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50.55a(a)(3)(ii)

NLS2003059
September 19, 2003

U.S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555-0001

Subject: Inservice Testing Program Relief Request RP-06, Revision 1
Cooper Nuclear Station, NRC Docket 50-298, DPR-46

References:

1. NRC letter to NPPD dated August 5, 2003, "Request for Additional Information Regarding the Request for Relief From the Requirements of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code Concerning Inservice Testing of Core Spray Pump CS-P-B as Required by ASME/ANSI OMA-1988, Part 6, Paragraphs 4.6.1.6 and 5.2.(d) (TAC No. MB6821)"

2. NPPD letter NLS2002111 to the NRC dated November 14, 2002, "Inservice Testing Program Relief Request RP-06, RP-07"

The purpose of this letter is to respond to a request for additional information (RAI) from the U.S. Nuclear Regulatory Commission (NRC) (Reference 1) regarding Cooper Nuclear Station (CNS) Inservice Testing (IST) Program Relief Request, RP-06. The response to the RAI is provided in Attachment 1.

RP-06 requests relief from certain IST code requirements for testing of Core Spray Pump B pursuant to 10 CFR 50.55a(a)(3)(ii) for CNS. The original relief request, RP-06, Revision 0, submitted by Reference 2, has been revised to reflect the information requested by the NRC. RP-06, Revision 1, supercedes RP-06, Revision 0, in its entirety, and is provided in Attachment 2. Supporting figures are provided in Attachment 3.

Nebraska Public Power District (NPPD) requests NRC approval of this relief request by December 16, 2003. NRC approval of this relief request will allow Core Spray Pump B to return

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to the normal testing interval. NPPD requests relief for the remainder of the Third Ten-year IST Program (March 2006).

Should you have any questions concerning this matter, please contact Paul V. Fleming at (402) 825-2774.

Sincerely,

Clay C. Warren
Vice President-Nuclear and
Chief Nuclear Officer

/rer
Attachments

cc: Regional Administrator w/ attachments
USNRC - Region IV

Senior Project Manager w/ attachments
USNRC - NRR Project Directorate IV-1

Senior Resident Inspector w/ attachments
USNRC

NPG Distribution w/o attachments

Records w/ attachments

Attachment 1

Responses to NRC Request for Additional Information
Relief Request RP-06

Cooper Nuclear Station
Docket No. 50-298
(TAC No. MB6281)

NRC Request

RP-06 requests relief from the requirements to obtain vibration measurements for Core Spray Pump CS-P-B from one-third minimum pump shaft rotational speed to at least 1000 Hz. Nebraska Public Power District (NPPD), the licensee, proposes that the vibration data be filtered, removing the measurement associated with the piping induced vibration occurring at less than 1/2 of the pump operating speed. Currently, the vibration measurements are taken from one-third of pump minimum rotational speed to 1000Hz. The proposed relief would allow exclusion of vibration data between 1/3 and 1/2 pump speed.

The licensee has provided the following statements for the relief request:

1. A similar relief request has been approved by the NRC for the Sequoyah Nuclear Plant (SNP) on October 5, 2000.

2. Vibrations occurring at these low frequencies should not be detrimental to the long term reliability of either the pump or the motor.

Request No. 1

With regard to Item #1, RP-06 is different from SNP's relief request in two respects.

a) At SNP, the pumps are tested quarterly using the minimum flow recirculation line. However, during each refueling outage, the pumps are tested at full flow in accordance with Code requirements, i.e., the relief request is only applicable to quarterly mini-flow.

b) At SNP, the higher vibration only occurs during mini-flow tests, and is primarily caused by low frequency flow pulsations combined with low structural resonant frequencies of the pump assembly. Although the pumps have experienced high vibration during previous mini-flow tests, the licensee for SNP has monitored this high vibration condition since original installation of these pumps and was able to conclude that there has been no degradation of the pump/motor/foundation assembly from the inherent high vibration in this range during mini-flow tests. Another key element for approving SNP's relief request is that the pump operability can be demonstrated and verified each refueling

outage by full flow test without the relief from Code requirements. Therefore, the vibration data between 1/3 and ½ pump speed are excluded only from mini-flow tests but the vibration between 1/3 and ½ pump speed continues to be monitored by full flow tests during each refueling outage.

The licensee should address the above differences between Cooper and SNP, and determine if SNP's relief request is applicable to Cooper. If so, the licensee should revise the relief request and resubmit it along with documentation and justification similar to SNP.

NPPD Response

a) NPPD acknowledges that there are differences between the SNP relief request and the Cooper Nuclear Station (CNS) relief request. The method of testing the Residual Heat Removal (RHR) system pumps at SNP differs from the method of testing the Core Spray (CS) pumps at CNS. At SNP, the RHR pumps are tested quarterly in minimum flow, whereas at CNS, the CS B pump (CS-P-B) is tested quarterly using full flow recirculation back to the suppression pool. SNP performs a full flow test in accordance with the Code requirements once each cycle during the refueling outage. CS-P-B has a minimum flow (mini-flow) line, but it is used only to protect the pump from overheating when pumping against a closed discharge valve. The mini-flow line isolation valve for CS-P-B is initially open when the "B" Core Spray pump is started and flow is initially recirculated through the mini-flow line back to the suppression pool. The full flow test line isolation valve is throttled open to establish flow through the full flow recirculation test line. The mini-flow line is then isolated automatically and all flow remains through the full flow test line for the Inservice Testing (IST) test.

The CS system is operated in the same manner and under the same conditions for each test of CS-P-B, regardless of whether CNS is operating or shut down. Consequently, the potential for the flow-induced, low frequency vibration exists each time the pump is tested. Therefore, the relief is needed for all testing of CS-P-B.

CNS considers full flow testing to be preferable to mini-flow testing due to the ability to evaluate overall pump performance at post-accident flow design conditions.

With the approval of RP-06, Revision 1, CNS would be monitoring the full flow operation of the pump each quarter. This will include obtaining vibration data over the full range of frequencies required by the code through administrative monitoring of the range from one-third to one-half pump running speed and monitoring of the range from one-half pump running speed to 1000 Hz for IST Program trending and test acceptance. This constitutes a thorough monitoring program for CS-P-B that will detect the start of degradation in the pump/motor and allow appropriate actions to be taken as needed.

b) As noted in the response to item "a)" above, the quarterly test of CS-P-B at CNS is performed with CS operating in full flow, whereas the quarterly test of RHR at SNP is performed on mini-flow. The similarity in the two cases is the existence of low-frequency vibrations that have been determined by each respective plant to have no detrimental effect on the pump and motors. Similar to SNP, the vibrations at CNS are a result of low frequency flow pulsations which tend to excite the structural resonant frequencies of the machine assembly. The low frequency flow pulsations at CNS are caused by turbulent flow through a S-curve in the discharge piping from the CS pump.

The higher than normal vibration on CS-P-B occurs at only two horizontal vibration points on the upper portion of the motor. CNS is requesting relief for only these two points. Also, SNP stated that when applying the Operations and Maintenance (OM) Part 6 criteria, the vibration limits will place the pump consistently in the "Alert Range" or the "Required Action Range" during their quarterly mini-flow testing. At CNS, vibration readings occasionally put the pump above the "Alert Range," but have never approached the "Required Action Range." A comparison of the data for the two plants indicates that the SNP data is consistent with the CNS phenomena in that the low frequency vibrations are random and contribute varying amounts to the overall average vibration from one test to the next. However, the CNS variation of approximately 0.25 in/sec for vibration points 1H and 5H (1996 data to present) is smaller than the variation seen in some of the SNP overall pump vibration data.

Vibration monitoring has been a part of CS-P-B testing at CNS, just as it has been for the RHR pumps at SNP, since original installation of the pumps. However, vibration at points 1H and 5H on CS-P-B were not measured consistently until April 1990 at CNS. Monitoring vibration at these two points was started as part of an approved relief request that exceeded the requirements of the 1980 Edition of the Code (1981 Addenda) that only a single point needed to be monitored. SNP, similarly, did not begin monitoring multiple points until the 1990s. An additional six years of vibrational data on CS-P-B has been provided with RP-06, Revision 1.

As at SNP, CNS also concludes that there has been no degradation of pump performance as a result of the flow-induced vibration that the pump experiences at low frequencies.

Conclusion

After consideration of the configuration differences and resulting test variations between CNS and SNP, NPPD no longer considers it appropriate to cite the SNP relief request as similar to the CNS request. Therefore, CNS is revising the relief request by removing the statement that the CNS relief request is similar to the SNP relief request. RP-06, Revision 1, is provided as Attachment 2, with supporting figures provided in Attachment 3.

NRC Request No. 2

[Part A] With regard to Item #2, NPPD should address the four key components recommended by NRC NUREG/CP-0152 in order to conclude that vibrations occurring at these low frequencies should not be detrimental to the long term reliability of either the pump or the motor. The licensee may want to review more thoroughly the SNP submittal regarding how those components were addressed. [Part B] The licensee should also discuss whether there are alternative means to monitor the vibration in the excluded range so that action can be taken if they are trending higher. [Part C] A review of vibration histories at Cooper indicates that the vibration data varied widely and the variation at locations 1H and 5H could be as high as 0.25 in/sec. The licensee should provide a justification why vibration measurements could vary so widely and discuss actions taken to reduce them. [Part D] The key issue for the proposed relief request is to provide justification along with alternative to show that doubling the test frequency does not provide any additional information nor additional assurance as to the condition of the pump and its ability to perform its safety function.

NPPD Response

Part A. Four Key Components of NUREG/CP-0152

The four key components that the NRC is referring to were discussed in a paper entitled, Nuclear Power Plant Safety Related Pump Issues, by Joseph Colaccino of the NRC Staff as published in the version of NUREG/CP-0152 entitled "Proceedings of the Fourth NRC/ASME Symposium on Valve and Pump Testing", July 15-18, 1996. The NRC staff considers these four key components in evaluating certain relief requests. These four key components have been specifically addressed in RP-06, Revision 1, provided in Attachments 2 and 3.

Part B. Alternative Means to Monitor the Vibration in the Excluded Range:

Vibration occurring in the excluded range of frequencies from one-third to one-half pump rotational speed, for vibration points 1H and 5H, will be monitored for any vibration anomaly or degrading trend, in addition to monitoring the range of one-half pump running speed to 1000 Hz by the IST Program. (Relief is requested only for points 1H and 5H on CS-P-B, since testing of the other points on CS-P-B complies fully with code requirements.) The IST acceptance criteria will be based on the vibration that occurs in the range of one-half pump running speed to 1000 Hz for points 1H and 5H, and in the range of one-third pump running speed to 1000 Hz for the other points monitored. Appropriate actions will be taken for any vibration anomaly or degrading trend observed in the administrative range of one-third to one-half pump running speed frequencies or in the filtered range of one-half pump running speed to 1000 Hz. This is discussed in the Alternate Test section of RP-06, Revision 1.

