Tennessee Valley Authority, Post Office Box 2000, Soddy-Daisy, Tennessee 37379

July 21, 2000

10 CFR 50.50a(a)(3)(i)

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555

Gentleman:

In the Matter of	)	Docket Nos. 50-327
Tennessee Valley Authority	)	50-328

SEQUOYAH NUCLEAR PLANT (SQN) - REVISED REQUEST FOR RELIEF FROM AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME) CODE REQUIREMENTS - REQUEST FOR RELIEF RP-08 - RESIDUAL HEAT REMOVAL (RHR) PUMP VIBRATION MEASUREMENT

Enclosed is revised Request for Relief RP-08 for SQN's Second 10-Year Inservice Test Program. The revised RP-08 provides additional information to support NRC review of the subject relief request. The additional information is provided in response to discussions with your staff during a May 2, 2000, teleconference. The revised RP-08 information supersedes the information provided by TVA letter dated November 15, 1999.

The proposed request for relief is applicable to SQN's RHR pumps and is associated with pump vibration measurement. TVA is submitting RP-08 pursuant to 10 CFR 50.55a(a)(3)(i) as a proposed alternative that would provide an acceptable level of quality and safety. The applicable sections of the ASME Code are contained in Operations and Maintenance Standard, Part 6 (OM-6), Paragraph 4.6.1.6. TVA's request for relief is similar to other utility requests described in Section 3.5 of NUREG/CR-6396, "Example, Clarifications, and Guidance on Preparing Requests for Relief from Pump and Valve Inservice Testing Requirements." Enclosure 1 provides the request for relief RP-08. Enclosure 2 provides the applicable sections of the ASME Code (OM-6).

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TVA is requesting NRC review and approval by August 2000 to support ongoing test activities associated with these pumps and to reduce the potential for unnecessary placement of RHR pumps on an increased frequency of testing. If you have any questions regarding this request, please contact me at (423) 843-7170 or Jim Smith at (423) 843-6672.

Sincerely,

Pedro Salas
Licensing and Industry Affairs Manager

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ENCLOSURE 1

TENNESSEE VALLEY AUTHORITY
SEQUOYAH NUCLEAR PLANT (SQN)
UNITS 1 AND 2
SECOND 10-YEAR INTERVAL
REVISED REQUEST FOR RELIEF RP-08

Executive Summary:

TVA performs testing of safety-related pumps in accordance with American Society of Mechanical Engineers (ASME) Code, which endorses Operations and Maintenance Standard, Part 6 (OM-6). The provisions of OM-6 require the vibration measurements to be broad band and unfiltered with instrumentation calibrated in a range from one-third minimum pump shaft rotational speed to at least 1000 hertz. TVA's proposed request for relief provides alternative testing to measure RHR pump vibration in the range from one-half pump shaft rotational speed to at least 1000 hertz (Hz). The request is based on high natural vibration levels in the low frequency band (between one-third to one-half rotational speed) that is inherent to the pump/motor framework design. The inherent vibration levels at this frequency range are not representative of pump vibration trends and do not provide useful information for the assessment of pump performance and trending during quarterly pump tests.

TVA's request for relief includes consideration of four key components recommended by NRC NUREG/CP-0152. These key components include:

1) Pump vibration history
2) Information from pump manufacturer
3) Discussion of TVA attempts to lower vibration
4) Spectral analysis of the pump-driver system.

TVA's request for relief is submitted for SQN's second 10-year inservice test (IST) interval. This relief request is provided for NRC review and approval in accordance with 10CFR50.55a(a)(3)(i).

Unit Affected: Units 1 and 2

System: Residual Heat Removal (RHR) System

Components: RHR Pumps 1A, 1B, 2A, and 2B.

Code Class: ASME Code Class 2

Component Function: Provides low-head safety injection during emergency core cooling and provides RHR for core cooling during unit shutdown.

Code Requirement: OM-6, Paragraph 5.2 (last paragraph) states "Vibration measurements are to be broad band (unfiltered)."

OM-6, Paragraph 4.6.1.6 states: "the frequency response range of the vibration measuring transducers and their readout system shall be from one-third minimum pump shaft rotational speed to at least 1000 Hz."

Code Requirement From Which Relief is Requested: Relief is requested to exclude the measurement of broad band (unfiltered) vibration in the response range from one-third rotational speed up to one-half rotational speed.

Basis for Relief: Background

The following background information is provided in accordance with the guidance of NUREG/CP-0152.

Historical Data: Examples of Pump performance history, as provided in Enclosure 3, documents a high vibration condition that has existed on SQN's RHR pumps since original installation of these pumps. This condition also existed prior to the ASME conversion to the OM-6 pump criteria that incorporated an expanded frequency range for measurement of pump vibration (one-third to one-half rotational speed). TVA has monitored this condition for SQN's RHR pumps and concludes there is no degradation of the pump/motor/foundation assembly from the inherent high vibration in this range.

Manufacturer Data: Westinghouse Electric Company, provider of SQN's RHR pumps, issued a Technical Bulletin (NSID-TB-86-02) that advised utilities of the potential for a high vibration condition in vertical pump/motor/foundation support assemblies. The bulletin references the condition that SQN is experiencing. Consultation with Westinghouse and the results of TVA's evaluation of this issue are provided below.

Attempts to Correct Problem: In accordance with the vendor recommendations from NSID-TB-86-02, TVA inspected SQN's RHR pumps and pump supports to verify there were no loose supporting connections contributing to the vibration condition. Plant modifications to lower vibration by installing additional supports was not a preferred option based on a concern for relocation of the vibration to other points in the pump/motor/foundation. Attempts to relocate the vibration were found to have limited success at other utilities and in some instances vibration levels were increased.

Spectral Analysis: Analysis of the condition indicates that the vibration occurs in a low frequency range less than one-half rotational speed. Analysis indicates there are no problems with the bearings or rotating elements (i.e., imbalance or misalignment). TVA's request is restricted to those frequencies that exhibit the natural resonance vibration levels. The results and evaluation of TVA's spectral analysis is provided in Enclosure 3.

Pump/System Design: The RHR system pumps for SQN are the typical design for more recent Westinghouse four loop plants, which are centrifugal pumps with the motor in the vertical position. There is no typical bearing housing(s) associated with these pumps as there are with centrifugal pumps where the pump and the driver are in the horizontal position. The pump and motor utilize one continuous shaft. There is no coupling located along the shaft and all of the bearings for the pump/motor assembly are located in the motor. Although mounted vertically, these pumps are not vertical line shaft pumps. Two motor designs exists for this application with different bearing arrangements. In one design the bearing located in the upper motor housing acts as a thrust and upper radial bearing while the lower bearing is a radial bearing. In the other pump/motor design, the lower motor housing bearing acts as the thrust and lower radial bearing while the upper bearing is a radial bearing.

The pump support is designed to support the pump and the motor which rests on top of the pump. The motor is unrestrained and is in effect a large moment arm. The bearings for this pump are within the motor.

Compliance with ASME OM-6: The natural system frequency of 10 to 11 Hz exhibits sufficient force such that when measurements are taken during quarterly pump testing at the upper motor bearing, the vibration readings are outside of the OM Part 6 acceptable range limits. When applying the OM Part 6 criteria, the vibration limits will place the pump consistently in the "Alert Range" or the "Required Action Range."

SQN originally took a literal reading of OM Part 6 wording to determine if vibration testing is required for the RHR pumps. Since the bearings are part of the motor (i.e., pump driver), these vibration points were not included in SQN's IST program. Following a self-assessment of SQN's IST program, TVA determined that this is not the most conservative position. SQN now evaluates these measurements in accordance with the OM Part 6 acceptance criteria for pump vibration.

Plant Operation and Pump Vibration History: Prior to initial operation of either unit, a nonconformance report was written which identified a natural frequency of the RHR pumps of 10 to 11 Hz. At the time, the seismic qualification of the pump had been performed based upon no natural frequencies below 33 Hz. The safety implication was that the RHR pumps did not meet their design basis for seismic qualification. This was reported to the NRC. TVA performed design changes and reanalysis of the pump support structure and piping system to qualify the 10 to 11 Hz natural frequency condition. Westinghouse Electric Company reviewed and approved the changes.

Both units were shut down for approximately three years beginning in 1985. Both units remained on RHR at shut down cooling flow conditions (greater than 2,000 gallons per minute [gpm]) in order to maintain the RCS in accordance with the Technical Specifications. During this time, there were no problems with the RHR pumps. The pumps operated continuously with no adverse conditions identified.

Both units at SQN were again shut down in 1993 for approximately one year. During this time, both units remained on RHR with the pumps operating at full flow conditions. The pumps operated continuously with no adverse conditions identified.

Advanced Vibration Diagnostics: SQN has performed advanced vibration diagnostics to assess the condition on all four RHR pumps. The same 10 to 11 Hz natural frequency identified in the late 1970's was identified again.

Impact testing (see Enclosure 3) was performed on all four RHR pump/motor assemblies. The testing revealed the following data:

Pump ID	Natural Frequency of Motor Alone	Natural Frequency of Motor and Frame[1]
1A	14 to 16 Hz	120 to 350 Hz
1B	11 Hz	175 to 331 Hz
2A	10 Hz	287 to 356 Hz
2B	11 to 13 Hz	100 to 350 Hz

[1]Based on location on the frame.

For the 1B and 2A RHR pump motors, this data confirms the previous evaluation that a resonant condition exists at 10 and 11 Hz, respectively. The testing revealed that the motor upper bearing **exhibited** natural frequencies at approximately 10 and 11 Hz, respectively, which is coincident with the maximum amplitude vibration measurement for the same point found during OM Part 6 quarterly pump testing.

The testing performed on the 1A RHR pump motor revealed a 14 to 16 Hz response frequency range on the motor and the motor/support frame frequency response is between 120 and 350 Hz. The overall vibration levels on 1A RHR pump are stable and below the alert range. However, the vibration occurring at the 14 Hz frequency is contributing to the overall levels.

The testing performed on the 2B RHR pump motor revealed a 11 to 13 Hz response frequency range on the motor and the motor support/frame frequency response is between 100 and 350 Hz. The overall vibration levels on 2B RHR pump are stable and below alert range. However, the vibration occurring at the 11 Hz frequency is contributing to the overall levels.

Quarterly OM Part 6 pump testing is performed with the pump operating on miniflow, approximately 500 gpm. The pump operation flow characteristics create low frequency flow pulsations which tend to excite the structural resonant frequencies of the machine assembly. Spectra analysis of vibration data collected during pump testing activities (see Enclosure 3) indicates a dominant peak between 10 to 14 Hz for all RHR pump motors. To improve the vibration would require separating the low natural frequencies away from the operating frequency of 29.8 Hz. Physical modifications to drive the natural frequency up beyond 30 Hz (greater than 15 percent of operating frequency as a rule of thumb) can be unpredictable and difficult

even when performed with detailed analysis. Efforts at other plants have been unsuccessful due to shifting the vibration to adjacent components such as the pump or piping.

Full Flow Testing: Near full flow vibration data obtained during refueling outages (see Enclosure 3) shows that the vibration is greatly reduced at near full flow conditions. This indicates that the higher test measurements occur only during the quarterly OM-6 tests, which are conducted with the RHR pumps on miniflow. The pumps are designed to run at full-flow conditions for normal plant operations and for accident conditions. Thus, the minimum flow test configuration causes the motor structure to be excited and a higher vibration to be present during the OM Part 6 quarterly pump tests.

This testing supports the expected results identified by Westinghouse in Technical Bulletin NSID-TB-86-02.

Civil/Structural Evaluations: TVA originally modeled the pump and its support as a rigid anchor. During the reanalysis discussed above, the pump and its support were modeled as a flexible member. The results of this analysis confirmed that the measured natural frequency of approximately 10 to 11 Hz was a system frequency, i.e., pump, pump support, and piping. The reanalysis changed the nozzle loads on the pump and on local pipe supports to meet the new support loads. The pump support was also stiffened, incidental to the vibration problem.

A Civil Engineering review has been performed on the results of the advanced vibration diagnostics with respect to the problem described above. The review determined that the new measurements reflect the problem identified during initial system operation and is not a new vibration problem. Based upon this analysis, the pump and its structure continue to meet the design requirements for acceptable operation.

ISI Examinations of the Piping and Supports: A review of ISI examinations of pipe welds and pipe supports in the area surrounding the pumps was performed. Of the examinations in this area which did not meet the acceptance criteria, all of them were minor indications and are characterized as typical indications found during inservice examinations following the completion of construction activities. No failures were associated with any of these indications. None of the

indications could be characterized as defects due to pump vibration.

No further indications have been identified. The issues found by in-service examination are indicative that the vibration problems are a natural frequency of the system and not a destructive vibration force.

Alternative Testing:

Vibration measurements of the upper motor bearing of the RHR pumps will be taken during the quarterly OM Part 6 pump tests in a range from one-half minimum pump shaft rotational speed to at least 1000 Hz.

Conclusion:

SQN proposes to exclude from the OM Part 6 pump test the vibration measurement in the range from one-third up to one-half pump shaft rotational speed. The exclusion of vibration measurements from one-third to one-half minimum pump shaft rotational speed will exclude the readings associated with the natural frequencies as described above. It has been shown that these frequencies do not affect pump performance. Excluding this range of vibration for test measurements would prevent placing the pumps in an "Increased Frequency " test status. Placing SQN's RHR pumps on an increase frequency test status provides no added value for monitoring pump performance. The dominant peak at one-third running speed masks data trending at the frequencies that represent actual pump/motor health. This places an unnecessary burden on SQN resources and of having to place the pumps on an increased frequency for testing resulting in additional wear on the equipment and potential challenges to the plant. Pump degradation due to real physical problems, will be evident with the OM Part 6 pump test monitoring the representative pump/motor condition frequencies without being masked by the unrelated structural resonant peak. This will ensure appropriate corrective actions are taken to address those levels of vibration that could result in pump degradation.

Based upon the above, SQN concludes that the pumps operate acceptably and will perform their safety function as required during normal and accident conditions.

Implementation of the proposed alternative is requested for SQN's second 10-year IST Program interval.

ENCLOSURE 2

ASME SECTION XI CODE PAGES

OPERATIONS AND MAINTAINENCE STANDARD

PART 6

(OM-6)

RHR DATA FOR NRC RELIEF REQUEST- TVA Sequoyah Nuclear Plant

5/8/00

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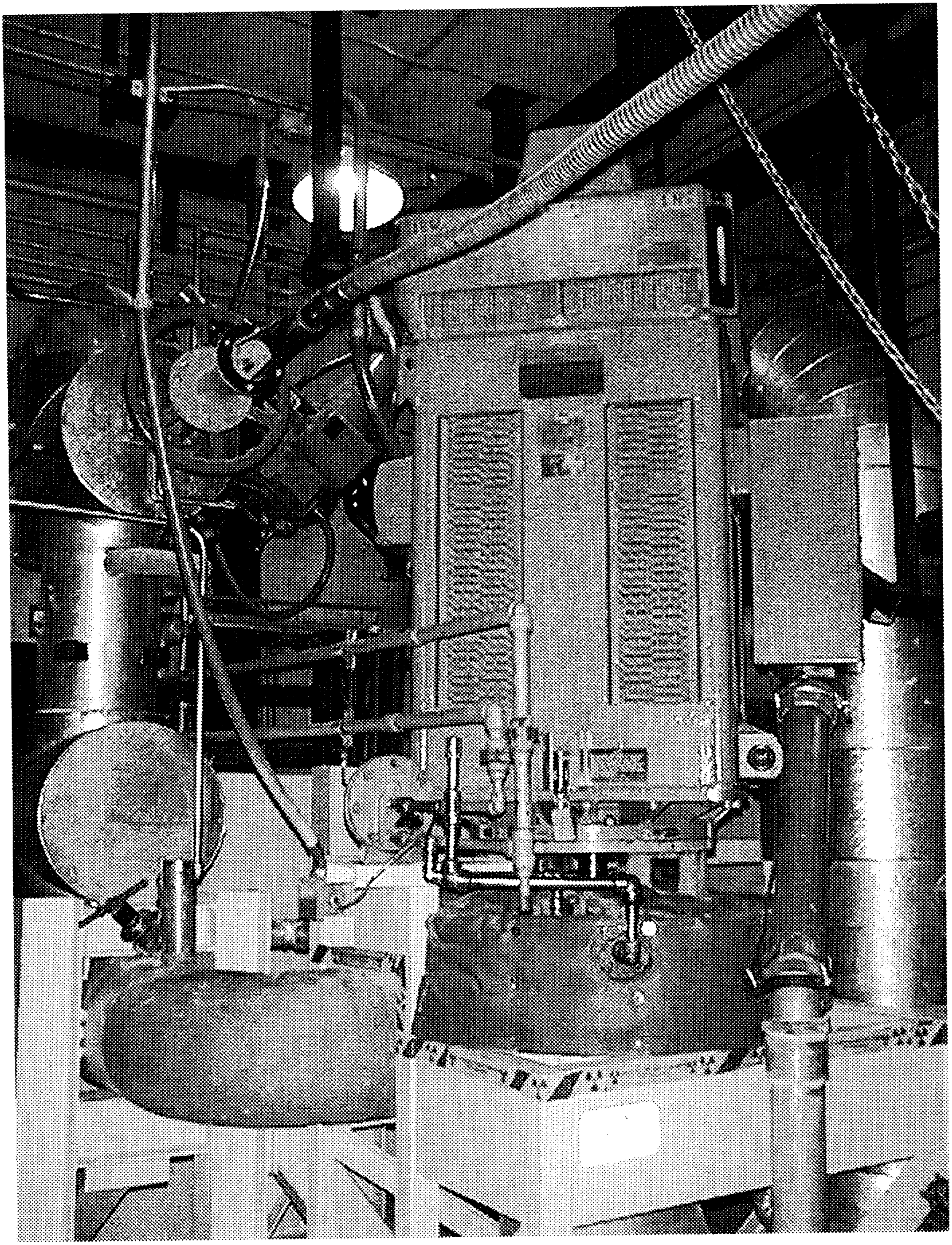
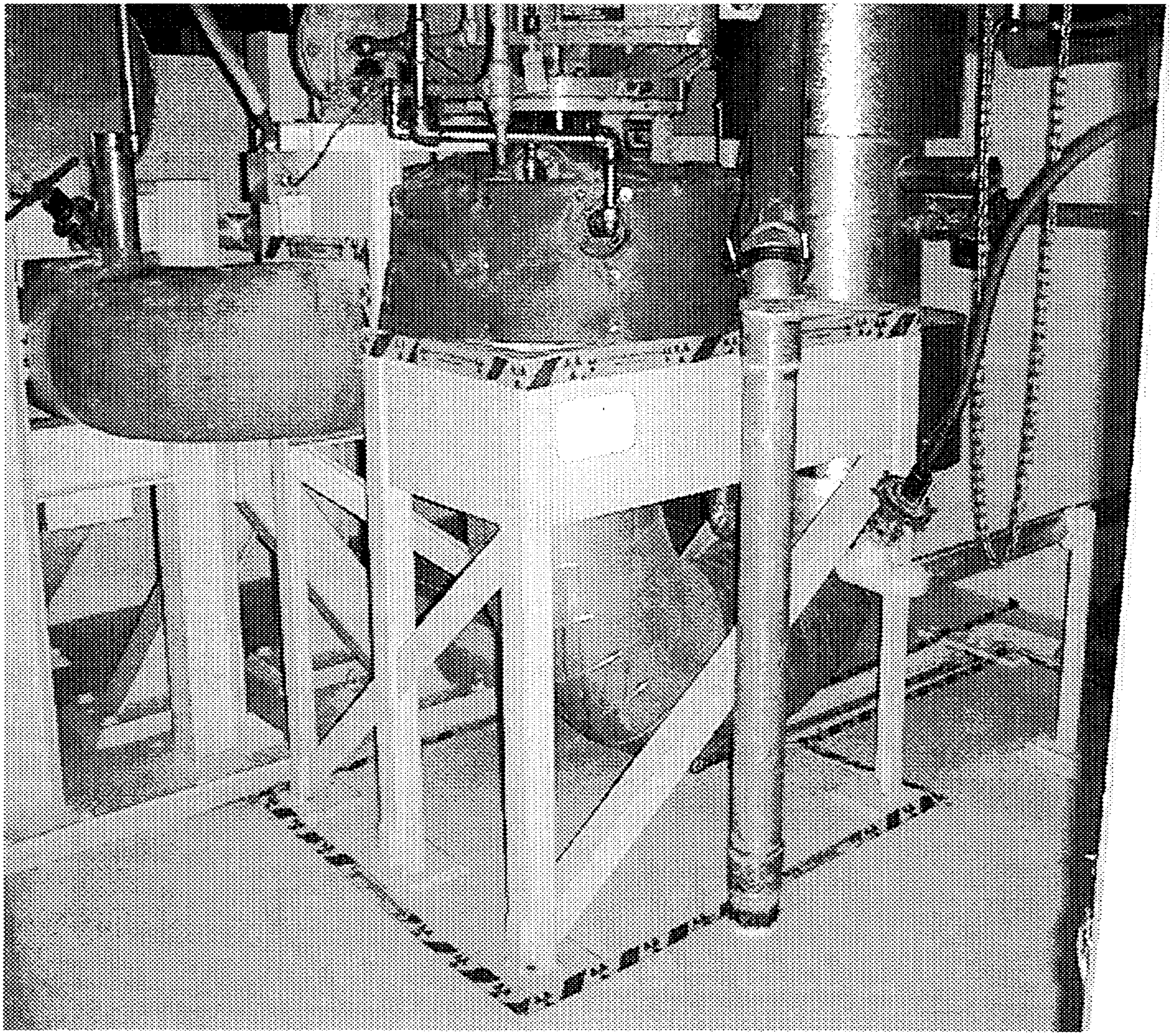
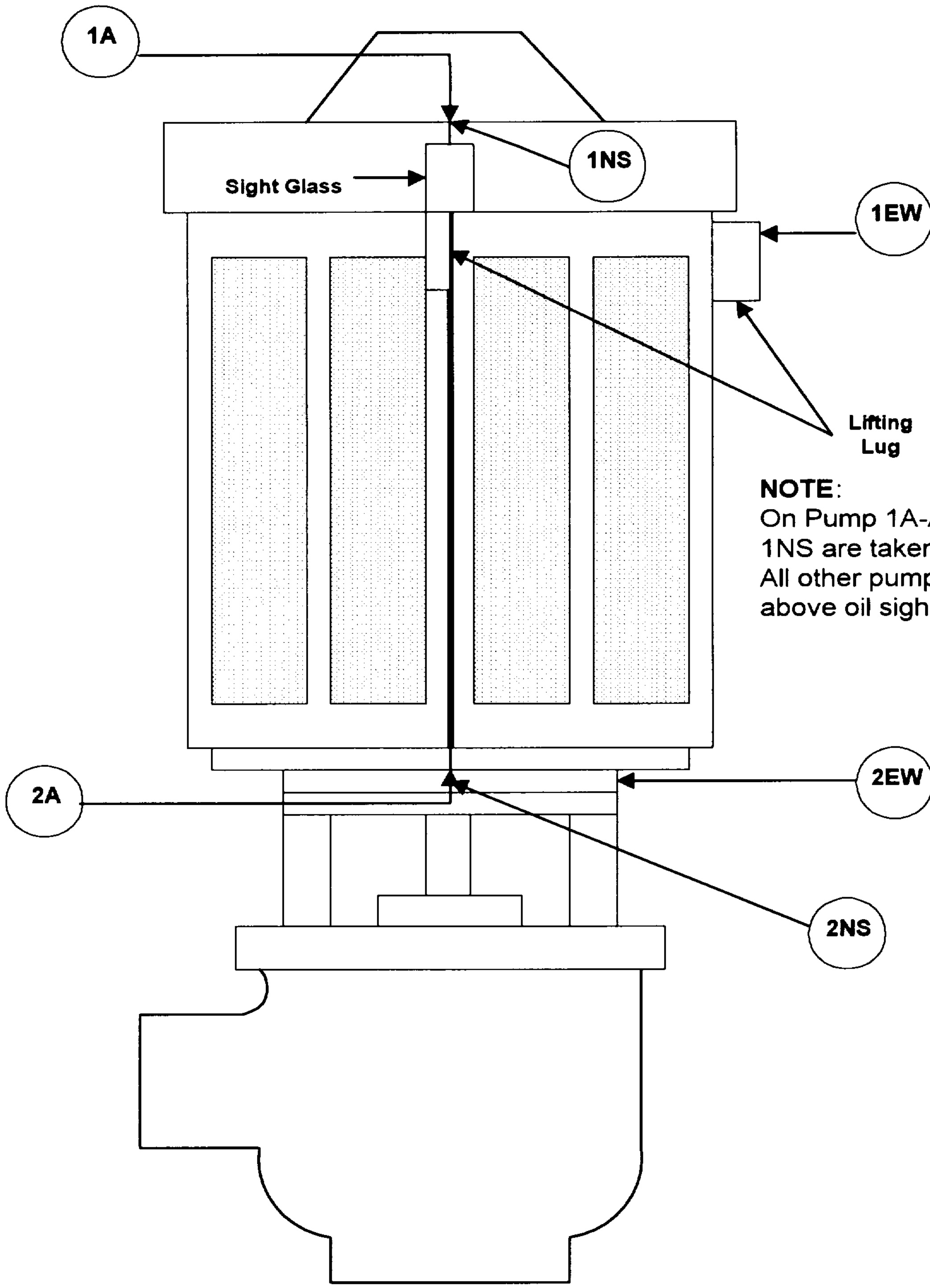




RESIDUAL HEAT REMOVAL PUMP VIBRATION TEST LOCATIONS



NOTE:
On Pump 1A-A, both 1EW and 1NS are taken on lifting lugs. All other pumps, 1NS is taken above oil sight glass.

