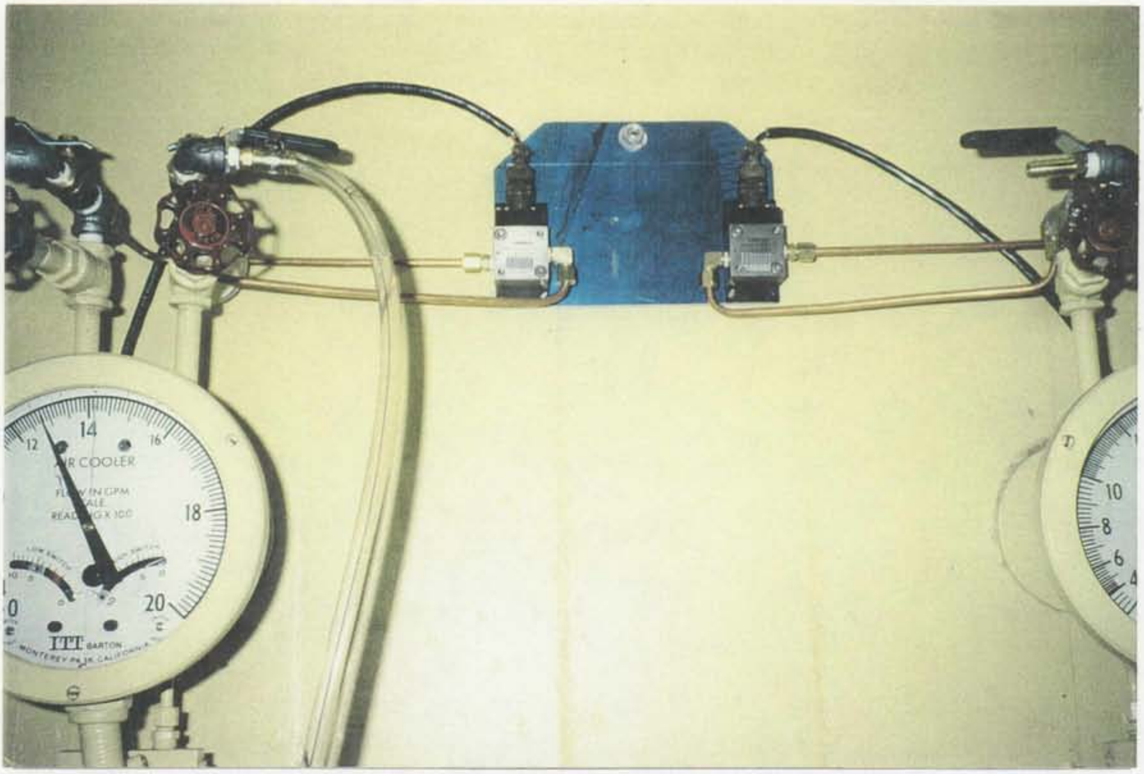
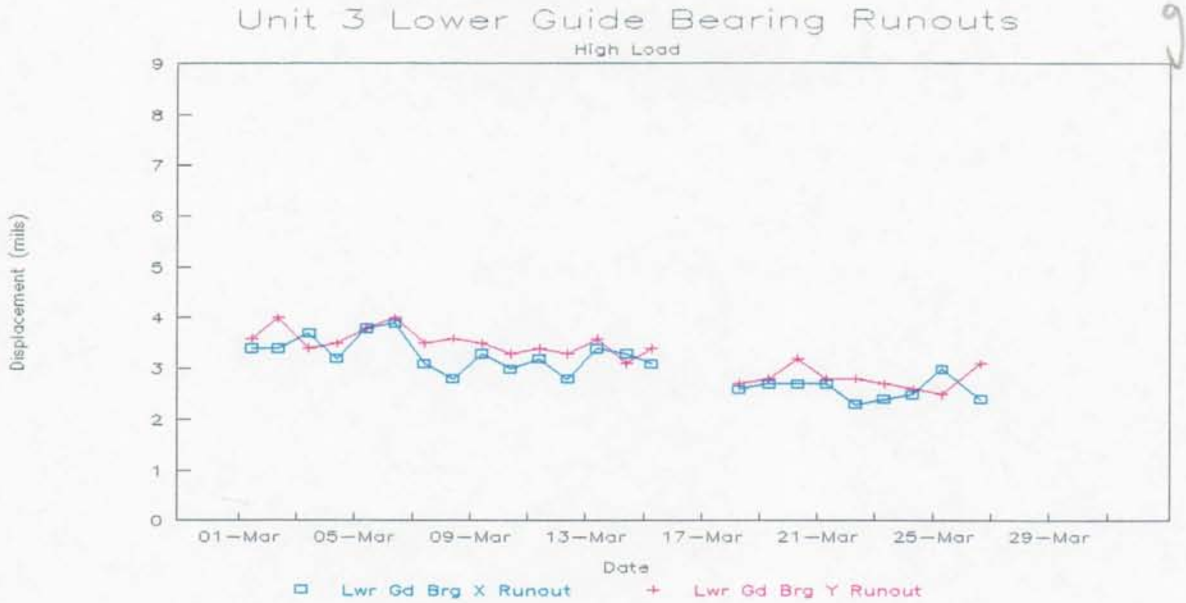


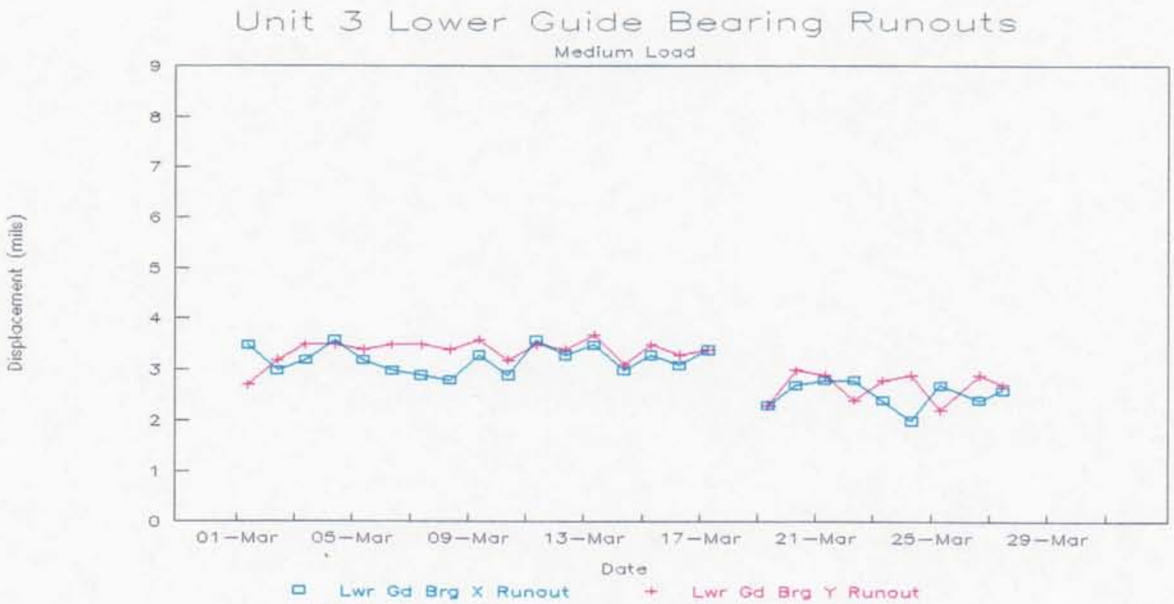
Photo No 11 - Cooling water flows using differential pressure transducer. - Lower Granite Dam and Powerplant, Pool Lowering Test, March 1992.

Bearing and stator temperatures

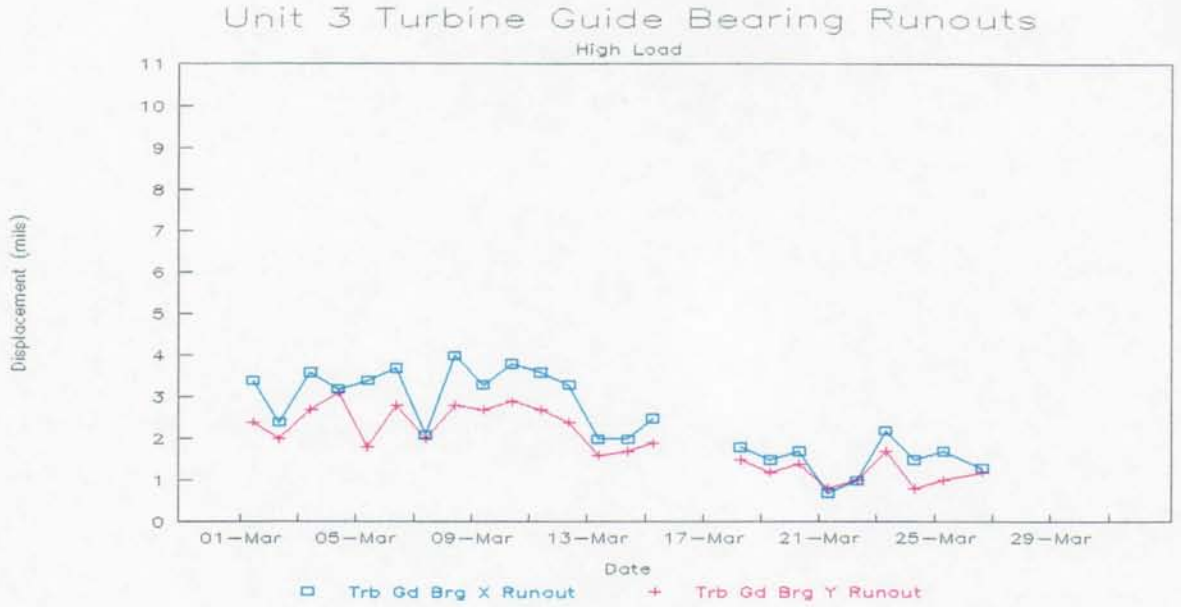
Bearing babbitt and stator iron temperatures were monitored using the permanently installed instrumentation. Readouts were available through the DACS system at pre-programmed intervals or upon request.

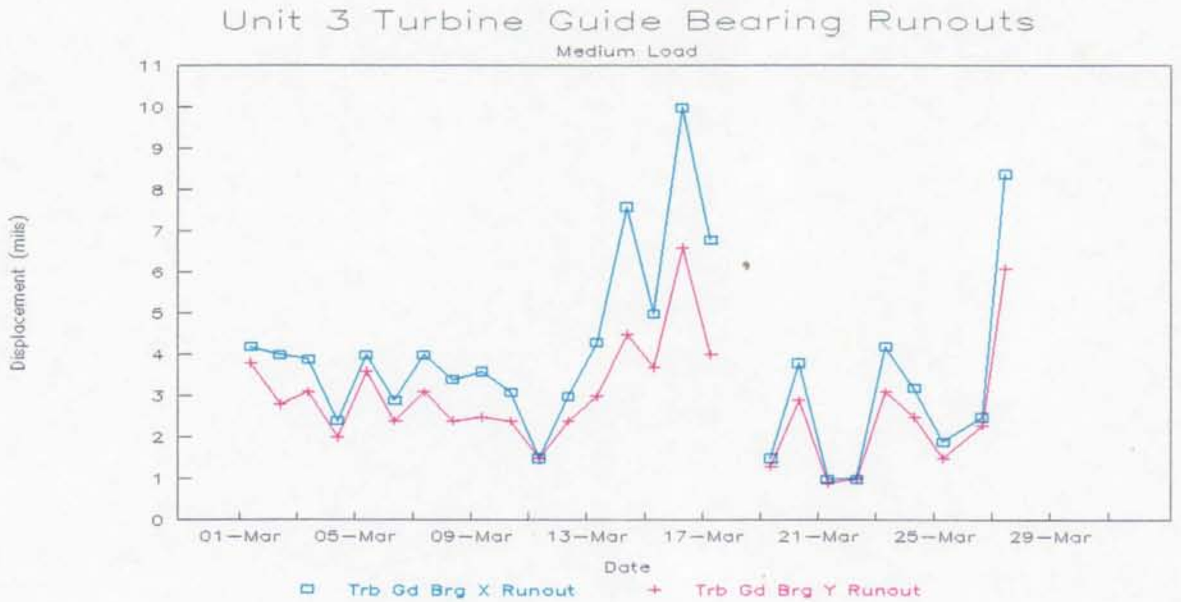
APPENDIX

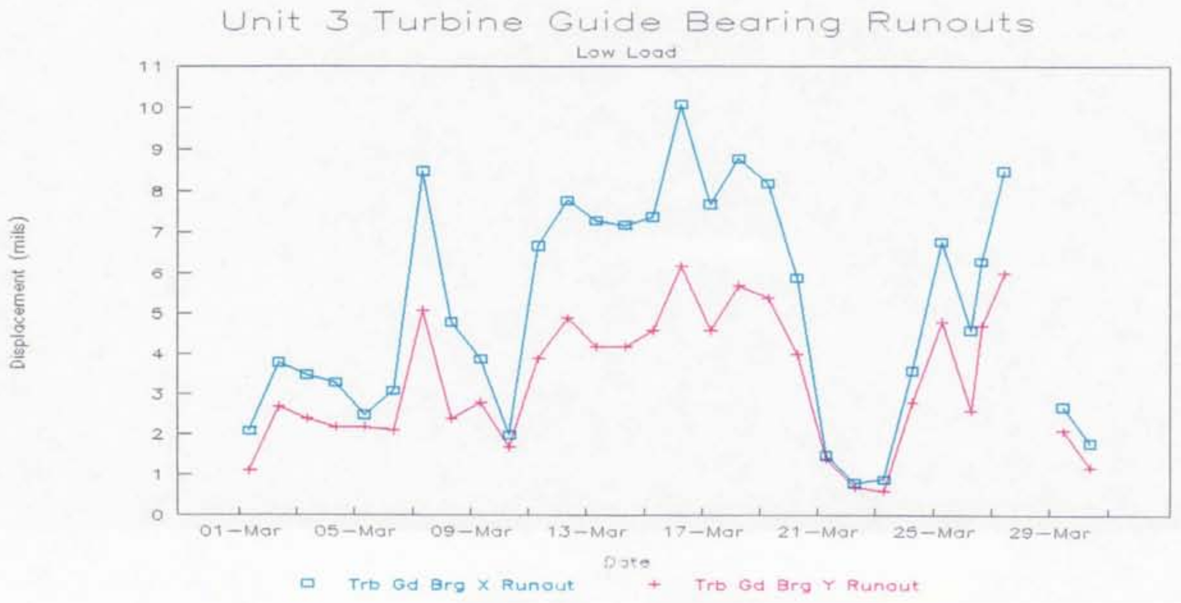

Unit 3 Lower Guide Bearing Runouts
High Load
Displacement (mils)
9
8
7
6
5
4
3
2
1
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout


Unit 3 Lower Guide Bearing Runouts
Medium Load
Displacement (mils)
9
8
7
6
5
4
3
2
1
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout


Unit 3 Lower Guide Bearing Runouts
Low Load
Displacement (mils)
9
8
7
6
5
4
3
2
1
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout

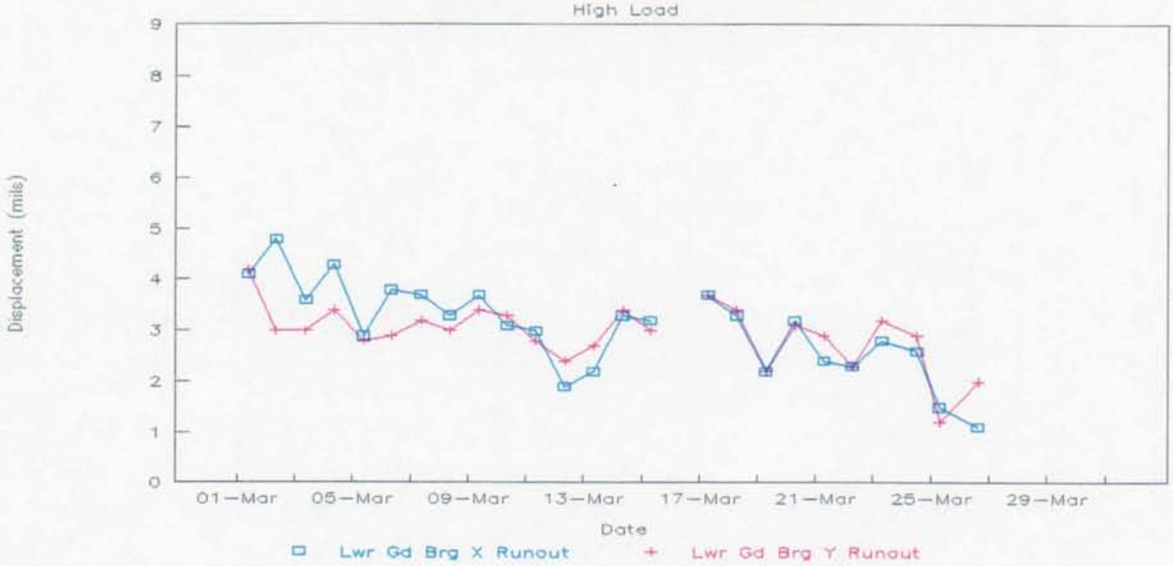

Unit 3 Turbine Guide Bearing Runouts
High Load
Displacement (mils)
Date
Trb Gd Brg X Runout
Trb Gd Brg Y Runout


Unit 3 Turbine Guide Bearing Runouts
Medium Load
Displacement (mils)
Date
Trb Gd Brg X Runout
Trb Gd Brg Y Runout


Unit 3 Turbine Guide Bearing Runouts
Low Load
Displacement (mils)
Date
Trb Gd Brg X Runout
Trb Gd Brg Y Runout