Part C. Justification for Vibration Variations and Discussion of Actions Taken to Reduce Them:

As the NRC has correctly observed from the data (covering the period from 1996 to the present) provided with RP-06, Revision 0, the vibration at locations 1H and 5H has varied by as much as 0.25 in/sec. The best explanation for this was provided by Machinery Solutions, a known expert in vibration. Machinery Solutions evaluated CS-P-B at CNS and concluded that most of the vibration measured on the motor casing is due to excitation of the structural resonances of the motor/pump by turbulent flow. These structural resonances are poorly damped and can be easily excited. Most vertical pumps have similar types of behavior that is not necessarily problematic by itself. Points 1H and 5H experience the greatest vibration magnitude because they are at the top of the pump-motor assembly, which is the largest distance from the point of pump attachment to the piping. A problem occurs when a pump has a continuous forcing function whose frequency coincides with a resonance (i.e. running speed). The forcing function in this case is flow turbulence caused in large part by the S-curve in the piping just off the pump discharge. The flow through this area generates lateral broadband forces, due to elbow effects, that excite the resonances in a noncontinuous fashion. This is the cause of the variation in amplitude of the vibration on the motor case. The system goes from brief periods of excitation to brief periods of no excitation. The discharge riser is also moving side to side from the same forces. This evaluation by Machinery Solutions supports independent evaluations performed by Byron Jackson (CS-P-B vendor), and CNS experts, that have determined that this condition poses no threat to the long term reliability of either the pump or the motor. This information has been documented in RP-06, Revision 1.

It should also be noted that this phenomena is not isolated to CNS. As stated earlier, the data from SNP is consistent with the CNS phenomena of random, low frequency vibrations that contribute a different amount to the overall vibration amplitude from one test to the next. In fact, the CNS deviation of approximately 0.25 in/sec in vibration amplitude at points 1H and 5H (based on data from 1996 to the present) is lower than the deviation seen in some of the SNP pump vibration data.

Part D. Justification That Doubling the Test Frequency Does Not Provide Additional Information Nor Additional Assurance as to the Condition of the Pump and its Ability to Perform its Safety Function:

The additional clarifications and additions made in RP-06, Revision 1, demonstrate that doubling the test frequency under the current conditions does not provide additional assurance as to the condition of the pump and its ability to perform its safety function.

Attachment 2

Relief Request RP-06 (Revision 1)

Cooper Nuclear Station
Docket No. 50-298
(TAC No. MB6281)

PUMP Core Spray, CS-P-B

CLASS ASME Code Class 2

FUNCTION The core spray pump has an active safety function to provide cooling spray water to the reactor vessel to mitigate the consequences of a Loss of Coolant Accident. The pump delivers water from the suppression pool to the spray spargers in the reactor vessel above the fuel to cool the core and limit cladding temperature. The pump must deliver a minimum of 4720 gpm at $\geq$ 113 psid to meet its safety function. Injection to the vessel occurs only after pressure has dropped below 436 psig, which allows the injection check valve to open.

REQUIRED TEST OMa-1988, Part 6, Paragraph 4.6.1.6, Frequency Response Range, which 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."

OMa-1988, Part 6, Paragraph 5.2.(d), which states, in part:

> "Vibration measurements are to be broad band (unfiltered)."

BASIS FOR RELIEF A. Summary of Basis for Relief

The Nebraska Public Power District (NPPD) submits this relief request for Nuclear Regulatory Commission (NRC) review and approval in accordance with 10CFR50.55a (a)(3)(ii). Compliance with the specified requirement results in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The Inservice Testing (IST) Program has consistently required that CS-P-B be tested on an increased frequency due to vibrational values at points 1H and 5H, as shown in Figure 1 of Attachment 3, periodically being in the alert range. Relief is requested to exclude from consideration the vibration in the frequency range from one-third pump rotational speed up to one-half pump rotational speed for points 1H and 5H. Excluding this low frequency vibration band will filter out piping-

induced vibration that is not indicative of CS-P-B performance and enable restoring CS-P-B to a normal testing frequency. However, Cooper Nuclear Station (CNS) will monitor vibration over the entire range of frequencies required by ANSI/ASME Operation and Maintenance Standard, OMa-1988, Part 6, including one-third to one-half pump running speed, for pump degradation and will take required actions as appropriate.

B. Pump Testing Methodology

Core Spray (CS) pump B (CS-P-B) at CNS is tested using a full flow recirculation test line back to the suppression pool each quarter. CS-P-B has a minimum flow line which is used only to protect the pump from overheating when pumping against a closed discharge valve. The mini-flow line isolation valve for CS-P-B is initially open when the pump is started and flow is initially recirculated through the mini-flow line back to the suppression pool. Then, the full flow test line isolation valve is throttled open to establish flow through the full flow recirculation test line. The mini-flow line is then isolated automatically and all flow remains through the full flow test line for the IST test.

The B train of the CS system is operated in the same manner and under the same conditions for each test of CS-P-B, regardless of whether CNS is operating or shut down. Consequently, the pump will experience the same potential for flow-induced, low frequency vibration whenever it is tested, whether CNS is operating or shut down. As a result, this relief is needed for all testing of CS-P-B.

CNS considers full flow testing to be preferable to mini-flow testing due to the ability to evaluate overall pump performance at post-accident flow design conditions. Mini-flow testing would provide only limited information about the pump. With the approval of this relief request, CNS will monitor the full flow operation of the pump each quarter, including review of the full range of vibrational data as described in the "Alternate Test" section of this relief request. This will provide a thorough monitoring program for CS-P-B and will identify the start of degradation in the pump/motor, allowing appropriate actions to be taken, if needed.

C. NRC Staff Document NUREG/CP-0152

NRC Staff document NUREG/CP-0152, entitled "Proceedings of the Fourth NRC/ASME Symposium on Valve and Pump Testing," dated July 15-18, 1996, included a paper entitled Nuclear Power Plant Safety Related Pump Issues, by Joseph Colaccino of the NRC staff. That paper presented four key components that should be addressed in a relief request of this type to streamline the review process. These four key components are as follows:

I. The licensee should have sufficient vibration history from inservice testing which verifies that the pump has operated at this vibration level for a significant amount of time, with any "spikes" in the data justified.

II. The licensee should have consulted with the pump manufacturer or vibration expert about the level of vibration the pump is experiencing to determine if pump operation is acceptable.

III. The licensee should describe attempts to lower the vibration below the defined Code absolute levels through modifications to the pump.

IV. The licensee should perform a spectral analysis of the pump-driver system to identify all contributors to the vibration levels.

The following is a discussion of how these four key components are addressed for this relief request.

I. Vibration History (Key Component No. 1)

A. Testing Methods and Code Requirements

Inconsistent higher vibrations on CS-P-B have been a condition that has existed since original installation of this pump in 1973. During the construction and preoperational testing, vibrations were measured in "mils" at the top and side of the motor outboard (furthest from the pump), the side of the motor inboard (nearest the pump), and pump inboard (nearest the motor). The vibration signals were tape recorded along with the dynamic pressure pulsations in the suction and discharge of the pump as the flow was varied. The intention was to see if hydraulic disturbances were responsible for the observed phenomena. Observation of the vibration signals on the oscilloscope showed conclusively that the motor was vibrating with randomly distributed bursts of energy at the natural frequency of the total system. Therefore, it was determined that the hydraulic disturbances found in the piping was the source of the energy. Pipe restraints were added that reduced the piping system vibrations.

The monitoring of multiple vibration points over the years had not been a requirement of Section XI of the ASME Code until the adoption of the O&M Standards/Codes. Therefore, at CNS, the first and second ten-year interval IST code requirements did not include the monitoring of multiple vibration points. The CNS second interval IST Program was committed to the 1980 Edition, Winter 1981 Addenda, of Section XI. Paragraph IWP-4510 of this code required that "at least one displacement vibration amplitude shall be read during each inservice test." This code was in effect at CNS until the start of the current third ten-year interval, which began on March 1, 1996. The CNS third interval IST Program is committed to the 1989 Edition of Section XI, which requires multiple

vibration points to be recorded during IST pump testing in accordance with the ANSI/ASME Operations and Maintenance Standard, Part 6, 1987 Edition with the 1988 Addenda. However, CNS proactively began monitoring vibration on pumps in the IST Program in velocity units (inches per second) at multiple vibration points in 1990 in accordance with an approved relief request. Therefore, data exists for vibration points 1H and 5H from April 1990 to the present. This data is included in the figures provided in Attachment 3 of RP-06, Revision 1. In April 1990, an analog velocity meter was utilized to begin measuring five different points in units of velocity. These are the same points measured today. Further technological advances resulted in the utilization of more reliable vibration meters beginning in late 1996.

B. Review of Vibration History Data

Beginning in April 1990, five vibration points (1V, 1H, 2H, 3H, 5H) were recorded for CS-P-B. However, the pump was tested at 4720 gpm from April 1990 to April 1992, then at 4800 gpm from April 1992 through December 1994, and finally at 5000 gpm from January 1995 to the present. The January 1995 test was also a post-maintenance test following the work that replaced the restricting orifice in the test return line. The last re-baseline occurred on November 6, 1996 due to the implementation of a new vibration meter with new instrument settings. Therefore, it would be appropriate to review the data from this date forward to track for degradation. This would be over six and one-half years of data at the same reference points.

CS-P-B IST vibration trend graphs (Figures 2a, 3a, 4a, 5a, and 6a in Attachment 3), which include data from November 6, 1996 to the present, show essentially flat or slightly downward trends, indicating that CS-P-B vibrations are not increasing in magnitude. These trends also show that points 1H and 5H occasionally exceed the alert range criteria (Figures 2a and 3a). Figure 12 illustrates the trend for CS-P-B differential pressure (D/P) readings from January 1995 (re-baselined pump at 5000 gpm) to the present. This represents nearly nine years of data for pump differential pressure with the testing at 5000 gpm. As can be seen from Figure 12, essentially no degradation in pump D/P has occurred.

Trend graphs 2b, 3b, 4b, 5b, and 6b illustrate vibration data dating back to April 1990 for all vibration points. The data prior to 1996 represents data taken with analog, less reliable vibration instruments and as discussed previously, at differing flows. This data should not be directly compared to data from November 1996 to the present, but it does clearly indicate that the piping induced vibrations for vibration points 1H and 5H were present in the early 1990s. This condition was also documented in the 1980s. In July 1985, CNS work item #85-2497 documented high vibration readings on the horizontal motor position. A pipe resonance problem was suspected at that time. Vibrational readings varied

between 0.3 and 0.5 in/sec with spikes to 0.7 in/sec every few seconds. This 1985 documentation, available vibration data since 1990, along with the testing performed during the preoperational time period, substantiates that the piping induced vibrations have been in existence since the pump was installed. These graphs indicate that the vibration point trends since April 1990 are essentially flat or slightly downward. Therefore, based on the available data at CNS, this pump has experienced essentially no degradation in vibration levels for the last thirteen years or in D/P for nearly the last nine years.

C. Review of "Spikes" in Vibration Data

In reviewing the trend data for vibration points 1H (Figures 2a, 2b) and 5H (Figures 3a, 3b), which includes the Code required frequency ranges (one-third pump running speed to 1000 Hz.), random spikes were observed throughout the data that resulted in values above the alert range. These spikes are best described in a 2001 report by Machinery Solutions, an industry expert on vibrations, as follows:

> Most of the vibration that is measured on the motor casing is due to excitation of the structural resonances of the motor/pump by turbulent flow. These structural resonances are poorly damped and can be easily excited. Most vertical pumps have similar types of behavior and it is not necessary problematic by itself. A problem occurs when a pump has a continuous forcing function whose frequency coincides with a resonance (i.e., running speed). The forcing function in this case is flow turbulence caused in large part by the S-curve in the piping just off the pump discharge. The flow through this area generates lateral broadband forces, due to elbow effects, that excite the resonances in a noncontinuous fashion. This is why the amplitude swings so dramatically on the motor case [the location of vibration points 1H and 5H]. The system goes from brief periods of excitation to brief periods of no excitation. The discharge riser is also moving side to side from the same forces. Although the discharge piping configuration is both non standard and less than optimum for this application, it poses no threat to the long term reliability of either the pump or the motor. The only negative impact is on vibration levels relative to a generic standard.