ELEVATION VIEW

RHR PUMP 1B

Measurement Point History

Database: auxbldg.rbm
Station: SQN SECURED AREAS UNITS 1,2&COM
Report Date: 08-Jun-00 17:17
Period Reported: ALL DATA AVAILABLE

OVERALL = ALL spectrum combined
PAR#1 = subharmonics 0.2 to 0.8X running speed (nominal speed of 1780 RPM)
PAR#2 = First Order 0.8 to 1.2X running speed
PAR#3 = 2nd/3rd Order 1.2X to 3.2X running speed
PAR#4 = 4-40 Orders 3.2 to 40X running speed
PAR#5 = Low freq acc 312 to 1250 HZ low frequency acceleration
PAR#6 = High Freq acc 1250 to 15000 HZ high frequency acceleration

Notes:
1) RPM and Load are nominal values; not actual test data
2) Highlighted data reflects comparisons of near full-flow and reduced-flow testing.

DATE	TIME	RPM	LOAD	OVERALL	PAR#1	PAR#2	PAR#3	PAR#4	PAR#5	PAR#6
RHR PUMP1B-1NS		(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95	13:09	1780.	100.0	.491	.398	.269	.061	.061	.169	.022
24-Mar-95	12:51	1780.	100.0	.197	.103	.090	.058	.122	.297	.093
29-Jun-95	13:48	1780.	100.0	.553	.472	.255	.073	.102	.156	.015
11-Jan-96	14:35	1780.	100.0	.259	.214	.110	.055	.074	.236	.535
22-Mar-96	15:54	1780.	100.0	.281	.244	.096	.040	.088	.228	.621
14-Jun-96	09:07	1780.	100.0	.206	.146	.110	.045	.079	.229	.633
05-Sep-96	16:38	1780.	100.0	.310	.275	.108	.035	.078	.235	.652
27-Nov-96	09:37	1780.	100.0	.341	.305	.104	.050	.091	.222	.492
21-Feb-97	13:12	1780.	100.0	.242	.186	.109	.045	.088	.237	.699
28-Mar-97	13:02	1780.	100.0	.109	.013	.095	.025	.042	.165	.307
15-May-97	14:18	1780.	100.0	.290	.250	.108	.042	.086	.228	.539
05-Aug-97	14:33	1780.	100.0	.304	.258	.113	.056	.091	.239	.590
31-Oct-97	09:20	1780.	100.0	.294	.247	.126	.039	.086	.252	.488
22-Jan-98	16:21	1780.	100.0	.424	.392	.120	.039	.082	.227	.441
09-Jul-98	09:04	1780.	100.0	.328	.294	.105	.059	.075	.258	.707
15-Sep-98	16:17	1780.	100.0	.178	.115	.111	.040	.068	.238	.508
16-Oct-98	08:16	1780.	100.0	.370	.337	.118	.057	.078	.204	.602
21-Dec-98	11:09	1780.	100.0	.506	.486	.110	.054	.079	.194	.428
19-Mar-99	14:37	1780.	100.0	.344	.318	.095	.055	.074	.173	.512
10-Jun-99	12:25	1780.	100.0	.226	.189	.076	.054	.082	.220	.816
01-Sep-99	14:09	1780.	100.0	.260	.229	.074	.055	.086	.232	.832
24-Nov-99	09:46	1780.	100.0	.248	.204	.094	.060	.086	.227	.828
16-Feb-00	14:17	1780.	100.0	.252	.210	.097	.059	.081	.248	.699
27-Feb-00	11:17	1780.	100.0	.149	.096	.089	.024	.065	.202	.520
10-May-00	14:21	1780.	100.0	.253	.209	.103	.056	.085	.215	.520
RHR PUMP1B-1EW		(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95	13:09	1780.	100.0	.362	.244	.244	.075	.068	.211	.032
24-Mar-95	12:52	1780.	100.0	.223	.163	.088	.064	.103	.260	.014
29-Jun-95	13:48	1780.	100.0	.443	.307	.304	.065	.072	.438	.021
11-Jan-96	14:37	1780.	100.0	.219	.189	.082	.052	.048	.129	.375
22-Mar-96	15:56	1780.	100.0	.252	.228	.076	.029	.063	.167	.594
14-Jun-96	09:10	1780.	100.0	.222	.192	.074	.044	.062	.140	.520

05-Sep-96 16:39	1780.	100.0	.264	.242	.076	.037	.057	.129	.494
27-Nov-96 09:38	1780.	100.0	.271	.250	.070	.027	.067	.146	.691
21-Feb-97 13:13	1780.	100.0	.170	.134	.071	.029	.066	.138	.357
28-Mar-97 13:03	1780.	100.0	.066	.011	.057	.017	.025	.101	.264

(Continued)

RHR PUMP1B-1EW	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
15-May-97 14:18	1780.	100.0	.240	.215	.072	.033	.060	.128	.420
05-Aug-97 14:33	1780.	100.0	.426	.406	.082	.043	.069	.188	.396
31-Oct-97 09:21	1780.	100.0	.366	.348	.072	.036	.069	.181	.648
22-Jan-98 16:22	1780.	100.0	.245	.213	.088	.028	.075	.185	.355
09-Jul-98 09:04	1780.	100.0	.198	.173	.067	.043	.054	.124	.484
15-Sep-98 16:18	1780.	100.0	.146	.120	.068	.028	.038	.094	.285
16-Oct-98 08:17	1780.	100.0	.280	.261	.074	.051	.053	.141	.369
21-Dec-98 11:09	1780.	100.0	.228	.196	.074	.056	.069	.132	.432
19-Mar-99 14:37	1780.	100.0	.280	.253	.077	.060	.072	.197	.684
10-Jun-99 12:26	1780.	100.0	.219	.196	.063	.056	.053	.131	.797
01-Sep-99 14:10	1780.	100.0	.210	.182	.066	.061	.055	.136	.805
24-Nov-99 09:49	1780.	100.0	.220	.192	.072	.058	.054	.147	.828
16-Feb-00 14:20	1780.	100.0	.237	.195	.082	.049	.097	.166	.816
27-Feb-00 11:18	1780.	100.0	.101	.064	.069	.020	.032	.099	.555
10-May-00 14:19	1780.	100.0	.260	.239	.074	.047	.060	.135	.492

RHR PUMP1B-1A	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95 13:10	1780.	100.0	.198	.105	.119	.052	.106	.453	.080
24-Mar-95 12:52	1780.	100.0	.208	.143	.103	.043	.101	.617	.236
29-Jun-95 13:49	1780.	100.0	.227	.117	.115	.056	.145	.543	.025
11-Jan-96 14:35	1780.	100.0	.138	.067	.066	.055	.085	.340	.871
22-Mar-96 15:55	1780.	100.0	.138	.059	.059	.013	.098	.355	.469
14-Jun-96 09:08	1780.	100.0	.148	.048	.073	.022	.103	.396	.563
05-Sep-96 16:38	1780.	100.0	.149	.057	.073	.023	.100	.271	.969
27-Nov-96 09:38	1780.	100.0	.189	.049	.097	.027	.109	.377	.719
21-Feb-97 13:13	1780.	100.0	.186	.057	.079	.024	.108	.367	.945
28-Mar-97 13:05	1780.	100.0	.060	.0029	.051	.012	.027	.188	.449
15-May-97 14:18	1780.	100.0	.160	.056	.085	.023	.106	.316	.574
05-Aug-97 14:34	1780.	100.0	.188	.101	.081	.027	.120	.352	.652
31-Oct-97 09:20	1780.	100.0	.165	.058	.088	.020	.102	.471	.711
22-Jan-98 16:21	1780.	100.0	.183	.057	.060	.026	.117	.500	.484
09-Jul-98 09:04	1780.	100.0	.176	.062	.084	.059	.116	.324	.738
15-Sep-98 16:17	1780.	100.0	.099	.024	.065	.024	.066	.260	.539
16-Oct-98 08:17	1780.	100.0	.158	.070	.074	.059	.104	.342	.680
21-Dec-98 11:09	1780.	100.0	.151	.050	.065	.067	.108	.377	.684
19-Mar-99 14:37	1780.	100.0	.169	.071	.037	.086	.122	.258	.424
10-Jun-99 12:26	1780.	100.0	.150	.051	.058	.060	.113	.373	1.016
01-Sep-99 14:10	1780.	100.0	.159	.080	.060	.056	.110	.369	1.063
24-Nov-99 09:46	1780.	100.0	.151	.059	.055	.075	.103	.354	1.234
16-Feb-00 14:19	1780.	100.0	.194	.076	.068	.127	.106	.371	.953
27-Feb-00 11:18	1780.	100.0	.095	.019	.051	.026	.073	.320	.762
10-May-00 14:22	1780.	100.0	.142	.042	.063	.059	.105	.361	.711

RHR PUMP1B-2NS	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95 13:11	1780.	100.0	.292	.164	.097	.048	.215	1.484	.645
24-Mar-95 12:54	1780.	100.0	.275	.184	.117	.046	.159	.809	.130
29-Jun-95 13:49	1780.	100.0	.176	.050	.111	.058	.112	.578	.031
11-Jan-96 14:39	1780.	100.0	.132	.068	.062	.047	.082	.119	1.383
22-Mar-96 15:56	1780.	100.0	.156	.084	.060	.021	.112	.157	.527
14-Jun-96 09:10	1780.	100.0	.130	.056	.062	.020	.095	.127	.695
05-Sep-96 16:41	1780.	100.0	.135	.054	.066	.025	.100	.114	.984
27-Nov-96 09:39	1780.	100.0	.141	.038	.088	.021	.096	.114	.770

21-Feb-97 13:14	1780.	100.0	.162	.092	.088	.020	.093	.095	.918
28-Mar-97 13:05	1780.	100.0	.068	.0059	.059	.0093	.031	.036	.084
15-May-97 14:20	1780.	100.0	.134	.055	.078	.026	.087	.103	.969
05-Aug-97 14:35	1780.	100.0	.166	.074	.106	.031	.095	.109	.641
31-Oct-97 09:22	1780.	100.0	.149	.065	.086	.030	.095	.102	.520
22-Jan-98 16:23	1780.	100.0	.153	.043	.097	.027	.102	.135	.648
09-Jul-98 09:05	1780.	100.0	.173	.124	.057	.046	.086	.116	.738
15-Sep-98 16:18	1780.	100.0	.091	.031	.065	.029	.048	.050	.250

(Continued)

RHR PUMP1B-2NS	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
16-Oct-98 08:18	1780.	100.0	.139	.077	.067	.049	.080	.096	1.297
21-Dec-98 11:09	1780.	100.0	.156	.090	.080	.051	.084	.070	.578
19-Mar-99 14:38	1780.	100.0	.161	.115	.048	.051	.089	.217	.660
10-Jun-99 12:27	1780.	100.0	.146	.087	.056	.053	.089	.102	1.609
01-Sep-99 14:11	1780.	100.0	.134	.071	.049	.051	.088	.104	1.594
24-Nov-99 09:47	1780.	100.0	.132	.064	.055	.052	.088	.092	1.250
16-Feb-00 14:18	1780.	100.0	.154	.088	.063	.067	.087	.106	.996
27-Feb-00 11:19	1780.	100.0	.079	.022	.049	.023	.052	.101	.463
10-May-00 14:20	1780.	100.0	.133	.074	.056	.050	.082	.118	.914

RHR PUMP1B-2EW	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95 13:11	1780.	100.0	.266	.065	.166	.051	.189	.422	.024
24-Mar-95 12:55	1780.	100.0	.180	.098	.093	.058	.103	.578	.053
29-Jun-95 13:52	1780.	100.0	.213	.086	.106	.055	.153	.338	.029
11-Jan-96 14:40	1780.	100.0	.127	.058	.070	.051	.071	.083	.816
22-Mar-96 15:57	1780.	100.0	.127	.045	.079	.021	.080	.089	1.188
14-Jun-96 09:11	1780.	100.0	.120	.046	.068	.026	.079	.091	.941
05-Sep-96 16:41	1780.	100.0	.141	.077	.065	.035	.085	.085	.633
27-Nov-96 09:39	1780.	100.0	.138	.062	.074	.030	.086	.095	.691
21-Feb-97 13:15	1780.	100.0	.130	.049	.070	.025	.081	.075	.383
28-Mar-97 13:06	1780.	100.0	.097	.0048	.093	.0066	.027	.066	.074
15-May-97 14:20	1780.	100.0	.144	.076	.075	.039	.077	.082	.605
05-Aug-97 14:35	1780.	100.0	.136	.046	.084	.034	.082	.082	.637
31-Oct-97 09:22	1780.	100.0	.138	.045	.086	.024	.089	.098	.801
22-Jan-98 16:23	1780.	100.0	.146	.084	.071	.019	.083	.093	.471
09-Jul-98 09:05	1780.	100.0	.124	.040	.069	.052	.079	.094	1.289
15-Sep-98 16:19	1780.	100.0	.087	.016	.071	.021	.042	.058	.190
16-Oct-98 08:18	1780.	100.0	.143	.079	.076	.049	.078	.106	1.234
21-Dec-98 11:10	1780.	100.0	.132	.058	.067	.061	.076	.097	.652
19-Mar-99 14:38	1780.	100.0	.207	.078	.064	.047	.173	1.141	1.016
10-Jun-99 12:28	1780.	100.0	.129	.048	.061	.065	.081	.085	.934
01-Sep-99 14:12	1780.	100.0	.128	.047	.059	.059	.085	.090	1.219
24-Nov-99 09:48	1780.	100.0	.152	.066	.068	.054	.106	.116	1.352
16-Feb-00 14:21	1780.	100.0	.145	.052	.064	.060	.104	.106	1.063
27-Feb-00 11:20	1780.	100.0	.078	.016	.062	.020	.039	.047	.355
10-May-00 14:18	1780.	100.0	.131	.042	.065	.046	.095	.100	.590

RHR PUMP1B-2A	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Jan-95 13:11	1780.	100.0	.194	.129	.114	.051	.072	.785	.104
24-Mar-95 12:54	1780.	100.0	.184	.110	.106	.043	.092	.891	.077
29-Jun-95 13:53	1780.	100.0	.241	.181	.108	.046	.105	.609	.043
11-Jan-96 14:39	1780.	100.0	.131	.082	.061	.060	.055	.314	.578
22-Mar-96 15:57	1780.	100.0	.140	.068	.082	.015	.069	.167	1.125
14-Jun-96 09:11	1780.	100.0	.121	.047	.074	.017	.070	.201	1.016
27-Nov-96 09:39	1780.	100.0	.150	.065	.084	.019	.076	.234	.609
28-Mar-97 13:06	1780.	100.0	.059	.0036	.052	.012	.024	.095	.125

22-Jan-98	16:25	1780.	100.0	.166	.058	.093	.020	.080	.185	.988
09-Jul-98	09:05	1780.	100.0	.182	.115	.087	.056	.094	.226	.965
16-Oct-98	08:18	1780.	100.0	.137	.077	.074	.054	.066	.273	2.359
21-Dec-98	11:10	1780.	100.0	.117	.054	.060	.055	.064	.220	1.133
19-Mar-99	14:38	1780.	100.0	.116	.042	.033	.070	.075	.291	1.414
10-Jun-99	12:27	1780.	100.0	.122	.049	.065	.056	.072	.250	1.914
01-Sep-99	14:11	1780.	100.0	.140	.078	.068	.057	.075	.289	2.063
24-Nov-99	09:48	1780.	100.0	.130	.053	.065	.069	.072	.279	2.484
16-Feb-00	14:18	1780.	100.0	.174	.069	.072	.122	.072	.268	1.523
27-Feb-00	11:19	1780.	100.0	.081	.012	.055	.023	.054	.216	.404
10-May-00	14:20	1780.	100.0	.117	.052	.064	.049	.067	.245	1.086

RHR PUMP DIFFERENTIAL PRESSURES

RHR PUMP1B-SP	(RPM)	APS 0	PSI
12-Jan-95 13:12	1780.	100.0	37.60
24-Mar-95 12:55	1780.	100.0	37.50
29-Jun-95 13:54	1780.	100.0	37.50
11-Jan-96 14:20	1780.	100.0	36.80
22-Mar-96 16:01	1780.	100.0	37.00
14-Jun-96 09:16	1780.	100.0	37.00
05-Sep-96 16:44	1780.	100.0	36.80
27-Nov-96 09:40	1780.	100.0	37.20
21-Feb-97 13:17	1780.	100.0	36.80
28-Mar-97 13:07	1780.	100.0	28.80
15-May-97 14:23	1780.	100.0	37.20
05-Aug-97 14:36	1780.	100.0	37.20
31-Oct-97 09:23	1780.	100.0	37.00
22-Jan-98 16:26	1780.	100.0	37.40
09-Jul-98 09:06	1780.	100.0	37.20
15-Sep-98 16:22	1780.	100.0	28.60
16-Oct-98 08:19	1780.	100.0	37.00
21-Dec-98 11:11	1780.	100.0	37.00
19-Mar-99 14:39	1780.	100.0	37.20
10-Jun-99 12:52	1780.	100.0	37.20
01-Sep-99 14:12	1780.	100.0	37.40
24-Nov-99 09:49	1780.	100.0	37.00
16-Feb-00 14:19	1780.	100.0	37.00
27-Feb-00 11:20	1780.	100.0	23.80
10-May-00 14:22	1780.	100.0	36.80

RHR PUMP1B-DP	(RPM)	APS 0	PSI
12-Jan-95 13:13	1780.	100.0	244.0
24-Mar-95 12:56	1780.	100.0	242.0
29-Jun-95 13:55	1780.	100.0	244.0
11-Jan-96 14:20	1780.	100.0	233.0
22-Mar-96 16:01	1780.	100.0	230.0
14-Jun-96 09:16	1780.	100.0	232.0
05-Sep-96 16:44	1780.	100.0	230.0
27-Nov-96 09:41	1780.	100.0	231.0
21-Feb-97 13:17	1780.	100.0	229.0
28-Mar-97 13:08	1780.	100.0	205.0
15-May-97 14:23	1780.	100.0	229.0
05-Aug-97 14:36	1780.	100.0	228.0
31-Oct-97 09:24	1780.	100.0	228.0
22-Jan-98 16:26	1780.	100.0	228.0
09-Jul-98 09:06	1780.	100.0	230.0
15-Sep-98 16:23	1780.	100.0	202.0
16-Oct-98 08:19	1780.	100.0	232.0
21-Dec-98 11:12	1780.	100.0	234.0
19-Mar-99 14:39	1780.	100.0	231.0
10-Jun-99 12:53	1780.	100.0	230.0
01-Sep-99 14:13	1780.	100.0	230.0
24-Nov-99 09:49	1780.	100.0	232.0
16-Feb-00 14:20	1780.	100.0	232.0
27-Feb-00 11:21	1780.	100.0	196.0
10-May-00 14:22	1780.	100.0	232.0

RHR PUMP FLOWRATES

RHR PUMP1B-PFL	(RPM)	APS 0	GPM
12-Jan-95 13:14	1780.	100.0	570.0
24-Mar-95 12:57	1780.	100.0	560.0
29-Jun-95 13:55	1780.	100.0	570.0
11-Jan-96 14:20	1780.	100.0	565.0
22-Mar-96 16:01	1780.	100.0	570.0
14-Jun-96 09:17	1780.	100.0	560.0
05-Sep-96 16:45	1780.	100.0	560.0
27-Nov-96 09:43	1780.	100.0	550.0
21-Feb-97 13:18	1780.	100.0	550.0
28-Mar-97 13:09	1780.	100.0	2698.0
15-May-97 14:24	1780.	100.0	560.0
05-Aug-97 14:37	1780.	100.0	565.0
31-Oct-97 09:25	1780.	100.0	540.0
22-Jan-98 16:26	1780.	100.0	540.0
09-Jul-98 09:07	1780.	100.0	545.0
15-Sep-98 16:23	1780.	100.0	2698.0
16-Oct-98 08:21	1780.	100.0	565.0
21-Dec-98 11:13	1780.	100.0	560.0
19-Mar-99 14:40	1780.	100.0	530.0
10-Jun-99 12:53	1780.	100.0	530.0
01-Sep-99 14:14	1780.	100.0	530.0
24-Nov-99 09:50	1780.	100.0	530.0
16-Feb-00 12:22	1780.	100.0	530.0
27-Feb-00 11:22	1780.	100.0	2698.0
10-May-00 14:24	1780.	100.0	530.0

RHR PUMP 2A

Measurement Point History

Database: auxbldg.rbm
Station: SQN SECURED AREAS UNITS 1,2&COM
Report Date: 08-Jun-00 17:22
Period Reported: ALL DATA AVAILABLE

OVERALL = ALL spectrum combined
PAR#1 = subharmonics 0.2 to 0.8X running speed (nominal speed of 1780 RPM)
PAR#2 = First Order 0.8 to 1.2X running speed
PAR#3 = $2^{nd}/3^{rd}$ Order 1.2X to 3.2X running speed
PAR#4 = 4-40 Orders 3.2 to 40X running speed
PAR#5 = Low freq acc 312 to 1250 HZ low frequency acceleration
PAR#6 = High Freq acc 1250 to 15000 HZ high frequency acceleration

Notes:
1) RPM and Load are nominal values; not actual test data
2) Highlighted data reflects comparisons of near full-flow and reduced-flow testing.