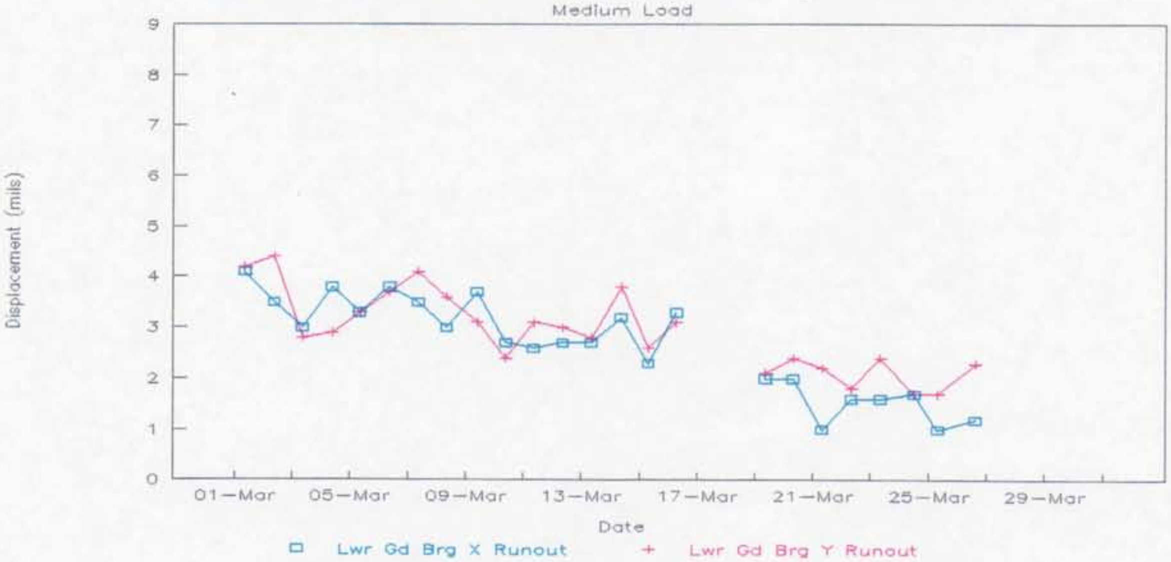
Unit 4 Lower Guide Bearing Runouts

High Load



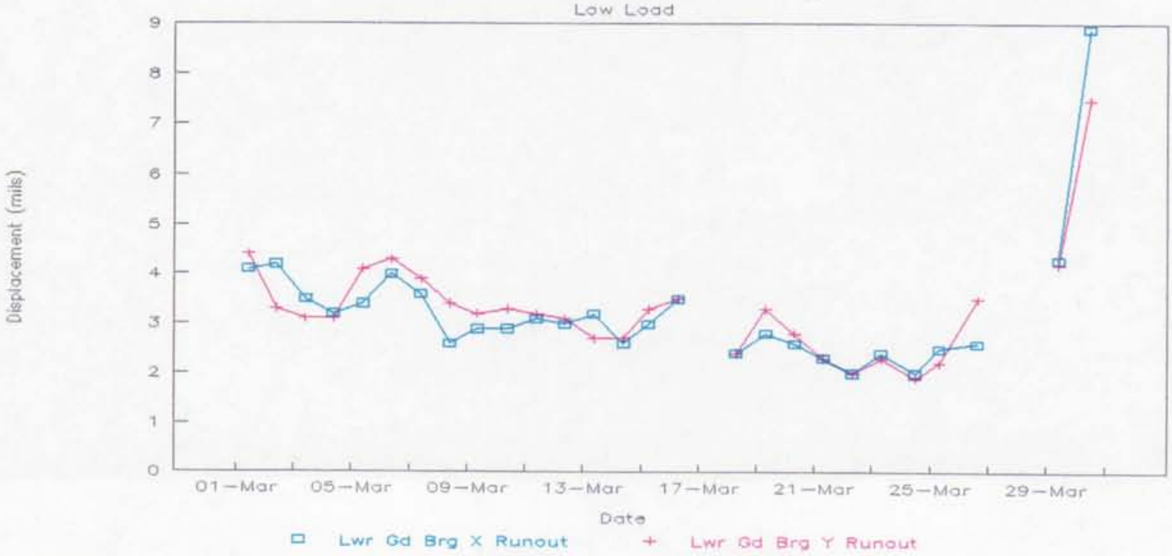
Unit 4 Lower Guide Bearing Runouts

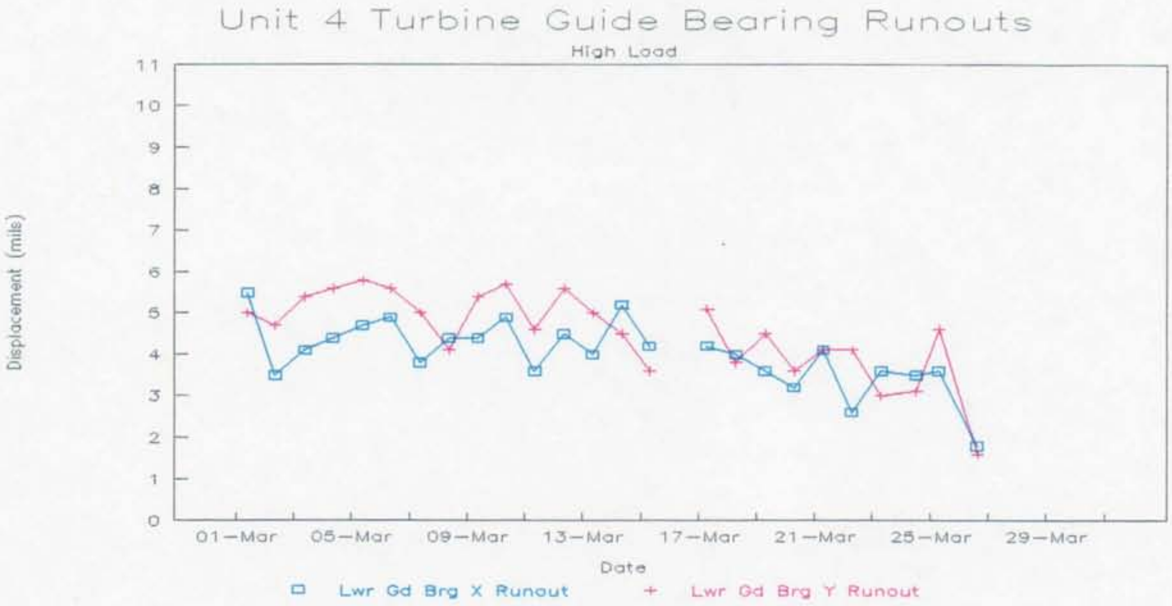
Medium Load

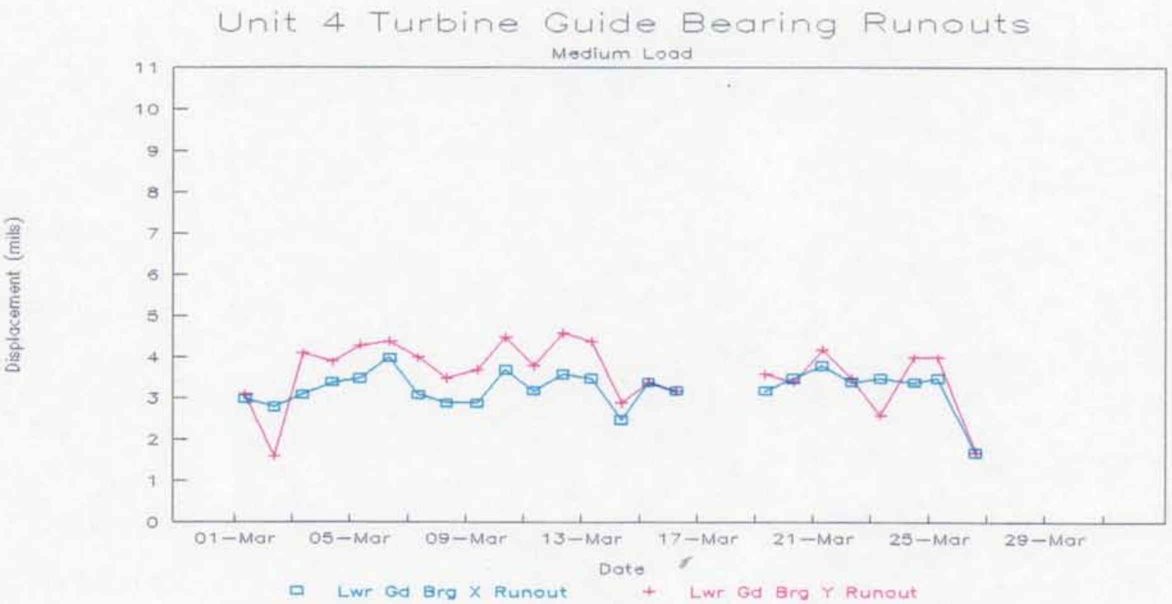


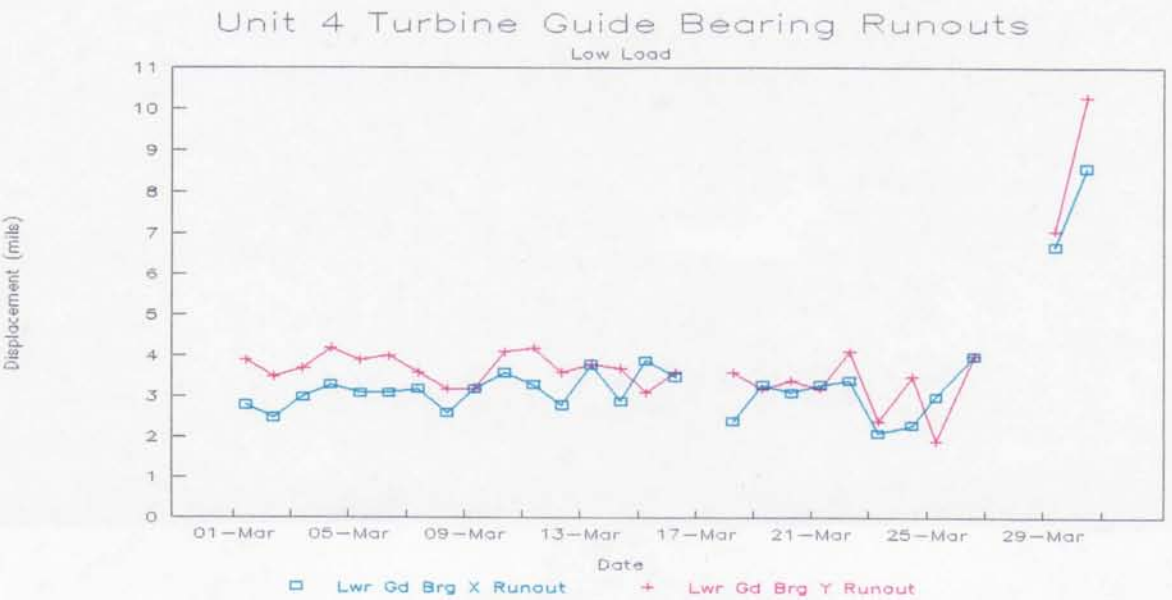
Unit 4 Lower Guide Bearing Runouts

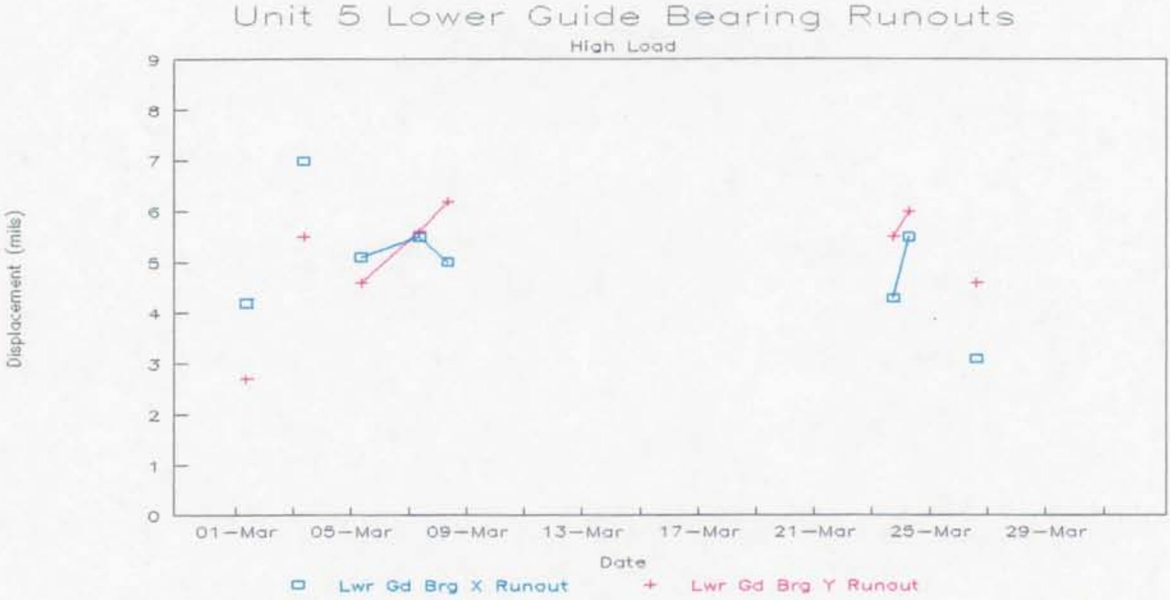
Low Load

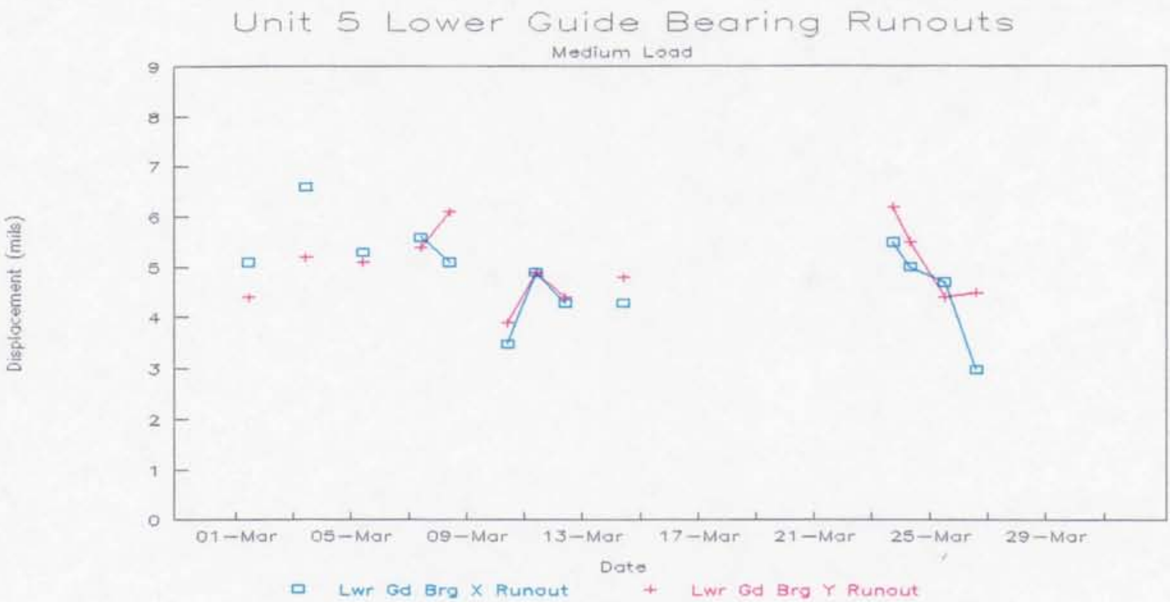


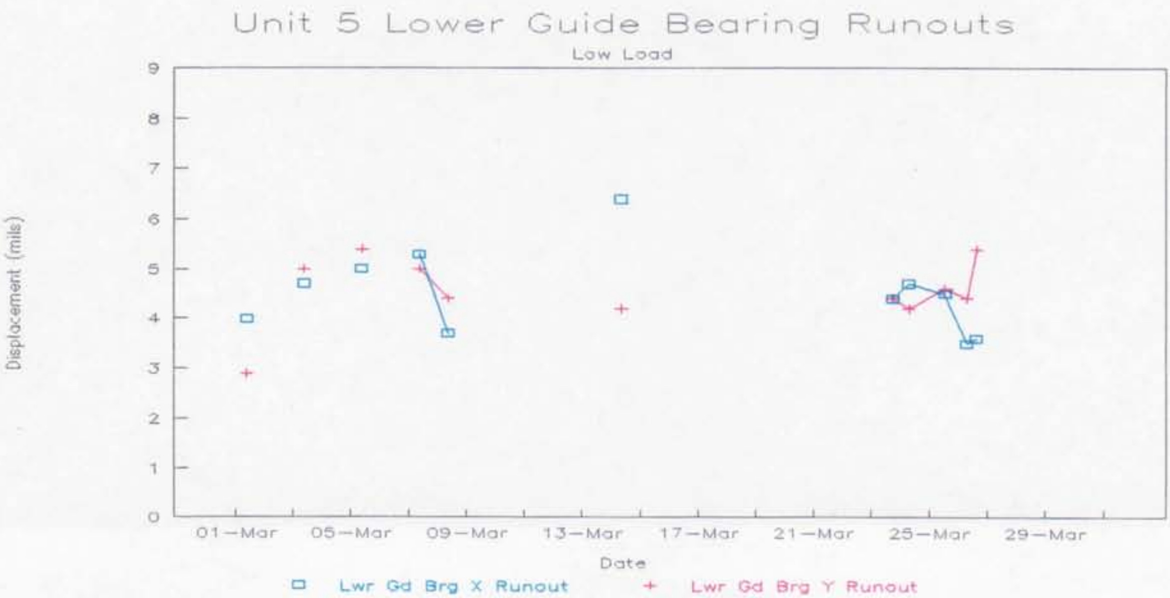

Unit 4 Turbine Guide Bearing Runouts
High Load
Displacement (mils)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout


Unit 4 Turbine Guide Bearing Runouts
Medium Load
Displacement (mils)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout

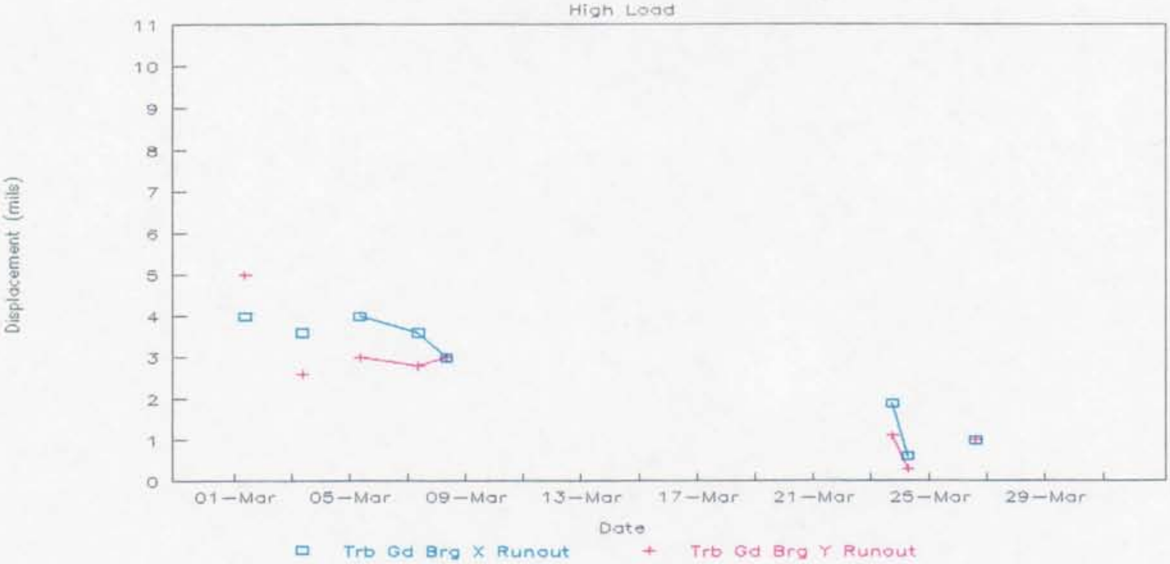

Unit 4 Turbine Guide Bearing Runouts
Low Load
Displacement (mils)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout


Unit 5 Lower Guide Bearing Runouts
High Load
Displacement (mils)
0
1
2
3
4
5
6
7
8
9
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout

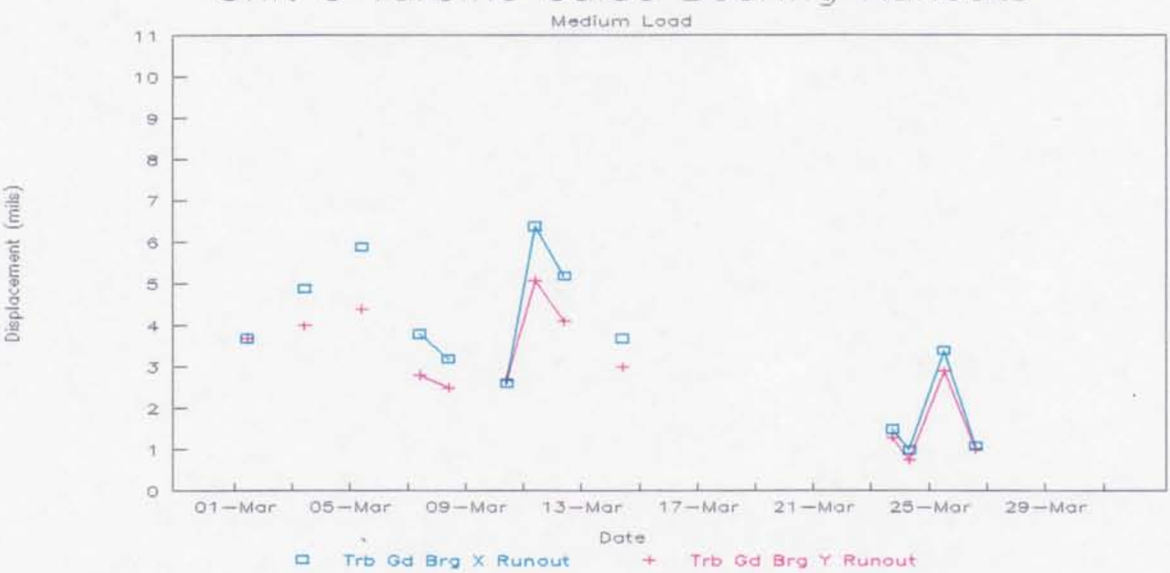

Unit 5 Lower Guide Bearing Runouts
Medium Load
Displacement (mils)
0
1
2
3
4
5
6
7
8
9
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout


Unit 5 Lower Guide Bearing Runouts
Low Load
Displacement (mils)
0
1
2
3
4
5
6
7
8
9
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Lwr Gd Brg X Runout
Lwr Gd Brg Y Runout

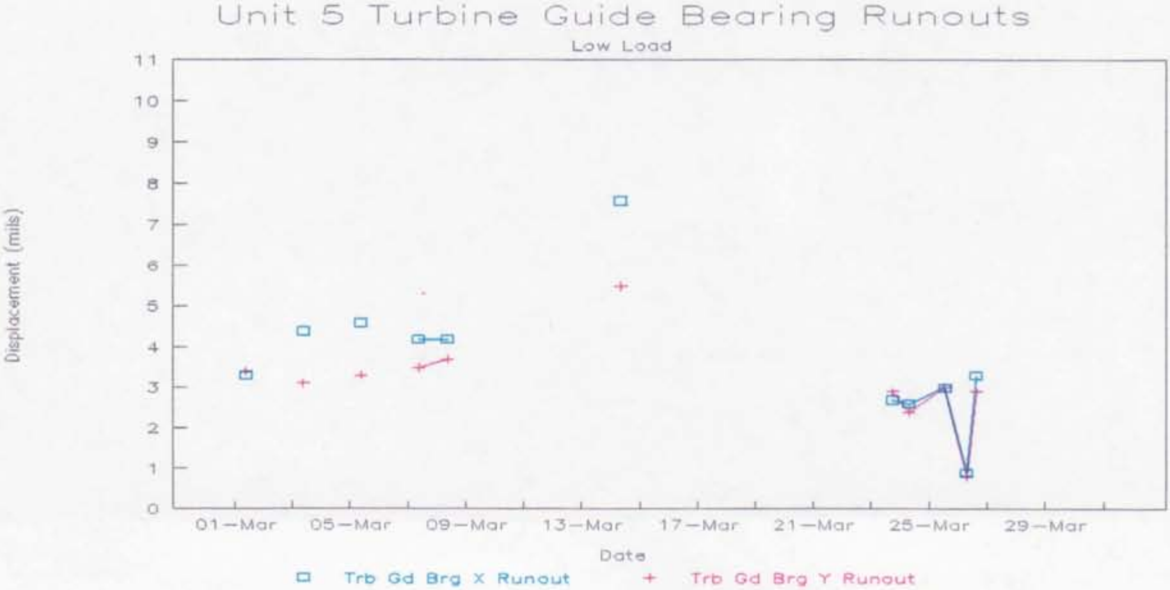
Unit 5 Turbine Guide Bearing Runouts



Unit 5 Turbine Guide Bearing Runouts



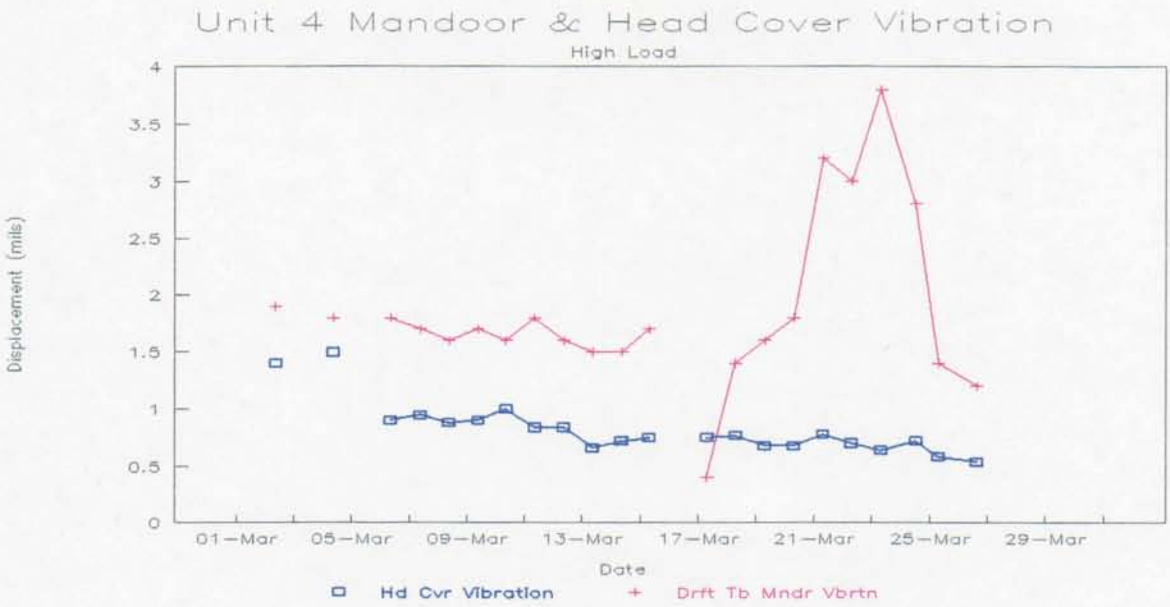
Unit 5 Turbine Guide Bearing Runouts



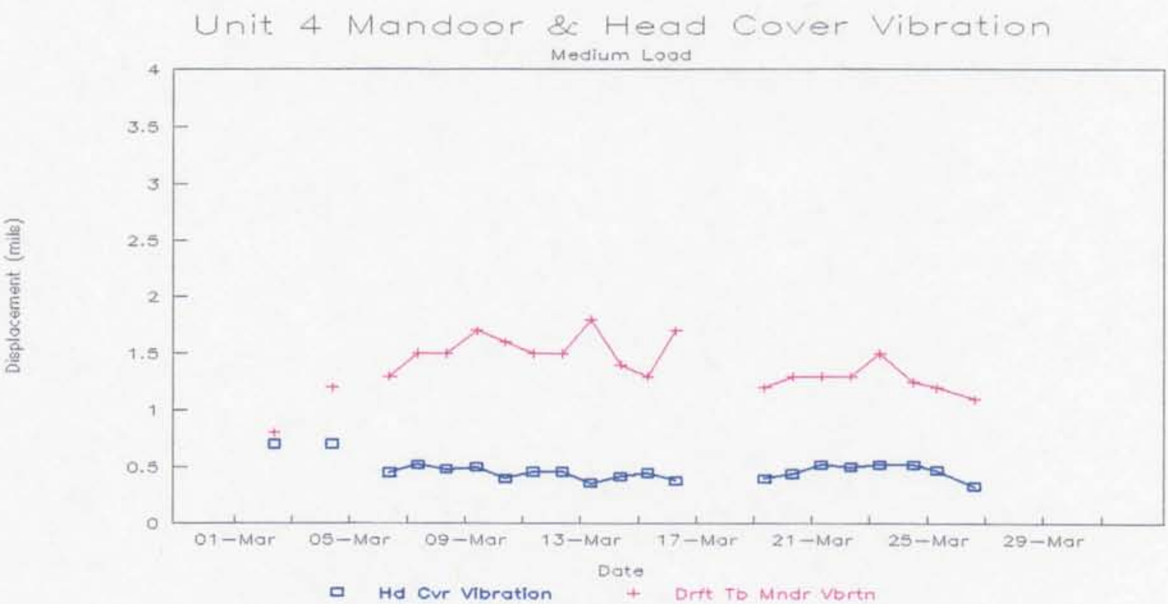

Unit 3 Mandoor & Head Cover Vibration
High Load
Displacement (mils)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Hd Cvr Vibration
Drft Tb Mndr Vbrtn


Unit 3 Mandoor & Head Cover Vibration
Medium Load
Displacement (mils)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

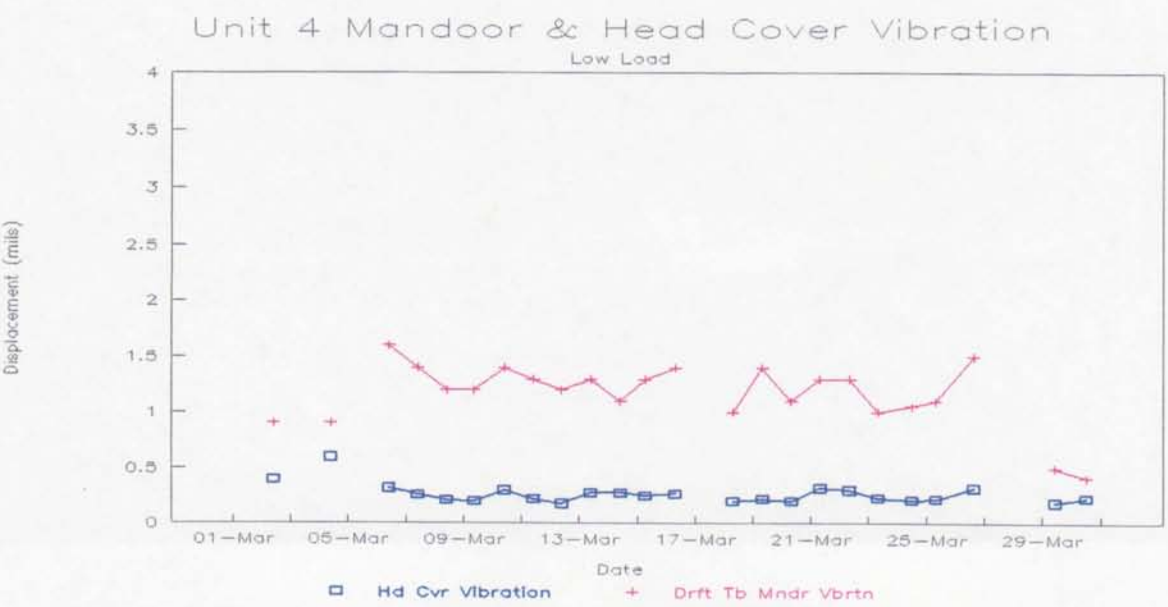

Unit 3 Mandoor & Head Cover Vibration
Low Load
Displacement (mils)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Hd Cvr Vibration
Drft Tb Mndr Vbrtn



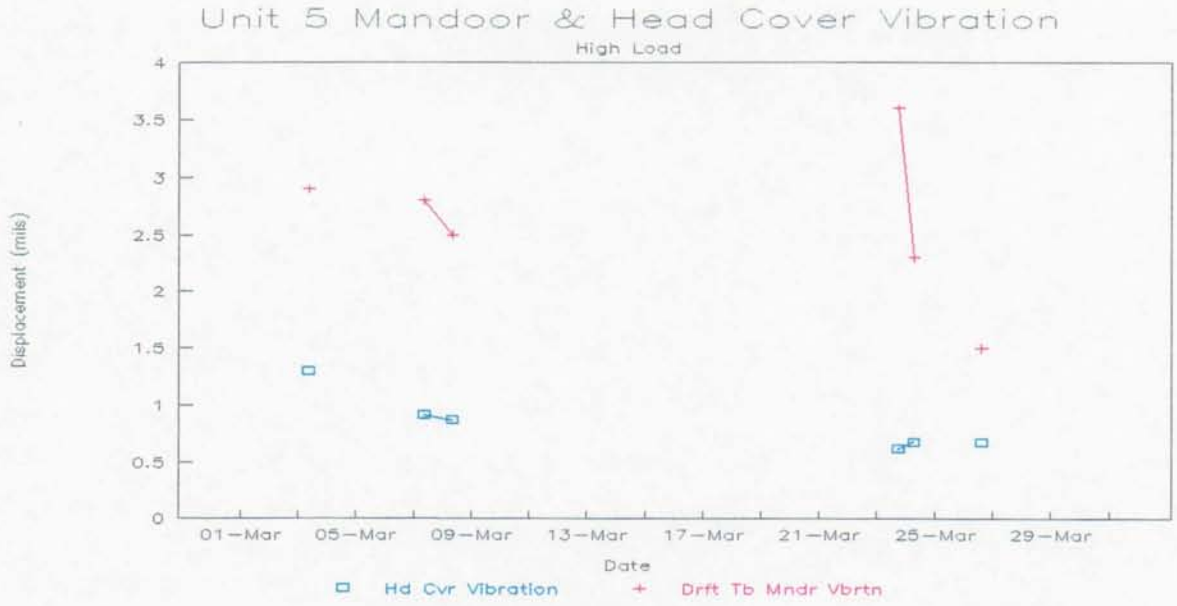
Unit 4 Mandoor & Head Cover Vibration
High Load
Displacement (mils)
0
0.5
1
1.5
2
2.5
3
3.5
4
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn



Unit 4 Mandoor & Head Cover Vibration
Medium Load
Displacement (mils)
0
0.5
1
1.5
2
2.5
3
3.5
4
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

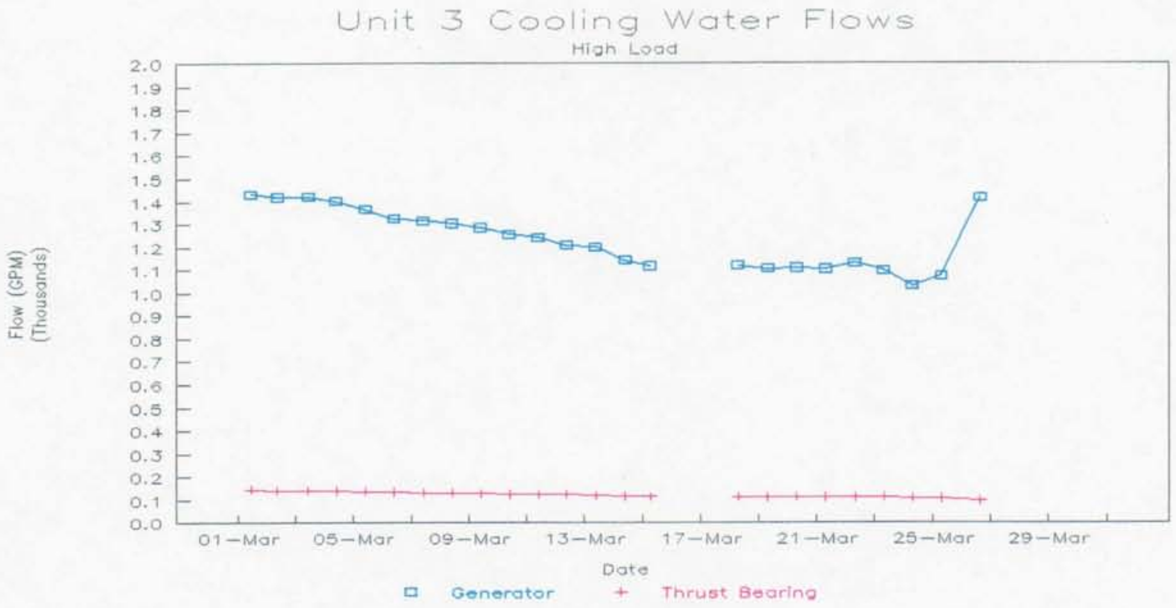


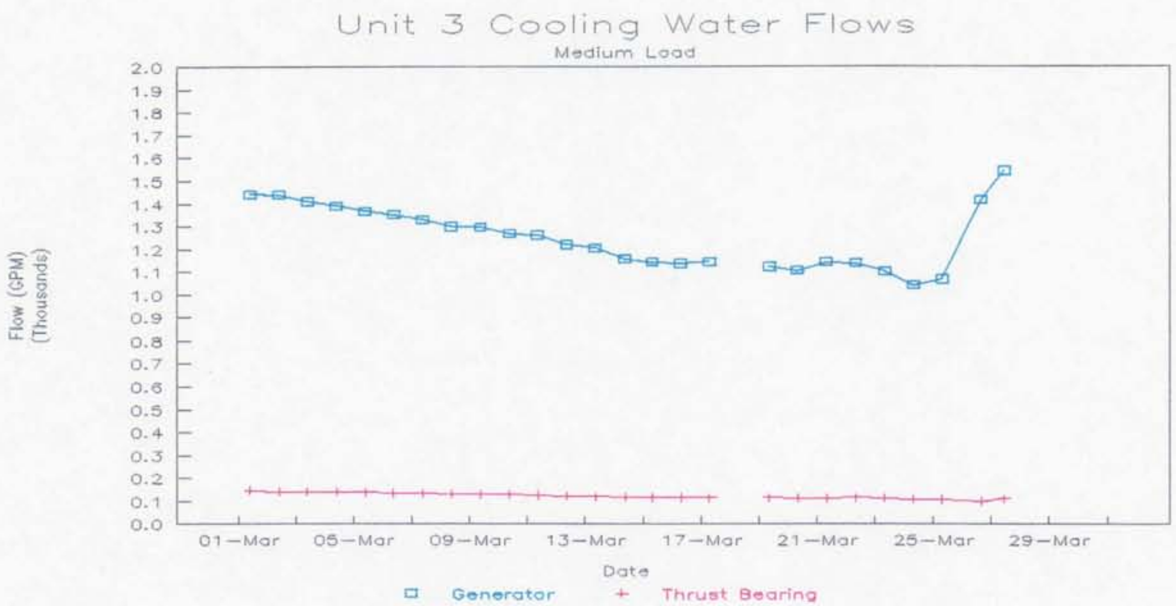
Unit 4 Mandoor & Head Cover Vibration
Low Load
Displacement (mils)
0
0.5
1
1.5
2
2.5
3
3.5
4
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

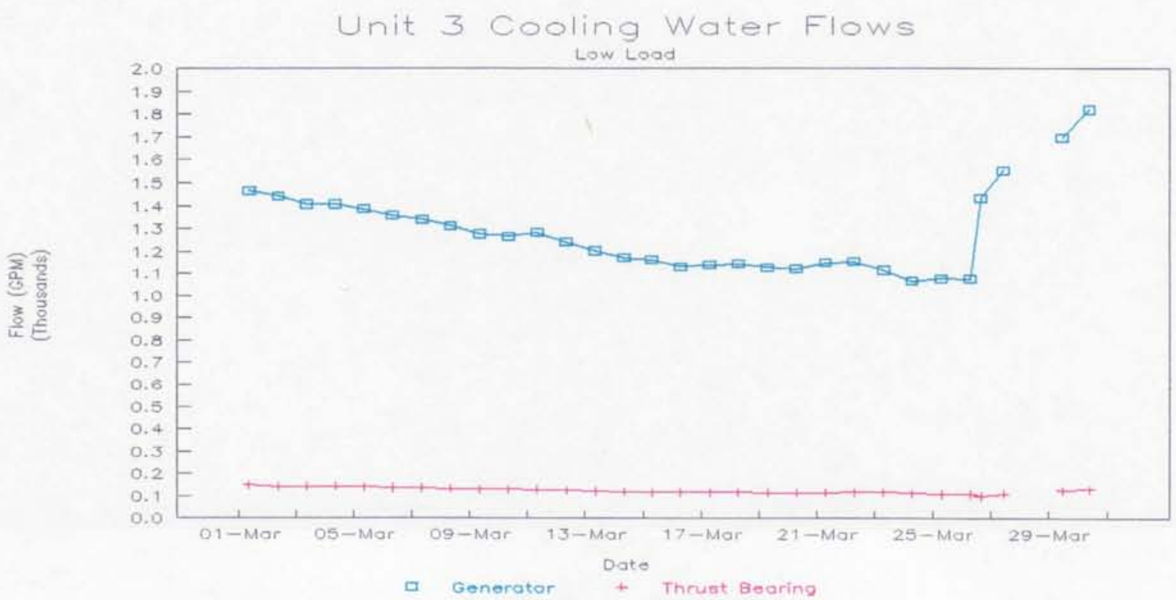

Unit 5 Mandoor & Head Cover Vibration
High Load
Displacement (mils)
4
3.5
3
2.5
2
1.5
1
0.5
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