Based on the noncontinuous nature of the low frequency piping induced vibration, under the current code requirements (monitoring vibrations from one-third pump running speed to 1000 Hz), trending of the overall vibrational average becomes very difficult if not impossible. General trends could only be made after obtaining years of data. In the short term, the input from the piping induced vibrations could potentially mask other actual pump or motor degradation when observing the overall average value. However, if the region from one-third pump running

speed to one-half pump running speed were filtered out, future degradation would be evident in the overall average value after a minimal number of data points. As illustrated previously, there have been no degrading trends associated with vibration data for the last thirteen years (Figures 2b and 3b). Since June 2002, filtered data (removal of one-third pump running speed to one-half pump running speed frequencies) has been recorded in addition to the current code required values for vibration points 1H and 5H (reference Figures 2c and 3c). In reviewing this data, the trends are lower in value, steady, and without the spikes that the code required data contains. This further supports the fact that the spikes in the original code data are due to the piping induced, non detrimental vibration occurring at the one-third to one-half pump running speed. By eliminating the one-third to one-half region, true degradation in the pump and motor could be trended and degradation identified nearly immediately.

II. Consultation With Pump Manufacturer or Vibration Expert (Key Component No. 2)

A. Pump Manufacturer Evaluation of CS-P-B Vibrations

Byron Jackson is the pump vendor for CS-P-B. The pump is a 8 x 14 x 30 DVSS, vertical mount, single stage centrifugal pump. The pump impeller is mounted on the pump motor's extended shaft. As outlined in the Core Spray System Summary of Preoperational Test, the data obtained for the B Core Spray Pump indicated high vibration. The high vibration had been recognized early in the construction testing phase and Byron Jackson, the pump manufacturer, sent a representative to the site to investigate. In a letter dated February 16, 1973, the Byron Jackson representative indicated the following:

1. Tests indicated that the natural frequency of the pump was 940 rpm (approximately one-half pump speed) in the direction of the piping and 720 rpm (between one-third and one-half of pump speed) in the direction perpendicular to the piping.

2. Observation of the test signals on the oscilloscope showed very conclusively that the motor was vibrating with randomly distributed bursts of energy, the frequency of which matched the natural frequency of the total system. This can only mean that the energy is coming from the hydraulic disturbances found in the piping.

3. Whenever large flows are carried in piping, there is usually considerable turbulence associated with the elbows, tees, etc. of the piping configuration, all of which results in piping reactions and motion. Apparently, the vibrating piping was in turn vibrating the pump.

4. When jacks were installed between the top of the pump and the bottom of the motor flange in an effort to stiffen the motor pump system, the motor vibrations went up due to more energy being transmitted from the pipe-pump system into the motor.

5. Testing was performed to determine any weaknesses in the pump-motor mechanical system. The vibration amplitude using the IRD instrument, with the filter set at operating speed, sampled many points vertically along the pump-motor structure. Plots of the data (along with phase angle determined by means of the strobe light) showed very clearly that the total structure was vibrating as a rigid assembly from the floor mounting. Examination of the high amplitude vibration signals showed them to be at the extremely low system natural frequencies as determined earlier.

6. Such low acceleration levels, along with the system acting as a rigid structure (between motor and pump), means that the motor and pump can operate with these levels of vibration with absolutely no impairment of operating life. This is the picture that seems very clearly described by the data obtained during these tests. There is absolutely no reason to restrict the operation of these pumps in any way.

Although the vibration was found to be acceptable, CNS took actions to install new pipe supports as an attempt to reduce these piping-induced vibrations. This action was successful as will be discussed in a later section of this relief request.

B. CNS Expert Analysis of CS-P-B Vibrations

As the Vibration Monitoring Program expanded in the early 1990s, it became evident that the low frequency piping-induced vibrations still remained in CS-P-B. Design Change (DC) 94-046 resulted in the replacement of the orifices in the test return line. A March 16, 1995 memo to the CNS IST Engineer from the CNS Lead Civil/Structural Engineer discussed the CS-P-B vibration measurements obtained during DC 94-046 acceptance testing. The vibration data was collected using peak velocity measuring instrumentation as required for the performance of the IST test, and with instrumentation that provides displacement and velocity versus frequency data. It was observed that the significant vibrations in the 1H direction were occurring around 700 cycles per minute (cpm), while the pump speed is at 1780 cpm (i.e., rpm). Given the piping movement of the system, and the knowledge that piping vibrations can commonly occur in the 700 cpm (12 Hz) range, CNS concluded that the pump vibrations were piping dependent.

The CNS Lead Civil/Structural Engineer concluded that the significant pump vibrations are occurring at less than one-half of the pump operating speed. The pumps are rigidly mounted at their bases, and any impeller induced vibrations

would occur at the pump running speed or at the vane passing frequency. Therefore, the sub-synchronous pump vibrations are clearly piping induced, non detrimental to pump/motor service or reliability, and should not be used as a basis for pump degradation. This is because the purpose of pump in-service testing is to diagnose and trends internal pump degradation.

The memo further states that the vibration data collection requirement specified in the IST procedure consists of peak velocity recordings, which may be masked by piping induced vibrations, negating internal pump degradation diagnosis and trending. Based on the historical trending data for both Core Spray pumps, the vibration has remained at a consistent amplitude, trending neither upward nor downward, indicating that the induced vibrations are not impairing pump operability, nor capable of preventing the pump from fulfilling its safety function. The piping vibration is present when flow is present through the test return line. It was visually observed during DC 94-046 acceptance testing that piping vibrations were minimal when flow was directed through the minimum flow line.

Following the DC 94-046 testing, CNS noted that the deflections observed in the discharge piping were significantly reduced. Based on these results, it was determined by the Nuclear Engineering Department, Civil/Structural Group, that the CS Loop B piping vibration stresses are less than the endurance limit of the piping.

On October 17, 2002, a Plant Engineering Supervisor at CNS, knowledgeable in the area of pump vibration analysis, issued a memo to the CNS Risk & Regulatory Affairs Manager, discussing the low frequency vibration issue with the "B" Core Spray Pump. In the memo, it is stated that the pipe is vibrating as a reaction to flow turbulence, which in turn is causing the pump to vibrate. The memo documents the basis for why the low frequency vibration (less than one-half pump running speed) experienced during CS-P-B operation is not indicative of degrading pump performance, and is not expected to adversely impact pump operability. To summarize, in the area of pump performance, aside from the randomness of the low frequency peaks, the spectral data shows no degrading trend in performance over several years of data. The low frequency piping induced vibrations are not expected to adversely impact pump operability.

CS-P-B is a single element BJ 8 X 14 X 30 DVSS pump, driven by a GE 6346 PZ 42 frame motor, which is mounted vertically. The pump has no bearings of its own and relies on the motor bearings for both radial and axial support. The motor bearings are rolling element bearings. This specific arrangement of pump and motor limits the sub-harmonic vibration frequencies (i.e., frequencies below one times running speed, [1X]) generated.

Sub-harmonic frequencies are a small fraction of the frequencies generated by pump and motor degradations, and therefore represent a small fraction of the frequencies used to detect pump and motor degradation. Some forms of pump and motor degradation include cavitation, flow recirculation, unbalance, misalignment, mechanical run-out such as bent shaft, eccentricity, electrical air gap disturbance, rotor bar problems, looseness, excessive clearances, and the vast majority of the bearing defect frequencies. The frequencies generated by these and other conditions are at or above 1X running speed, and are within the range of frequencies that will be monitored, which is between 1/2X and 1000 Hz.

Sub-harmonic vibration frequencies are typically generated by rotor rubs (pump or motor) or fluid film bearing defects, such as oil whirl, and oil whip. Some less common causes of sub-harmonic vibration frequencies are loose seals and bearings, bearing and coupling damage, poor shrink fit, and bearing support resonance.

Of these potential causes of sub-harmonic frequencies, only rotor rubs and certain forms of bearing damage (bearing cage defects) can produce sub-harmonic vibration frequencies between 1/3X and 1/2X when considering the CS-P-B and piping configuration. (Since CS-P-B does not have fluid film bearings oil whirl and oil whip are not a concern.) Loose seals and bearings, and poor shrink fits will produce frequencies around 1/2X, which will be monitored. No bearing support resonance has been found, so they are not a concern.

Rotor rubs typically produce frequencies around 1/2X. Light rotor rubs (partial rubs) describe a condition where a rotor may not rub as frequently. These types of rubs may produce frequencies that represent fractions of running speed below 1/2X. Light rotor rubs sometimes "wear-in" and self-correct the cause of the rub. The most common cause of rotor rubs is a rebuild or re-manufacturing defect, which causes the wearing ring clearances to be improper, or a wearing ring to come loose during normal operation. The typical rotor rub produces a 1/2X frequency which will be monitored by both the IST program and the equipment-monitoring program.

Light rotor rubs will produce frequencies below 1/2X. However, even if the equipment-monitoring program does not identify the light rub, and the condition degrades to a full rub, the frequencies generated by a full rub will then produce the more typical 1/2X frequencies, which will then be monitored by both the IST program and the equipment-monitoring program.

The presence of a rub does not indicate a loss of function, but rather indicates a condition of the pump that, if left unattended, may degrade to the point of a loss of function. Under IST testing, a condition may exist and continue to degrade until an alert level is triggered, and the function is assumed to be protected. A light rub

by itself may not produce enough energy to increase the base line vibration reading on these pumps to the point of triggering the alert level. If left unattended, the rub may continue to degrade until it becomes a full rub, and the alert level is reached. At this point, the pump will still perform its intended function. It will continue to perform its intended function between the Alert limit and the Required Action limit. The Required Action limit is the level of vibration energy at which empirical data has shown it is not prudent to continue to operate. At this point the pump must be declared inoperable. The Alert and Required Action levels required by the IST program are intended to recognize that a certain amount of degradation in the condition of a component is possible and acceptable without unduly challenging the performance of the component.

Therefore, administratively monitoring the vibration occurring at frequencies from 1/3X to 1/2X for points 1H and 5H, but excluding the vibration in this range from consideration when determining acceptance of IST Program testing, will not significantly reduce the ability of the IST program to identify a rub condition on this pump in a timely manner. Additionally, the equipment-monitoring program will continue to monitor the full range of frequencies.

Some of the fundamental rolling element bearing frequencies for ball bearings are in the sub-harmonic range, below 1/2X. These frequencies are indicators of bearing defects. Many rolling element bearing failures are the direct result of a rotor-related malfunction (e.g., unbalance, misalignment, or rotor instability), which produce frequencies 1X and above. Ball bearings may produce very high frequencies, as high as 8X roller pass frequencies, which may be very early warning information. However, the principal and vital data for rolling element bearings is contained in the region of 1X to 7X roller pass frequencies. These frequencies are monitored by the IST Program and contribute the majority of energy to the overall vibration level.

Ball bearings progress through three failure stages, Pre-failure, Failure, and Near Catastrophic/Catastrophic. During the pre-failure stage, the bearing is in the early stages of failure. It produces hairline cracks or microscopic spalls that are not normally visible by the human eye. During this stage, there is an increase in high frequency (greater than 7X element pass frequency) produced by the bearing. Both the IST program and the equipment-monitoring program are monitoring these frequencies. If temperature were measured, the readings would be normal. At this stage, the bearing has a significant amount of safe operating life left and it is not economical to replace it.