DATE	TIME	RPM	LOAD	OVERALL	PAR#1	PAR#2	PAR#3	PAR#4	PAR#5	PAR#6
RHR PUMP2A-1NS		(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95	15:12	1780.	100.0	.699	.682	.097	.064	.086	.277	.043
25-Apr-95	13:16	1780.	100.0	.438	.400	.093	.092	.111	.250	.010
20-Jul-95	14:17	1780.	100.0	.245	.202	.086	.062	.088	.167	.017
26-Oct-95	14:26	1780.	100.0	.337	.311	.090	.065	.064	.144	.432
05-Jan-96	17:01	1780.	100.0	.324	.293	.093	.050	.059	.037	.0040
28-Mar-96	15:07	1780.	100.0	.361	.336	.092	.042	.076	.144	.395
20-Jun-96	09:15	1780.	100.0	.319	.276	.124	.054	.074	.128	.467
12-Sep-96	09:03	1780.	100.0	.254	.220	.090	.033	.077	.127	.385
03-Dec-96	13:55	1780.	100.0	.402	.376	.104	.042	.074	.123	.316
26-Feb-97	14:14	1780.	100.0	.476	.456	.100	.044	.068	.120	.289
21-May-97	12:31	1780.	100.0	.380	.352	.108	.039	.079	.127	.416
14-Aug-97	13:00	1780.	100.0	.307	.279	.095	.040	.066	.123	.473
10-Oct-97	23:10	1780.	100.0	.103	.035	.090	.027	.025	.089	.221
06-Nov-97	12:38	1780.	100.0	.352	.327	.094	.037	.075	.084	.676
16-Jul-98	10:01	1780.	100.0	.342	.315	.093	.065	.064	.134	.465
08-Oct-98	10:03	1780.	100.0	.263	.231	.090	.056	.064	.103	.918
31-Dec-98	14:18	1780.	100.0	.557	.541	.104	.060	.065	.152	.439
08-Apr-99	09:26	1780.	100.0	.354	.331	.088	.057	.066	.133	.480
23-Apr-99	12:42	1780.	100.0	.114	.071	.079	.026	.030	.091	.527
17-Jun-99	12:47	1780.	100.0	.296	.262	.106	.062	.065	.142	.477
10-Sep-99	08:05	1780.	100.0	.286	.246	.110	.069	.070	.112	.453
03-Dec-99	10:16	1780.	100.0	.279	.242	.104	.065	.067	.105	.447
25-Feb-00	08:42	1780.	100.0	.291	.255	.102	.066	.070	.100	.457
18-May-00	10:20	1780.	100.0	.302	.267	.108	.063	.068	.106	.404
RHR PUMP2A-1EW		(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95	15:12	1780.	100.0	.451	.428	.097	.076	.062	.158	.033
25-Apr-95	13:16	1780.	100.0	.633	.608	.098	.072	.119	.216	.011
20-Jul-95	14:18	1780.	100.0	.504	.472	.104	.081	.106	.186	.015
26-Oct-95	14:26	1780.	100.0	.564	.539	.111	.087	.074	.090	.250
05-Jan-96	17:04	1780.	100.0	.724	.704	.108	.062	.064	.045	.0031
28-Mar-96	15:09	1780.	100.0	.682	.663	.111	.053	.088	.117	.424

29-May-96 09:32	1780.	100.0	.086	.036	.069	.011	.030	.069	.566
20-Jun-96 09:17	1780.	100.0	.588	.566	.118	.059	.077	.108	.369
12-Sep-96 09:06	1780.	100.0	.602	.580	.112	.066	.085	.119	.299
21-Oct-96 22:13	1780.	100.0	.114	.087	.063	.011	.028	.062	.328

(Continued)

RHR PUMP2A-1EW	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
03-Dec-96 13:56	1780.	100.0	.594	.572	.106	.056	.078	.095	.199
26-Feb-97 14:10	1780.	100.0	.605	.583	.113	.064	.082	.111	.230
21-May-97 12:31	1780.	100.0	.561	.536	.115	.060	.083	.113	.229
14-Aug-97 12:59	1780.	100.0	.520	.497	.104	.059	.075	.104	.582
10-Oct-97 23:10	1780.	100.0	.101	.035	.080	.033	.038	.106	.174
06-Nov-97 12:38	1780.	100.0	.625	.605	.109	.048	.081	.093	.266
16-Jul-98 10:04	1780.	100.0	.479	.450	.110	.078	.068	.131	.365
08-Oct-98 10:04	1780.	100.0	.515	.489	.108	.081	.064	.089	.371
31-Dec-98 14:19	1780.	100.0	.933	.917	.122	.087	.085	.131	.293
08-Apr-99 09:38	1780.	100.0	.755	.735	.118	.089	.082	.126	.250
23-Apr-99 12:43	1780.	100.0	.134	.090	.085	.030	.043	.082	.258
17-Jun-99 12:48	1780.	100.0	.508	.483	.117	.086	.071	.085	.270
10-Sep-99 08:30	1780.	100.0	.566	.536	.130	.094	.077	.102	.344
03-Dec-99 10:16	1780.	100.0	.510	.483	.119	.083	.073	.079	.210
25-Feb-00 08:43	1780.	100.0	.471	.442	.115	.079	.086	.100	.266
18-May-00 10:28	1780.	100.0	.561	.536	.119	.085	.076	.103	.297

RHR PUMP2A-1A	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95 15:13	1780.	100.0	.196	.133	.054	.064	.115	.270	.048
25-Apr-95 13:17	1780.	100.0	.175	.098	.036	.064	.125	.598	.048
20-Jul-95 14:18	1780.	100.0	.161	.052	.034	.059	.136	.660	.024
26-Oct-95 14:27	1780.	100.0	.128	.055	.032	.060	.093	.202	.770
05-Jan-96 17:02	1780.	100.0	.162	.104	.036	.024	.032	.063	.0061
28-Mar-96 15:08	1780.	100.0	.125	.042	.035	.023	.091	.162	.816
29-May-96 09:31	1780.	100.0	.102	.074	.017	.016	.060	.127	.645
20-Jun-96 09:14	1780.	100.0	.129	.065	.034	.019	.088	.183	.824
12-Sep-96 09:04	1780.	100.0	.124	.048	.038	.025	.090	.206	.566
21-Oct-96 22:13	1780.	100.0	.069	.020	.013	.015	.059	.123	.609
03-Dec-96 13:55	1780.	100.0	.195	.164	.039	.019	.085	.154	.500
26-Feb-97 14:14	1780.	100.0	.160	.120	.047	.020	.076	.196	.559
21-May-97 12:31	1780.	100.0	.113	.047	.032	.022	.082	.180	.473
14-Aug-97 12:58	1780.	100.0	.111	.041	.032	.023	.083	.159	.547
10-Oct-97 23:11	1780.	100.0	.039	.0087	.015	.0069	.033	.121	.155
06-Nov-97 12:39	1780.	100.0	.141	.072	.041	.017	.099	.151	.482
16-Jul-98 10:04	1780.	100.0	.124	.045	.034	.061	.092	.228	.494
08-Oct-98 10:03	1780.	100.0	.118	.049	.032	.062	.080	.157	.672
31-Dec-98 14:19	1780.	100.0	.138	.080	.037	.061	.085	.190	.482
08-Apr-99 09:26	1780.	100.0	.127	.061	.035	.063	.086	.191	.734
23-Apr-99 12:43	1780.	100.0	.084	.012	.017	.036	.074	.134	.520
17-Jun-99 12:46	1780.	100.0	.122	.056	.029	.062	.084	.198	.492
10-Sep-99 08:05	1780.	100.0	.136	.062	.040	.062	.096	.199	.467
03-Dec-99 10:17	1780.	100.0	.136	.071	.041	.063	.088	.156	.516
25-Feb-00 08:43	1780.	100.0	.121	.046	.034	.064	.085	.208	.500
18-May-00 10:21	1780.	100.0	.124	.045	.037	.065	.088	.189	.617

RHR PUMP2A-2NS	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95 15:13	1780.	100.0	.266	.164	.050	.052	.196	.855	.030
25-Apr-95 13:18	1780.	100.0	.216	.153	.045	.056	.135	.200	.0075
20-Jul-95 14:19	1780.	100.0	.130	.059	.043	.053	.093	.268	.0081
26-Oct-95 14:28	1780.	100.0	.121	.065	.042	.056	.074	.080	.171
05-Jan-96 17:06	1780.	100.0	.137	.088	.052	.033	.047	.042	.0015

28-Mar-96	15:10	1780.	100.0	.140	.084	.059	.032	.080	.070	.252
29-May-96	09:32	1780.	100.0	.047	.016	.018	.013	.032	.038	.097
20-Jun-96	09:17	1780.	100.0	.116	.058	.045	.034	.072	.069	.236

(Continued)

RHR PUMP2A-2NS	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
12-Sep-96 09:07	1780.	100.0	.120	.066	.047	.031	.076	.097	.126
21-Oct-96 22:14	1780.	100.0	.048	.021	.020	.015	.031	.036	.083
03-Dec-96 13:57	1780.	100.0	.143	.097	.050	.029	.080	.070	.271
26-Feb-97 14:12	1780.	100.0	.139	.096	.050	.030	.072	.056	.217
21-May-97 12:32	1780.	100.0	.117	.071	.039	.027	.073	.063	.173
14-Aug-97 13:02	1780.	100.0	.113	.062	.038	.030	.071	.069	.277
10-Oct-97 23:12	1780.	100.0	.047	.011	.020	.031	.025	.052	.068
06-Nov-97 12:39	1780.	100.0	.125	.075	.051	.030	.075	.080	.637
16-Jul-98 10:05	1780.	100.0	.117	.060	.047	.052	.071	.076	.115
08-Oct-98 10:04	1780.	100.0	.110	.058	.040	.051	.066	.082	.676
31-Dec-98 14:21	1780.	100.0	.129	.077	.050	.057	.070	.073	.332
08-Apr-99 09:27	1780.	100.0	.108	.052	.044	.053	.065	.100	.381
23-Apr-99 12:43	1780.	100.0	.050	.017	.030	.024	.027	.039	.161
17-Jun-99 12:45	1780.	100.0	.112	.060	.047	.051	.065	.069	.305
10-Sep-99 08:06	1780.	100.0	.120	.057	.049	.060	.071	.060	.551
14-Sep-99 09:58	1780.	100.0	.125	.044	.038	.062	.092	.106	.453
03-Dec-99 10:17	1780.	100.0	.132	.086	.040	.059	.070	.051	.311
25-Feb-00 08:44	1780.	100.0	.119	.066	.044	.058	.067	.061	.330
18-May-00 10:23	1780.	100.0	.113	.052	.045	.057	.069	.058	.318

RHR PUMP2A-2EW	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95 15:14	1780.	100.0	.161	.111	.039	.057	.093	.426	.031
25-Apr-95 13:18	1780.	100.0	.136	.074	.028	.060	.093	.144	.0061
20-Jul-95 14:20	1780.	100.0	.159	.113	.036	.065	.084	.147	.0072
26-Oct-95 14:29	1780.	100.0	.167	.129	.032	.065	.076	.067	.198
05-Jan-96 17:07	1780.	100.0	.219	.196	.033	.035	.049	.039	.0014
28-Mar-96 15:11	1780.	100.0	.192	.159	.035	.033	.081	.051	.180
29-May-96 09:33	1780.	100.0	.059	.023	.016	.015	.035	.051	.069
20-Jun-96 09:18	1780.	100.0	.177	.141	.035	.031	.081	.075	.117
12-Sep-96 09:08	1780.	100.0	.185	.153	.032	.028	.079	.078	.226
03-Dec-96 13:58	1780.	100.0	.159	.125	.024	.032	.079	.084	.130
26-Feb-97 14:11	1780.	100.0	.099	.031	.026	.031	.073	.066	.167
21-May-97 12:33	1780.	100.0	.132	.083	.031	.031	.085	.081	.110
14-Aug-97 13:01	1780.	100.0	.114	.067	.030	.030	.070	.082	.330
10-Oct-97 23:12	1780.	100.0	.041	.011	.028	.0094	.025	.045	.072
06-Nov-97 12:40	1780.	100.0	.156	.120	.031	.029	.079	.087	.316
16-Jul-98 10:05	1780.	100.0	.142	.101	.029	.061	.071	.071	.157
08-Oct-98 10:05	1780.	100.0	.142	.104	.027	.062	.068	.074	.387
31-Dec-98 14:20	1780.	100.0	.186	.156	.029	.065	.073	.085	.381
08-Apr-99 09:38	1780.	100.0	.205	.185	.040	.050	.059	.107	.340
23-Apr-99 12:44	1780.	100.0	.056	.028	.025	.030	.028	.038	.204
17-Jun-99 12:44	1780.	100.0	.162	.122	.035	.063	.077	.066	.369
10-Sep-99 08:07	1780.	100.0	.160	.109	.040	.074	.081	.079	.473
14-Sep-99 09:59	1780.	100.0	.111	.043	.036	.064	.071	.059	.563
03-Dec-99 10:18	1780.	100.0	.147	.105	.038	.066	.069	.061	.391
25-Feb-00 08:44	1780.	100.0	.157	.122	.036	.065	.065	.057	.338
18-May-00 10:23	1780.	100.0	.153	.113	.032	.061	.076	.078	.393

RHR PUMP2A-2A	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
31-Jan-95 15:14	1780.	100.0	.123	.071	.034	.062	.070	.240	.054
25-Apr-95 13:18	1780.	100.0	.136	.081	.031	.063	.083	.309	.024
20-Jul-95 14:22	1780.	100.0	.136	.048	.030	.063	.106	.140	.0093
26-Oct-95 14:28	1780.	100.0	.104	.047	.037	.059	.060	.128	.209

05-Jan-96 17:06	1780.	100.0	.120	.070	.034	.023	.028	.039	.0067
28-Mar-96 15:10	1780.	100.0	.104	.047	.032	.024	.065	.105	.365
29-May-96 09:33	1780.	100.0	.054	.016	.014	.016	.036	.079	.262
20-Jun-96 09:18	1780.	100.0	.107	.057	.040	.024	.057	.136	.279

(Continued)

RHR PUMP2A-2A	(RPM)	APS 20	In/Sec	In/Sec	In/Sec	In/Sec	In/Sec	G-s	G-s
03-Dec-96 13:57	1780.	100.0	.122	.085	.038	.021	.061	.106	.187
26-Feb-97 14:12	1780.	100.0	.130	.099	.035	.020	.056	.105	.256
10-Oct-97 23:13	1780.	100.0	.032	.0070	.021	.0082	.019	.119	.198
06-Nov-97 12:40	1780.	100.0	.106	.061	.041	.018	.061	.115	.277
16-Jul-98 10:07	1780.	100.0	.104	.045	.034	.064	.058	.139	.216
08-Oct-98 10:05	1780.	100.0	.100	.055	.029	.058	.052	.114	.594
31-Dec-98 14:21	1780.	100.0	.119	.074	.037	.065	.057	.131	.516
08-Apr-99 09:27	1780.	100.0	.104	.054	.042	.057	.055	.132	.629
23-Apr-99 12:44	1780.	100.0	.060	.015	.022	.029	.045	.093	.221
17-Jun-99 12:45	1780.	100.0	.106	.058	.040	.057	.056	.126	.432
10-Sep-99 08:07	1780.	100.0	.113	.054	.043	.065	.063	.135	.402
14-Sep-99 09:57	1780.	100.0	.102	.028	.037	.068	.060	.250	.523
03-Dec-99 10:19	1780.	100.0	.112	.059	.043	.062	.059	.125	.309
25-Feb-00 08:44	1780.	100.0	.109	.054	.039	.064	.058	.119	.318
18-May-00 10:24	1780.	100.0	.098	.040	.037	.059	.057	.119	.350

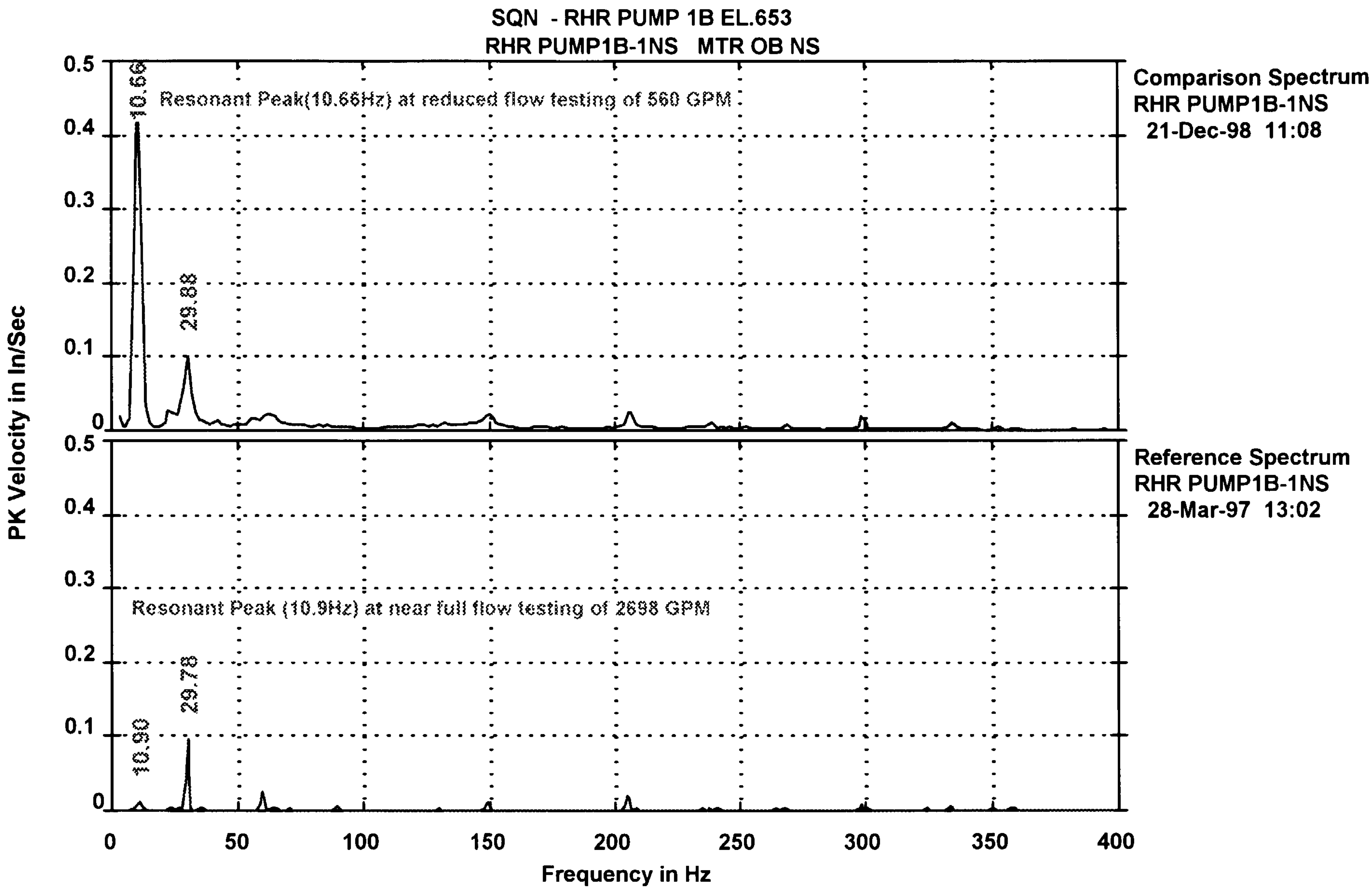
RHR PUMP DIFFERENTIAL PRESSURES

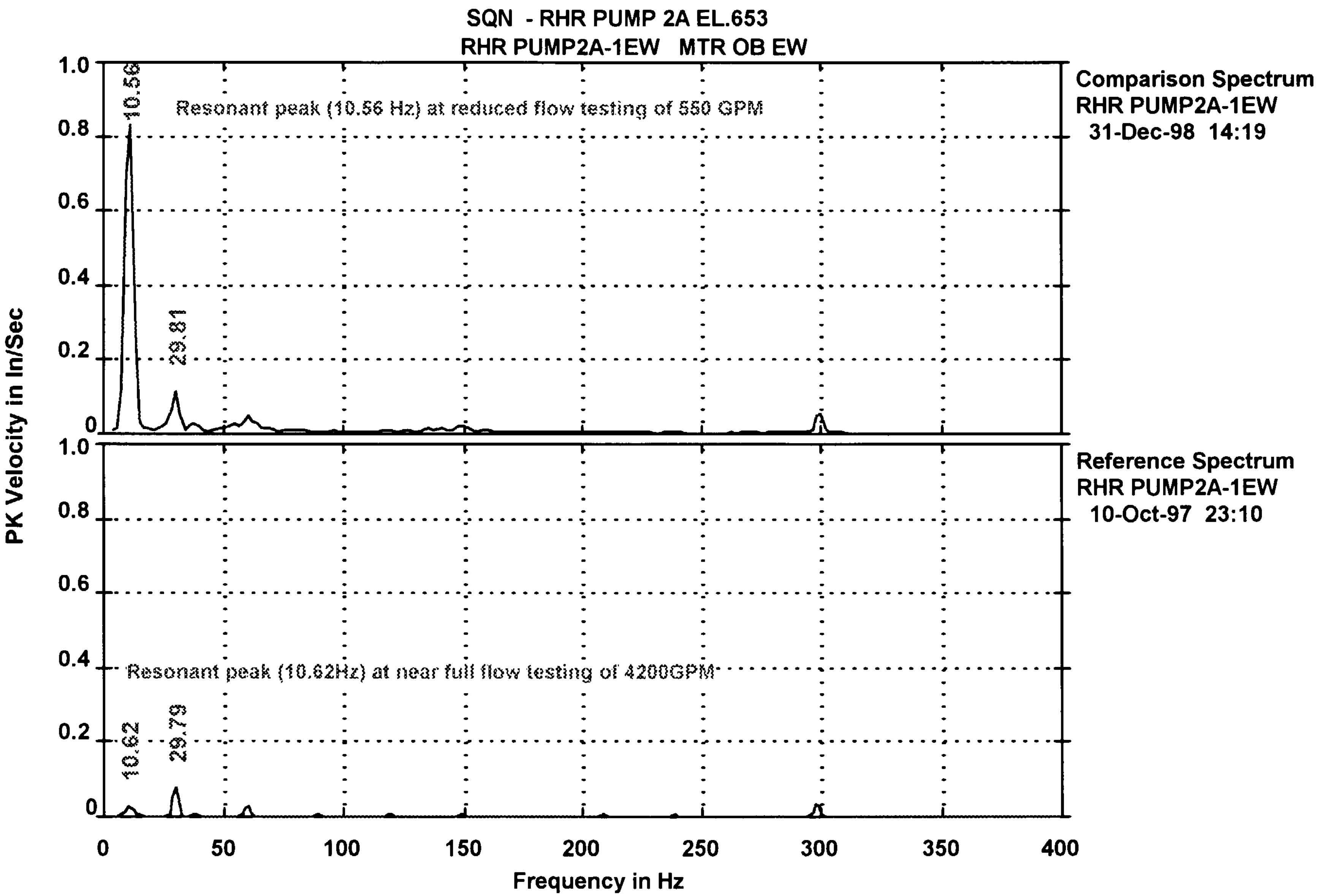
RHR PUMP2A-SP	(RPM)	APS 0	PSI
31-Jan-95 15:15	1780.	100.0	37.50
25-Apr-95 13:20	1780.	100.0	39.00
20-Jul-95 14:24	1780.	100.0	39.40
26-Oct-95 14:28	1780.	100.0	37.20
05-Jan-96 09:26	1780.	100.0	37.00
05-Jan-96 17:10	1780.	100.0	37.00
28-Mar-96 15:10	1780.	100.0	37.80
20-Jun-96 09:20	1780.	100.0	37.80
12-Sep-96 09:10	1780.	100.0	37.80
03-Dec-96 14:00	1780.	100.0	38.00
26-Feb-97 14:18	1780.	100.0	37.80
21-May-97 12:35	1780.	100.0	38.20
14-Aug-97 13:02	1780.	100.0	38.40
10-Oct-97 11:46	1780.	100.0	20.00
06-Nov-97 12:40	1780.	100.0	37.80
16-Jul-98 10:07	1780.	100.0	38.00
08-Oct-98 10:07	1780.	100.0	32.50
31-Dec-98 14:24	1780.	100.0	37.20
08-Apr-99 09:27	1780.	100.0	37.40
23-Apr-99 12:47	1780.	100.0	24.00
17-Jun-99 12:52	1780.	100.0	38.40
10-Sep-99 08:07	1780.	100.0	37.40
03-Dec-99 10:18	1780.	100.0	37.80
25-Feb-00 08:44	1780.	100.0	37.50
18-May-00 10:23	1780.	100.0	38.00

RHR PUMP2A-DP	(RPM)	APS 0	PSI
31-Jan-95 15:15	1780.	100.0	217.0
25-Apr-95 13:21	1780.	100.0	219.0
20-Jul-95 14:24	1780.	100.0	219.0
26-Oct-95 14:28	1780.	100.0	216.0
05-Jan-96 09:26	1780.	100.0	219.0
05-Jan-96 17:11	1780.	100.0	218.0
28-Mar-96 15:10	1780.	100.0	216.5
20-Jun-96 09:20	1780.	100.0	216.5
12-Sep-96 09:10	1780.	100.0	216.0
03-Dec-96 14:00	1780.	100.0	217.0
26-Feb-97 14:18	1780.	100.0	218.0
21-May-97 12:35	1780.	100.0	217.0
14-Aug-97 13:02	1780.	100.0	215.0
10-Oct-97 11:46	1780.	100.0	160.0
06-Nov-97 12:40	1780.	100.0	216.0
16-Jul-98 10:07	1780.	100.0	216.0
08-Oct-98 10:07	1780.	100.0	218.0
31-Dec-98 14:24	1780.	100.0	218.0
08-Apr-99 09:27	1780.	100.0	218.0
23-Apr-99 12:47	1780.	100.0	187.0
17-Jun-99 12:52	1780.	100.0	218.0
10-Sep-99 08:07	1780.	100.0	216.0
03-Dec-99 10:20	1780.	100.0	218.0
25-Feb-00 08:44	1780.	100.0	230.0
18-May-00 10:24	1780.	100.0	218.0