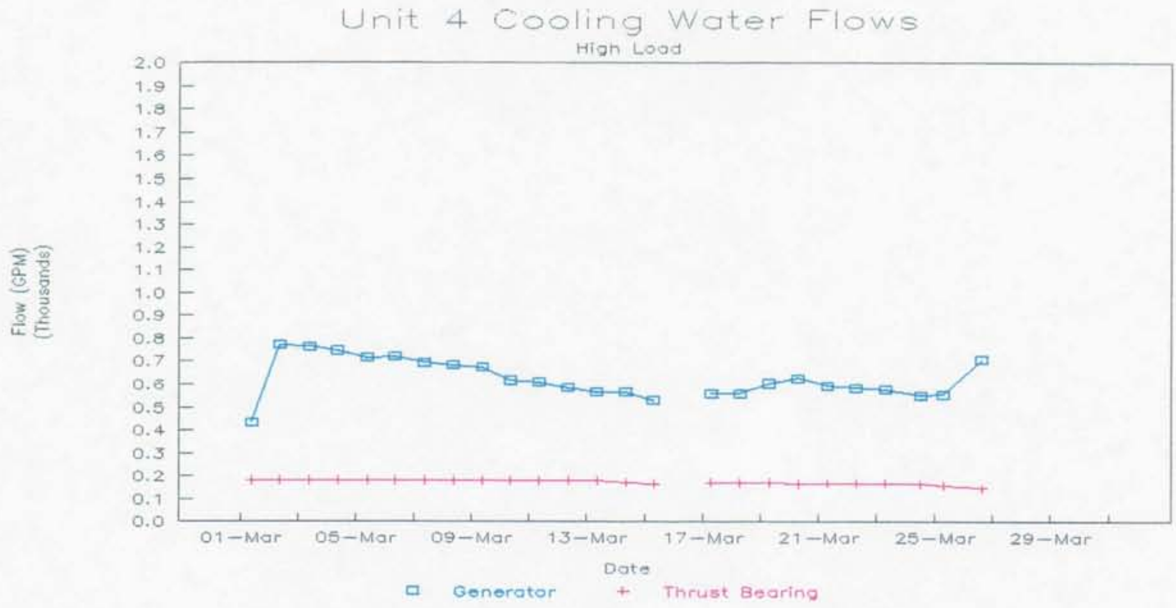

Unit 5 Mandoor & Head Cover Vibration
Medium Load
Displacement (mils)
4
3.5
3
2.5
2
1.5
1
0.5
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

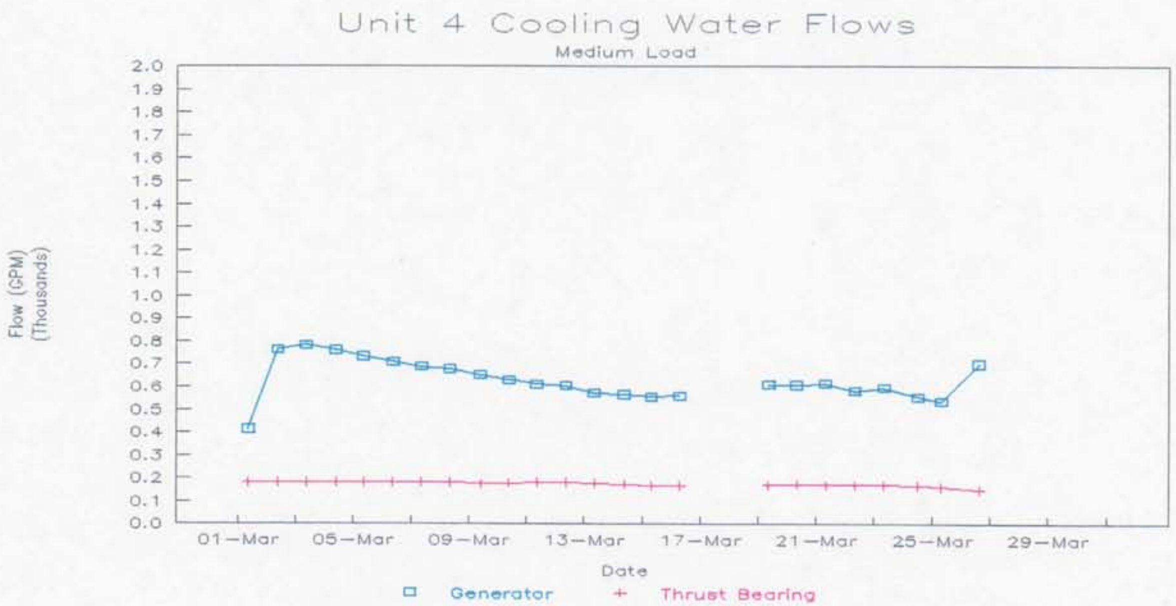

Unit 5 Mandoor & Head Cover Vibration
Low Load
Displacement (mils)
4
3.5
3
2.5
2
1.5
1
0.5
0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Hd Cvr Vibration
Drft Tb Mndr Vbrtn

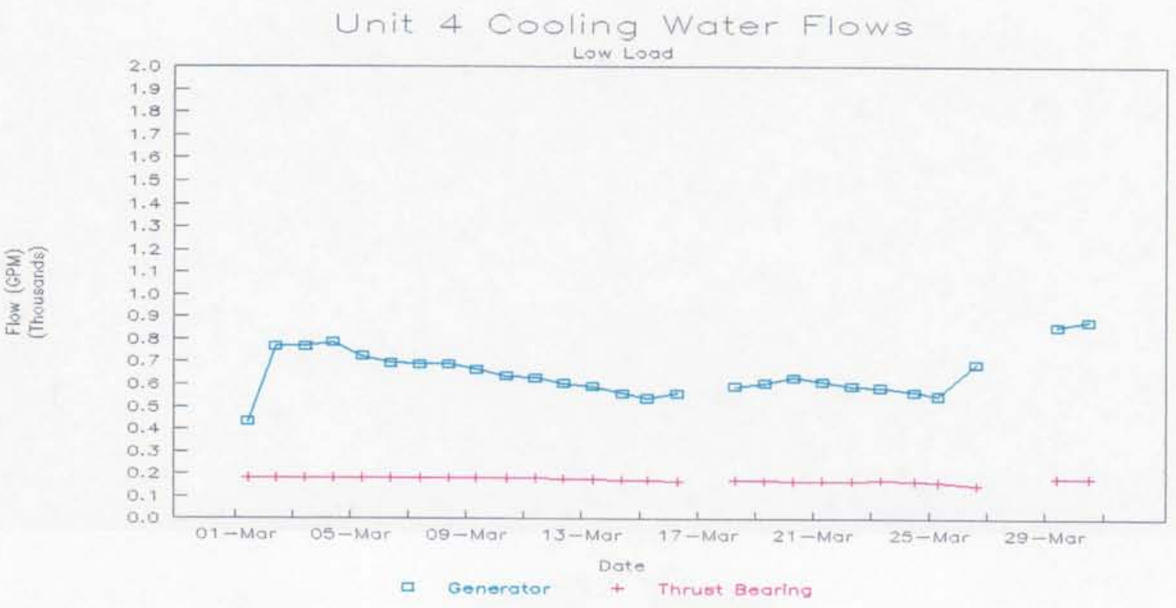

Unit 3 Cooling Water Flows
High Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing

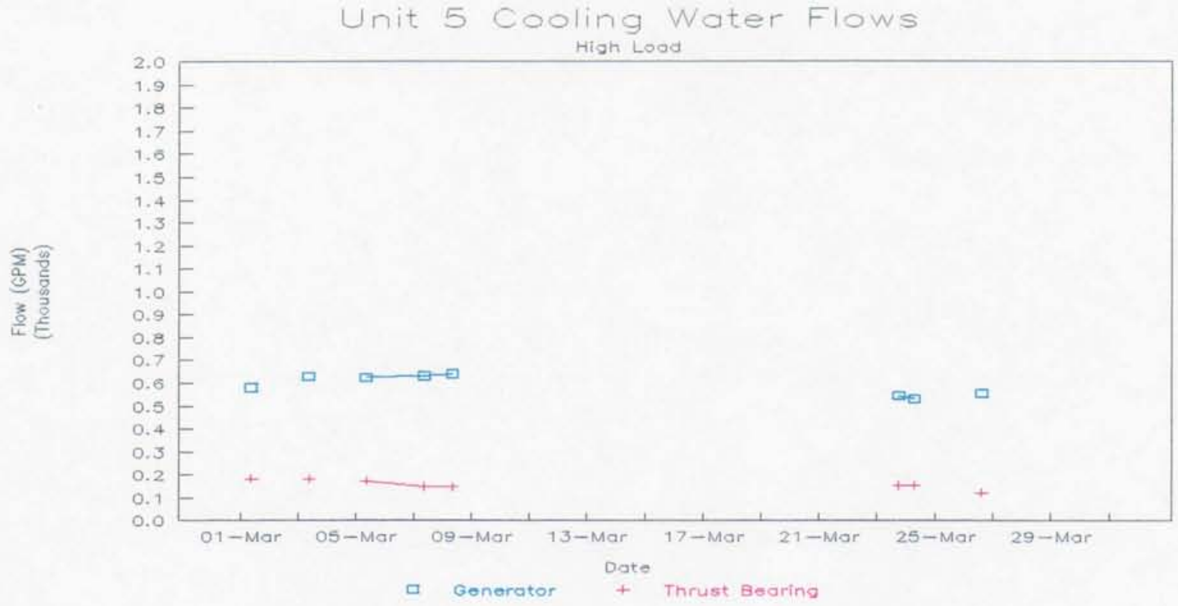

Unit 3 Cooling Water Flows
Medium Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing


Unit 3 Cooling Water Flows
Low Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing

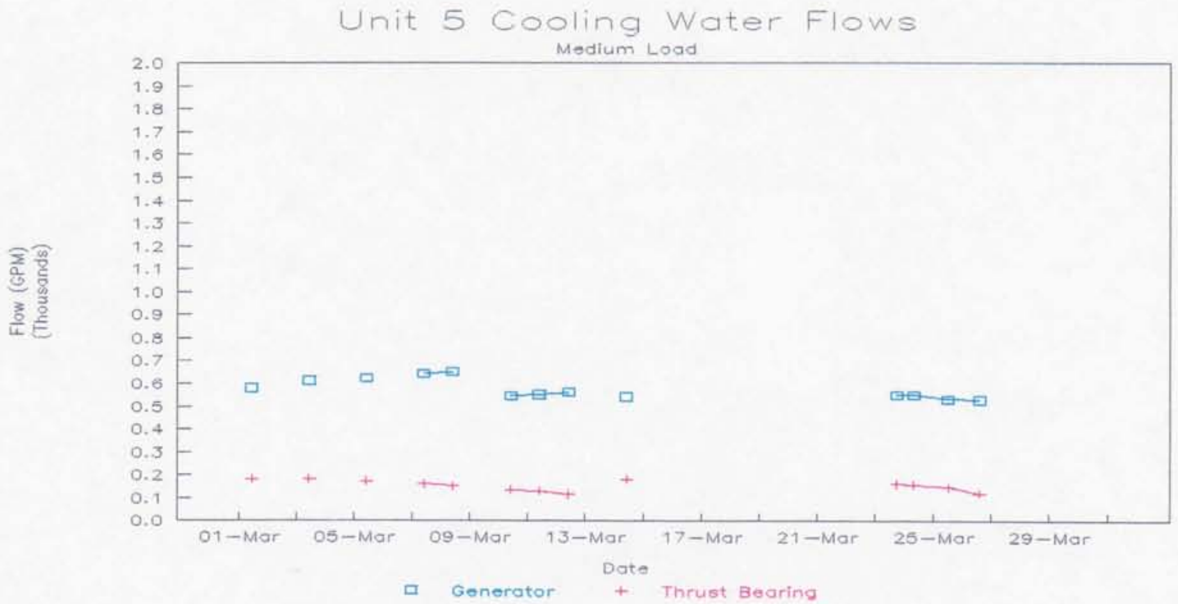

Unit 4 Cooling Water Flows
High Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing


Unit 4 Cooling Water Flows
Medium Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing

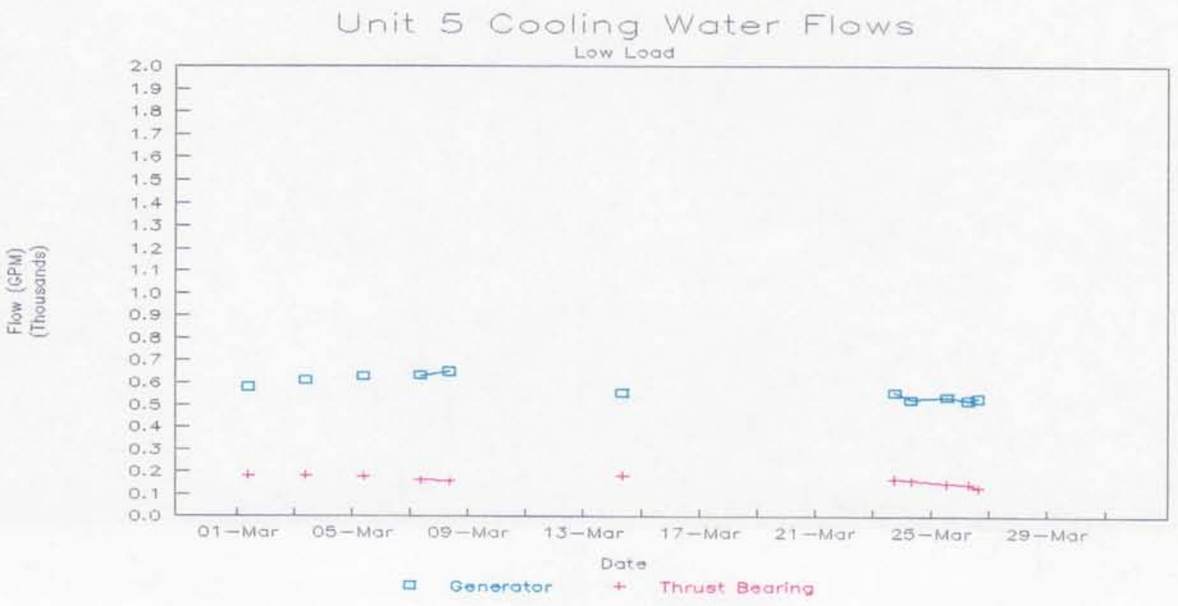

Unit 4 Cooling Water Flows
Low Load
Flow (GPM)
(Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Generator
Thrust Bearing



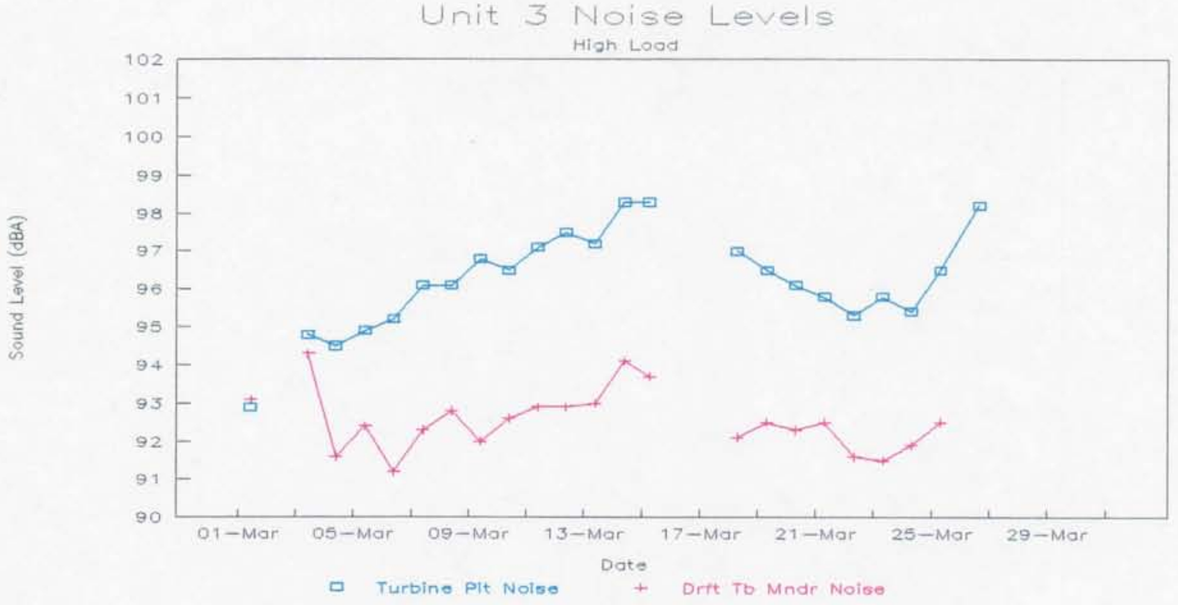
Unit 5 Cooling Water Flows
High Load
Flow (GPM) (Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Generator
Thrust Bearing