During the failure stage, the bearing develops flaws that are visible to the human eye. At this stage the bearing usually produces audible sound and the temperature of the bearing will rise. Vibration amplitudes in the fundamental rolling element bearing frequencies will have increased and are easily detectable. These

frequencies are typically 1X to 7X roller pass frequencies, and may include some sub-harmonic frequencies, including the region between 1/2X and 1/3X. The IST program is monitoring the principal and vital region of these frequencies, which would cause the overall vibration to increase and may approach the alert level. The equipment-monitoring program monitors all these frequencies. This is the stage where it is most economical to replace the bearing. At this point the pump will still be capable of performing its intended function.

If allowed to continue to degrade, bearing failure would enter the Near Catastrophic/Catastrophic stage. Prior to reaching this stage, it is expected that the overall vibration levels, primarily driven by the high frequency vibration, would have progressed beyond the Alert and Required Action levels. Since both the IST and the equipment-monitoring program monitor these high frequency vibrations, it is reasonable to expect that both programs will be able to detect a bearing defect in time to take corrective measures before the condition can affect its function.

Therefore, not monitoring frequencies between 1/3X and 1/2X for points 1H and 5H will not significantly reduce the ability of the IST program to identify a bearing failure on this pump and motor in a timely manner.

C. Independent Industry Vibration Expert Evaluation of CS-P-B

In 2001, Machinery Solutions, Inc. was retained to perform an independent study of the CS-P-B vibrations. The following discussion was obtained from their report, issued in September of 2001. Machinery Solutions utilized seven transducers and acquired data from CS-P-B continuously while it was operating, and data was stored every 3 seconds. Orbit plots, spectrum plots, bode and polar plots, cascade/waterfall plots, overall amplitude plots, trend plots, XY graph plots and tabular lists were utilized to analyze the data. The data obtained by Machinery Solutions indicated that the vibration amplitudes during the run were much higher at the top of the motor than they were at the bottom of the motor. The amplitudes decreased even further on the pump. The spectrum plots showed that most of the vibration was occurring below running speed. They also showed that the low frequency vibration is a different frequency in each direction. The predominant peaks occur at approximately 870 cpm (less than one-half pump running speed) in line with discharge and at approximately 630 cpm (less than one-half pump running speed) perpendicular to discharge. The amplitude of each of these peaks varied significantly from second to second. The natural frequency of the pump-motor-piping structure was determined via impact testing prior to starting the pump. The natural frequencies were determined to be approximately 830 cpm in line with discharge and 670 cpm perpendicular to discharge. Such a vibration response is typical for vertical pumps.

Machinery Solutions concluded the following:

1. Most of the vibration that is measured on the motor casing is due to excitation of the structural resonances of the motor/pump by turbulent flow. These structural resonances are poorly damped and can be easily excited. Most vertical pumps have similar types of behavior and it is not necessarily problematic by itself. A problem occurs when a pump has a continuous forcing function whose frequency coincides with a resonance (i.e., running speed). The forcing function in this case is flow turbulence caused in large part by the S-curve in the piping just off the pump discharge. The flow through this area generates lateral broadband forces, due to elbow effects, that excite the resonances in a noncontinuous fashion. This is why the amplitude swings so dramatically on the motor case [the location of vibration points 1H and 5H]. The system goes from brief periods of excitation to brief periods of no excitation. The discharge riser is also moving side to side from the same forces. Although the discharge piping configuration is both non standard and less than optimum for this application, it poses no threat to the long term reliability of either the pump or the motor. The only negative impact is on vibration levels relative to a generic standard.

2. The balance condition of the motor and pump are acceptable with no corrective action required at this time.

3. The shaft alignment between the motor and the pump is acceptable for long term operation.

4. There is no evidence of motor bearing wear.

Machinery Solutions recommended the following actions:

1. Create a new IST vibration data point configuration within the data collector database to use an overall level that is generated from spectral data above 950 cpm. This will eliminate the energy from the resonances from the data set and still allow for protection from bearing degradation, impeller degradation and motor malfunctions. The only potential failure mode that could occur within this excluded frequency range would be a fundamental train pass frequency generated by a rolling element bearing. This frequency only occurs with increased bearing clearance. On vertical machines, this increased bearing clearance causes increased bearing compliance and the 1X component will become larger. The 1X change will be evident in the monitored data set.

2. Continue to acquire the old data points with the low frequency data "for information only" to verify that the system response does not change.

III. Attempts to Lower Vibration (Key Component No. 3)

CNS installed additional pipe restraints during the preoperational period in order to reduce piping-induced vibrations. Testing on October 26 and 27, 1973, following the installation of these new supports, demonstrated significantly reduced vibrations.

Low frequency piping-induced vibrations continued, but with reduced amplitude following the installation of the pipe restraints. However, the issue resurfaced in the early 1990s when additional vibration points were recorded, more strict acceptance criteria were adopted for vibrations, and new technology was incorporated into the CNS vibration program. These new points were more influenced by the low-frequency piping-induced vibrations than the one or two points recorded in the 1980s. It was evident that the piping-induced vibrations were still prevalent with the CS-P-B pump.

In 1993, a deficiency report was written to address increased frequency IST testing of CS-P-B due to vibration. It was suspected that the pump vibrations were piping-induced. Preliminary investigation of the vibration issue concluded that cavitation at the Core Spray test return line throttle valve and/or restriction orifices was likely causing the elevated piping vibration in both Core Spray System loops. Vibration testing of the Core Spray piping confirmed this conclusion.

To reduce these flow-induced vibrations, DC 94-046 was developed to replace the existing simple, single-stage orifices on both Core Spray subsystem test return lines with multi-stage orifices. Post-installation testing with these multi-stage orifices demonstrated lower vibration levels on CS-P-A, but higher vibration levels on CS-P-B. A multi-hole single-stage orifice was fabricated and installed in the CS-P-B test return line (and later in the CS-P-A test return line) with significantly improved results. Visual observation and vibration data collected during acceptance testing determined that CS-P-B pump vibrations had been reduced, but one direction (location 1H in Figure 1) still demonstrated peak velocity reading in the alert range. The pump vibrations in the 1H direction were occurring at frequencies much lower than the pump operating speed. The major vibration peaks were occurring at approximately 700 cycles per minute (cpm), while the pump speed is at 1780 cpm, indicating that the vibration was piping induced. It was also observed during acceptance testing that vibrations were minimal during operation in the minimum flow condition.

IV. Spectral Analysis (Key Component No. 4)

Figures 7 through 11 in Attachment 3 show spectrum plots for CS-P-B, as well as spectrum trends. Markers drawn on these plots show that the peak energy spikes for points 1H and 5H remain below one-half pump running speed and that the pump vibration signature remains fairly uniform. Figure 12 shows that pump differential pressure is consistently acceptable. This data validates the analysis performed by Machinery Solutions, Inc., and the earlier conclusions that the elevated vibrations are piping-induced, and not indicative of degraded pump performance. No pump or motor faults and/or degradation are evident in the spectral analysis for this pump. This test data also shows that the vibrations experienced remain in the region of the CS-P-B pump-motor-piping system natural frequency, at less than half the pump's operating speed.

For this type of pump, only a small fraction of the existing failure modes would induce vibrations at frequencies lower than one-half pump speed. It has been discussed earlier in this request how this small fraction of pump degradation concerns (rotor rubs, and certain forms of bearing wear) will be sufficiently addressed by CNS. Vibrations occurring at these low frequencies are not expected to be detrimental to the long term reliability of either the pump or the motor. Typical pump faults, i.e., impeller wear, bearing problems, alignment problems, shaft bow, etc., would result in measurable vibration response in frequencies equal to or greater than one-half of pump running speed. Such faults would also be evident in pump trends. However, the vibrations are being experienced below one-half pump operating speed, have existed since initial operation, and are not trending higher. Visual inspection by Machinery Solutions in 2001 of the pump baseplate, soleplate, and grout identified no visible cracks or degradation. Further, they concluded that the balance condition and shaft alignment of the pump and motor were acceptable, and detected no evidence of motor bearing wear.

D. Maintenance History

The maintenance history for CS-P-B reflects that there have been no significant work items applicable to CS-P-B due to the low frequency vibrations that have been experienced since the construction phase of the plant. A review of maintenance history for the CS-P-B pump and motor was performed. The search consisted of a historical review of CS-P-B pump and motor maintenance in addition to a more general search of CS System vibrational issues. This search identified that the pump and motor installed in the plant today is the same combination that was installed during the construction phase of the plant. Some of the key items reviewed are summarized below:

1. 1973: Additional supports installed on "B" Core Spray System during pre-operational stage. As discussed previously, this resulted in lowering CS-P-B vibrations.

2. January 1977: Vibration eliminator on "B" Core Spray test line, CS-VE7, required tightening of wall plate bolts per Maintenance Work Request (MWR) 77-1-10. Bolts in pipe clamp were replaced and clamp was realigned. Design was determined to be adequate, but lock washers should be used to prevent recurrence of the problem. MWR 77-1-262 completed this action.

3. April 1989 (Work Item [WI] 89-0269); November 1991 (WI 91-1507), February 1993 (MWR #92-2876): CS-P-B stator end turn bracing brackets inspected for stress corrosion cracking or unusual conditions such as loose bolts or bending. No cracks, loose bolts, or other unusual conditions were observed.

4. March 1993: A magnetic particle examination of CS-P-B support attachment weld revealed an indication at Lug #5 of the pump support. The indication was ground out, repaired, and retested satisfactorily. The indication was very small and would not have affected the overall stiffness of the pump. In 2003, no recurrence of this indication was identified.

5. April 1993: Work order #93-1631 was initiated due to mechanical seal leakage. A complete inspection of the pump/motor was also completed. The pump was found with the keyway not properly aligned with the mechanical seal, causing the leakage. The impeller was found to have minor pitting at the base of the wear ring area. The pump casing and cover had minor erosion and pitting. No significant problems with the pump or motor were noted.

6. July 1994: Bolt torque checked for lower end bell and lower bearing housing on CS-P-B motor due to a loose bolt found on the "A" RHR pump motor. No movement on lower bearing housing bolts. Movement of lower end bell bolts were as follows: 1/16 flat on #1, 3, 4, and 5 and no movement on #2, 6, 7, and 8. These were very minor adjustments.

7. Late 1994: DC 94-046 installs new orifices in CS-P-B test line. As previously discussed, this reduced piping deflections in the test line.

8. Oil Samples (Dates: 09-22-95, 10-22-95, 11-24-95, 02-28-97, 03-26-98, 04-05-99, 01-24-00, 12-26-00, 10-28-02): Periodic Oil Sample Analysis of the upper and lower motor bearings in accordance with Preventive

Maintenance Program. Results of CS-P-B Motor oil analysis were satisfactory with no corrective actions required.

9. Numerous Visual Motor Inspections completed satisfactory (i.e. January of 2002): Visual motor inspection satisfactory per work order #4199724.

10. February 2003: Notification #10225272 identified an indication approximately 3/8" on a CS-P-B integral attachment (CS-PB-A1). The indication is at the top of one of the small gusset supports where the gusset is welded to the cast pump bowl extension (different spot than the 1993 indication). Within engineering evaluation 03-030, the indication was determined to be on the gusset side of the weld and appears to be an incomplete fusion of the weld and not a service load induced flaw. Poor accessibility was the most likely cause. Calculation NEDC 03-007 demonstrated that, even if the five minor gusset plates were ignored, the pump support is still qualified under the most severe design loads.