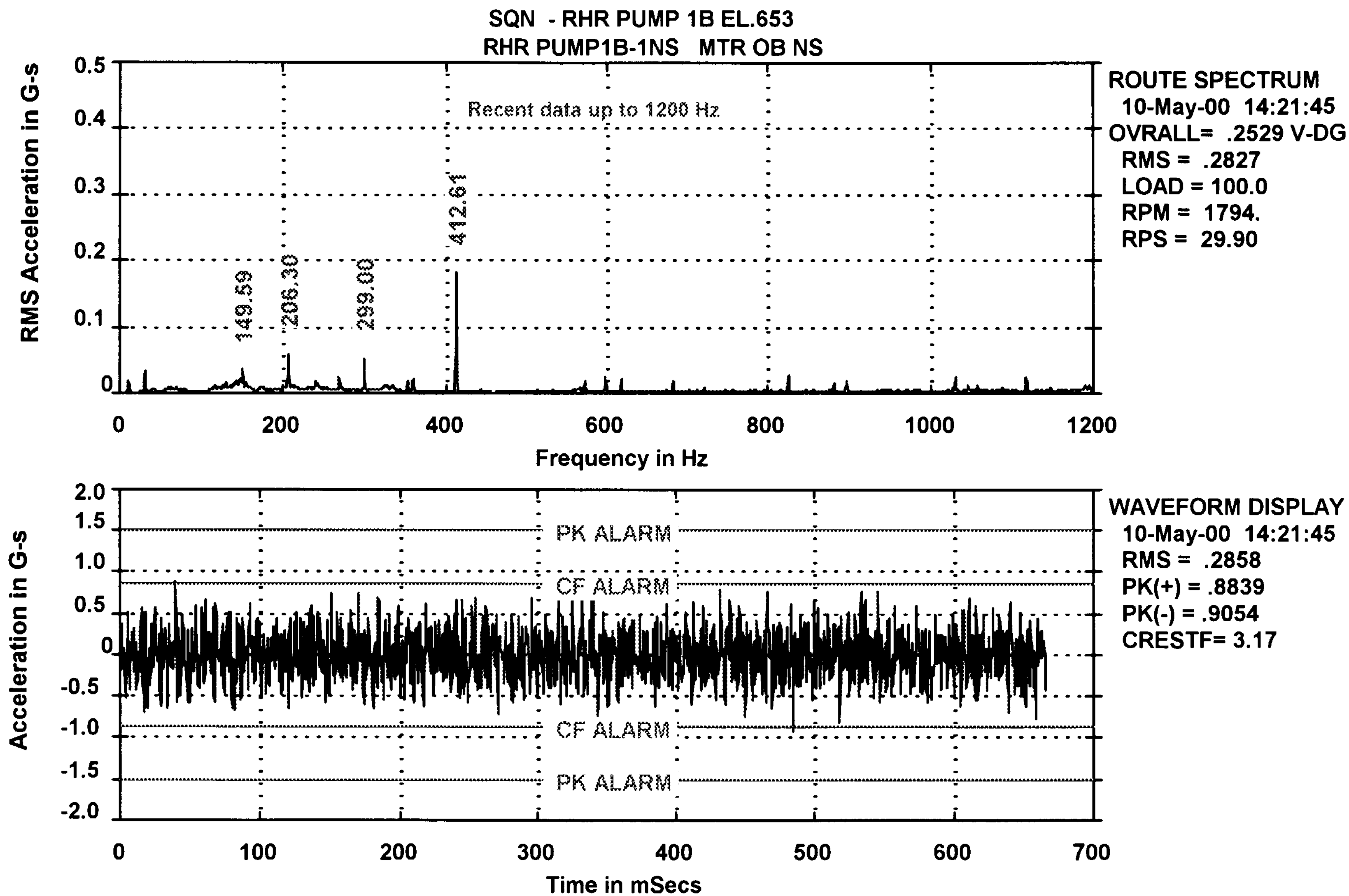
RHR PUMP FLOWRATES

RHR PUMP2A-PFL		(RPM)	APS 0	GPM
23-May-94	13:57	1780.	100.0	560.0
09-Sep-94	07:47	1780.	100.0	550.0
31-Jan-95	15:15	1780.	100.0	555.0
25-Apr-95	13:21	1780.	100.0	565.0
20-Jul-95	14:25	1780.	100.0	565.0
26-Oct-95	14:29	1780.	100.0	560.0
05-Jan-96	09:26	1780.	100.0	550.0
05-Jan-96	17:11	1780.	100.0	550.0
28-Mar-96	15:11	1780.	100.0	550.0
20-Jun-96	09:20	1780.	100.0	550.0
12-Sep-96	09:10	1780.	100.0	550.0
03-Dec-96	14:01	1780.	100.0	550.0
26-Feb-97	14:19	1780.	100.0	550.0
21-May-97	12:36	1780.	100.0	550.0
14-Aug-97	13:02	1780.	100.0	560.0
10-Oct-97	11:43	1780.	100.0	4200.0
06-Nov-97	12:40	1780.	100.0	550.0
16-Jul-98	10:08	1780.	100.0	550.0
08-Oct-98	10:06	1780.	100.0	550.0
31-Dec-98	14:24	1780.	100.0	550.0
08-Apr-99	09:27	1780.	100.0	550.0
23-Apr-99	14:50	1780.	100.0	2698.0
17-Jun-99	12:46	1780.	100.0	580.0
10-Sep-99	08:07	1780.	100.0	580.0
03-Dec-99	10:20	1780.	100.0	580.0
25-Feb-00	08:45	1780.	100.0	580.0
18-May-00	10:25	1780.	100.0	580.0

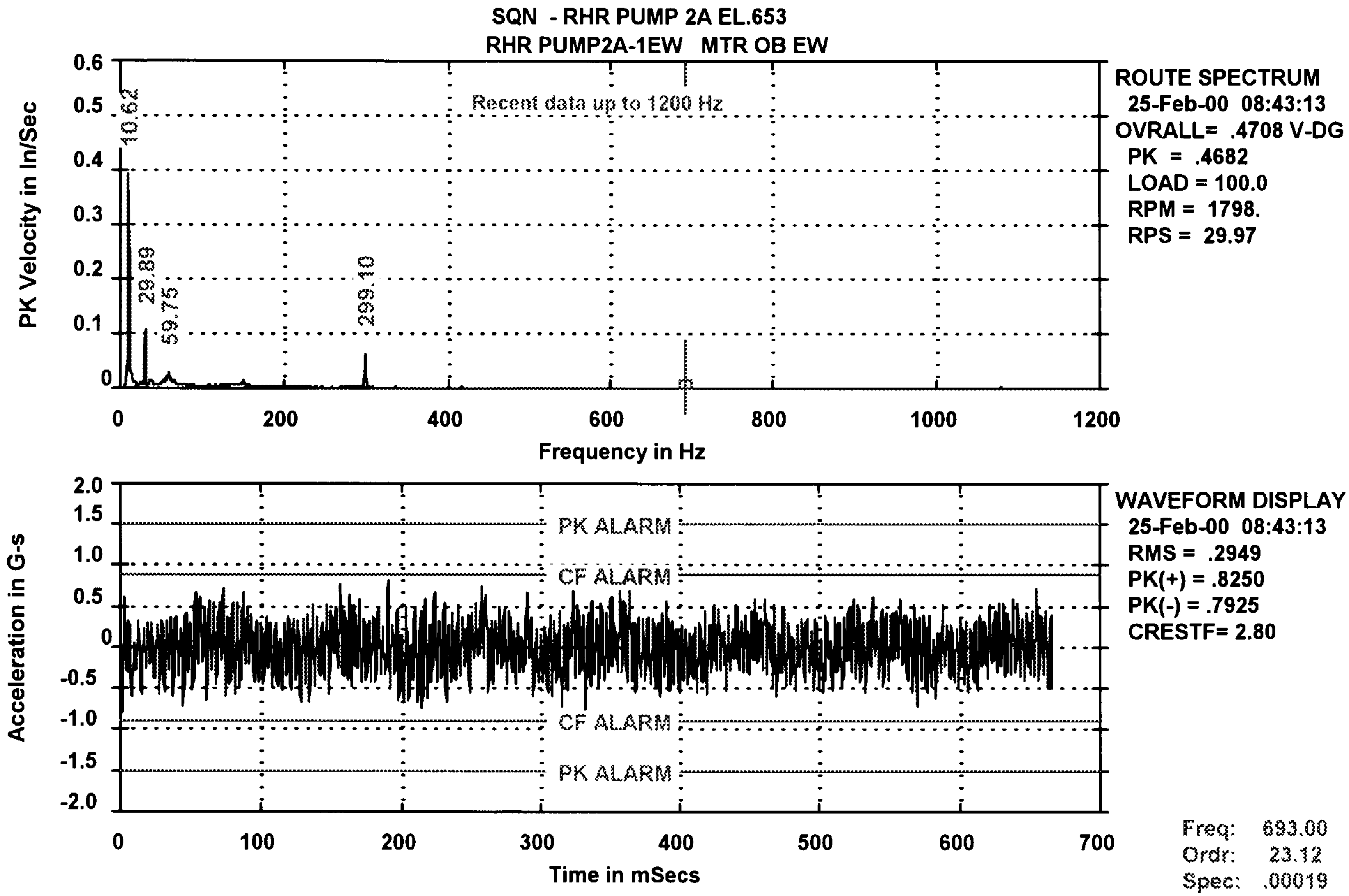

SQN - RHR PUMP 1B EL.653
RHR PUMP1B-1NS MTR OB NS
Comparison Spectrum
RHR PUMP1B-1NS
21-Dec-98 11:08
Resonant Peak(10.66Hz) at reduced flow testing of 560 GPM
10.66
29.88
Reference Spectrum
RHR PUMP1B-1NS
28-Mar-97 13:02
Resonant Peak (10.9Hz) at near full flow testing of 2698 GPM
29.78
10.90
PK Velocity in In/Sec
0.5
0.4
0.3
0.2
0.1
0
0
50
100
150
200
250
300
350
400
Frequency in Hz

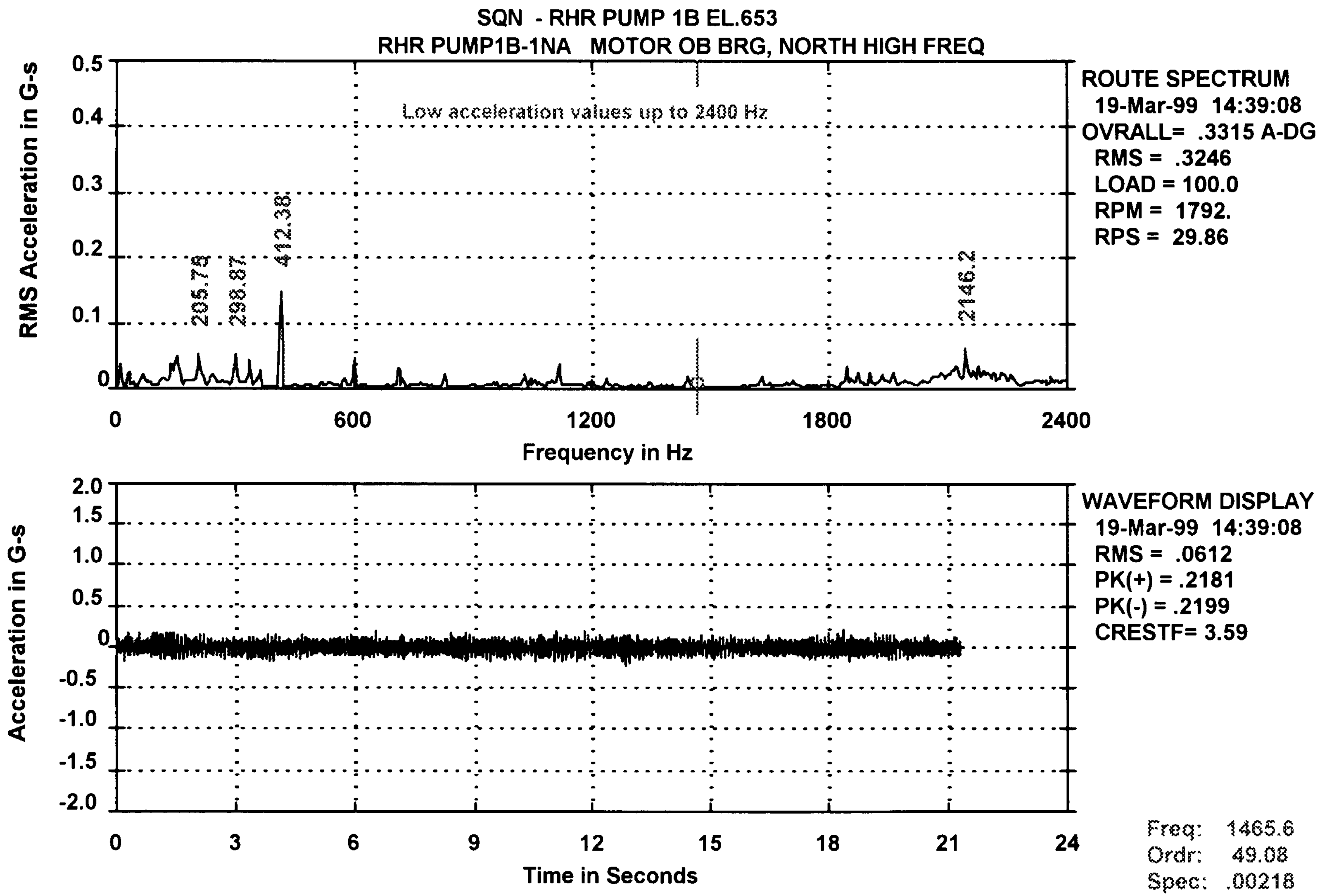


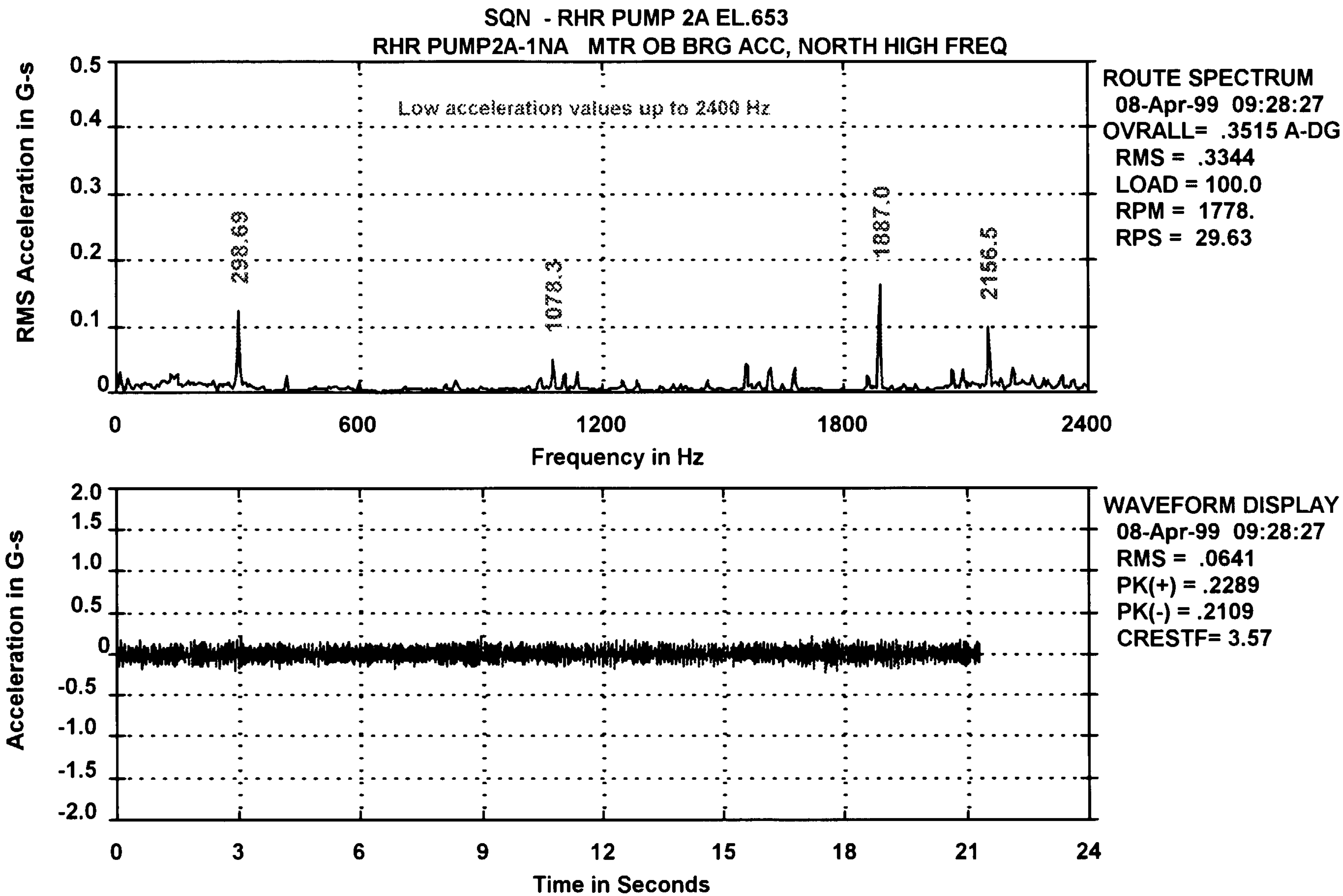
SQN - RHR PUMP 2A EL.653
RHR PUMP2A-1EW MTR OB EW
Comparison Spectrum
RHR PUMP2A-1EW
31-Dec-98 14:19
Resonant peak (10.56 Hz) at reduced flow testing of 550 GPM
10.56
29.81
Reference Spectrum
RHR PUMP2A-1EW
10-Oct-97 23:10
Resonant peak (10.62Hz) at near full flow testing of 4200GPM
10.62
29.79
PK Velocity in In/Sec
1.0
0.8
0.6
0.4
0.2
0
0
50
100
150
200
250
300
350
400
Frequency in Hz

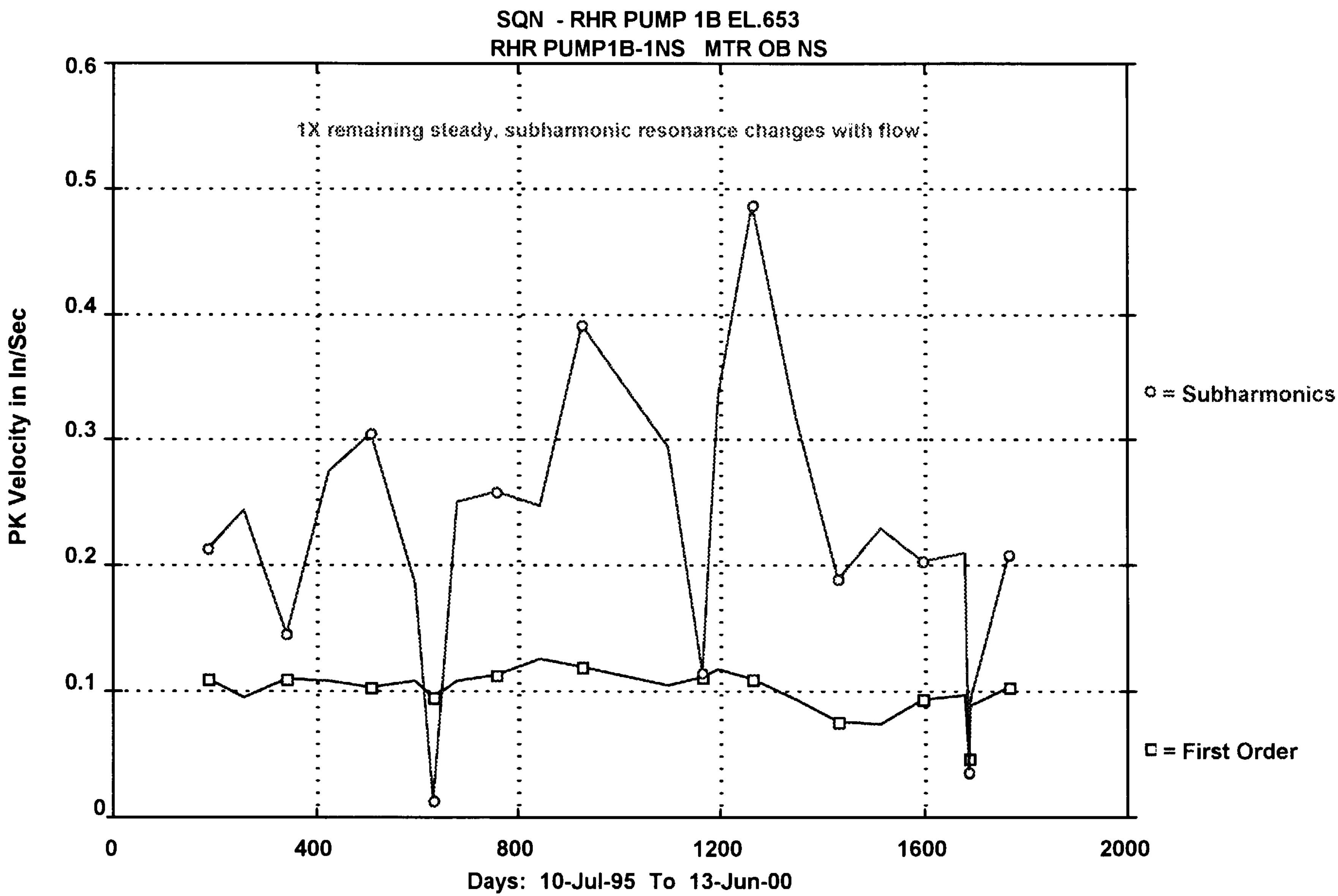


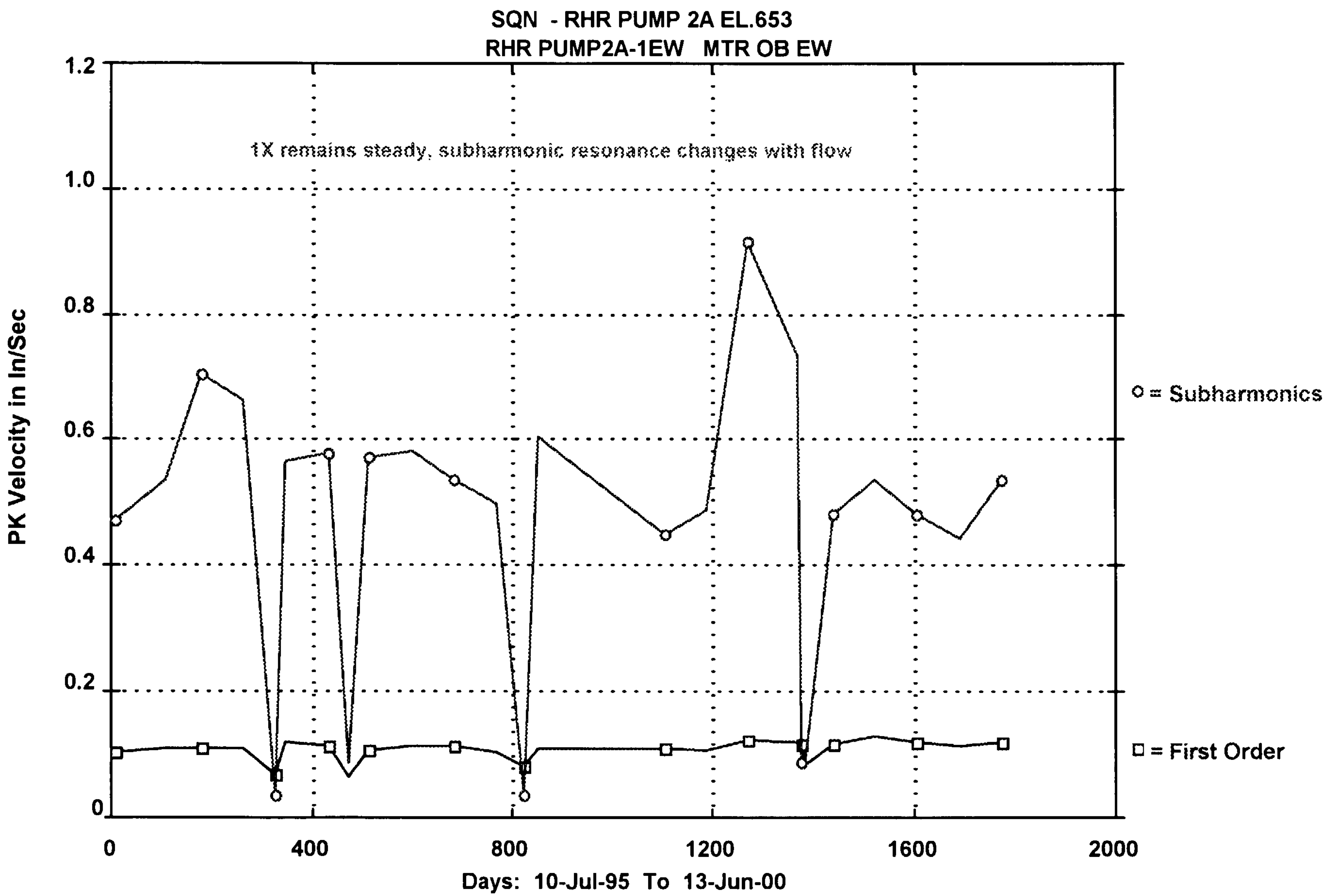
SQN - RHR PUMP 1B EL.653
RHR PUMP1B-1NS MTR OB NS
RMS Acceleration in G-s
Recent data up to 1200 Hz
149.59
206.30
299.00
412.61
Frequency in Hz
ROUTE SPECTRUM
10-May-00 14:21:45
OVRALL= .2529 V-DG
RMS = .2827
LOAD = 100.0
RPM = 1794.
RPS = 29.90
Acceleration in G-s
PK ALARM
CF ALARM
CF ALARM
PK ALARM
Time in mSecs
WAVEFORM DISPLAY
10-May-00 14:21:45
RMS = .2858
PK(+) = .8839
PK(-) = .9054
CRESTF= 3.17