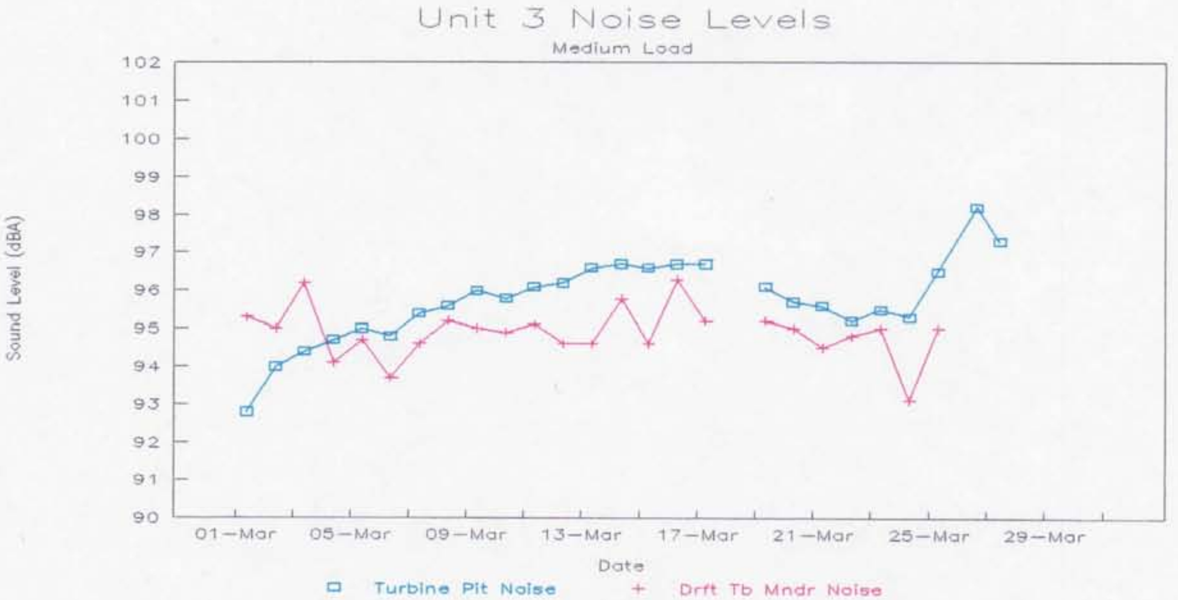


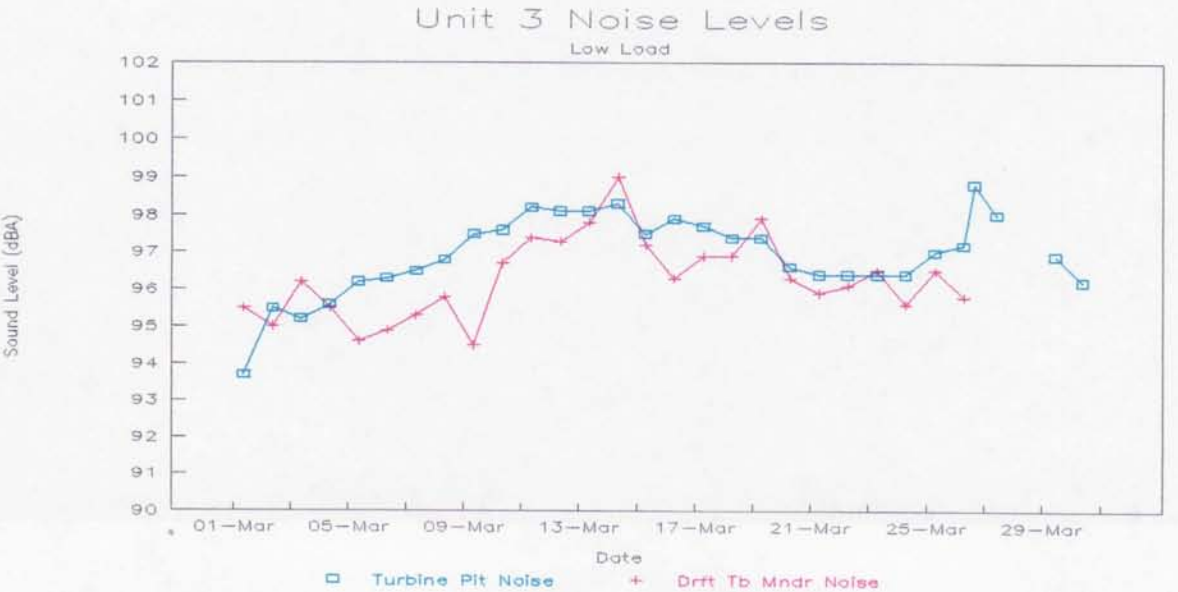
Unit 5 Cooling Water Flows
Medium Load
Flow (GPM) (Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Generator
Thrust Bearing



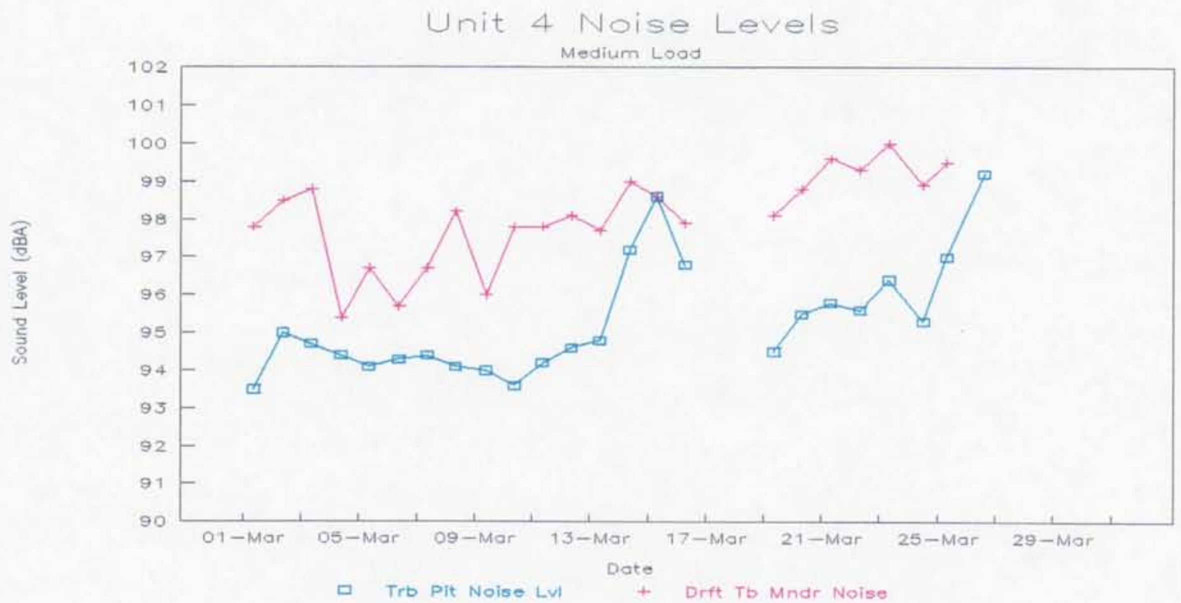
Unit 5 Cooling Water Flows
Low Load
Flow (GPM) (Thousands)
2.0
1.9
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Generator
Thrust Bearing

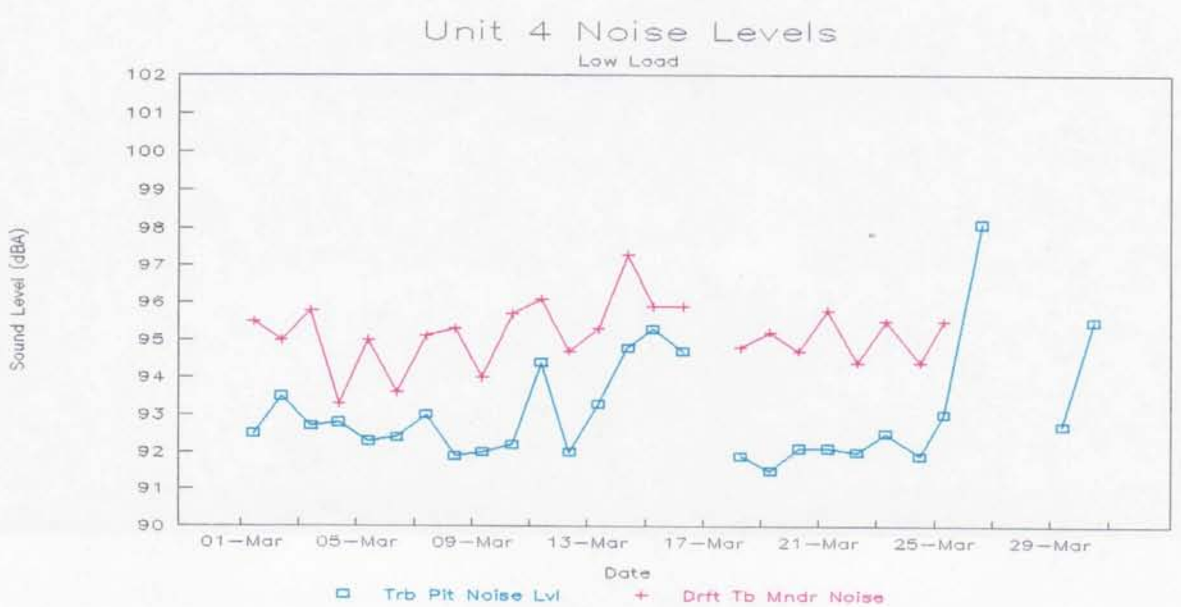

Unit 3 Noise Levels
High Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise

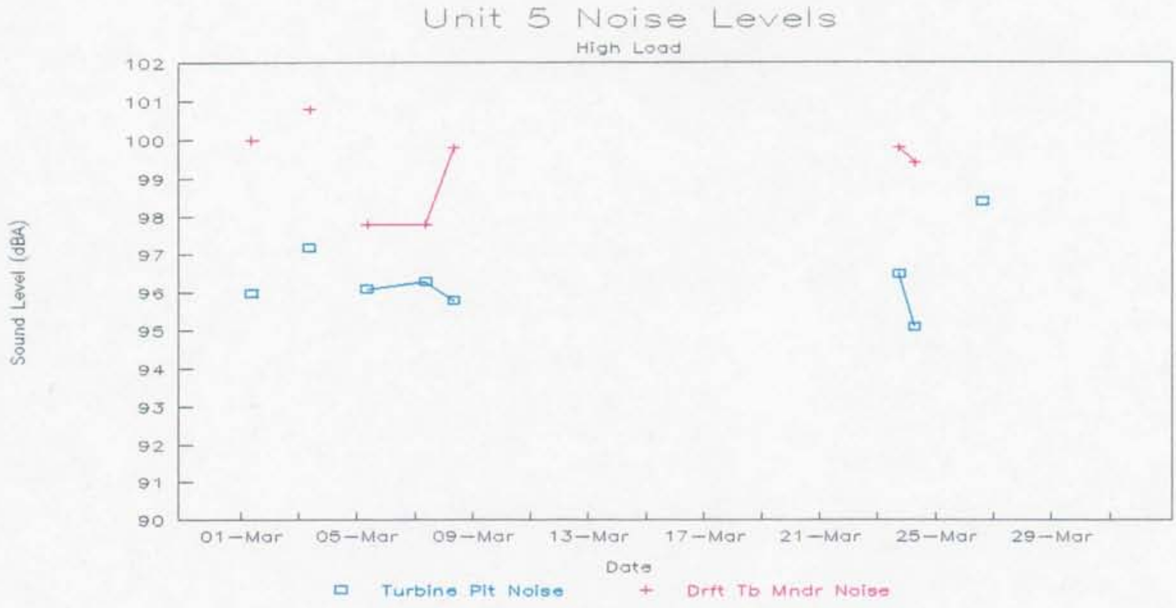

Unit 3 Noise Levels
Medium Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise


Unit 3 Noise Levels
Low Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01—Mar
05—Mar
09—Mar
13—Mar
17—Mar
21—Mar
25—Mar
29—Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise

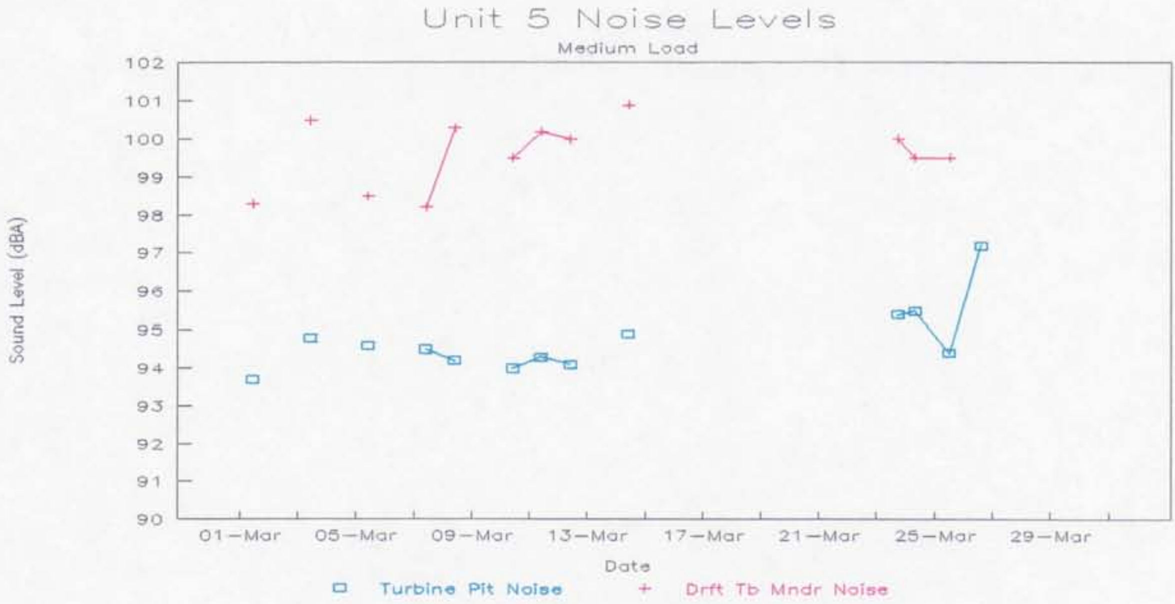

Unit 4 Noise Levels
High Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Trb Pit Noise Lvl
Drft Tb Mndr Noise


Unit 4 Noise Levels
Medium Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Trb Pit Noise Lvl
Drft Tb Mndr Noise

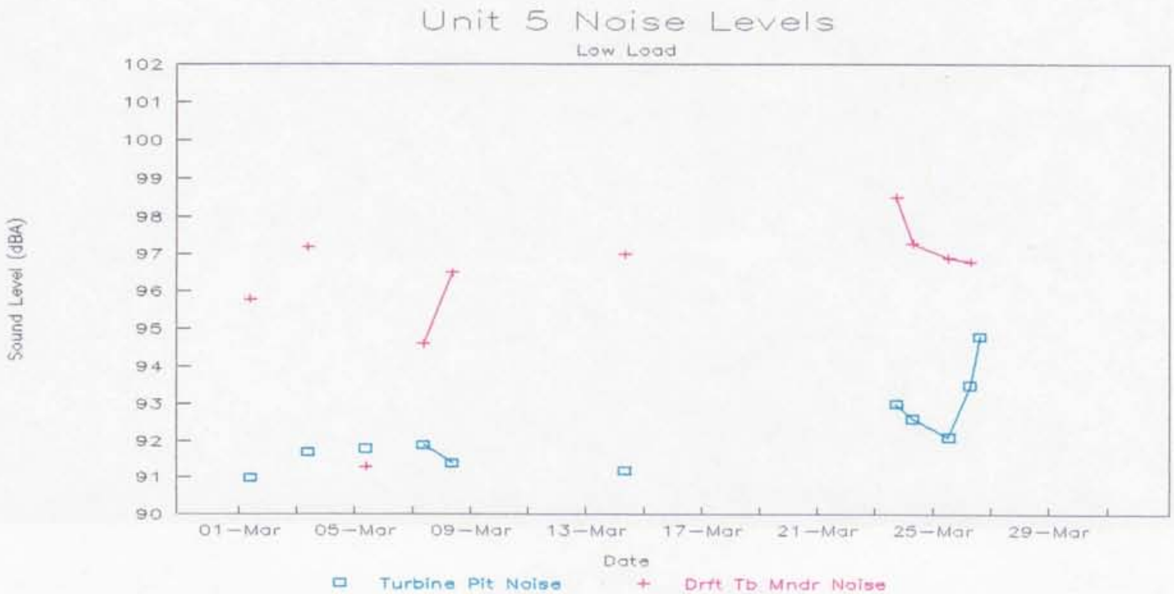

Unit 4 Noise Levels
Low Load
Sound Level (dBA)
102
101
100
99
98
97
96
95
94
93
92
91
90
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Trb Pit Noise Lvl
Drft Tb Mndr Noise



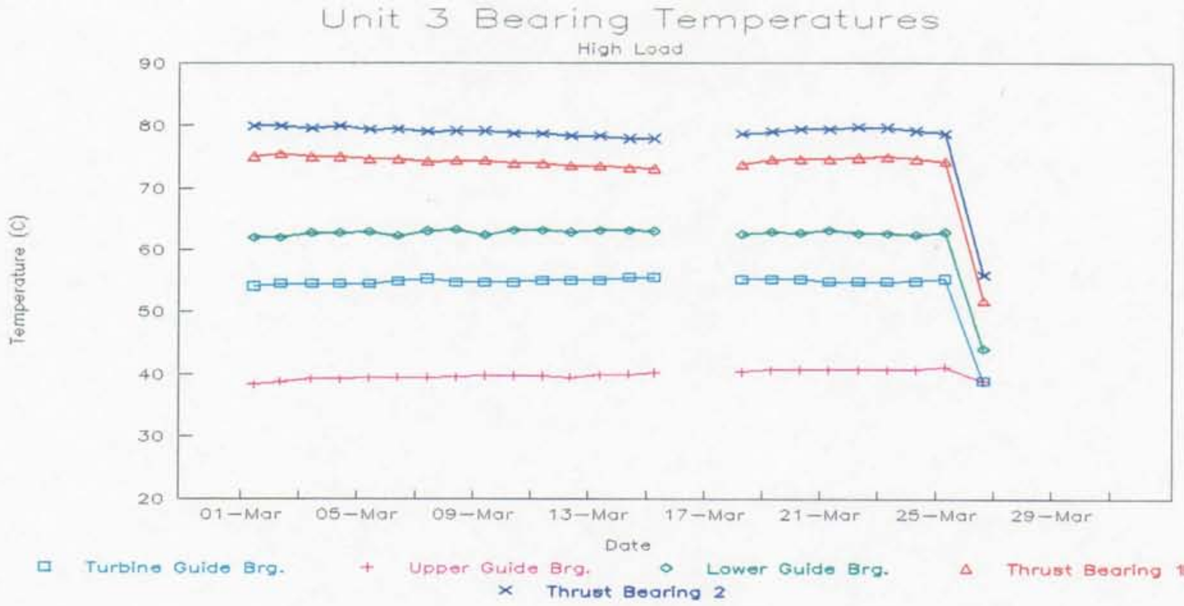
Unit 5 Noise Levels
High Load
102
101
100
99
98
97
96
95
94
93
92
91
90
Sound Level (dBA)
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise

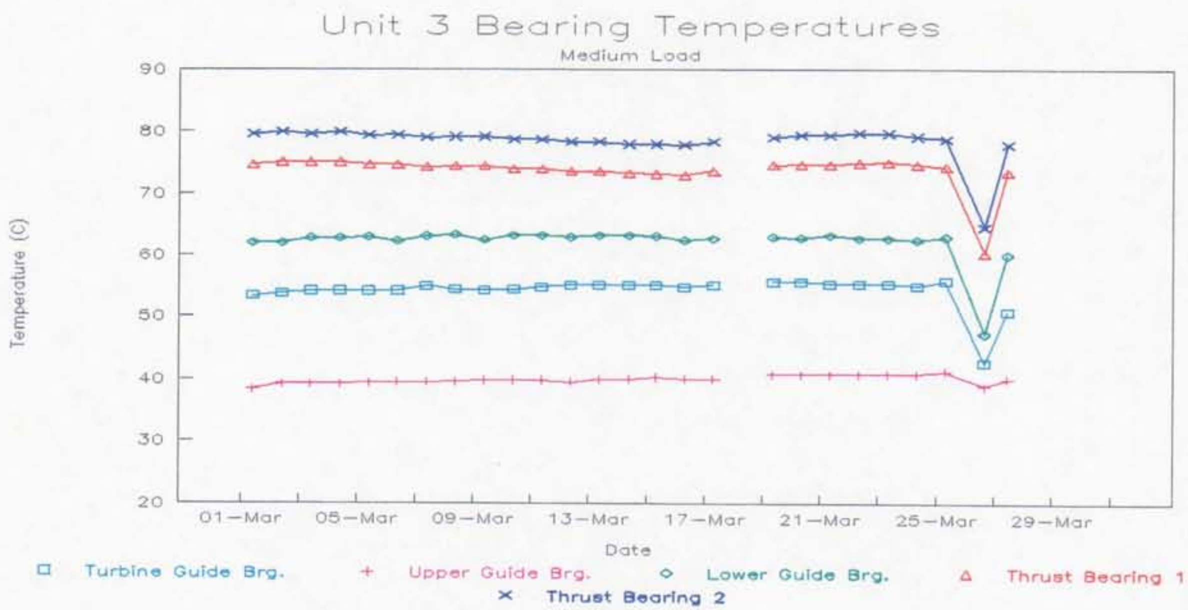


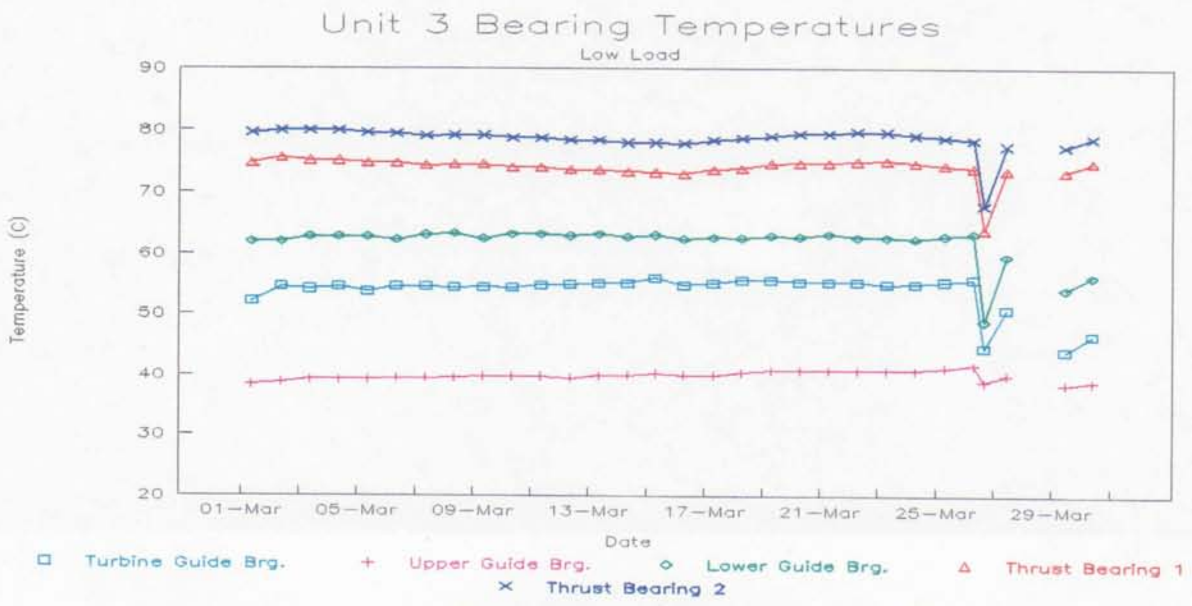
Unit 5 Noise Levels
Medium Load
102
101
100
99
98
97
96
95
94
93
92
91
90
Sound Level (dBA)
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise

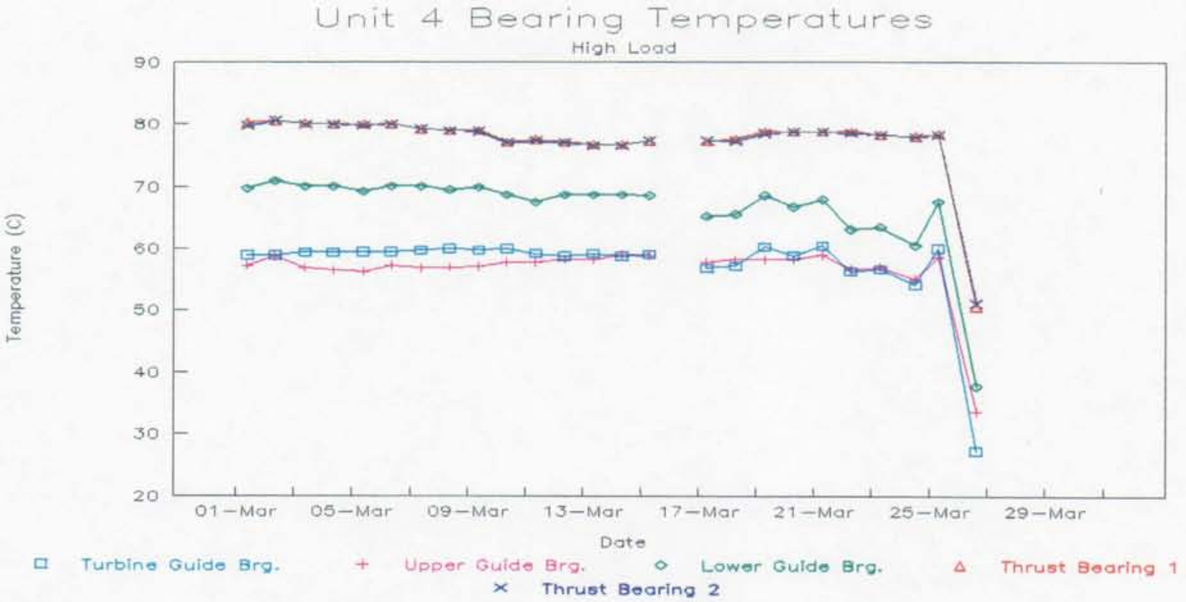


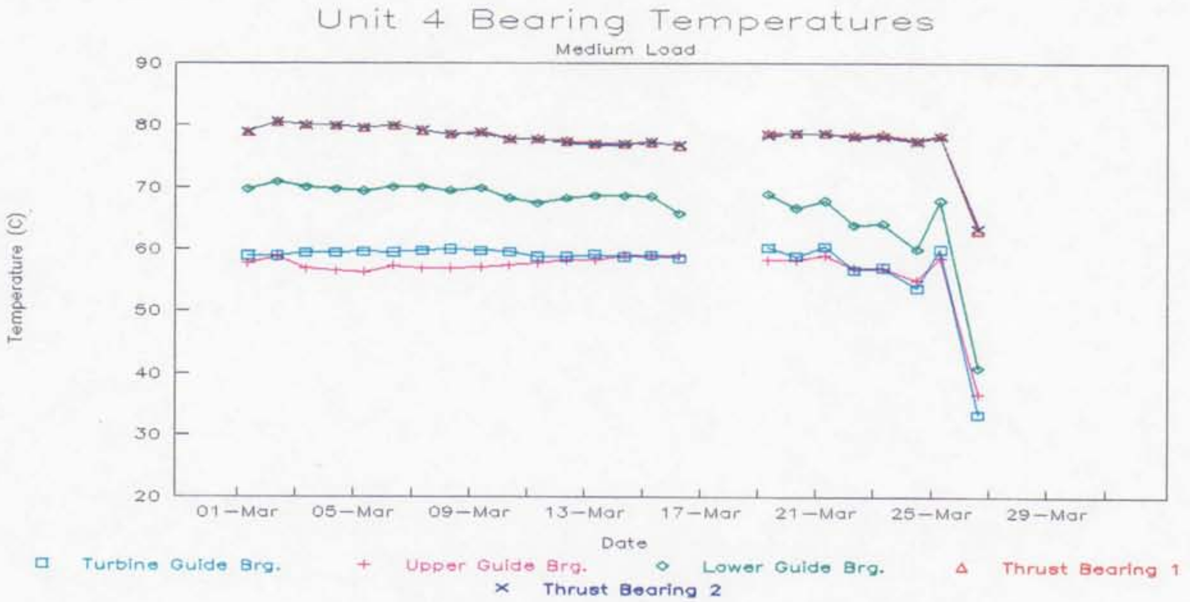
Unit 5 Noise Levels
Low Load
102
101
100
99
98
97
96
95
94
93
92
91
90
Sound Level (dBA)
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Pit Noise
Drft Tb Mndr Noise

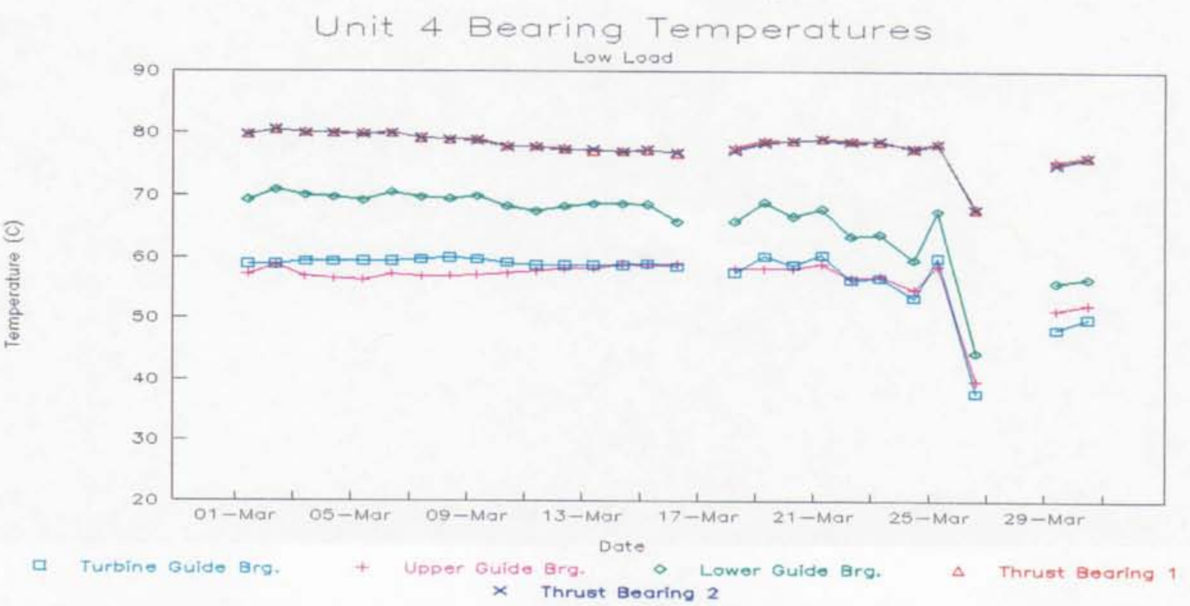

Unit 3 Bearing Temperatures
High Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

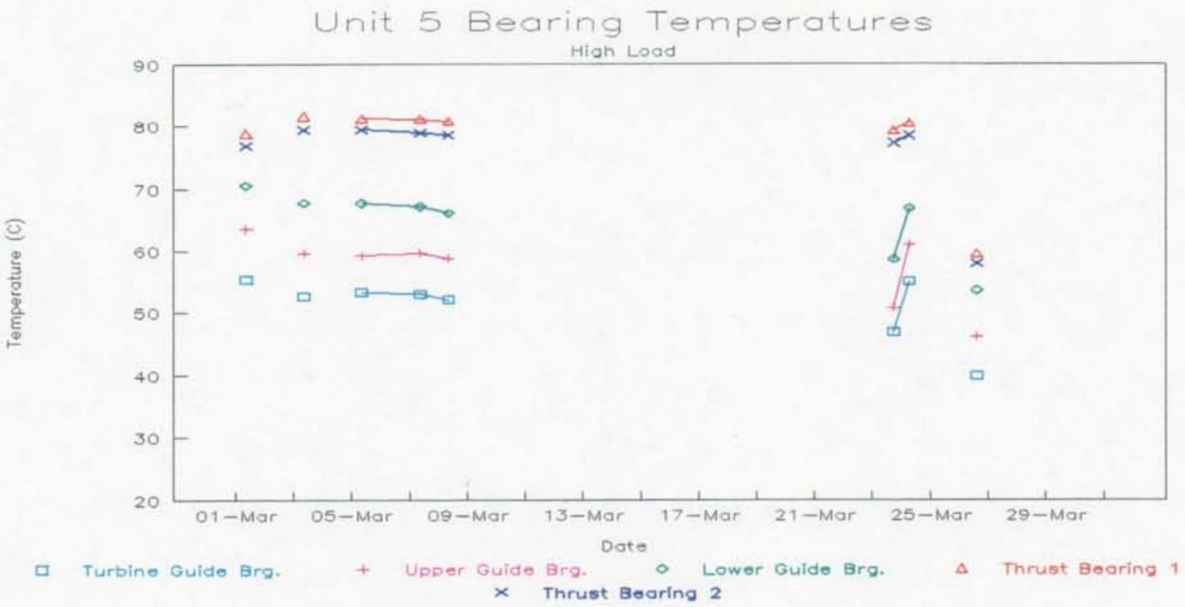

Unit 3 Bearing Temperatures
Medium Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

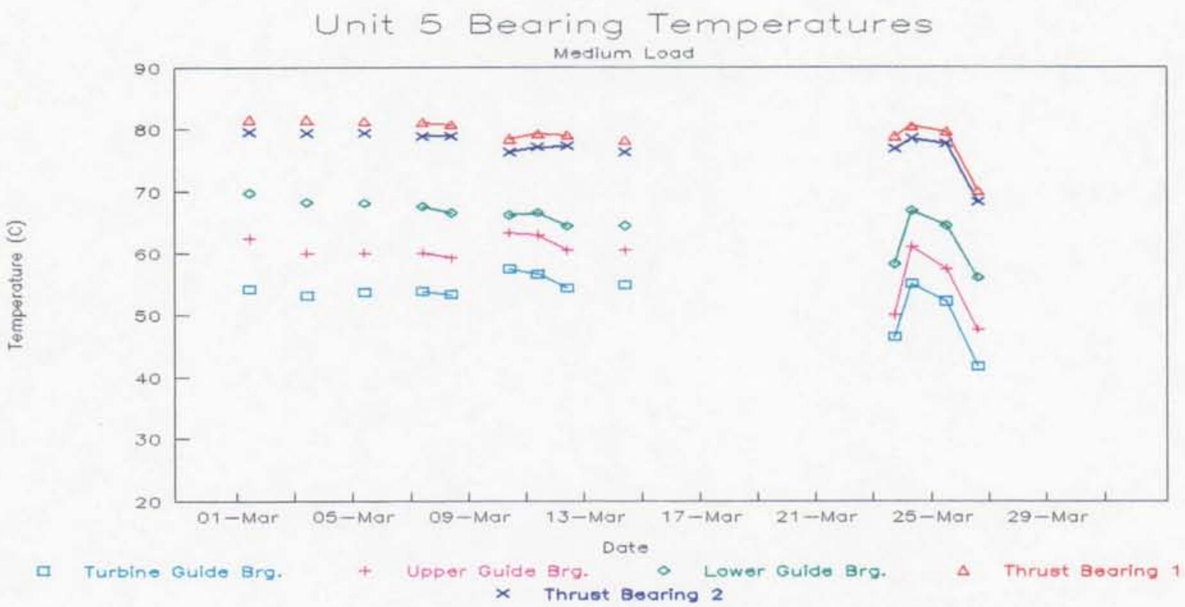

Unit 3 Bearing Temperatures
Low Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

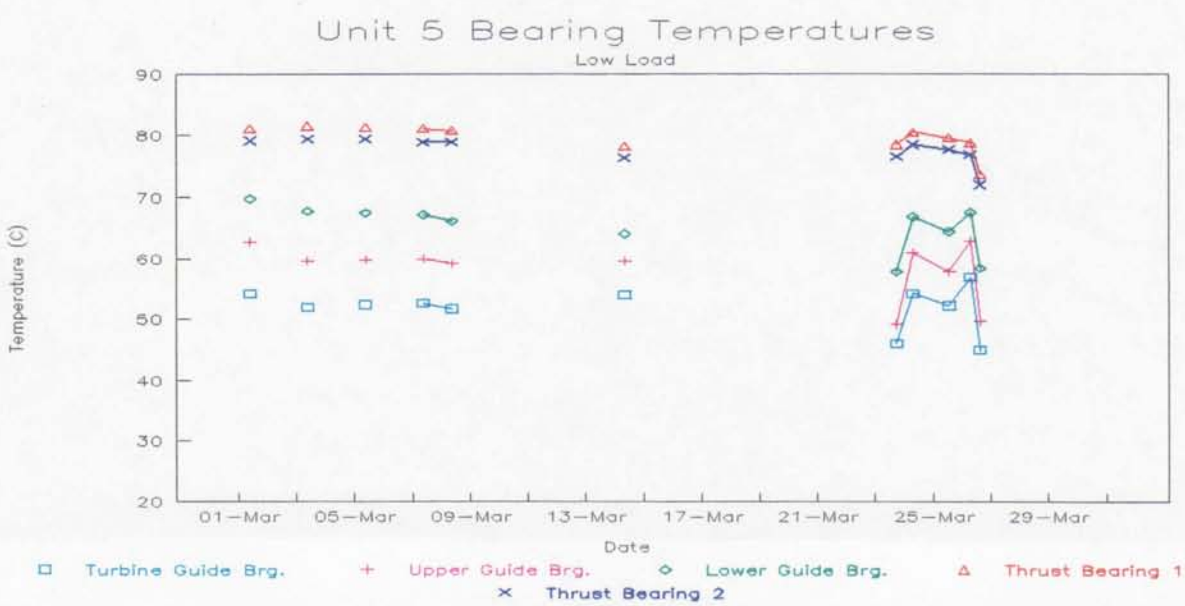

Unit 4 Bearing Temperatures
High Load
Temperature (C)
90
80
70
60
50
40
30
20
01–Mar
05–Mar
09–Mar
13–Mar
17–Mar
21–Mar
25–Mar
29–Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

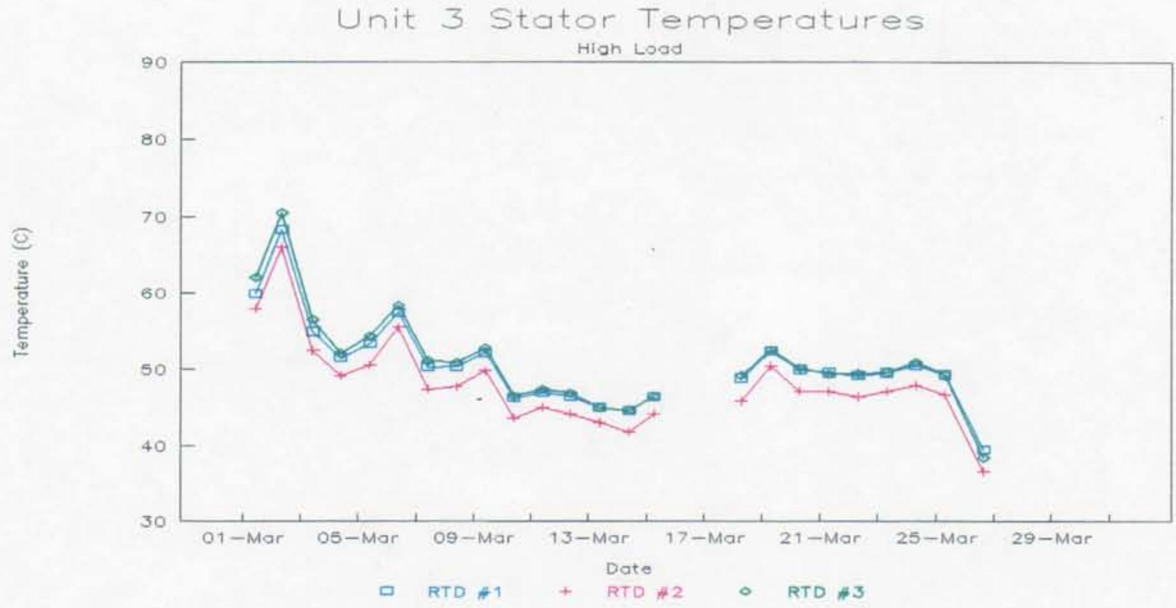

Unit 4 Bearing Temperatures
Medium Load
Temperature (C)
90
80
70
60
50
40
30
20
01–Mar
05–Mar
09–Mar
13–Mar
17–Mar
21–Mar
25–Mar
29–Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