This search of the maintenance history, covering a time period of approximately thirty years, identified no significant maintenance or corrective actions that had to be implemented for the "B" Core Spray pump and motor due to the piping induced vibrations. Only minor indications were noted on the pump impeller and casing during the last significant motor/pump disassembly in 1993. No other documentation of pump/motor disassembly inspection results was found during this review. Oil analyses of the CS-P-B lower and upper motor bearing housings were found to be satisfactory for all the results documented since 1995 to the present. Wear metals, contaminants, additives, etc. were all at acceptable levels. The addition of pipe supports in 1973 and new orifices in the test lines were necessary modifications and were previously discussed. Other than these modifications, only minor corrections have been made with pipe and/or pump supports (tightening bolts, minor indication, etc.), none of which were found to be significant. Therefore, the maintenance history supports the basis of this relief request in that the piping induced vibrations occurring on CS-P-B have not degraded the pump or motor in any way.

Conclusions

CNS has provided sufficient information in RP-06, Revision 1, to justify the alternative testing on points 1H and 5H. CNS will be monitoring the vibrational range of data as required by the Code. However, for points 1H and 5H, CS-P-B will be placed on increased frequency testing if a vibration level above the alert limit occurs in the frequency range of one-half pump running speed to 1000 Hz. The remainder of the code required frequency (one-third to one-half pump running speed) for these two points will be monitored administratively. This will alleviate any code concerns associated with filtering out vibration occurring in the range of one-third to one-half pump running speeds for determining whether or

not the pump should be placed on an increased frequency. The administrative monitoring will also ensure that the potential degradation mechanisms within the frequency range of one-third pump running speed to one-half pump running speed will be identified. Actions will be taken as appropriate to address any degrading trends identified.

Several expert evaluations have documented that no internal pump or motor degradation is occurring due to the piping induced vibration, which has been present since the pre-operational testing time period. The available vibration data over the last thirteen years and differential pressure data over nearly the last nine years supports this fact as essentially no degradation has been indicated.

CNS has been testing this pump unnecessarily on an increased frequency for many years. Doubling the test frequency does not provide additional information nor additional assurance as to the condition of the pump and its ability to perform its safety function. Testing of this pump on an increased frequency places an unnecessary burden on CNS resources.

The dominant peak at less than one-half pump running speed may mask the data trending at the frequencies that represent the majority of actual pump/motor health. All four key components discussed in NUREG/CP-0152 have been addressed in detail, supporting the alternative testing recommended in this relief request.

Trending will be improved, and actual pump or motor degradation will be better indicated, by separately monitoring the vibration occurring at frequencies from one-third to one-half pump rotational speed and at frequencies from one-half pump speed to 1000 Hz for points 1H and 5H. This will ensure appropriate corrective actions are taken to address those levels of vibration that could result in pump degradation.

CNS concludes that CS-P-B is operating acceptably and will perform its safety function as required during normal and accident conditions. The proposed alternative testing in this relief request will continue to assure long-term reliability of CS-P-B.

ALTERNATE TEST

The vibration at points 1H and 5H on CS-P-B will be monitored over the range of frequencies from one-third pump rotational speed to 1000 Hertz required by ASME Code OMa-1988, Part 6, Paragraphs 4.6.1.6, 4.6.4, and 5.2(d). The vibration occurring at frequencies between one-third and one-half pump speed at points 1H and 5H will be administratively monitored and any anomaly or trend of high vibration or degraded pump performance will be addressed. However, this vibration will not be included in the IST overall vibration averages for points 1H and 5H. Only the vibration occurring at frequencies from one-half pump

and 5H. Only the vibration occurring at frequencies from one-half pump rotational speed to 1000 Hz will be used in determining IST acceptance (including entry into the alert or required action ranges) based on the criteria of OMa-1988, Part 6, Table 3a.

All other pump vibration on CS-P-B will be monitored in accordance with OMa-1988, Part 6, Paragraphs 4.6.1.6, 4.6.4, and 5.2(d). The duration of this alternate testing is until the end of the current 10-year interval (March 2006.).

ATTACHMENT 3
CS-P-B Figures for Relief Request RP-06, Revision 1
Cooper Nuclear Station

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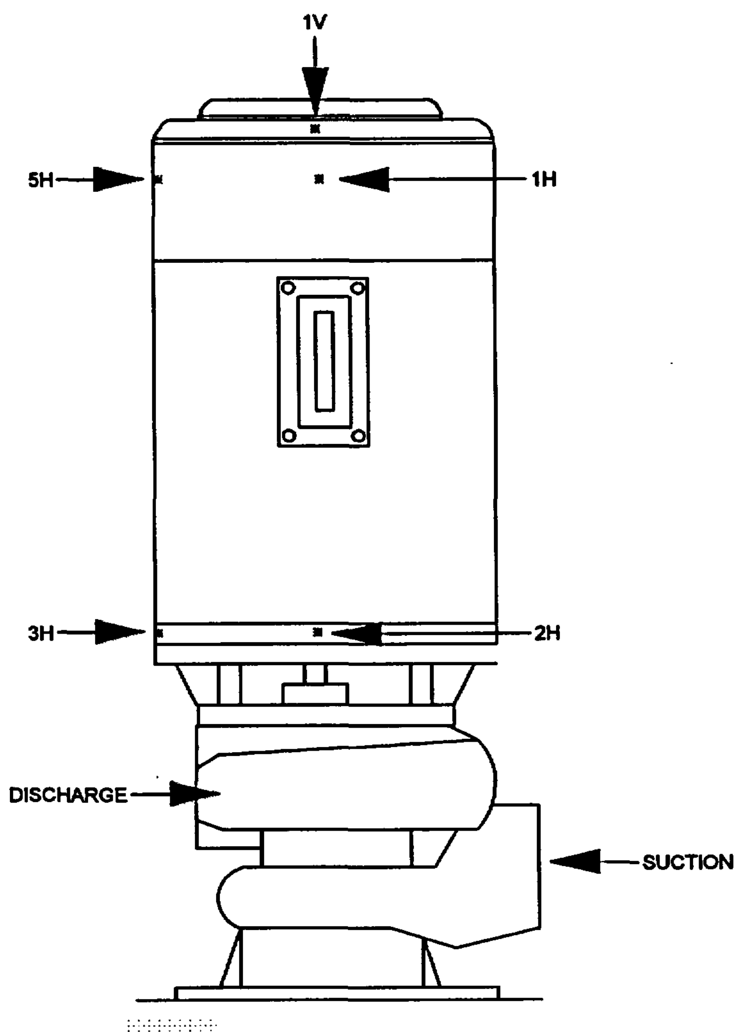


Figure 1 - CS-P-B Vibration Monitoring Points

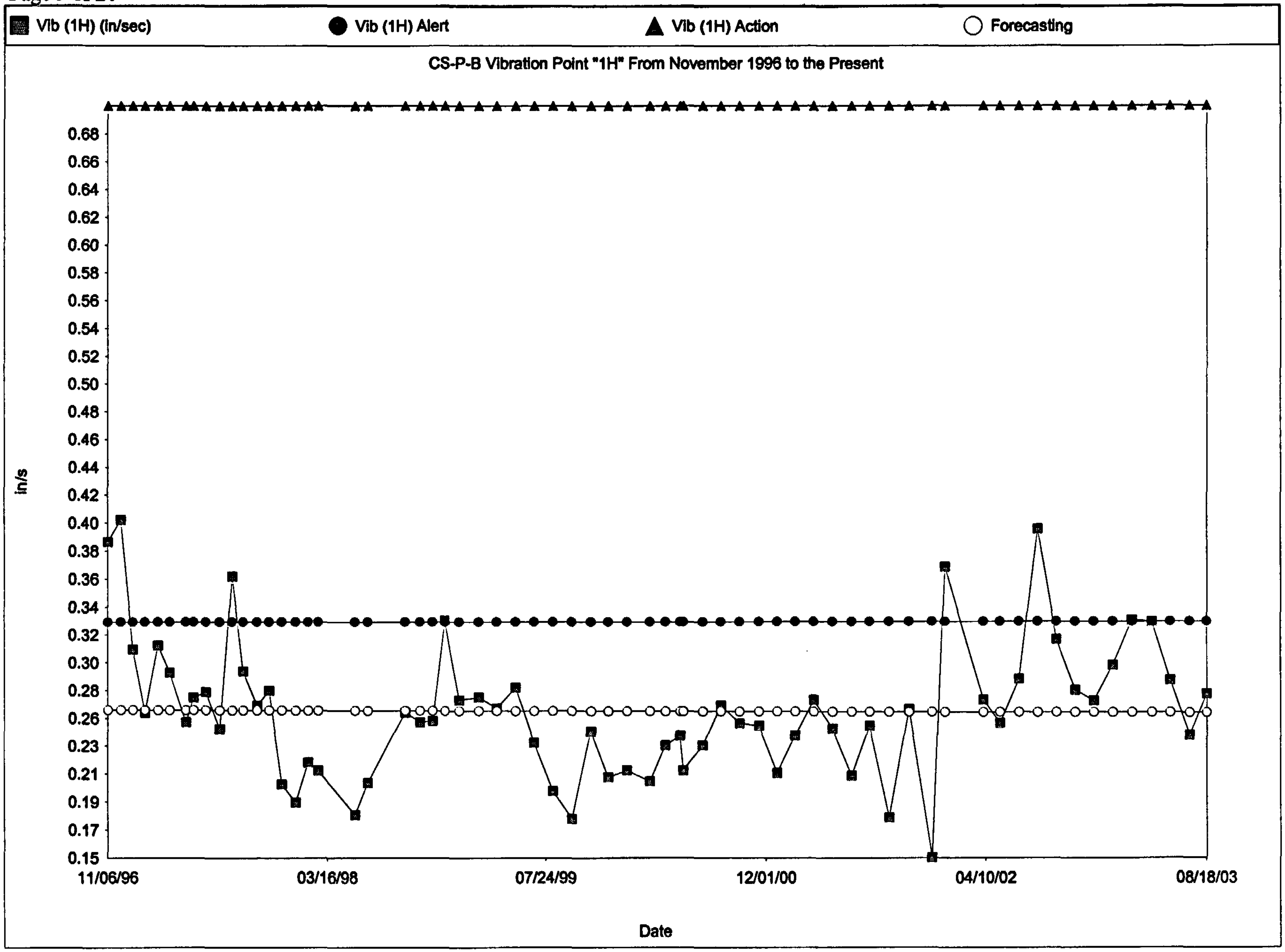

Vib (1H) (in/sec)
Vib (1H) Alert
Vib (1H) Action
Forecasting
CS-P-B Vibration Point "1H" From November 1996 to the Present
in/s
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.23
0.21
0.19
0.17
0.15
11/06/96
03/16/98
07/24/99
12/01/00
04/10/02
08/18/03
Date