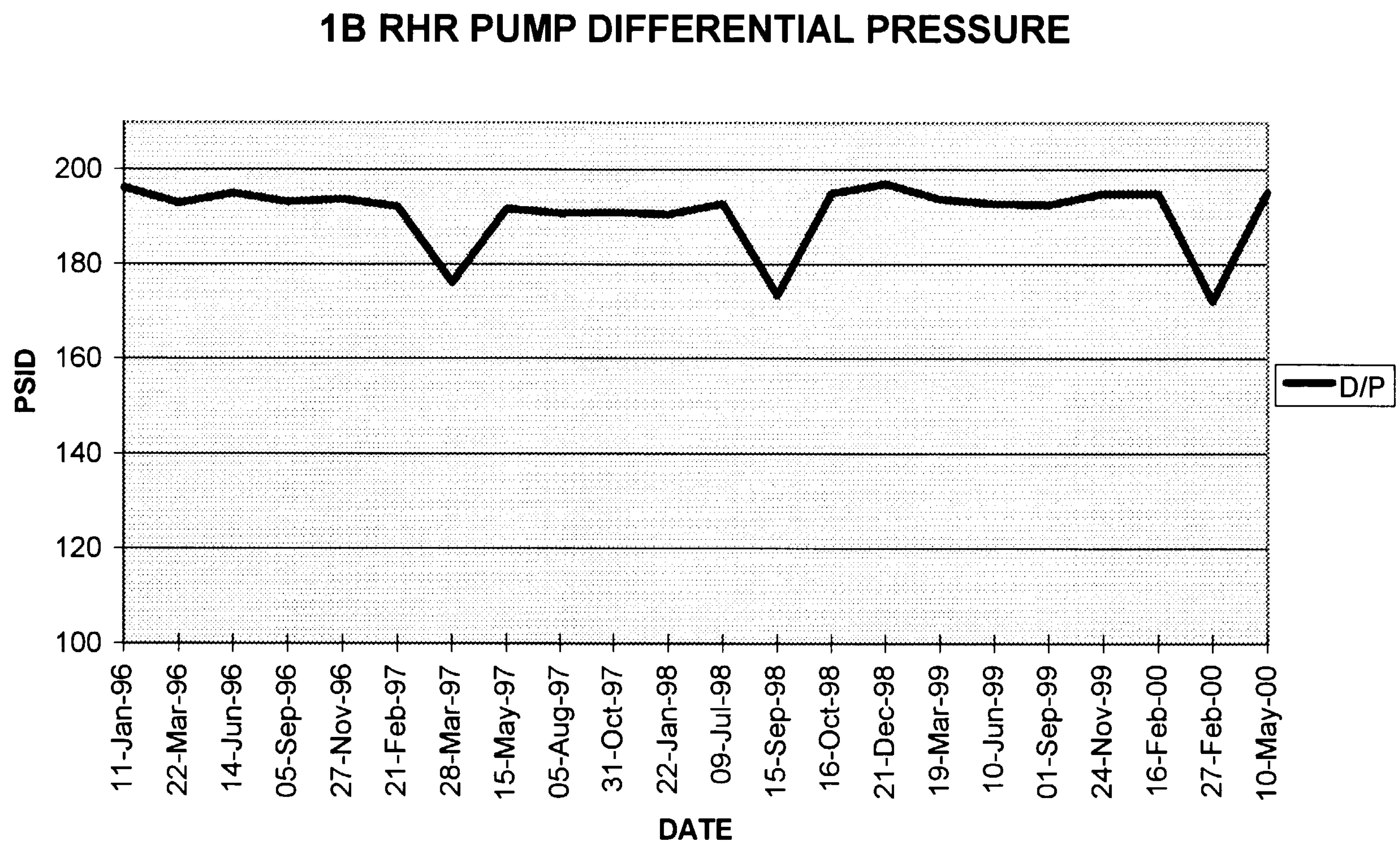

SQN - RHR PUMP 2A EL.653
RHR PUMP2A-1EW MTR OB EW
PK Velocity in In/Sec
Recent data up to 1200 Hz
10.62
29.89
59.75
299.10
Frequency in Hz
ROUTE SPECTRUM
25-Feb-00 08:43:13
OVRALL= .4708 V-DG
PK = .4682
LOAD = 100.0
RPM = 1798.
RPS = 29.97
Acceleration in G-s
PK ALARM
CF ALARM
CF ALARM
PK ALARM
Time in mSecs
WAVEFORM DISPLAY
25-Feb-00 08:43:13
RMS = .2949
PK(+) = .8250
PK(-) = .7925
CRESTF= 2.80
Freq: 693.00
Ordr: 23.12
Spec: .00019


SQN - RHR PUMP 1B EL.653
RHR PUMP1B-1NA MOTOR OB BRG, NORTH HIGH FREQ
Low acceleration values up to 2400 Hz
205.78
298.87
412.38
2146.2
RMS Acceleration in G-s
0.5
0.4
0.3
0.2
0.1
0
0
600
1200
1800
2400
Frequency in Hz
ROUTE SPECTRUM
19-Mar-99 14:39:08
OVRALL= .3315 A-DG
RMS = .3246
LOAD = 100.0
RPM = 1792.
RPS = 29.86
Acceleration in G-s
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
0
3
6
9
12
15
18
21
24
Time in Seconds
WAVEFORM DISPLAY
19-Mar-99 14:39:08
RMS = .0612
PK(+) = .2181
PK(-) = .2199
CRESTF= 3.59
Freq: 1465.6
Ordr: 49.08
Spec: .00218

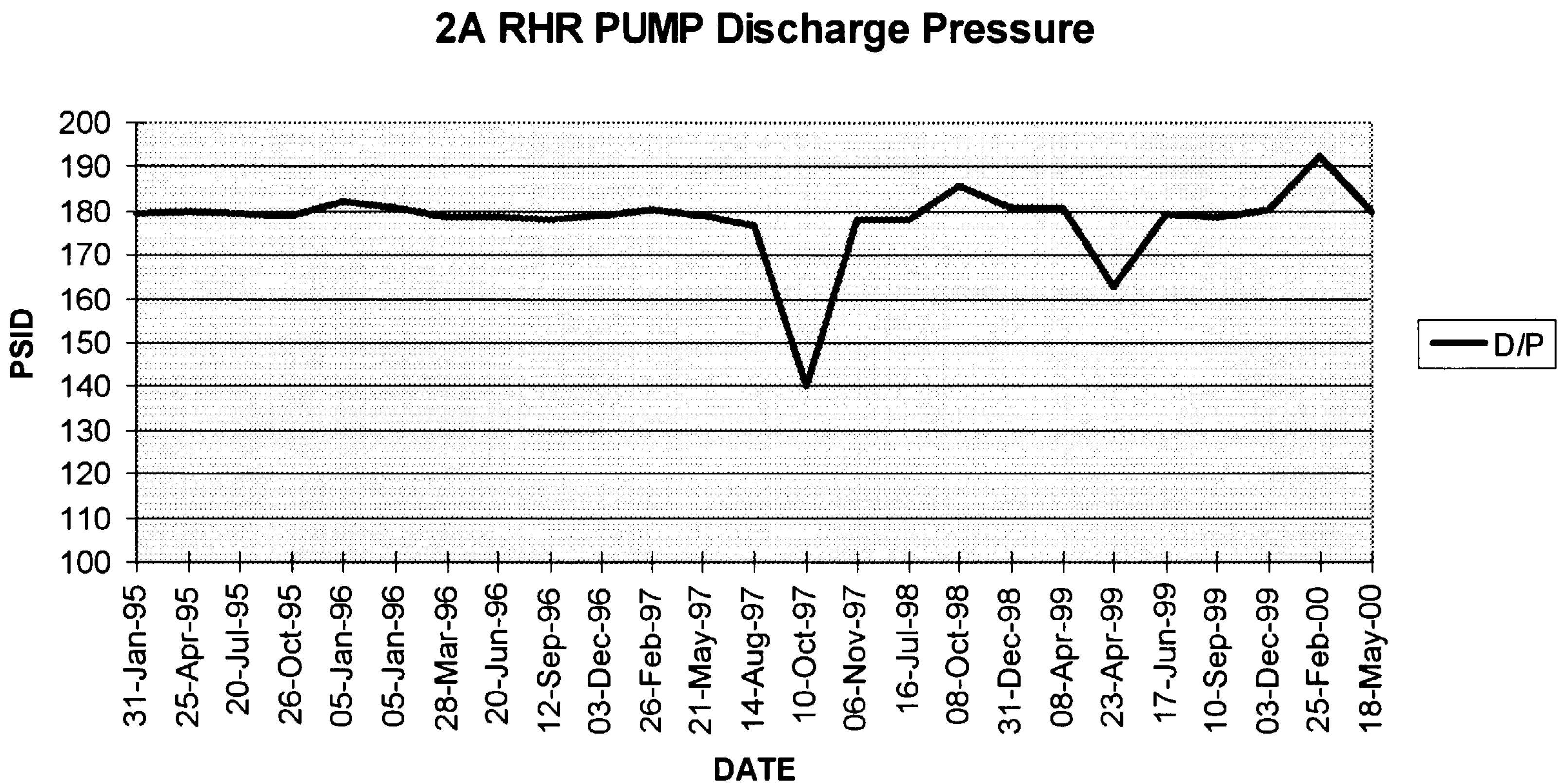

SQN - RHR PUMP 2A EL.653
RHR PUMP2A-1NA MTR OB BRG ACC, NORTH HIGH FREQ
RMS Acceleration in G-s
0.5
0.4
0.3
0.2
0.1
0
Low acceleration values up to 2400 Hz
298.69
1078.3
1887.0
2156.5
0
600
1200
1800
2400
Frequency in Hz
ROUTE SPECTRUM
08-Apr-99 09:28:27
OVRALL= .3515 A-DG
RMS = .3344
LOAD = 100.0
RPM = 1778.
RPS = 29.63
Acceleration in G-s
2.0
1.5
1.0
0.5
0
-0.5
-1.0
-1.5
-2.0
0
3
6
9
12
15
18
21
24
Time in Seconds
WAVEFORM DISPLAY
08-Apr-99 09:28:27
RMS = .0641
PK(+) = .2289
PK(-) = .2109
CRESTF= 3.57


SQN - RHR PUMP 1B EL.653
RHR PUMP1B-1NS MTR OB NS
1X remaining steady, subharmonic resonance changes with flow
0.6
0.5
0.4
0.3
0.2
0.1
0
PK Velocity in In/Sec
0
400
800
1200
1600
2000
Days: 10-Jul-95 To 13-Jun-00
o = Subharmonics
□ = First Order


SQN - RHR PUMP 2A EL.653
RHR PUMP2A-1EW MTR OB EW
1X remains steady, subharmonic resonance changes with flow
PK Velocity in In/Sec
1.2
1.0
0.8
0.6
0.4
0.2
0
0
400
800
1200
1600
2000
Days: 10-Jul-95 To 13-Jun-00
o = Subharmonics
□ = First Order



NOTE: DIPS IN D/P ARE CONCURRENT WITH NEAR FULL FLOW TESTING.



NOTE: DIPS IN D/P ARE CONCURRENT WITH NEAR FULL FLOW TESTING.

Predictive Maintenance Condition Report for RHR Pumps

PROBLEM DESCRIPTION

The 2A and 1B RHR pumps have elevated vibration levels on the motor outboard bearing (top of motor).

EXECUTIVE SUMMARY

The elevated vibration on the RHR motors is due to a resonant condition that has existed since their original installation. No pump or motor bearing degradation has been detected since their installation. Vibration diagnostics has determined the resonant component to be the motor being excited by the flow energy from the pump and piping.

EVALUATION OF VIBRATION LEVELS

The evaluation will concentrate on 2A, but all RHR motor/pumps are experiencing the same type of excitation at a sub-synchronous frequency.

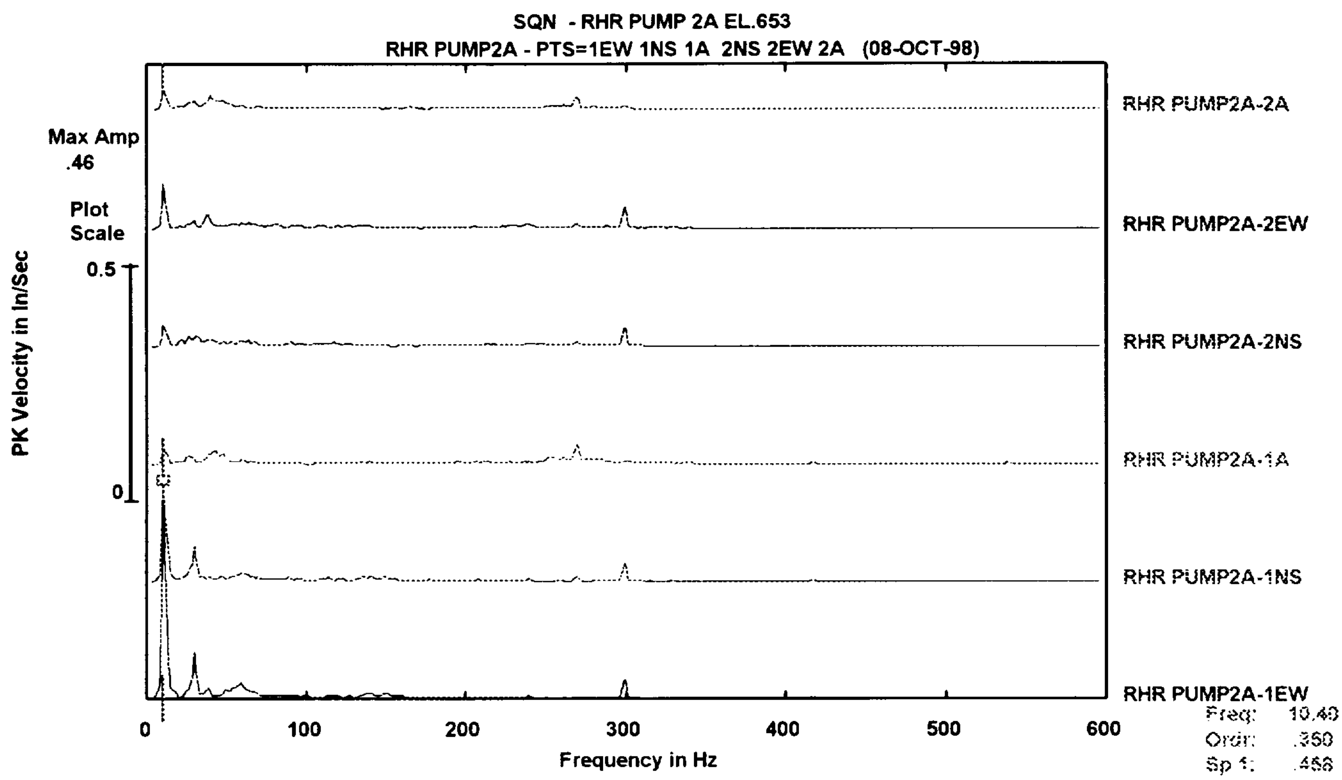
2A RHR PUMP/MOTOR

The 2A RHR motor has a dominant vibration at the top of the motor(1EW) at .5ipsp. The frequency of the vibration is at 10.4HZ. The normal operating frequency for the machine is 29.9HZ. Vibration data since 1991 confirms that the condition has existed in the same amplitudes and frequencies.

With the majority of the vibration occurring sub-synchronous to running speeds the possibility of resonance needs to be verified. Resonance of the pump or motor can cause the elevated vibration that is present.

Full Flow Data-

Data from full flow shows that the vibration is reduced greatly. Values at .1 ipsp are the average. Thus, running Section XI tests at reduced flows is the major contributor to the elevated vibration. The reduced flows have created flow related vibration that is near a resonant frequency of the pump or motor. The resonance caused the pump/motor to be excited and vibrate at elevated levels. The top of the motor acts as a lever and allows us to see the majority of the vibration at this area.


SQN - RHR PUMP 2A EL.653
RHR PUMP2A - PTS=1EW 1NS 1A 2NS 2EW 2A (08-OCT-98)
Max Amp
.46
Plot
Scale
0.5
0
PK Velocity in In/Sec
RHR PUMP2A-2A
RHR PUMP2A-2EW
RHR PUMP2A-2NS
RHR PUMP2A-1A
RHR PUMP2A-1NS
RHR PUMP2A-1EW
0
100
200
300
400
500
600
Frequency in Hz
Freq: 10.40
Ordr: .350
Sp 1: .458

Continuing Discussion:

The source of the resonance can be determined by impact testing and advanced diagnostics. Possible sources of the resonance are:

Pump housing
Pump support frame
Motor housing
System piping/system excitation
Other machines in the area

Tools that PDM can use to determine source:

Impact testing
Phase relationship vibration data
Vibration/spectrum analysis on adjacent components

When a resonant frequency is causing elevated vibration the possible solutions in order of preference are:

1. Change running speed of the equipment
2. Stiffen the structure to drive the natural frequency upward
3. Dampen the component to drive the natural frequency lower

Since changing the running speed is very unlikely, the best solution might be to stiffen the structure. A DCN to change the structure on the RHR pumps might be solution in the end, but only after proven by diagnostics.

Impact data obtained on both 1B and 2A confirmed that the top part of the motor has a resonant frequency from 10 to 14 Hz. This resonant condition is not causing any motor or pump bearing degradation at this time.

References:

SQ960029PER
NSID-TB-86-02 Westinghouse Technical Bulletin
Logical Problem Solving, Art Crawford

Predictive Maintenance Condition Report for 1B RHR PUMP/MOTOR Impact Testing

1/25/99

SUMMARY

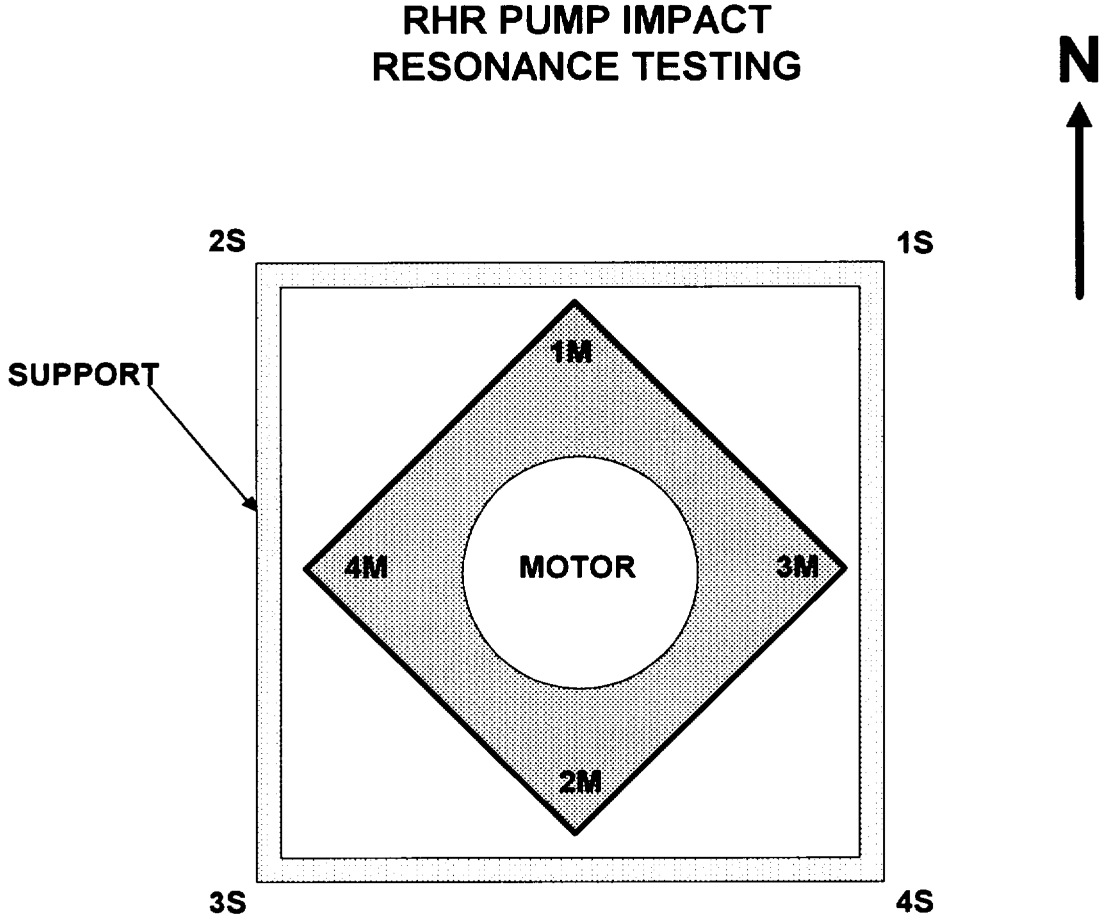
Impact testing was performed on the 1B RHR motor and frame by the Predictive Maintenance personnel. The testing revealed a 11HZ natural frequency on the RHR motor. The motor support and frame natural frequency is between 175Hz and 331Hz based on location on the frame. This confirms previous evaluation that a resonant condition exists at 11Hz.

The pump operation flow characteristics create low frequency flow noise which tends to excite the structural frequencies of the machine assembly. Thus, the dominant vibration frequency when running is 11Hz. To improve the vibration would require separating the 11Hz natural frequency away from operating flow noise and the normal operating frequency of 29.8Hz. Driving the natural frequency up beyond 30Hz (greater than 15% of operating frequency as rule of thumb) can be difficult unless performed with detailed analysis. It could make performance worse at higher flow rates where the system operates for normal plant evolutions and accidents.

Setup Criteria for taking Data:

- ALL DATA WAS TAKEN WITH THE ACCELEROMETER IN THE HORIZONTIAL DIRECTION
- FMAX WAS SET AT 500 Hz USING 3200 LINES OF RESOLUTION
- ADDITIONAL DATA WAS TAKEN WITH FMAX EQUAL TO 5000 Hz. PRIMARY VIBRATION SIGNATURE " FLAT-LINES " AT ~ 600 Hz
- ALL ATTEMPTS WERE MADE TO IMPACT AT THE SAME ENERGY