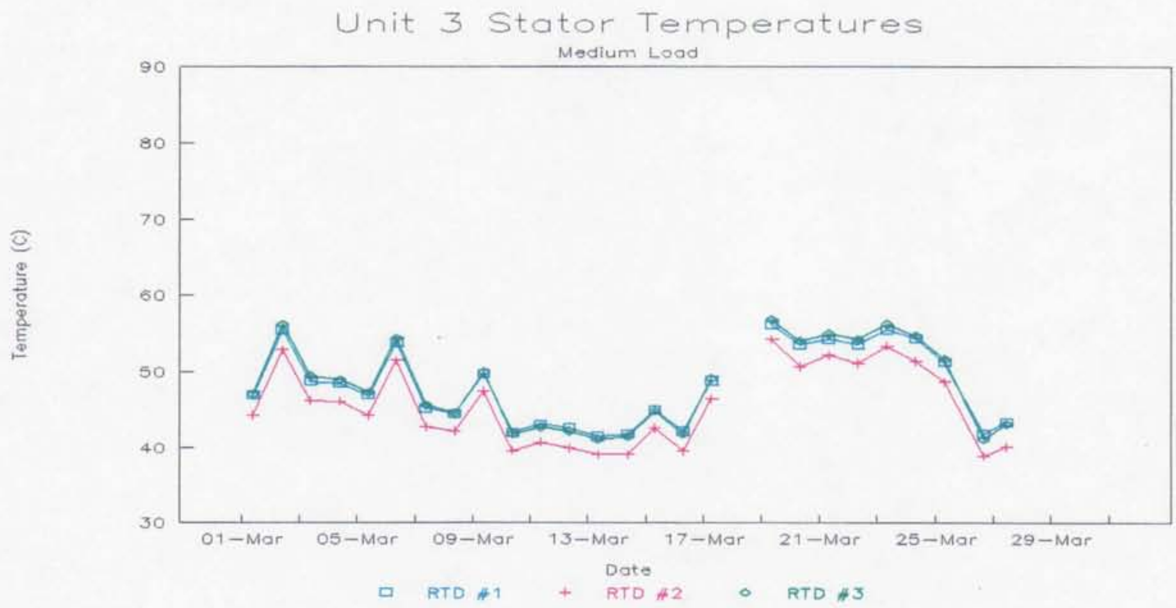

Unit 4 Bearing Temperatures
Low Load
Temperature (C)
90
80
70
60
50
40
30
20
01–Mar
05–Mar
09–Mar
13–Mar
17–Mar
21–Mar
25–Mar
29–Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

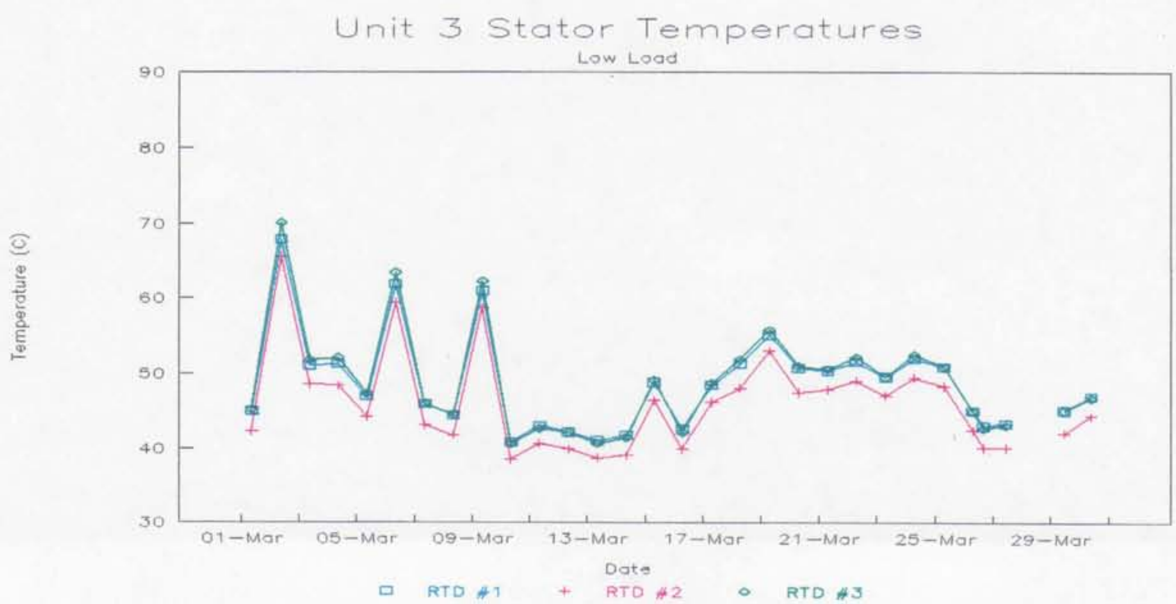

Unit 5 Bearing Temperatures
High Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2


Unit 5 Bearing Temperatures
Medium Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2


Unit 5 Bearing Temperatures
Low Load
Temperature (C)
90
80
70
60
50
40
30
20
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
Turbine Guide Brg.
Upper Guide Brg.
Lower Guide Brg.
Thrust Bearing 1
Thrust Bearing 2

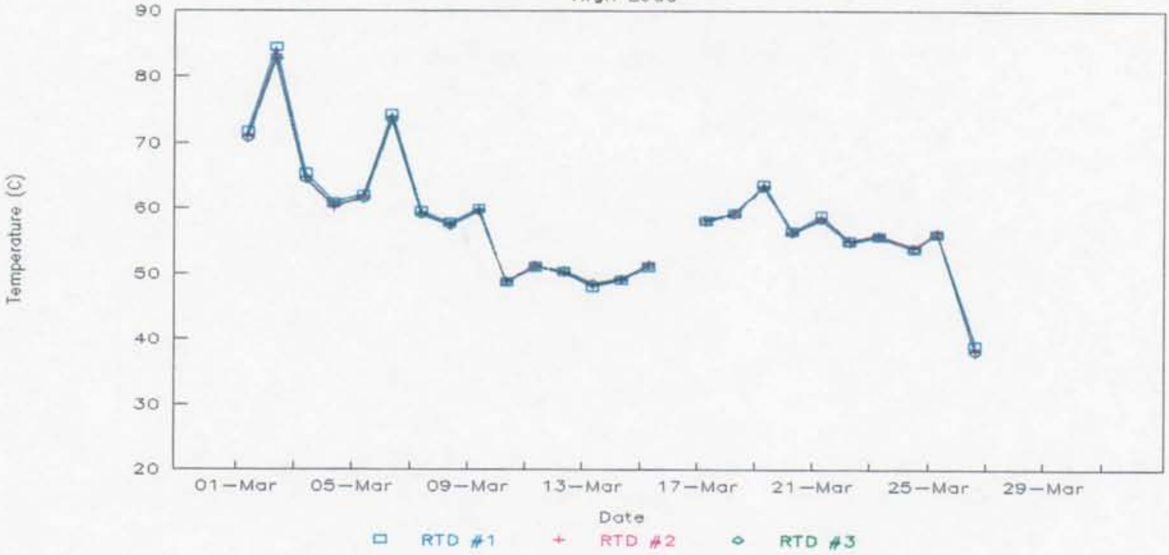

Unit 3 Stator Temperatures
High Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3


Unit 3 Stator Temperatures
Medium Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3


Unit 3 Stator Temperatures
Low Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3