Figure 2a

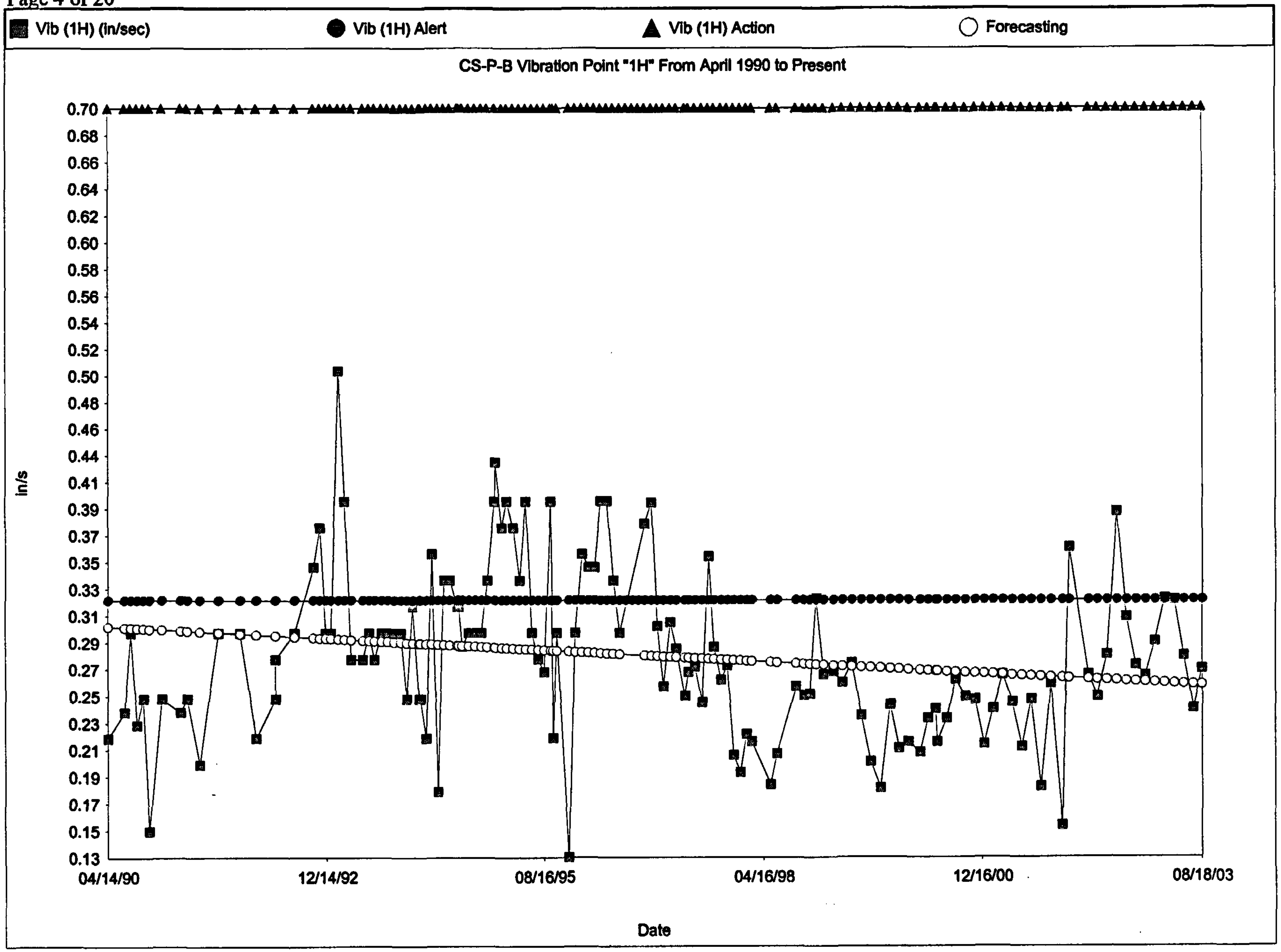
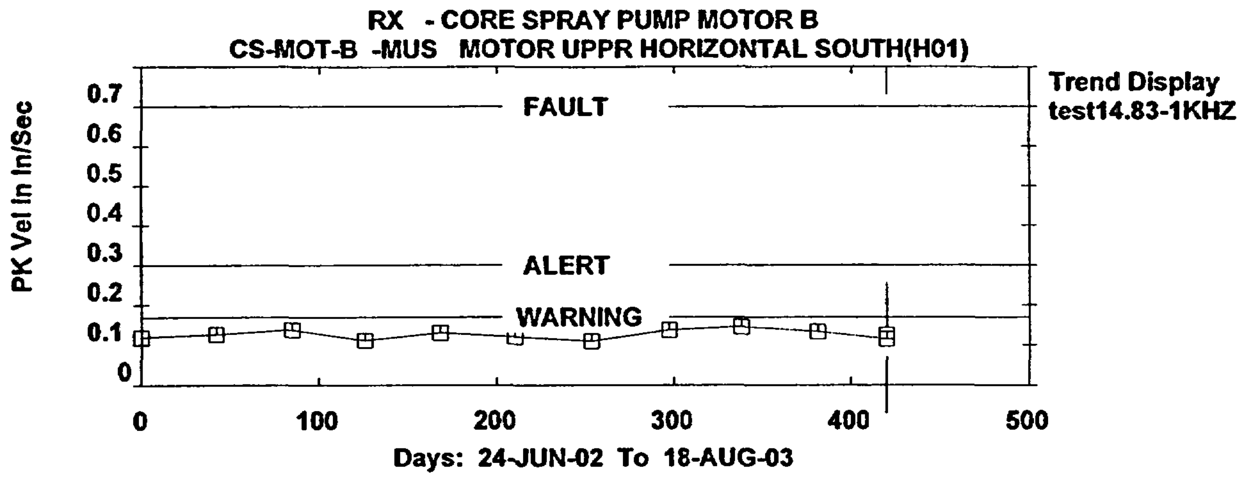
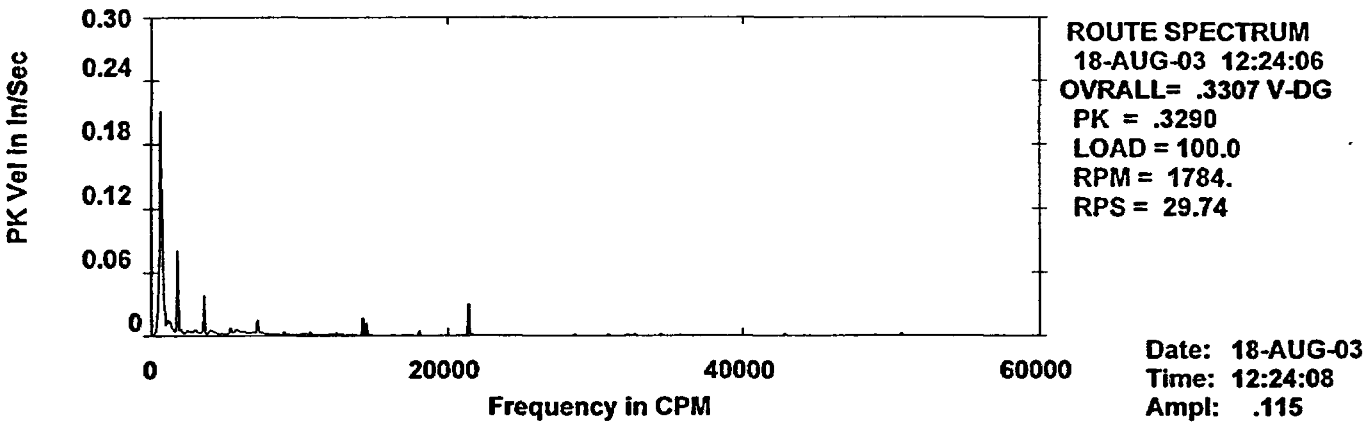

Vib (1H) (in/sec)
Vib (1H) Alert
Vib (1H) Action
Forecasting
CS-P-B Vibration Point "1H" From April 1990 to Present
0.70
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.41
0.39
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
0.17
0.15
0.13
in/s
04/14/90
12/14/92
08/16/95
04/16/98
12/16/00
08/18/03
Date

Figure 2b





List of Trend Points
****

Station: RX --> REACTOR BUILDING
Machine: CS-MOT-B --> CORE SPRAY PUMP MOTOR B
Meas Point: MUS --> MOTOR UPPR HORIZONTAL SOUTH(H01)
Parameter: test14.83-1KHZ (PK Velocity in In/Sec)

DATE	TIME	VALUE	ALARM
24-JUN-02	12:45	.1194	
05-AUG-02	13:06	.1257	
17-SEP-02	02:12	.1374	
28-OCT-02	10:18	.1105	
09-DEC-02	12:54	.1298	
20-JAN-03	15:52	.1201	
04-MAR-03	12:37	.1091	
17-APR-03	13:35	.1367	
28-MAY-03	13:16	.1450	
10-JUL-03	11:57	.1326	
18-AUG-03	12:24	.1146	

ALARMS:	WARNING	ALERT	FAULT
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Figure 2c

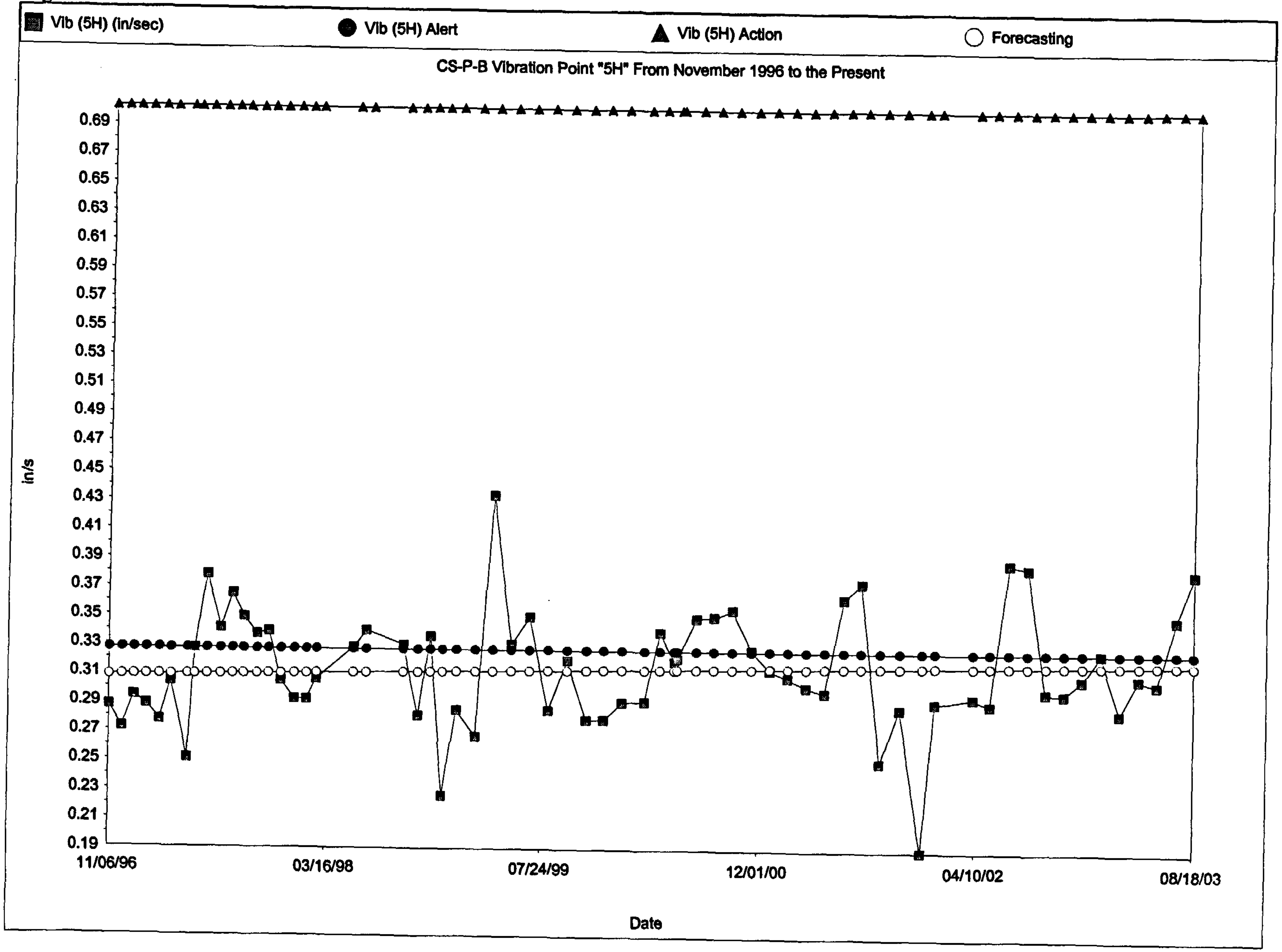

Vib (5H) (in/sec)
Vib (5H) Alert
Vib (5H) Action
Forecasting
CS-P-B Vibration Point "5H" From November 1996 to the Present
in/s
0.69
0.67
0.65
0.63
0.61
0.59
0.57
0.55
0.53
0.51
0.49
0.47
0.45
0.43
0.41
0.39
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
11/06/96
03/16/98
07/24/99
12/01/00
04/10/02
08/18/03
Date