RHR PUMP IMPACT RESONANCE TESTING



PLAN VIEW

POINT LEGEND

1M - MOTOR NORTH
2M - MOTOR SOUTH
3M - MOTOR EAST
4M - MOTOR WEST

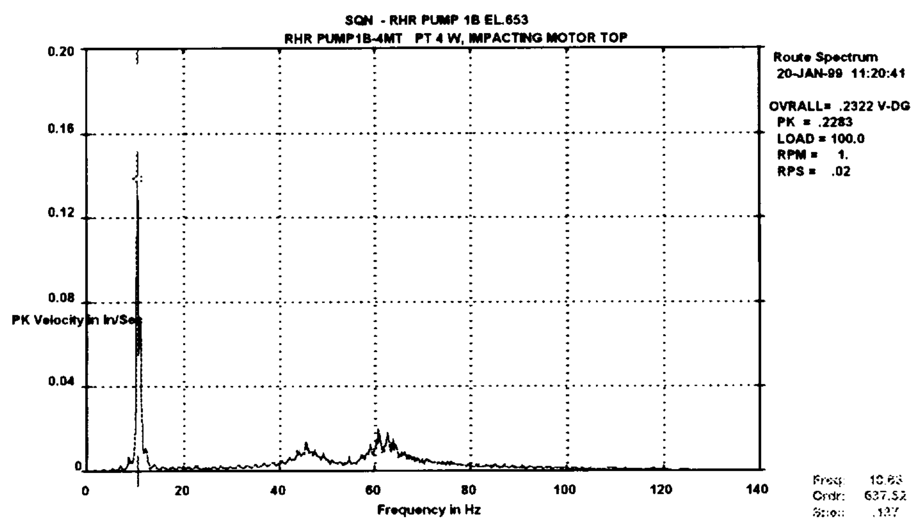
1S - NE SUPPORT LEG
2S - NW SUPPORT LEG
3S - SW SUPPORT LEG
4S - SE SUPPORT LEG

T - TOP
M - MIDDLE
B - BOTTOM

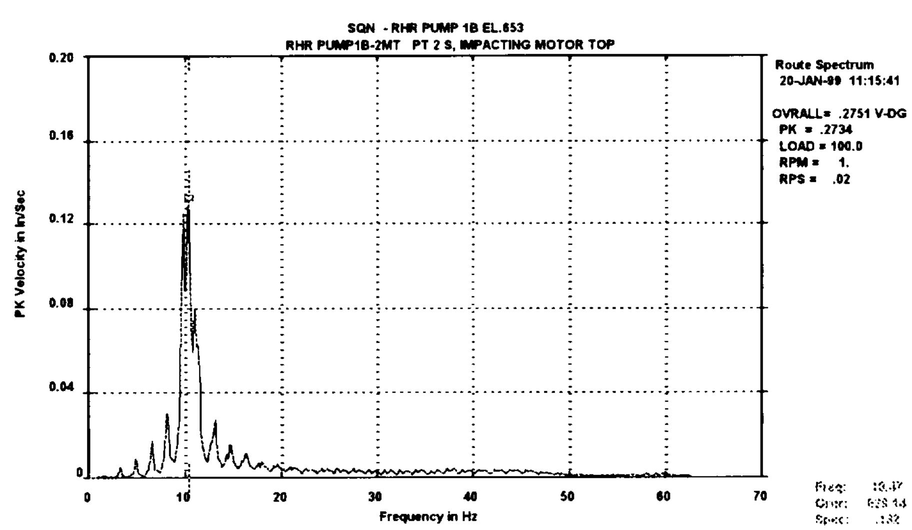
EXAMPLE:
1MT = NORTH SIDE, TOP OF MOTOR

RHR PUMP-1B IMPACT TESTING

MOTOR TOP IN SOUTH DIRECTION

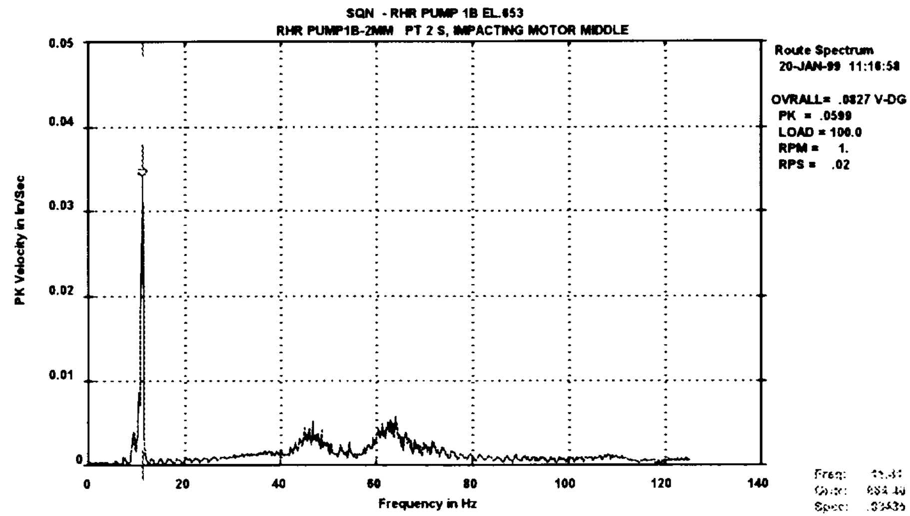


MOTOR TOP IN WEST DIRECTION

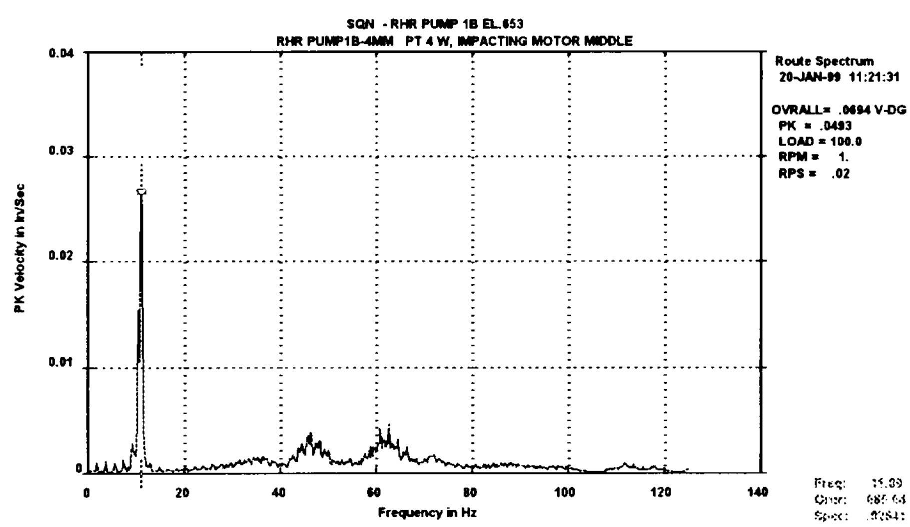


RHR PUMP -1B IMPACT TESTING

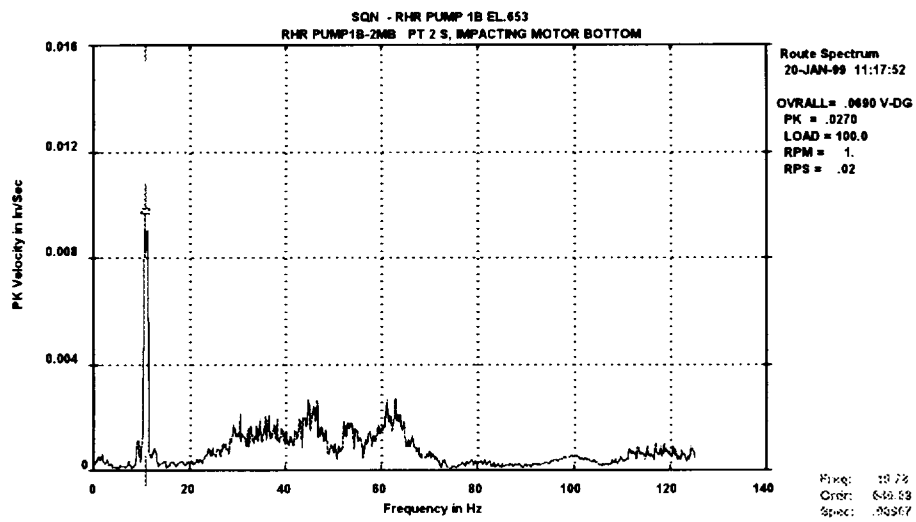
MID SECTION OF MOTOR IN WEST DIRECTION



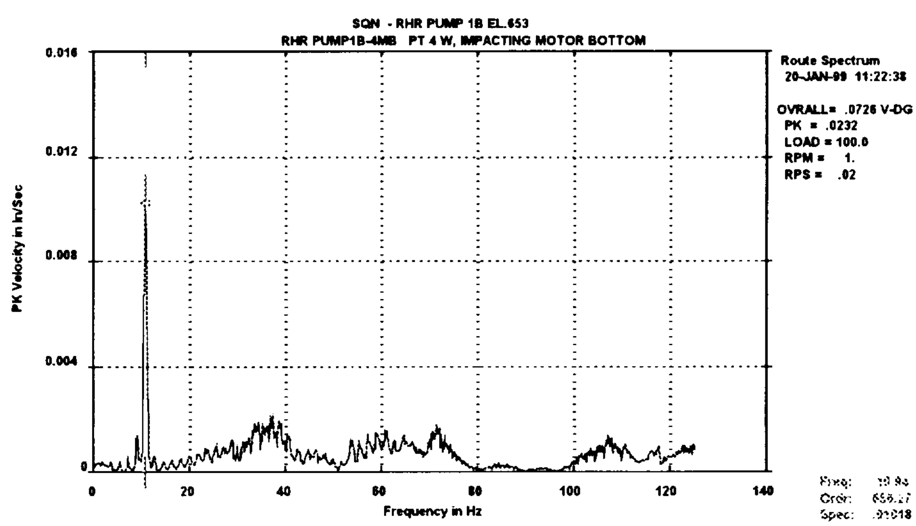
MID SECTION OF MOTOR IN SOUTH DIRECTION



BOTTOM AREA OF MOTOR IN SOUTH DIRECTION

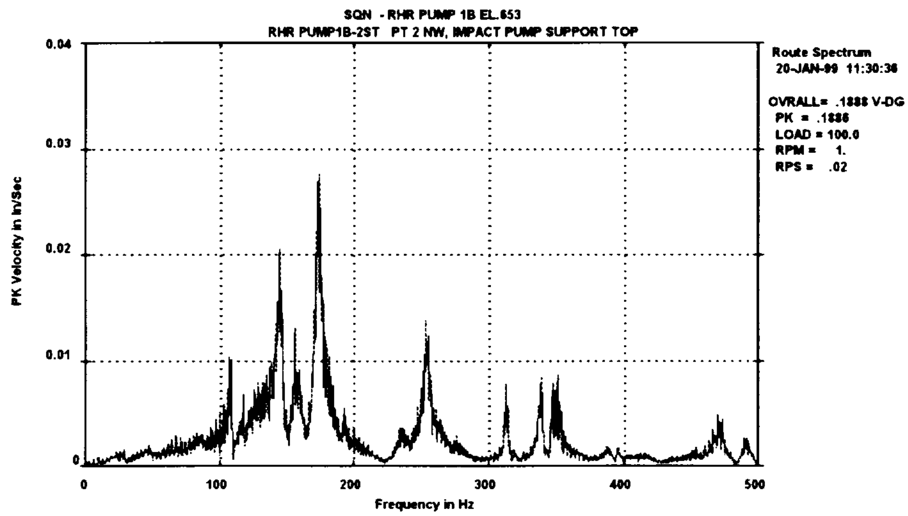


BOTTOM AREA OF MOTOR IN WEST DIRECTION

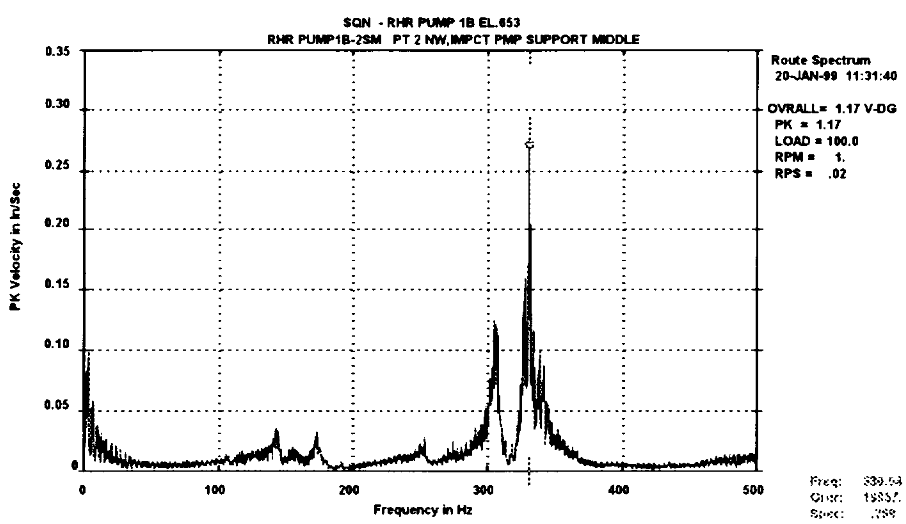


RHR PUMP -1B IMPACT TESTING

TOP OF PUMP SUPPORTING STRUCTURE
ON THE NW LEG

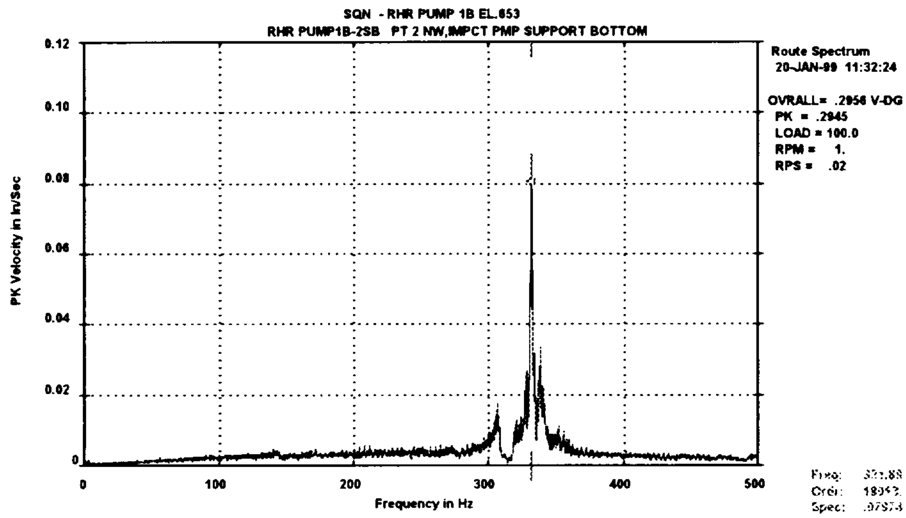


MID AREA OF PUMP SUPPORTING STRUCTURE
ON NW LEG



RHR PUMP -1B IMPACT TESTING

BOTTOM OF PUMP SUPPORTING STRUCTURE ON NW LEG



Predictive Maintenance Condition Report for 2A RHR PUMP/MOTOR Impact Testing

SUMMARY

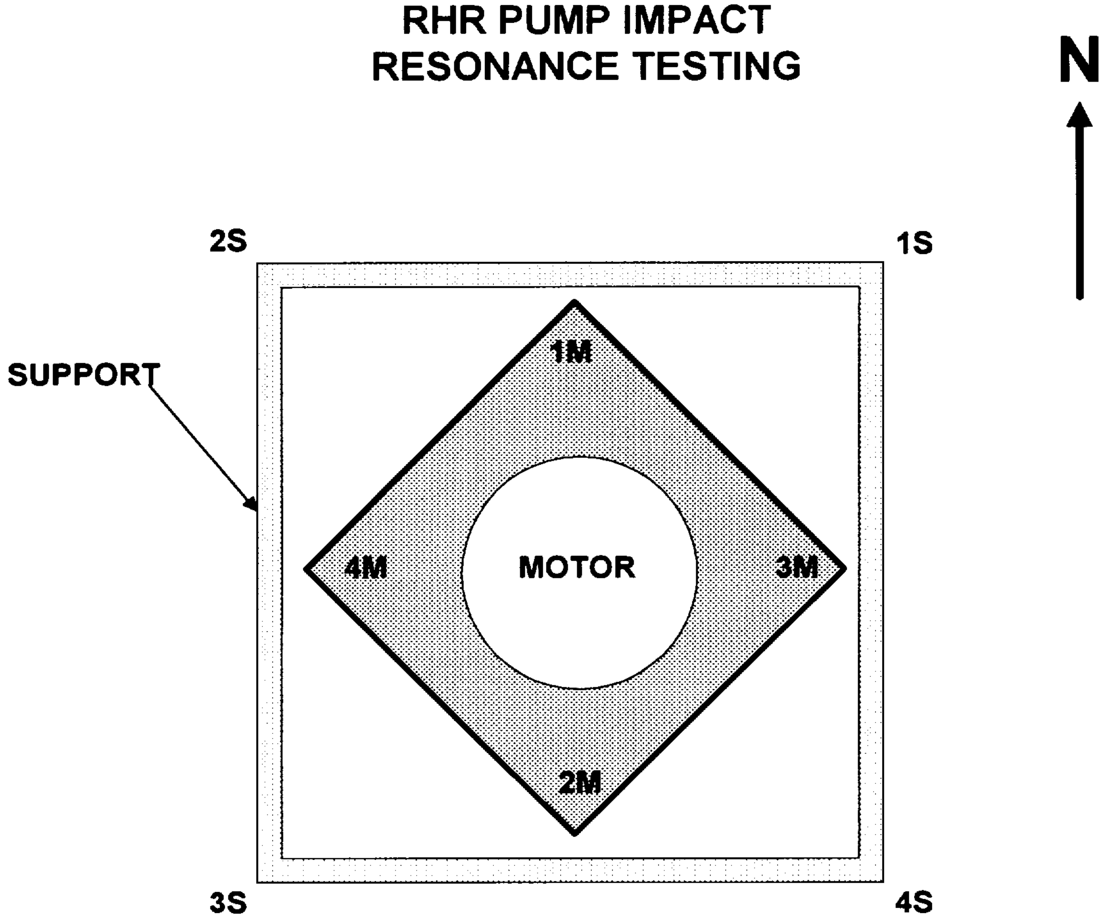
Impact testing was performed on the 2A RHR motor and frame by the Predictive Maintenance personnel. The testing revealed a 10HZ natural frequency on the RHR motor. The motor support and frame natural frequency is between 287Hz and 356Hz based on location on the frame. This confirms previous evaluation that a resonant condition exists at 10Hz.

The pump operation flow characteristics create low frequency flow noise which tends to excite the structural frequencies of the machine assembly. Thus, the dominant vibration frequency when running is 10Hz. To improve the vibration would require separating the 10Hz natural frequency away from operating flow noise and the normal operating frequency of 29.8Hz. Driving the natural frequency up beyond 30Hz (greater than 15% of operating frequency as rule of thumb) can be difficult unless performed with detailed analysis. It could make performance worse at higher flow rates where the system operates for normal plant evolutions and accidents.

Setup Criteria for taking Data:

- ALL DATA WAS TAKEN WITH THE ACCELEROMETER IN THE HORIZONTIAL DIRECTION
- FMAX WAS SET AT 500 Hz USING 3200 LINES OF RESOLUTION
- ADDITIONAL DATA WAS TAKEN WITH FMAX EQUAL TO 5000 Hz. PRIMARY VIBRATION SIGNATURE " FLAT-LINES " AT ~ 600 Hz
- ALL ATTEMPTS WERE MADE TO IMPACT AT THE SAME ENERGY