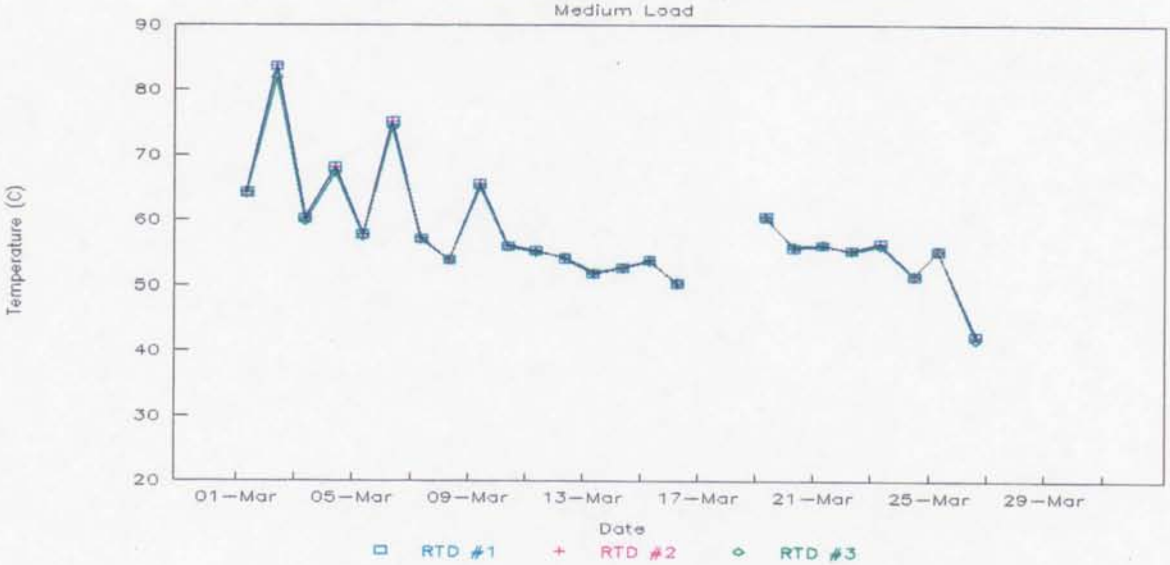
Unit 4 Stator Temperatures

High Load



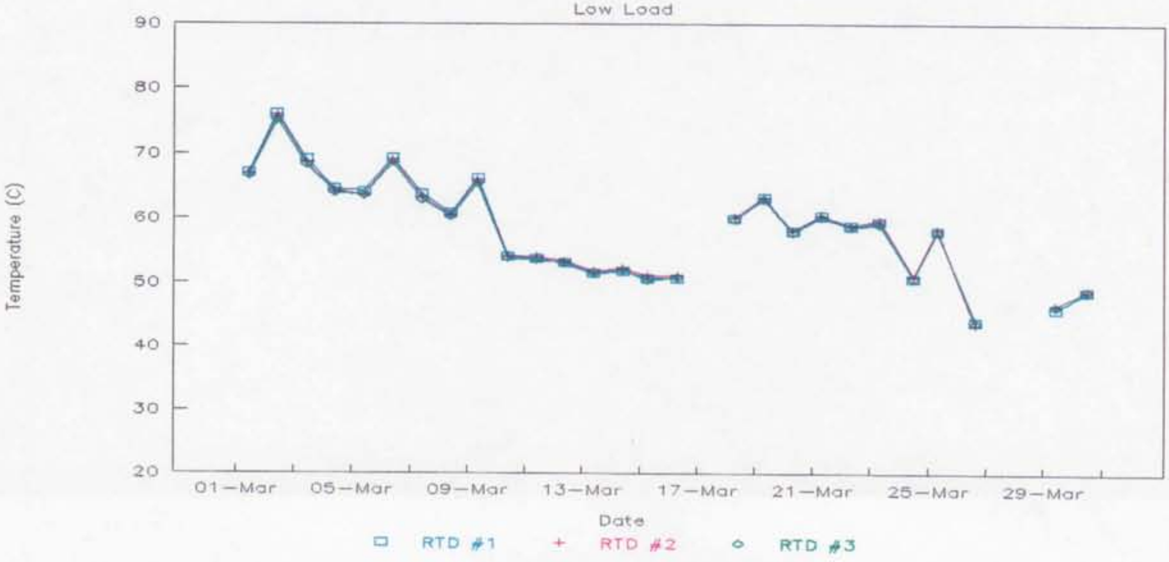
Unit 4 Stator Temperatures

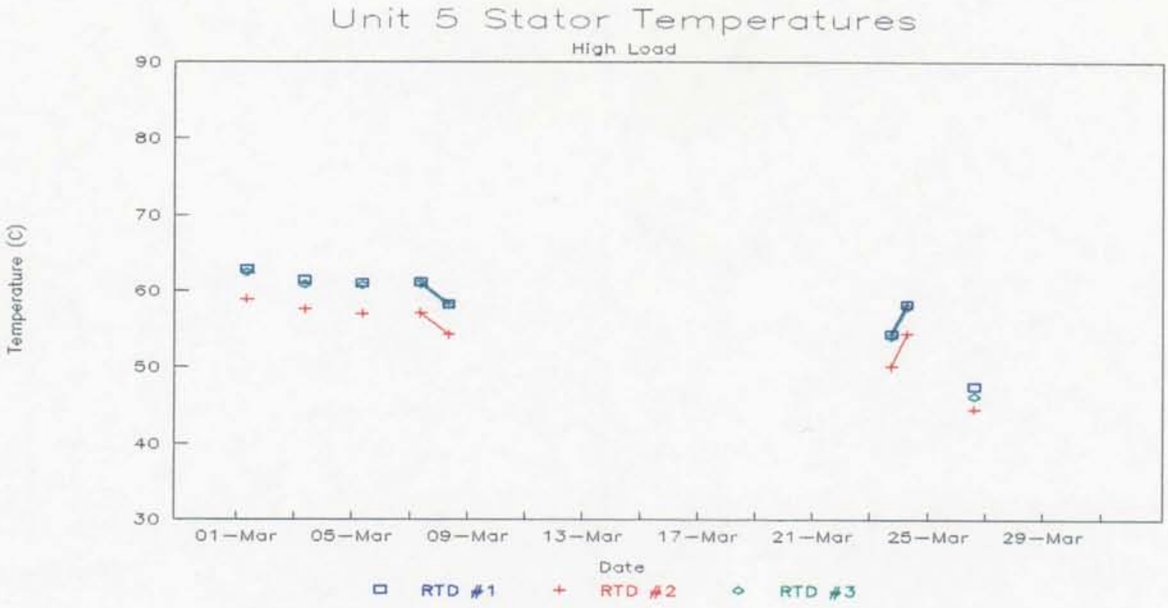
Medium Load

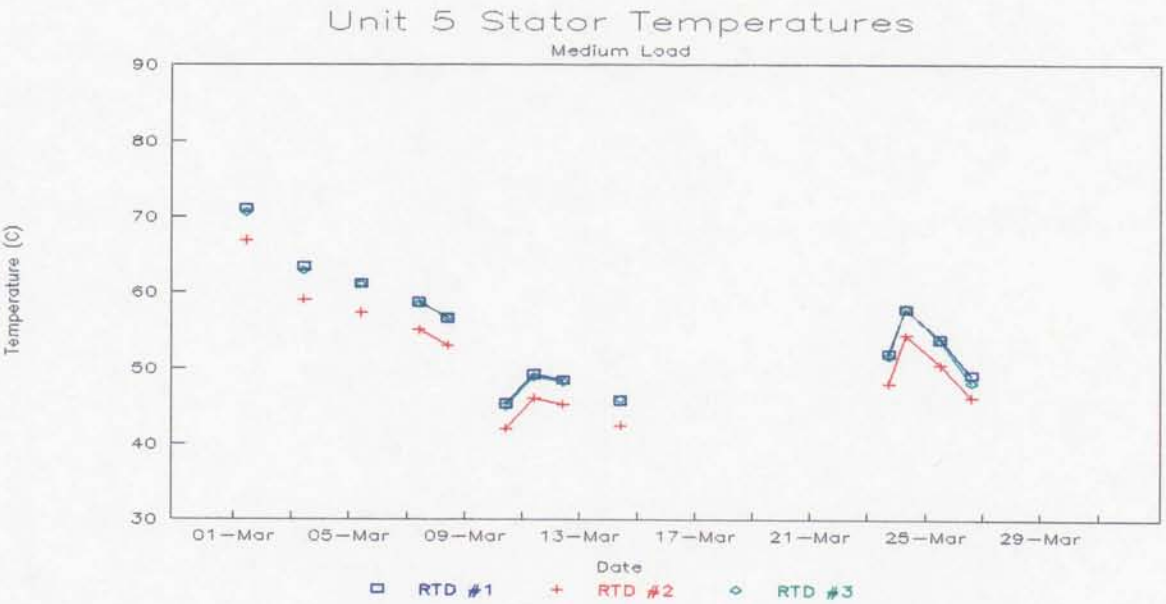


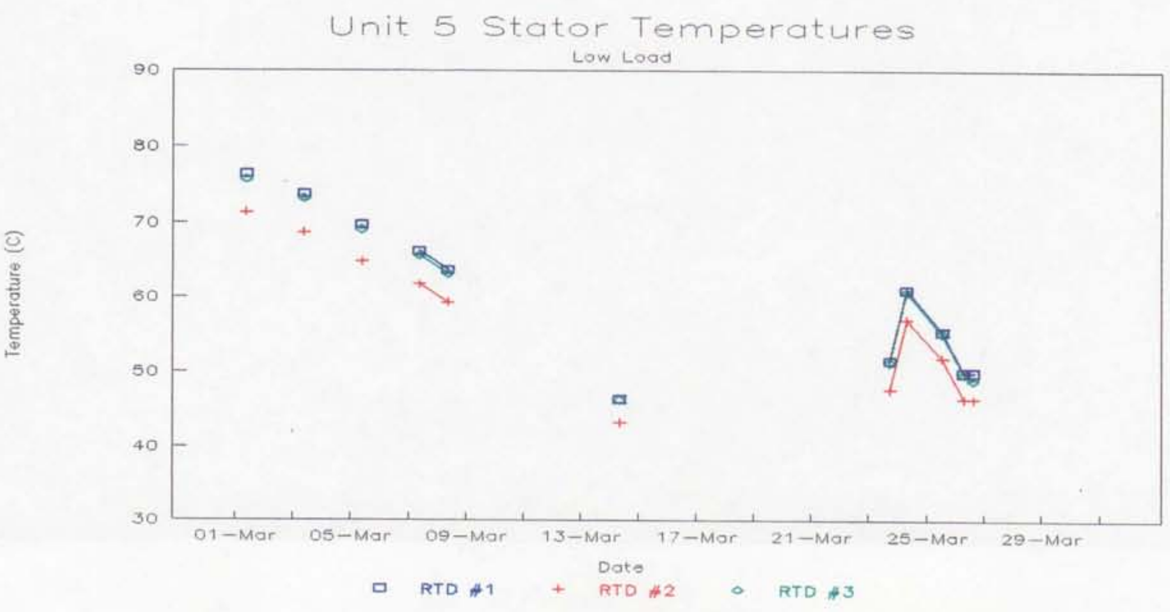
Unit 4 Stator Temperatures

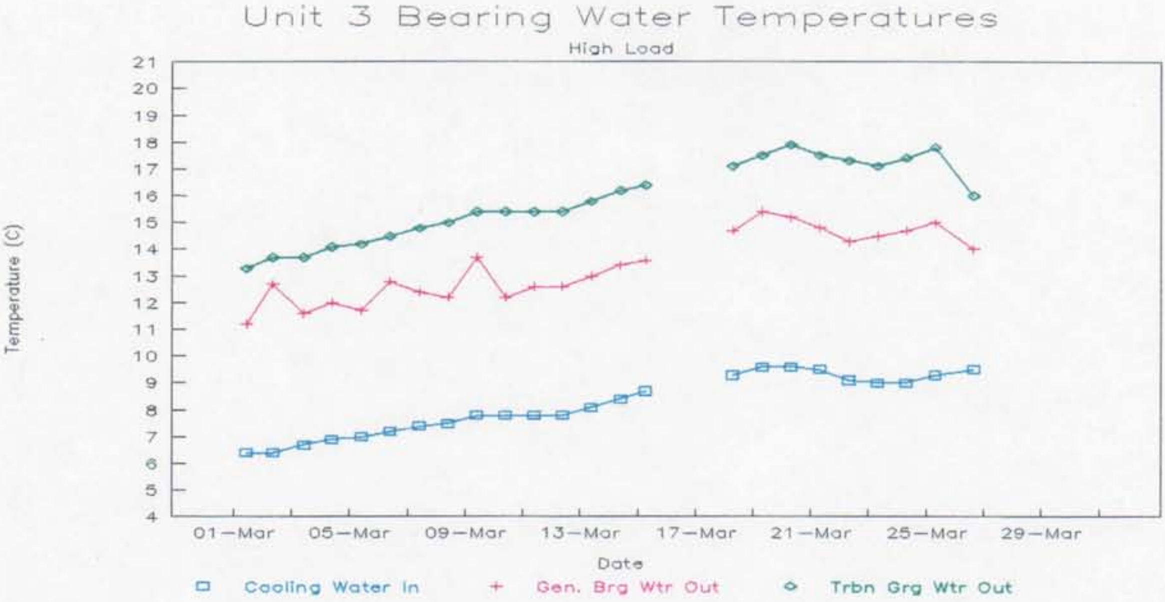
Low Load

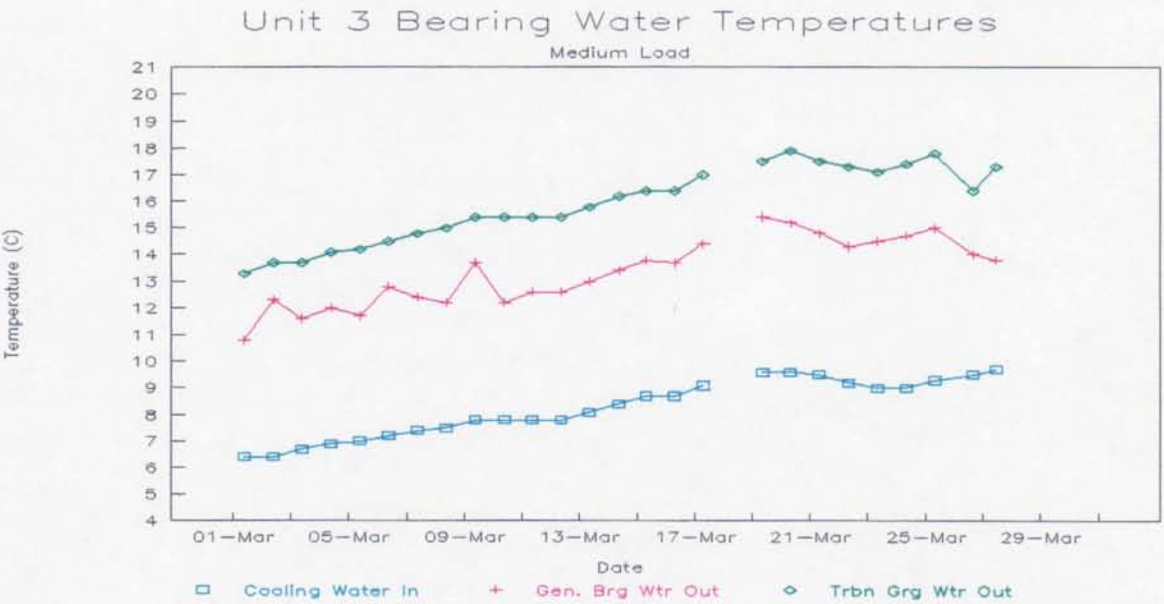


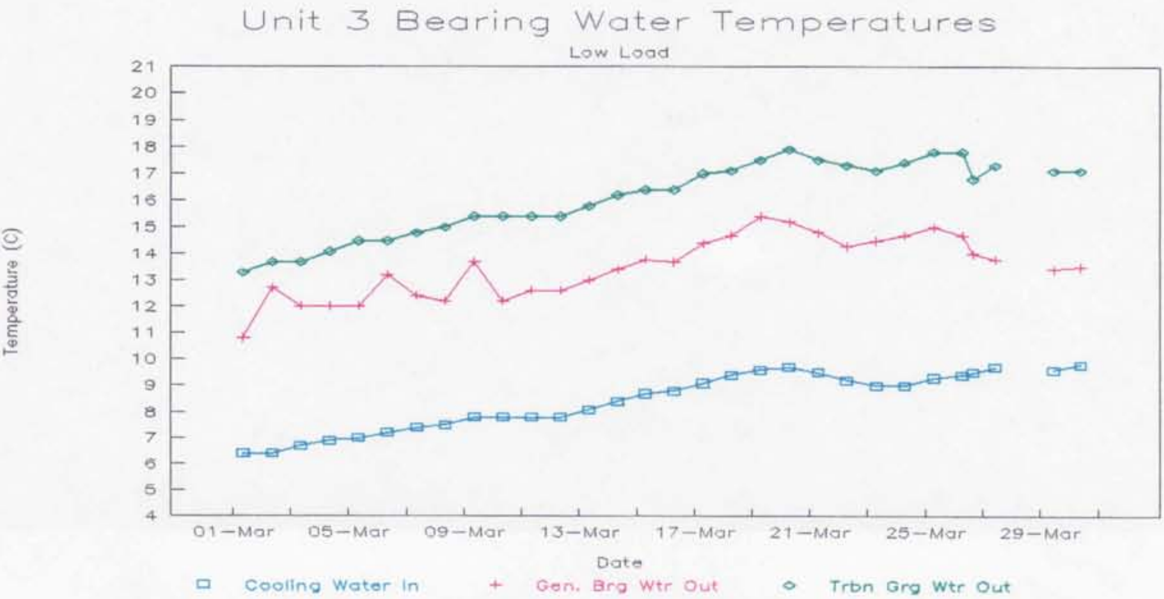

Unit 5 Stator Temperatures
High Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3

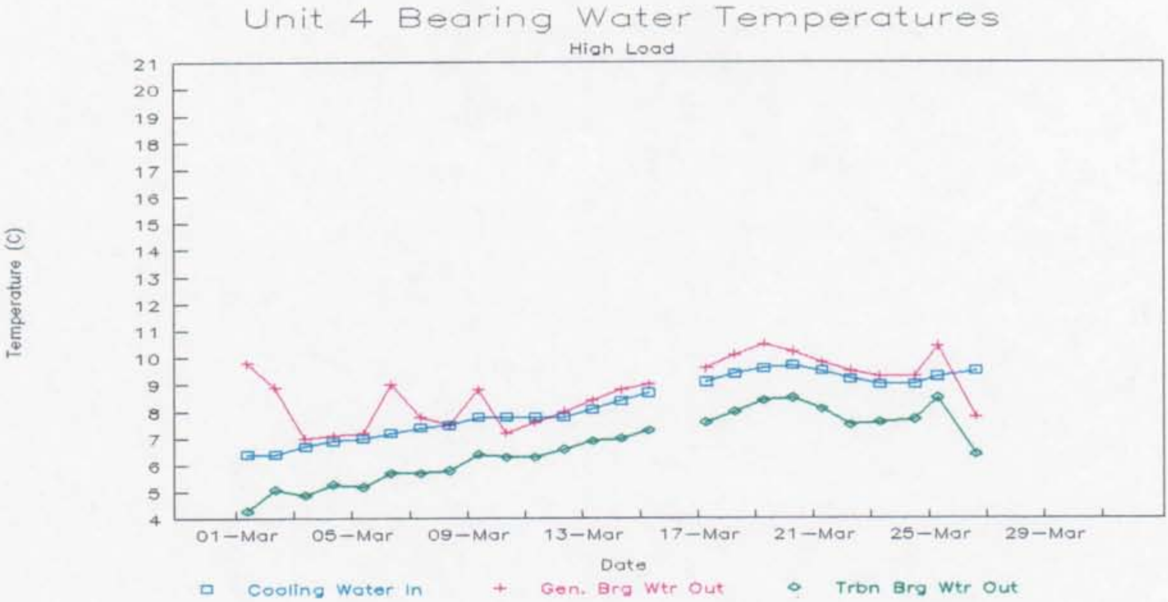

Unit 5 Stator Temperatures
Medium Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3


Unit 5 Stator Temperatures
Low Load
Temperature (C)
90
80
70
60
50
40
30
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Date
RTD #1
RTD #2
RTD #3

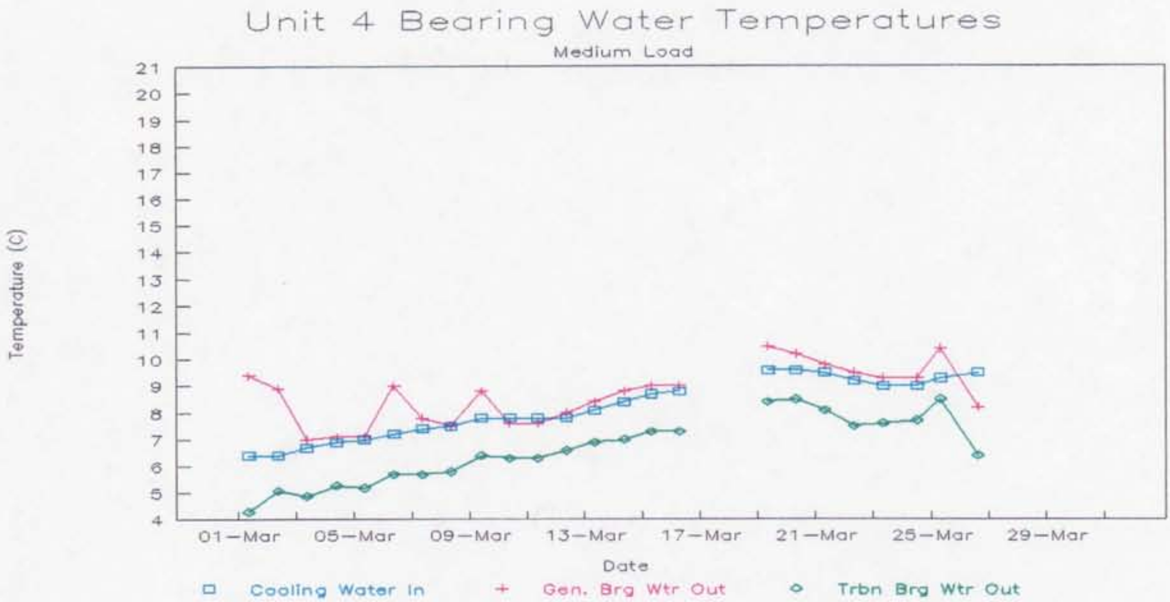

Unit 3 Bearing Water Temperatures
High Load
Temperature (C)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Grg Wtr Out


Unit 3 Bearing Water Temperatures
Medium Load
Temperature (C)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Grg Wtr Out

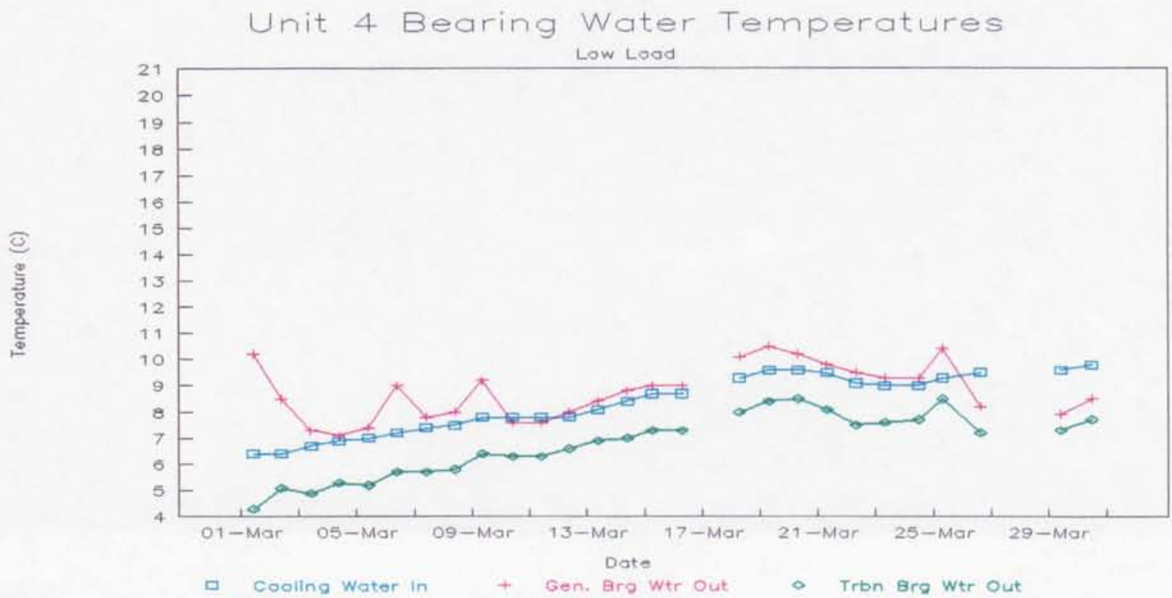

Unit 3 Bearing Water Temperatures
Low Load
Temperature (C)
Date
01-Mar 05-Mar 09-Mar 13-Mar 17-Mar 21-Mar 25-Mar 29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Grg Wtr Out



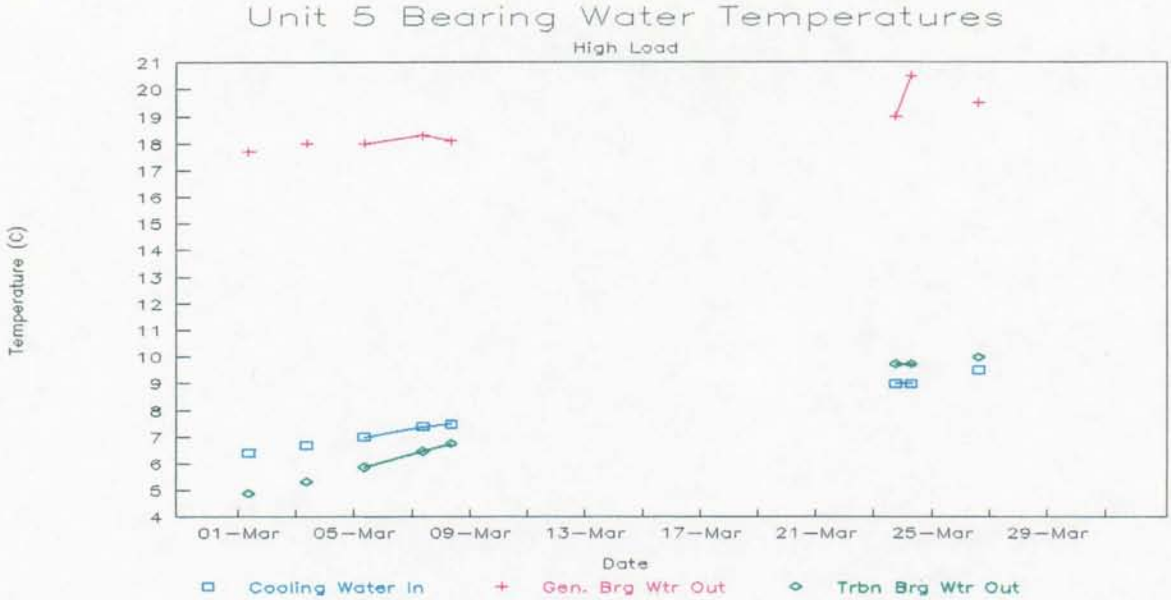
Unit 4 Bearing Water Temperatures
High Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out

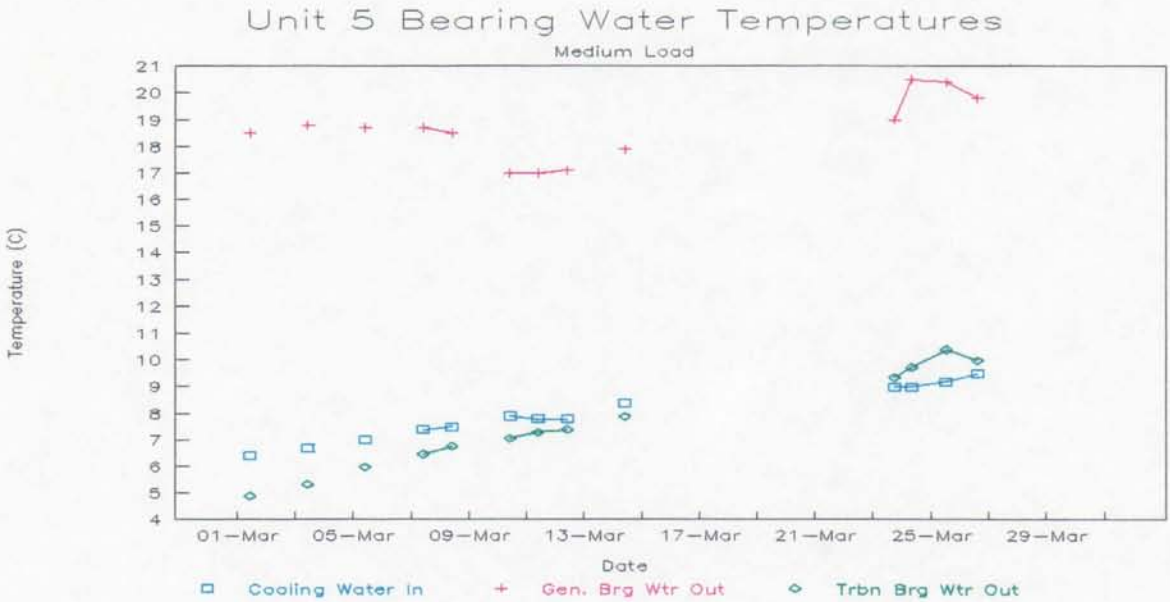


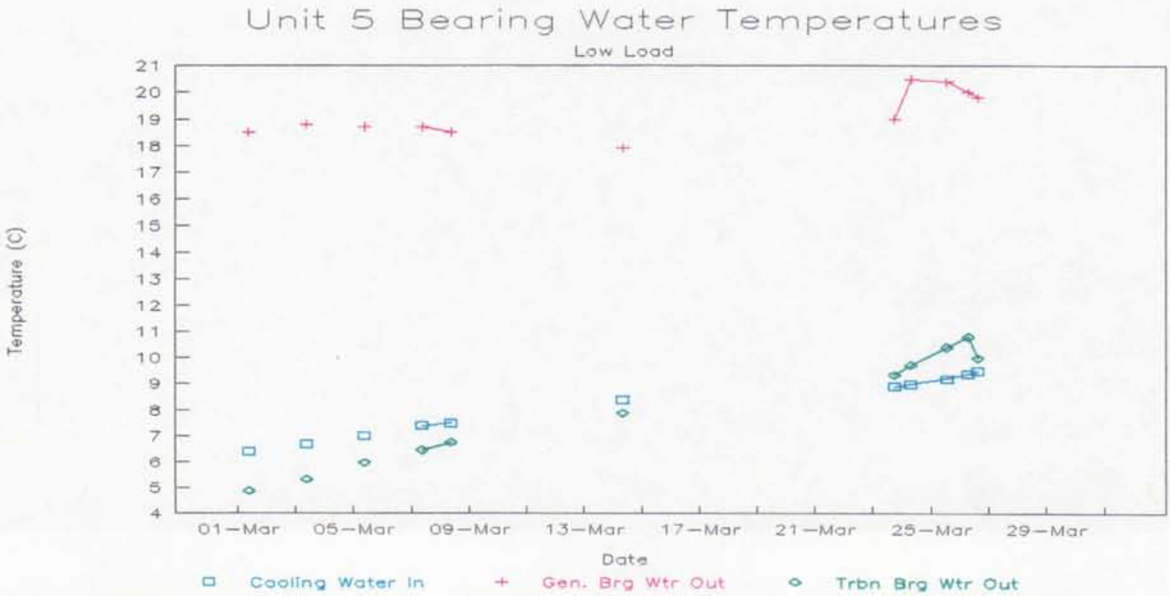
Unit 4 Bearing Water Temperatures
Medium Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out



Unit 4 Bearing Water Temperatures
Low Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out


Unit 5 Bearing Water Temperatures
High Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out


Unit 5 Bearing Water Temperatures
Medium Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out


Unit 5 Bearing Water Temperatures
Low Load
Temperature (C)
Date
01-Mar
05-Mar
09-Mar
13-Mar
17-Mar
21-Mar
25-Mar
29-Mar
Cooling Water In
Gen. Brg Wtr Out
Trbn Brg Wtr Out