Figure 3a

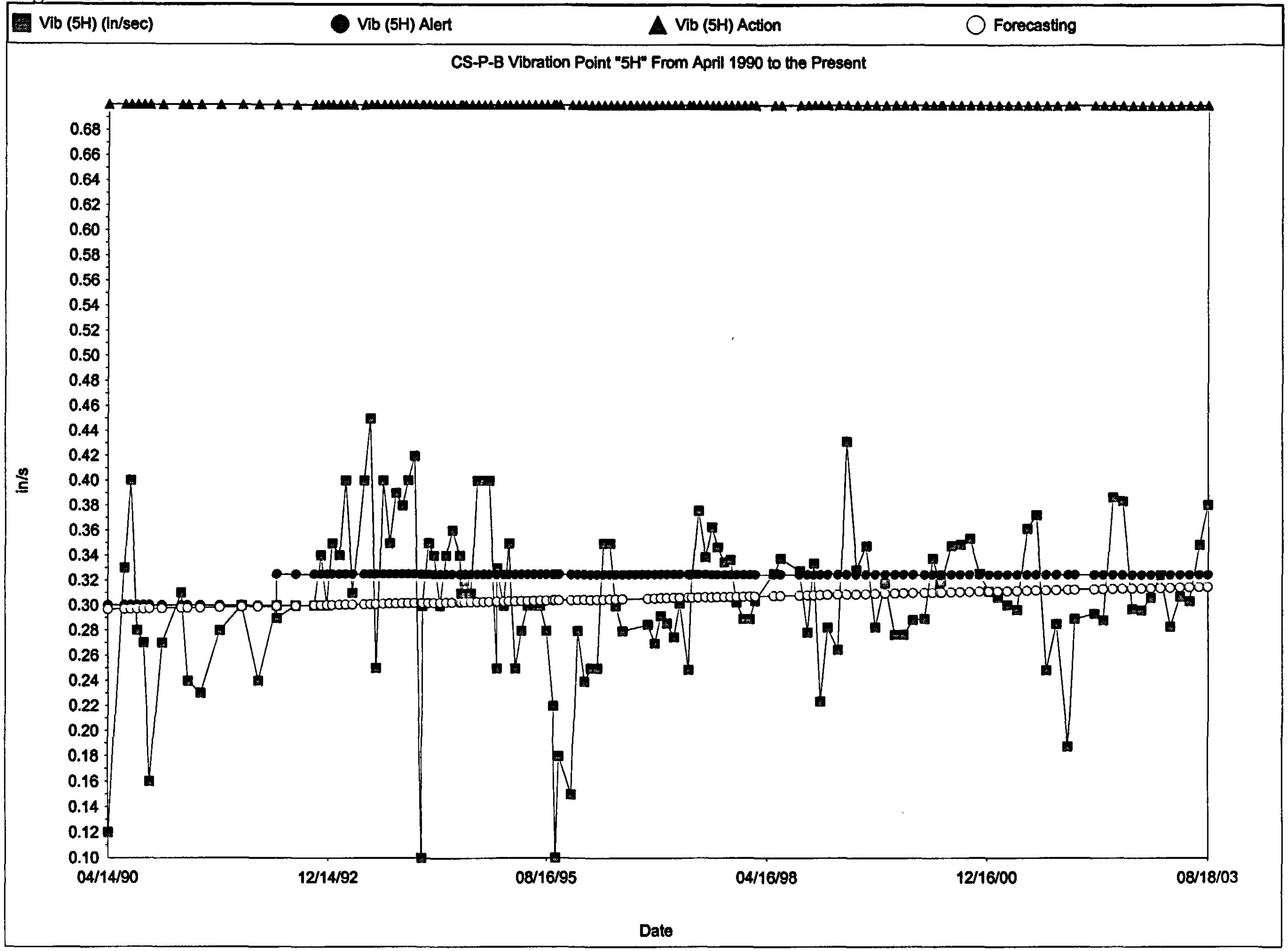
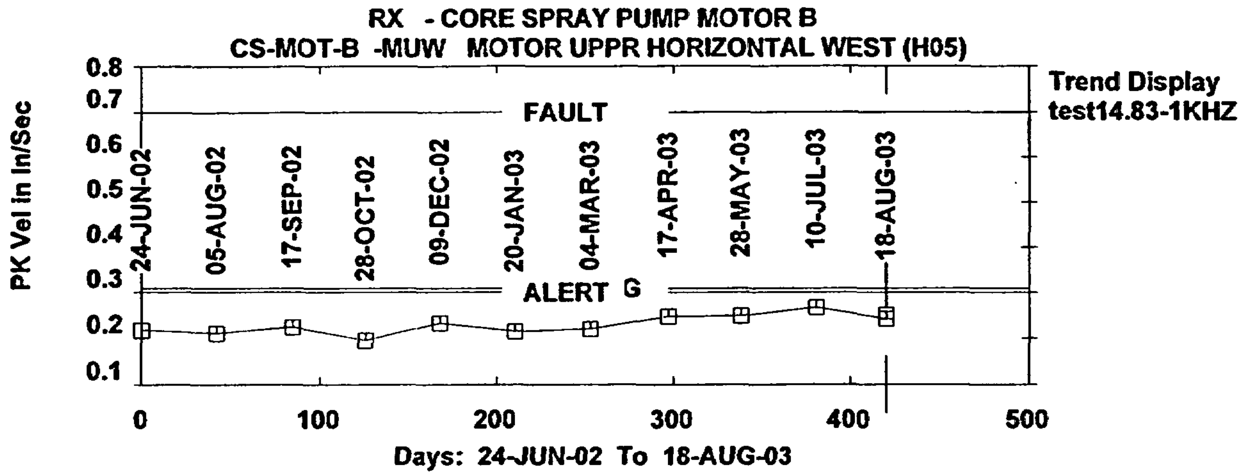
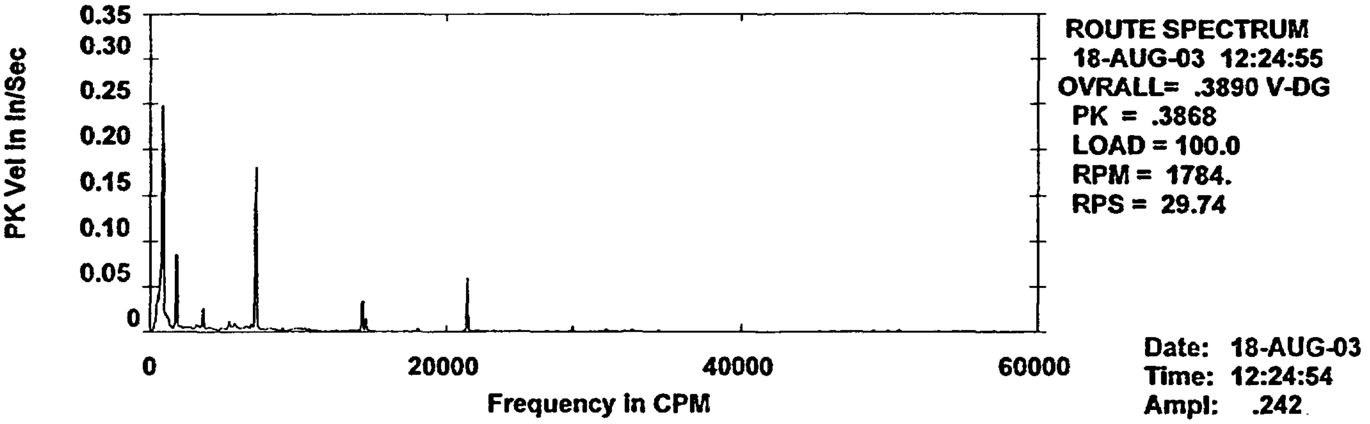

Vib (5H) (in/sec)
Vib (5H) Alert
Vib (5H) Action
Forecasting
CS-P-B Vibration Point "5H" From April 1990 to the Present
in/s
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
04/14/90
12/14/92
08/16/95
04/16/98
12/16/00
08/18/03
Date

Figure 3b





List of Trend Points
****

Station: RX --> REACTOR BUILDING
Machine: CS-MOT-B --> CORE SPRAY PUMP MOTOR B
Meas Point: MUW --> MOTOR UPPR HORIZONTAL WEST (H05)
Parameter: test14.83-1KHZ (PK Velocity in In/Sec)

DATE	TIME	VALUE	ALARM
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28-OCT-02	10:19	.1947	
09-DEC-02	12:54	.2320	
20-JAN-03	15:53	.2140	
04-MAR-03	12:38	.2196	
17-APR-03	13:35	.2472	
28-MAY-03	13:17	.2486	
10-JUL-03	11:59	.2665	
18-AUG-03	12:24	.2417	