RHR PUMP IMPACT RESONANCE TESTING



PLAN VIEW

POINT LEGEND

1M - MOTOR NORTH
2M - MOTOR SOUTH
3M - MOTOR EAST
4M - MOTOR WEST

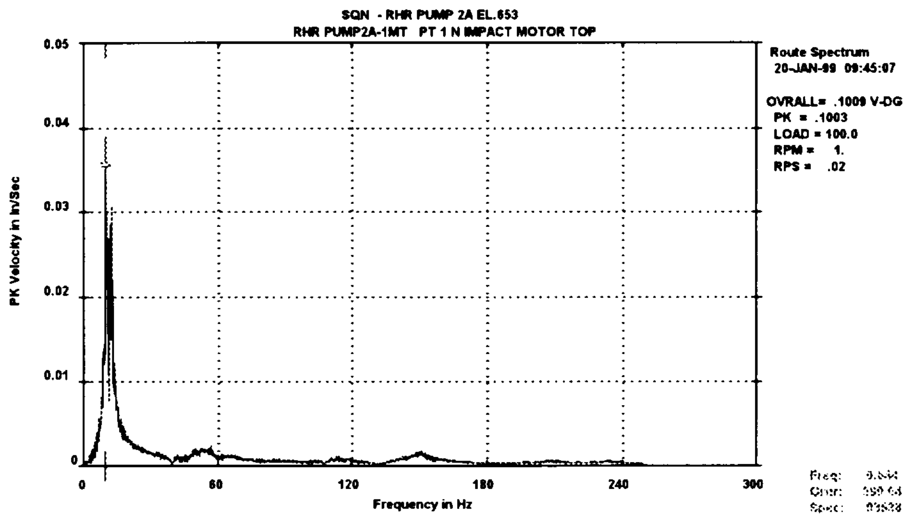
1S - NE SUPPORT LEG
2S - NW SUPPORT LEG
3S - SW SUPPORT LEG
4S - SE SUPPORT LEG

T - TOP
M - MIDDLE
B - BOTTOM

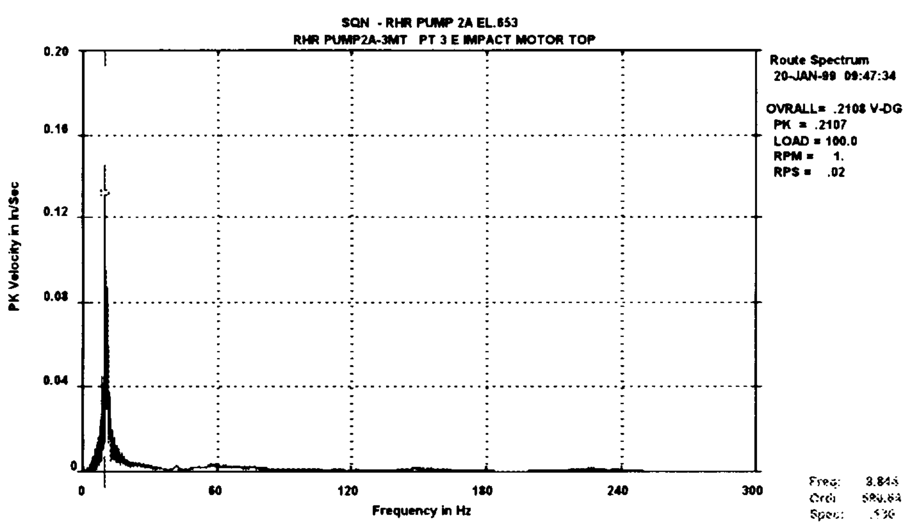
EXAMPLE:
1MT = NORTH SIDE, TOP OF MOTOR

RHR PUMP 2A IMPACT TESTING

MOTOR TOP IN NORTH DIRECTION

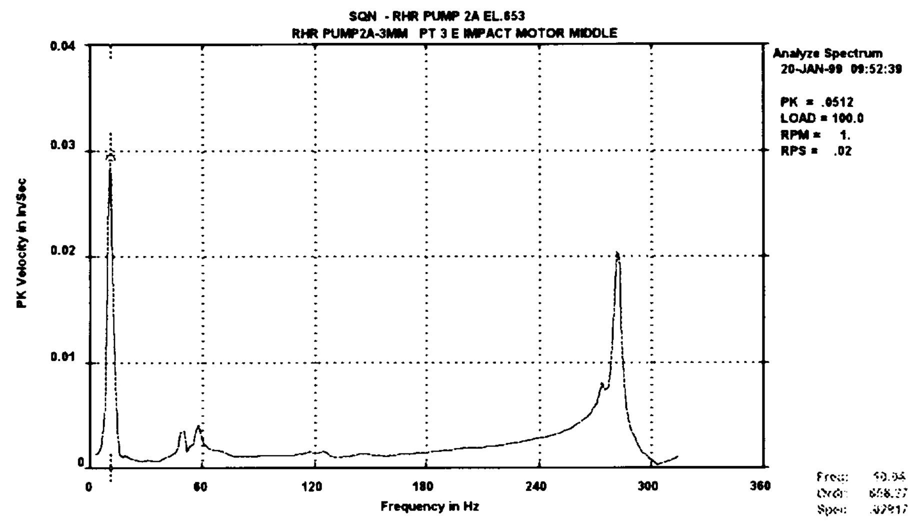


MOTOR TOP IN EAST DIRECTION

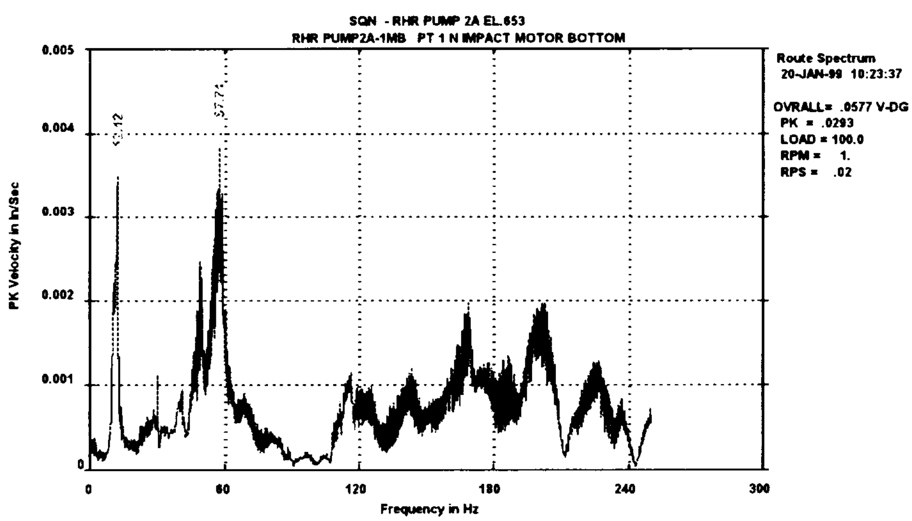


RHR PUMP 2A IMPACT TESTING

MID SECTION OF MOTOR IN EAST DIRECTION

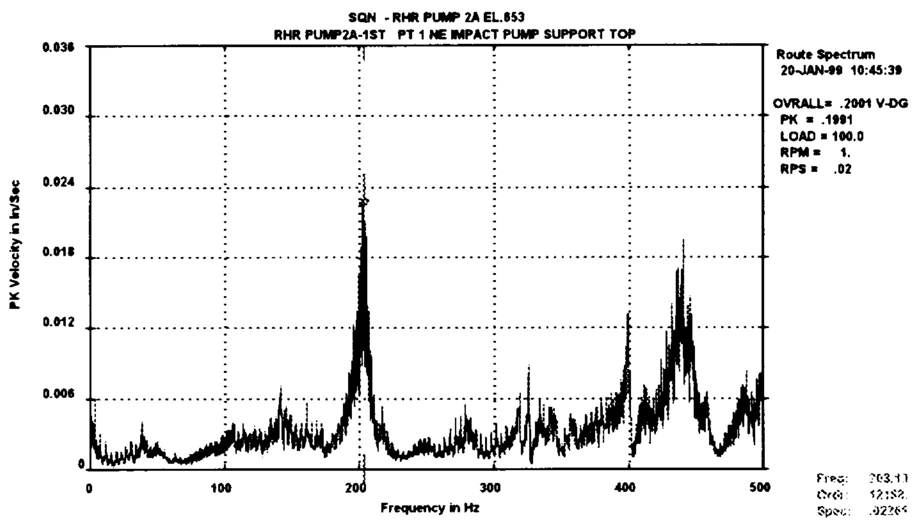


BOTTOM AREA OF MOTOR IN NORTH DIRECTION

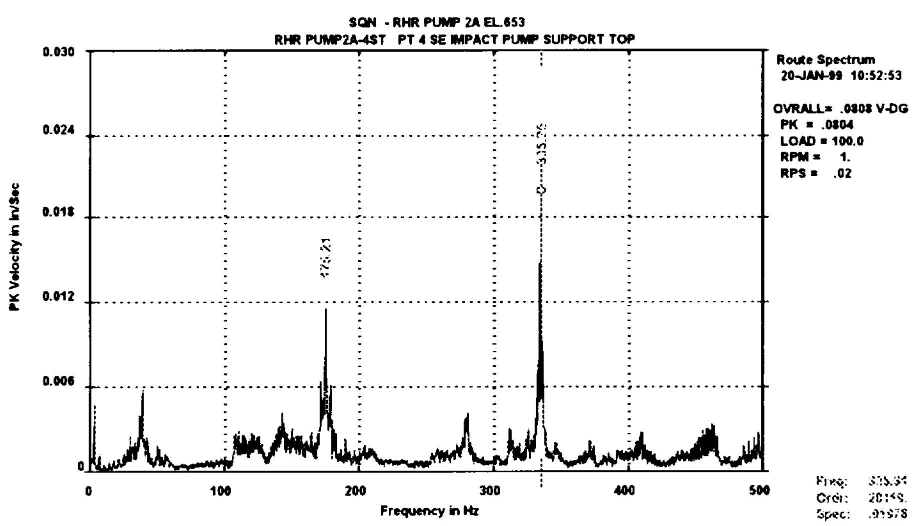


RHR PUMP 2A IMPACT TESTING

TOP OF PUMP SUPPORTING STRUCTURE ON THE NE LEG

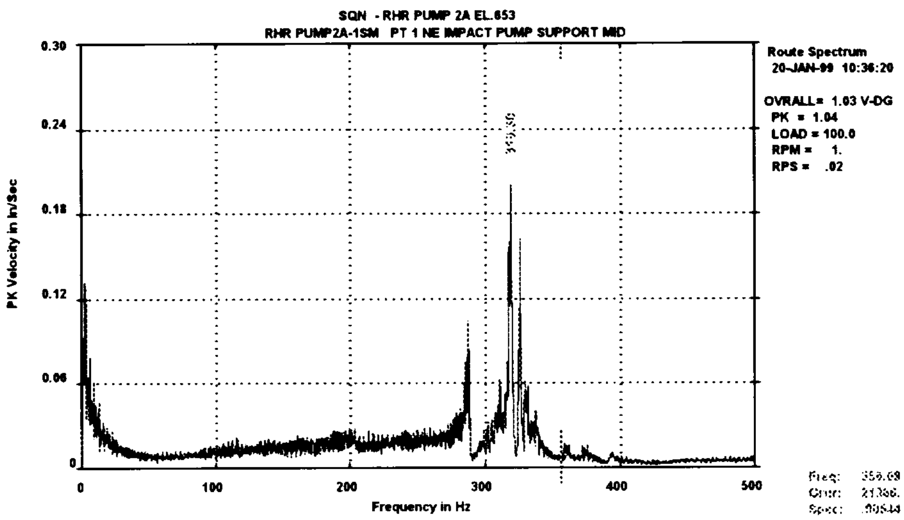


TOP OF PUMP SUPPORTING STRUCTURE ON THE SE LEG

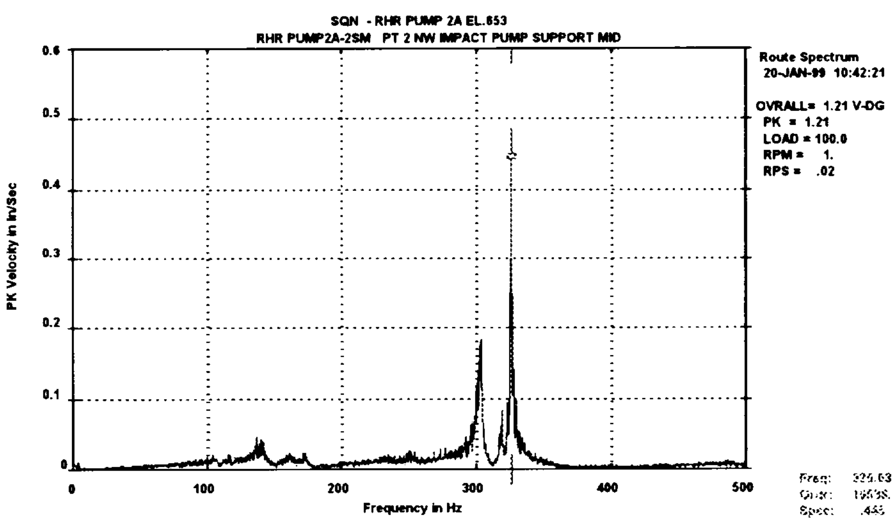


RHR PUMP 2A IMPACT TESTING

MID AREA OF PUMP SUPPORTING STRUCTURE ON NE LEG

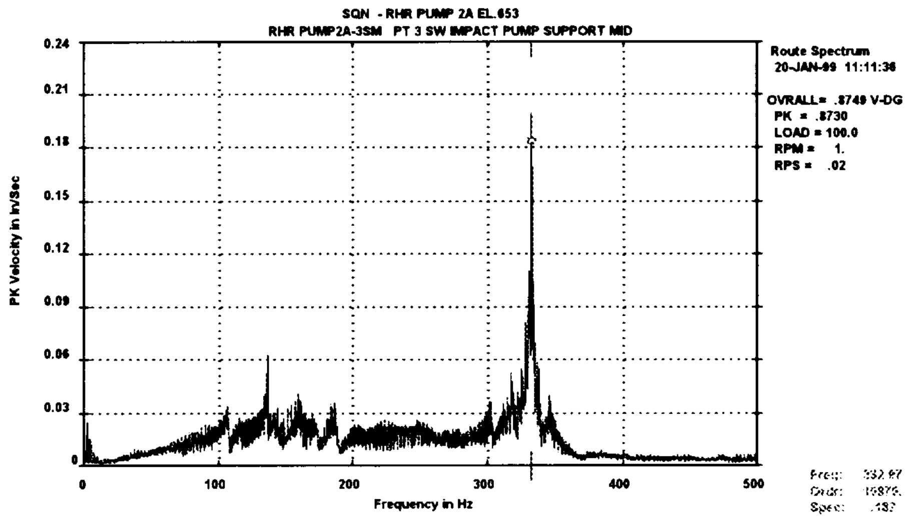


MID AREA OF PUMP SUPPORTING STRUCTURE ON NW LEG

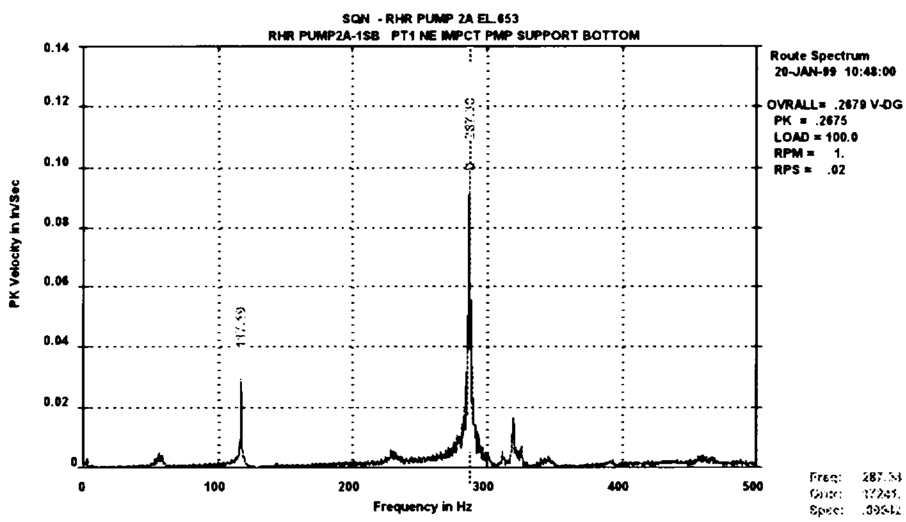


RHR PUMP 2A IMPACT TESTING

MID AREA OF PUMP SUPPORTING STRUCTURE ON SW LEG

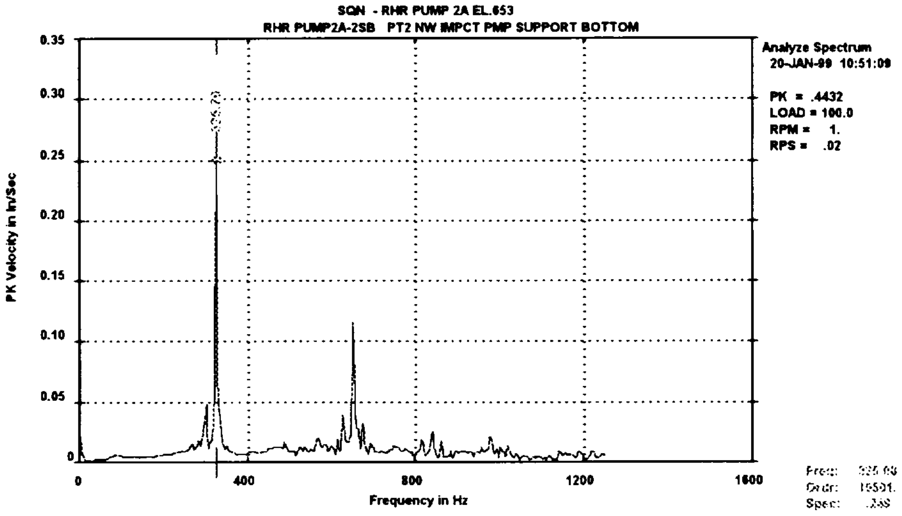


BOTTOM OF PUMP SUPPORTING STRUCTURE ON NE LEG

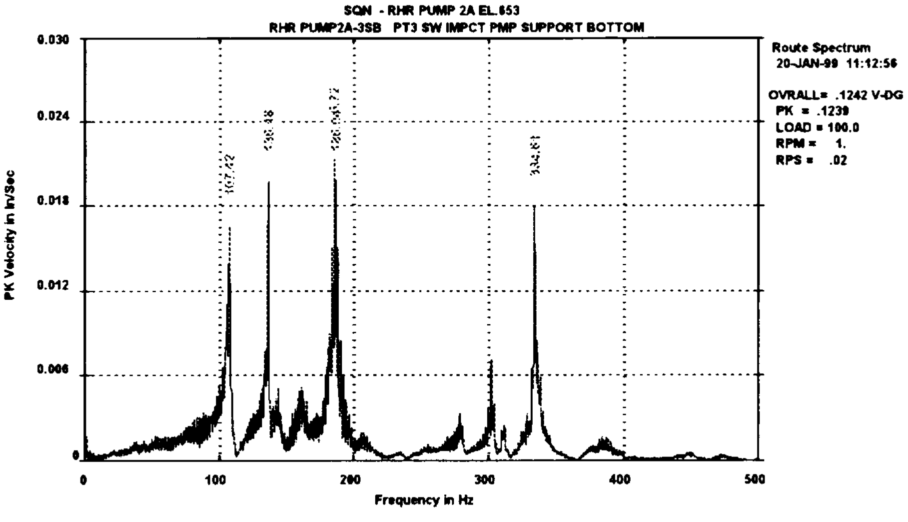


RHR PUMP 2A IMPACT TESTING

BOTTOM OF PUMP SUPPORTING STRUCTURE ON NW LEG

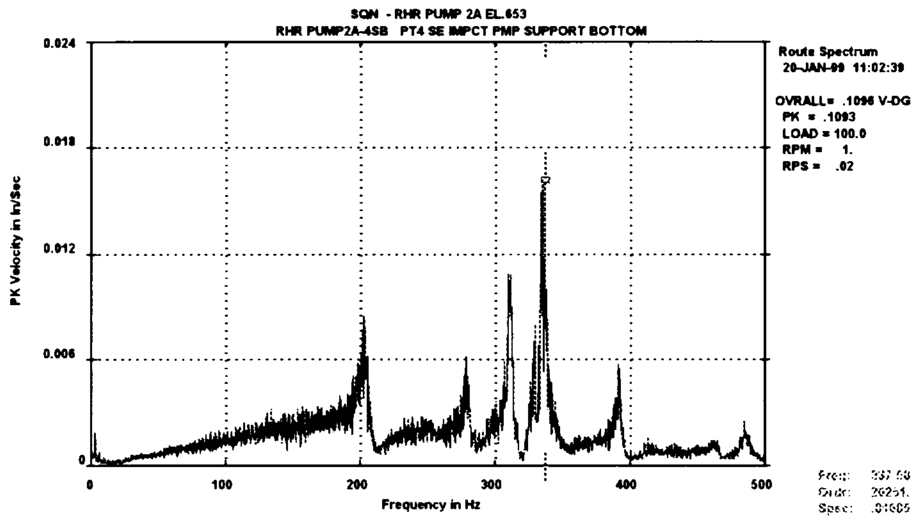


BOTTOM OF PUMP SUPPORTING STRUCTURE ON SW LEG



RHR PUMP 2A IMPACT TESTING

BOTTOM OF PUMP SUPPORTING STRUCTURE ON SE LEG



Predictive Maintenance Condition Report for 2B RHR PUMP/MOTOR Impact Testing

7/7/99

SUMMARY

Impact testing was performed on the 2B RHR motor and frame by Predictive Maintenance personnel. The testing revealed a 11 to 13 Hz response frequency on the RHR motor. The motor support and frame frequency response is between 100 and 350 Hz based on location on the frame.

The pump operation flow characteristics create low frequency flow noise which tends to excite the structural frequencies of the machine assembly. Spectra analysis of vibration data collected during pump testing activities indicates a dominant peak at 11 Hz occurring at low amplitudes. To improve the vibration would require separating the 11 Hz frequency away from operating flow noise and the normal operating frequency of 29.8Hz. Driving the natural frequency up beyond 30 Hz (greater than 15% of operating frequency as rule of thumb) can be difficult unless performed with detailed analysis.

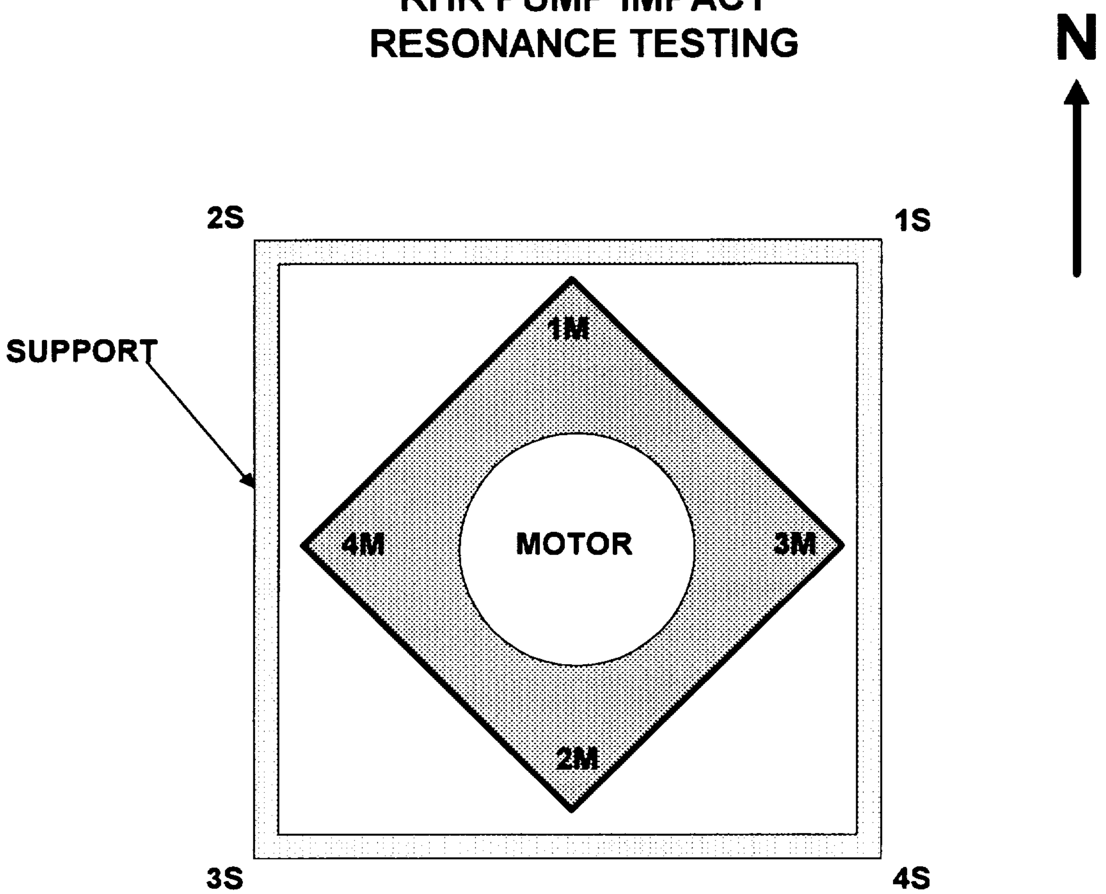
The overall vibration levels on 2B RHR pump are stable and below alert range. However, the vibration occurring at the 11 Hz frequency is contributing to the overall levels.

Future repairs would be best attempted after modal/ODS vibration analysis have been completed to specifically identify locations for stiffness, mass, or dampening. This can be performed in-house with the purchase of additional equipment or contract the work to CSI in Knoxville.

Setup Criteria for taking Data:

- ALL DATA WAS TAKEN WITH THE ACCELEROMETER IN THE HORIZONTIAL DIRECTION
- FMAX WAS SET AT 500 Hz USING 3200 LINES OF RESOLUTION AND 6 AVERAGES
- ADDITIONAL DATA WAS TAKEN WITH FMAX EQUAL TO 5000 Hz. PRIMARY VIBRATION SIGNATURE " FLAT-LINES " AT ~ 600 Hz
- ALL ATTEMPTS WERE MADE TO IMPACT AT THE SAME ENERGY

RHR PUMP IMPACT
RESONANCE TESTING



PLAN VIEW

POINT LEGEND

1M - MOTOR NORTH
2M - MOTOR SOUTH
3M - MOTOR EAST
4M - MOTOR WEST

1S - NE SUPPORT LEG
2S - NW SUPPORT LEG
3S - SW SUPPORT LEG
4S - SE SUPPORT LEG

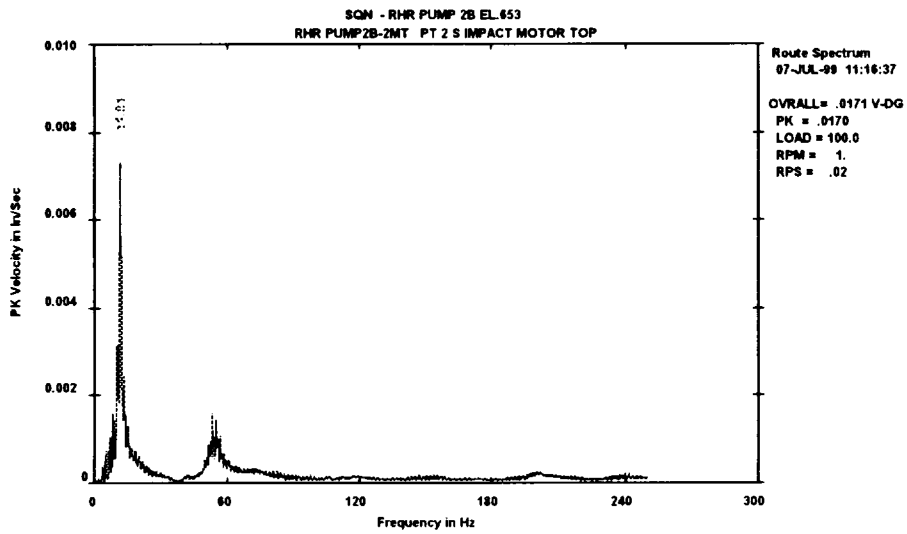
T - TOP
M - MIDDLE
B - BOTTOM

EXAMPLE:
1MT = NORTH SIDE, TOP OF MOTOR

RHR PUMP 2B IMPACT TESTING

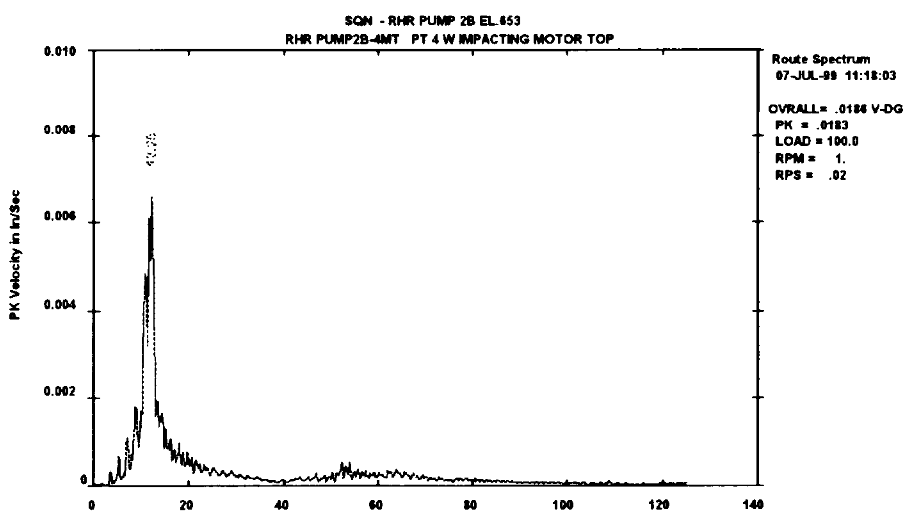
MOTOR TOP IN NORTH/SOUTH DIRECTION

The dominant peak is at 11.88 Hz



MOTOR TOP IN EAST/WEST DIRECTION

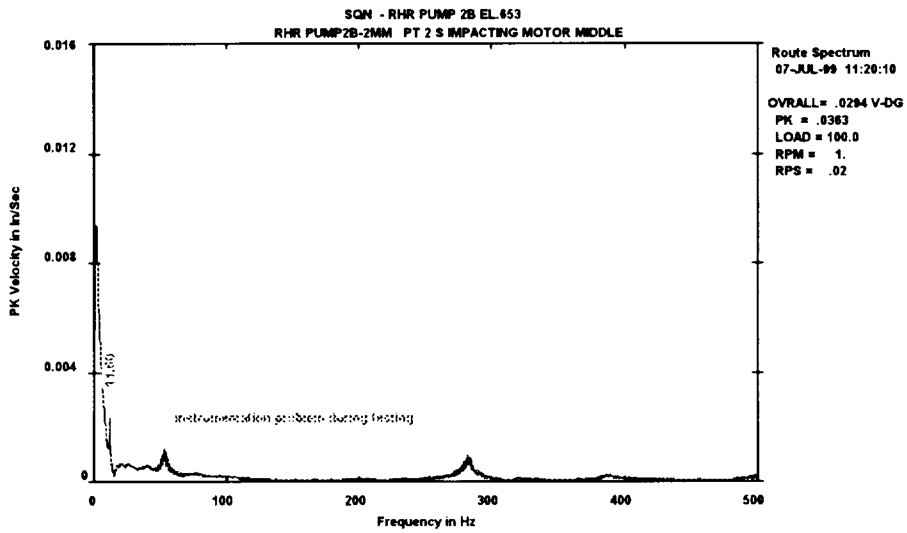
The dominant peak is at 12.19 Hz



RHR PUMP 2B IMPACT TESTING

MID SECTION OF MOTOR IN NORTH/SOUTH DIRECTION

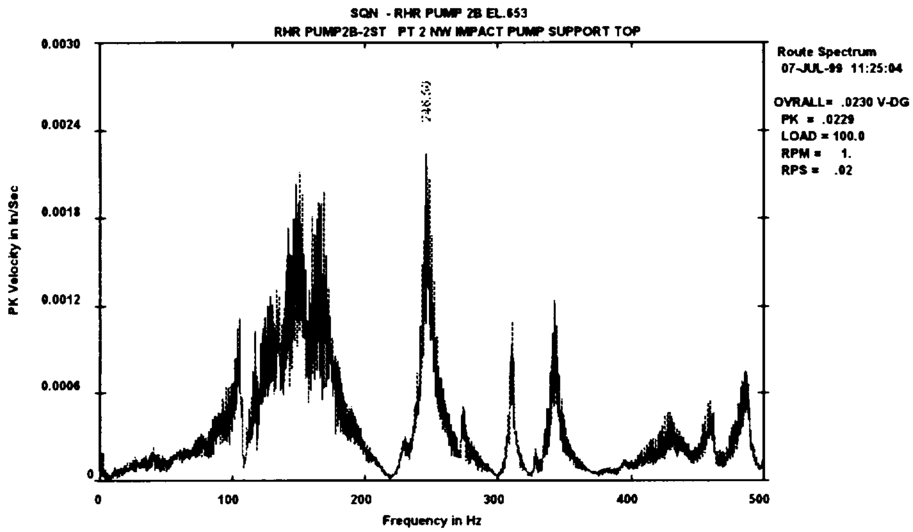
The dominant peak is at 11.56 Hz



RHR PUMP 2B IMPACT TESTING

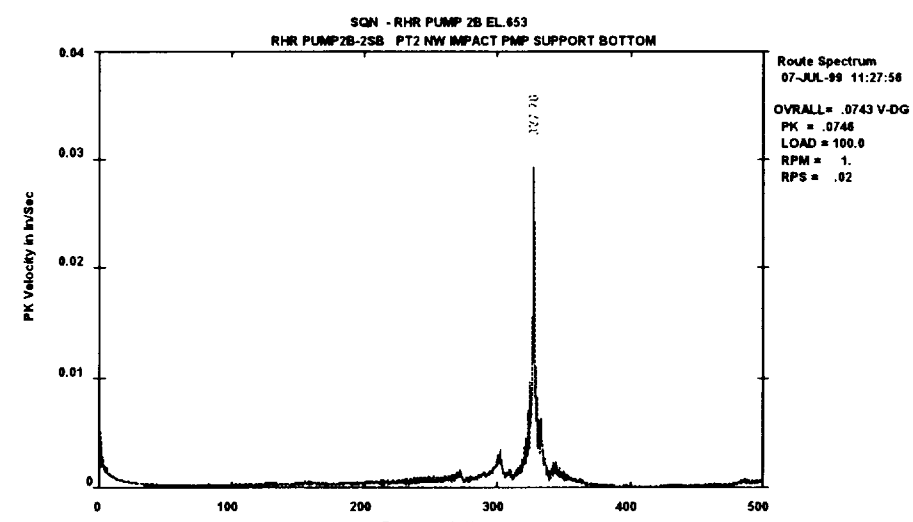
TOP OF PUMP SUPPORTING STRUCTURE
ON THE NE LEG

The frequency response on the supporting frame is well above the frequency response from the motor



BASE OF PUMP SUPPORTING STRUCTURE
ON NW LEG

The frequency response on the supporting frame is well above the frequency response from the motor



Predictive Maintenance Condition Report for 1A RHR PUMP/MOTOR Impact Testing

7/7/99

SUMMARY

Impact testing was performed on the 1A RHR motor and frame by Predictive Maintenance personnel. The testing revealed a 14 to 16 Hz response frequency on the RHR motor. The motor support frame frequency response is between 120 and 350 Hz based on location on the frame.

The pump operation flow characteristics during pump performance testing create low frequency flow noise which tends to excite the structural frequencies of the machine assembly. Spectra analysis of vibration data collected during pump testing activities indicates a dominant peak at 14 Hz occurring at low amplitudes. To improve the vibration would require separating the 14 Hz frequency away from operating flow noise and the normal operating frequency of 29.8Hz. Driving the natural frequency up beyond 30 Hz (greater than 15% of operating frequency as rule of thumb) would require detailed analysis for installation of upper motor supports.

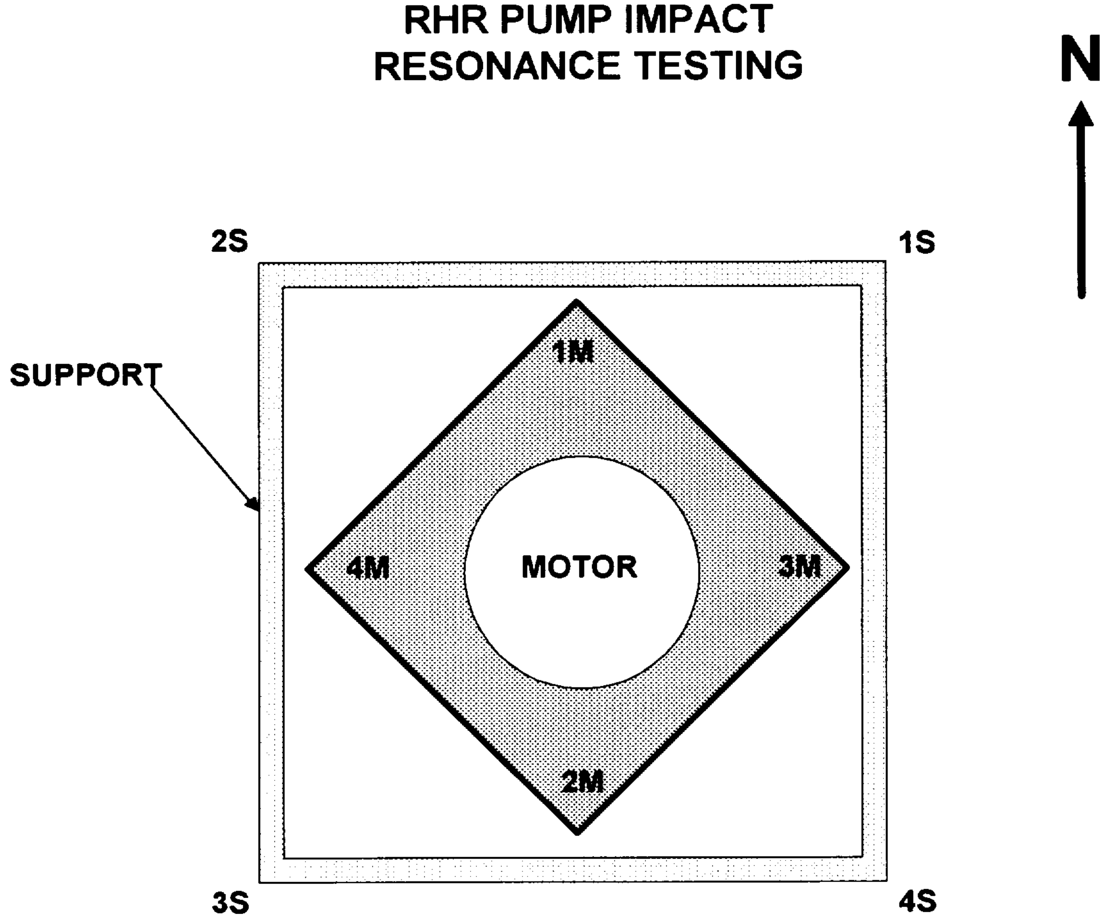
The overall vibration levels on 1A RHR pump are stable and below alert range. However, the vibration occurring at the 14 Hz frequency is contributing to the overall levels.

Future repairs would be best attempted after modal/ODS vibration analysis have been completed to specifically identify locations for stiffness, mass, or dampening. This can be performed in-house with the purchase of additional equipment or contract the work to CSI in Knoxville.

Setup Criteria for taking Data:

- ALL DATA WAS TAKEN WITH THE ACCELEROMETER IN THE HORIZONTIAL DIRECTION
- FMAX WAS SET AT 500 Hz USING 3200 LINES OF RESOLUTION AND 6 AVERAGES
- ADDITIONAL DATA WAS TAKEN WITH FMAX EQUAL TO 5000 Hz. PRIMARY VIBRATION SIGNATURE " FLAT-LINES " AT ~ 600 Hz
- ALL ATTEMPTS WERE MADE TO IMPACT AT THE SAME ENERGY

RHR PUMP IMPACT RESONANCE TESTING



PLAN VIEW

POINT LEGEND

1M - MOTOR NORTH
2M - MOTOR SOUTH
3M - MOTOR EAST
4M - MOTOR WEST

1S - NE SUPPORT LEG
2S - NW SUPPORT LEG
3S - SW SUPPORT LEG
4S - SE SUPPORT LEG

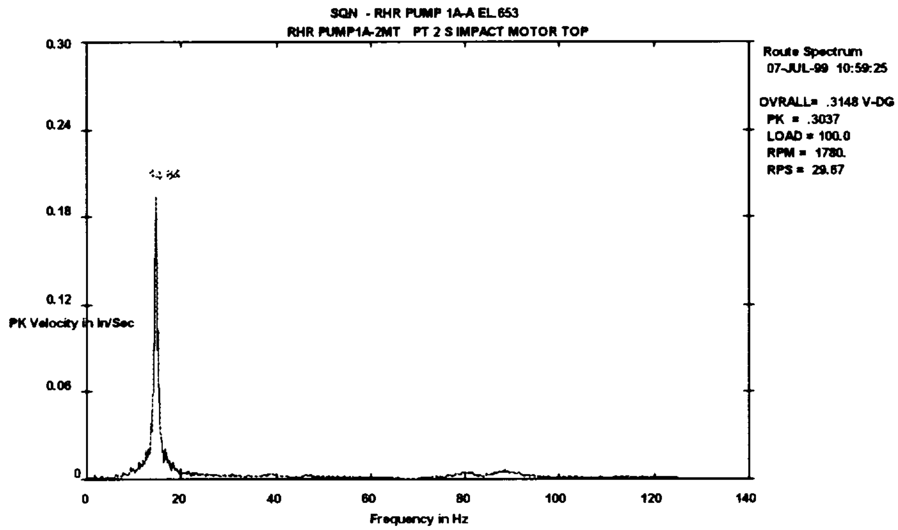
T - TOP
M - MIDDLE
B - BOTTOM

EXAMPLE:
1MT = NORTH SIDE, TOP OF MOTOR

RHR PUMP 1A IMPACT TESTING

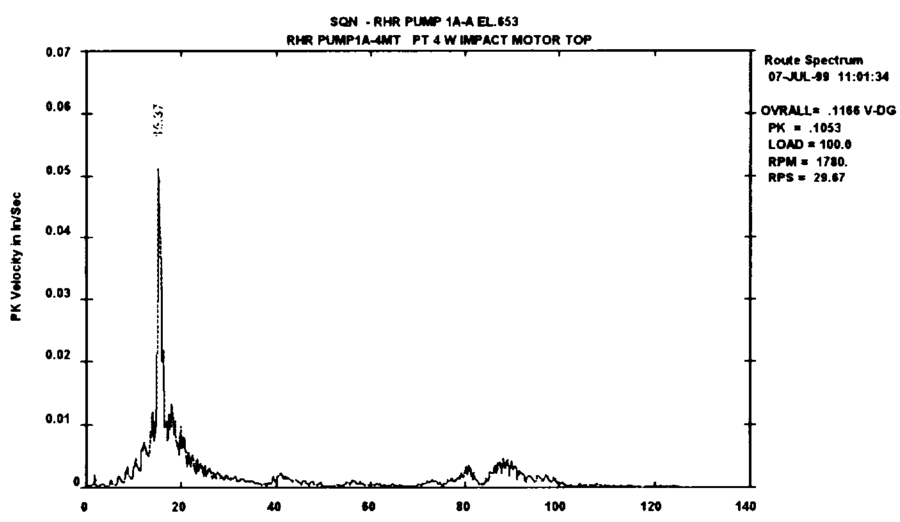
MOTOR TOP IN NORTH/SOUTH DIRECTION

The dominant peak is at 14.69 Hz



MOTOR TOP IN EAST/WEST DIRECTION

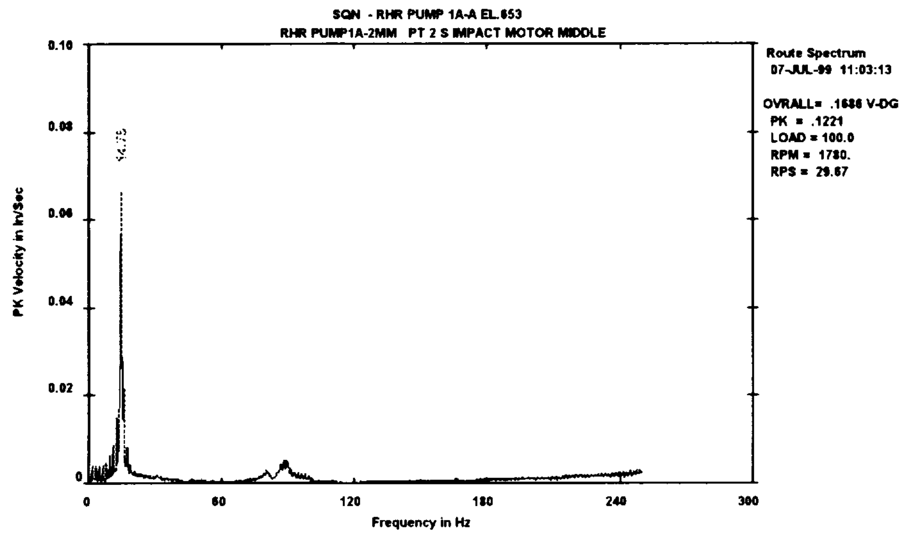
The dominant peak is at 15.31 Hz



RHR PUMP 1A IMPACT TESTING

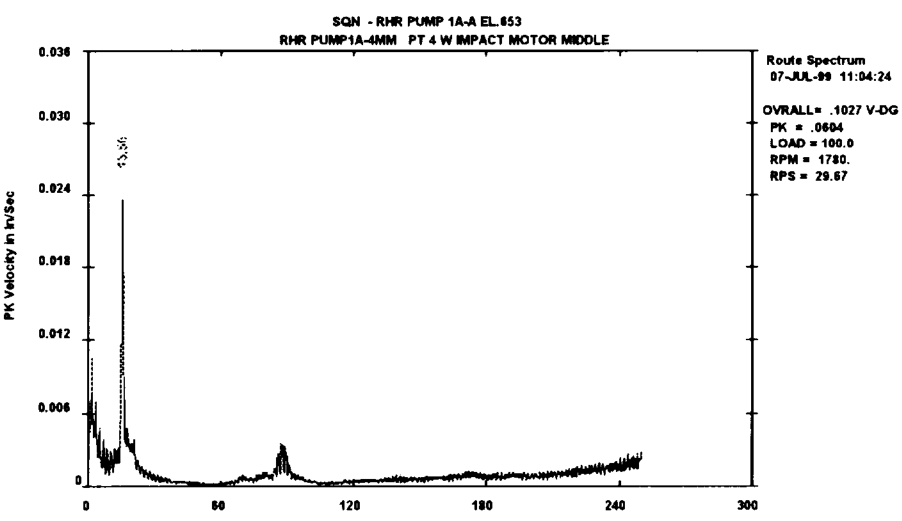
MID SECTION OF MOTOR IN NORTH/SOUTH DIRECTION

The dominant peak is at 14.69 Hz



MID SECTION OF MOTOR IN EAST/WEST DIRECTION

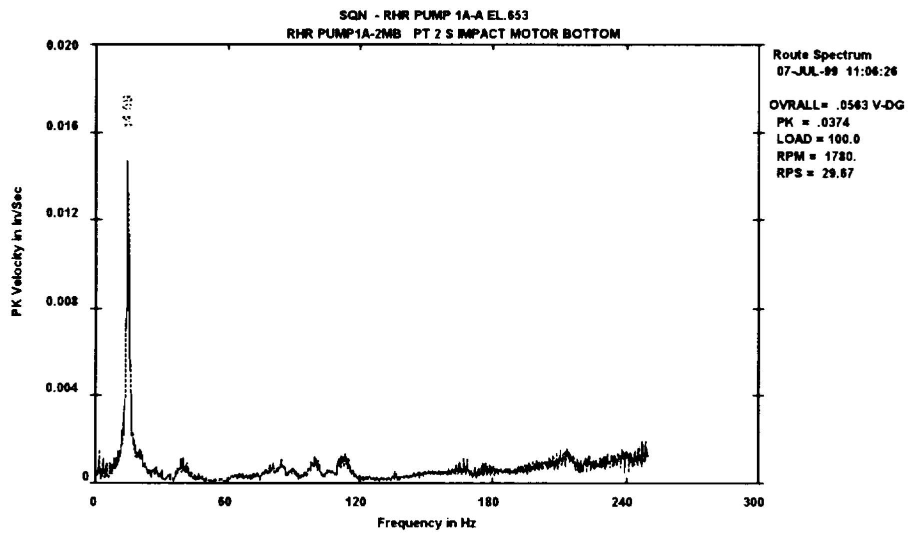
The dominant peak is at 15.63 Hz



RHR PUMP 1A IMPACT TESTING

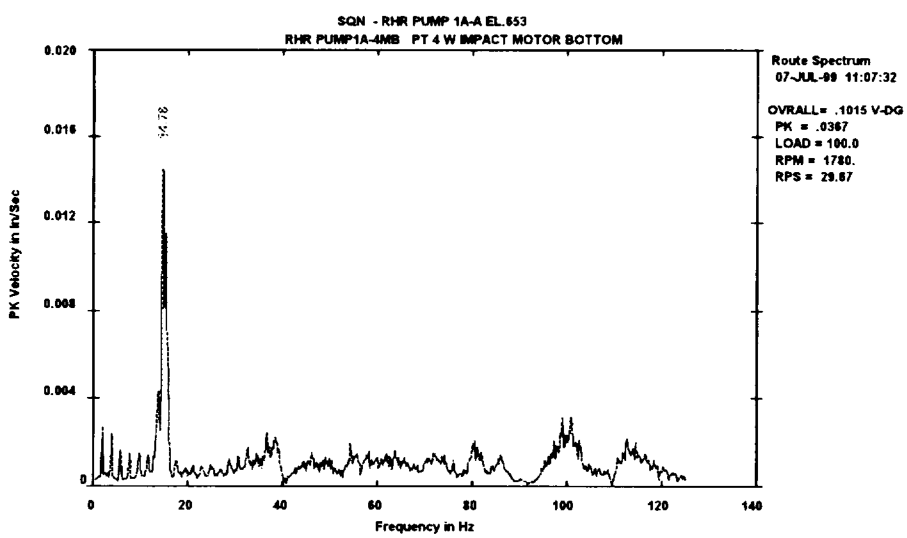
BOTTOM SECTION OF MOTOR IN NORTH/SOUTH DIRECTION

The dominant peak is at 14.53 Hz



BOTTOM SECTION OF MOTOR IN EAST/WEST DIRECTION

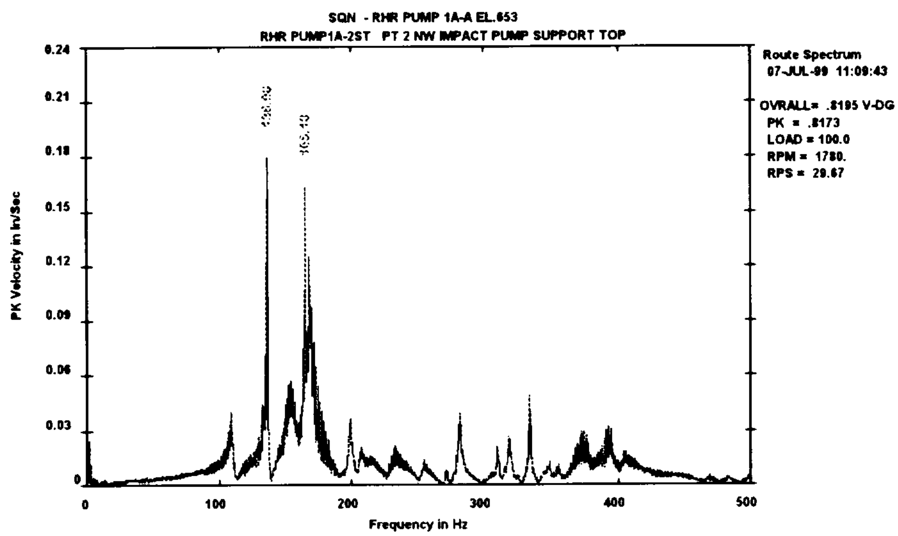
The dominant peak is at 14.84 Hz



RHR PUMP 1A IMPACT TESTING

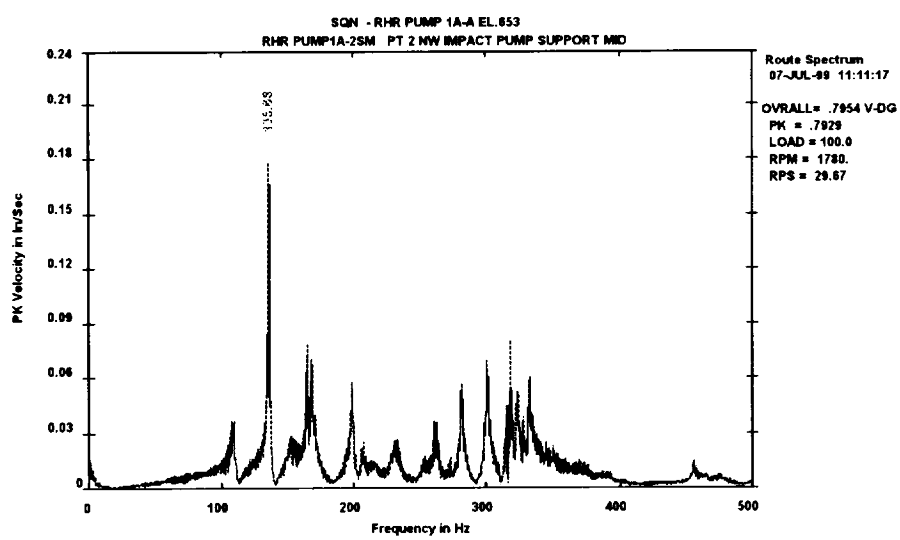
TOP OF PUMP SUPPORTING STRUCTURE
ON THE NE LEG

The frequency response on the supporting frame is well above the frequency response from the motor



MID AREA OF PUMP SUPPORTING STRUCTURE
ON NE LEG

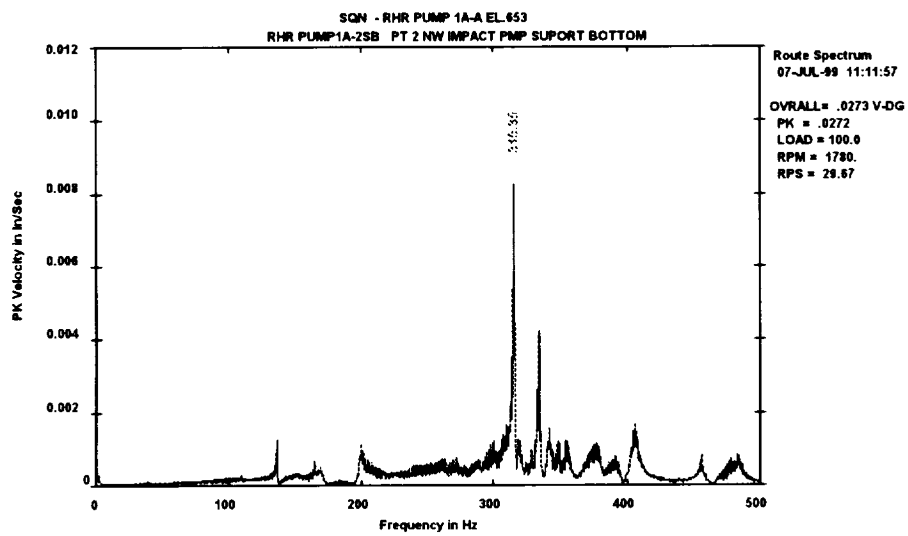
The frequency response on the supporting frame is well above the frequency response from the motor



RHR PUMP 1A IMPACT TESTING

The frequency response on the supporting frame is well above the frequency response from the motor

BASE OF PUMP SUPPORTING STRUCTURE ON NW LEG



LICENSING TRANSMITTAL TO NRC
SUMMARY AND CONCURRENCE SHEET

THE PURPOSE OF THIS CONCURRENCE SHEET IS TO ASSURE THE ACCURACY AND COMPLETENESS OF TVA SUBMITTALS TO THE NRC.

DATE May 31, 2000 DATE DUE NRC ASAP

SUBMITTAL PREPARED BY D. V. Goodin

SUBJECT: Revised Request for Approval of Relief from American Society of Mechanical Engineers (ASME) Code Requirements - Request for Relief RP-08 - Residual Heat Removal Pump Vibration Measurement

PURPOSE/SUMMARY Propose alternative testing for SQN's RHR pumps to measure vibration in the frequency from one-half rotational speed to 1000 hertz.

RESPONDS TO ______ (RIMS NO.)

NEW COMMITMENTS ____ YES ____ NO

INDEPENDENT REVIEW ______ DATE: ______

LICENSING BASIS CHANGE - If this submittal requires a change to the licensing basis, a change has been initiated in accordance with NADP-7. N/A DATE ______

A concurrence signature reflects that the signatory has assured that the submittal is appropriate and consistent with TVA Policy, applicable commitments are approved for implementation and supporting documentation for submittal completeness and accuracy has been prepared.

CONCURRENCE (3)

NAME	ORGANIZATION	SIGNATURE	DATE
Joe Valente	SQN Engr and Supp Svs Mgr		
D. L. Lundy	SQN Eng Mgr		
P. D. Osborne	SQN Civil Eng (page 9)		
G. N. Buchanan	SQN Comp Eng Mgr		
D. L Koehl	SQN Plant Mgr		
J. D. Smith	SQN Licensing Mgr		
D. V. Goodin	SQN Lic Prj Mgr		

I:License/ASME/RP-08 R1

DVG:DJS