ALARMS:	WARNING	ALERT	FAULT
	.3087	.3000	.7000

Figure 3c

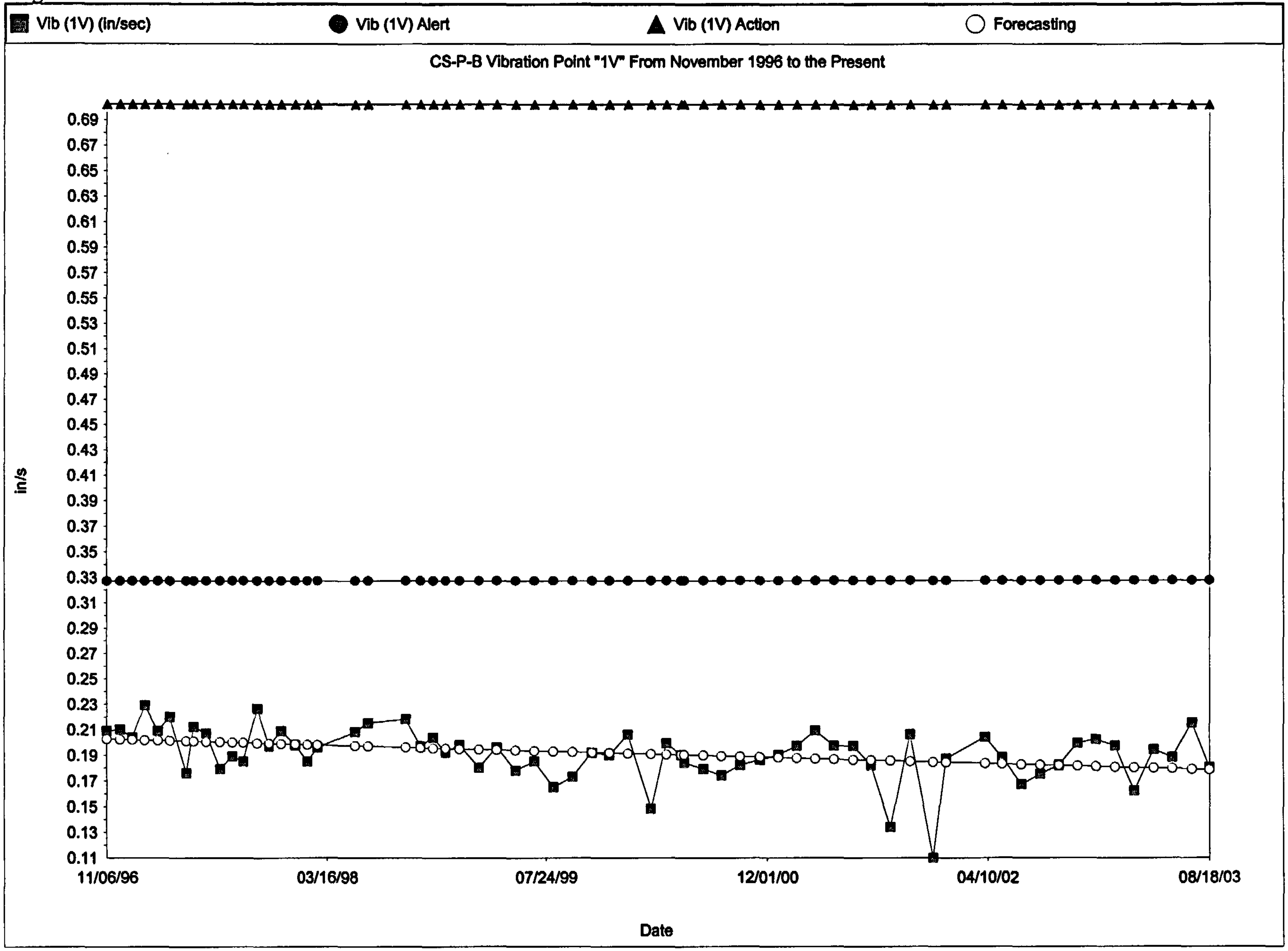

Vib (1V) (in/sec)
Vib (1V) Alert
Vib (1V) Action
Forecasting
CS-P-B Vibration Point "1V" From November 1996 to the Present
0.69
0.67
0.65
0.63
0.61
0.59
0.57
0.55
0.53
0.51
0.49
0.47
0.45
0.43
0.41
0.39
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
0.17
0.15
0.13
0.11
in/s
11/06/96
03/16/98
07/24/99
12/01/00
04/10/02
08/18/03
Date

Figure 4a

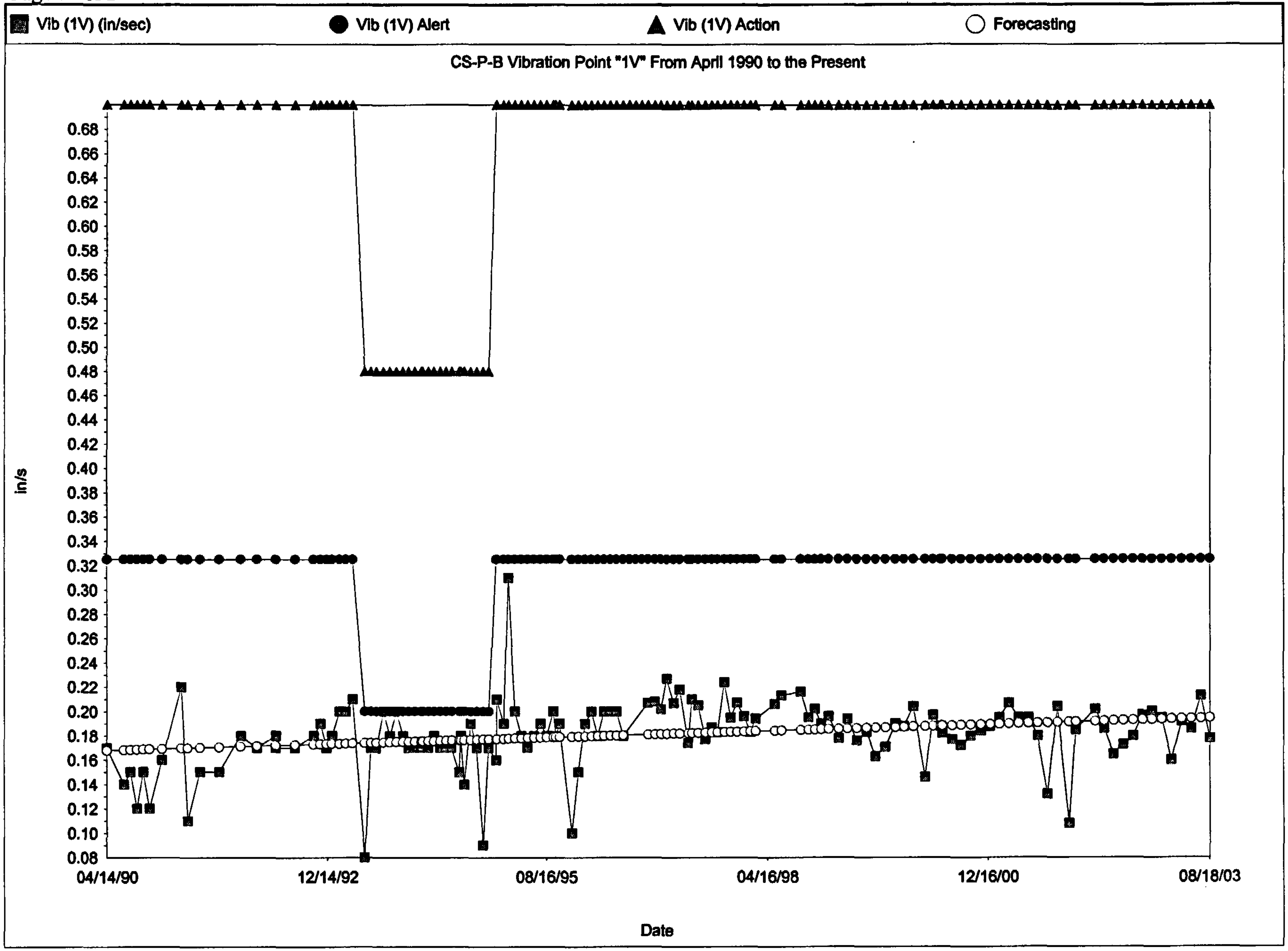

Vib (1V) (in/sec)
Vib (1V) Alert
Vib (1V) Action
Forecasting
CS-P-B Vibration Point "1V" From April 1990 to the Present
in/s
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.16
0.14
0.12
0.10
0.08
04/14/90
12/14/92
08/16/95
04/16/98
12/16/00
08/18/03
Date

Figure 4b

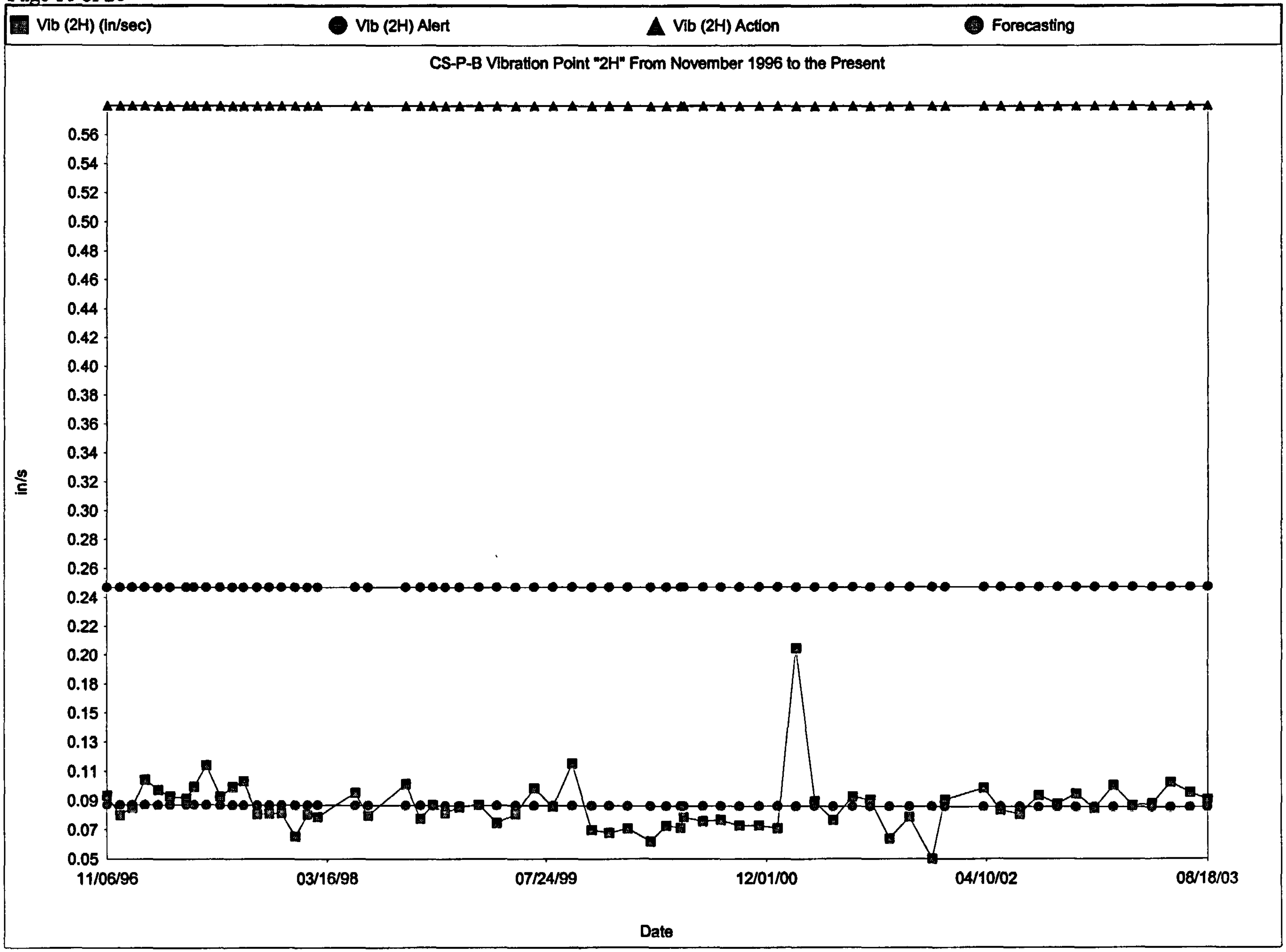

Vib (2H) (in/sec)
Vib (2H) Alert
Vib (2H) Action
Forecasting
CS-P-B Vibration Point "2H" From November 1996 to the Present
in/s
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.38
0.36
0.34
0.32
0.30
0.28
0.26
0.24
0.22
0.20
0.18
0.15
0.13
0.11
0.09
0.07
0.05
11/06/96
03/16/98
07/24/99
12/01/00
04/10/02
08/18/03
Date

Figure 5a

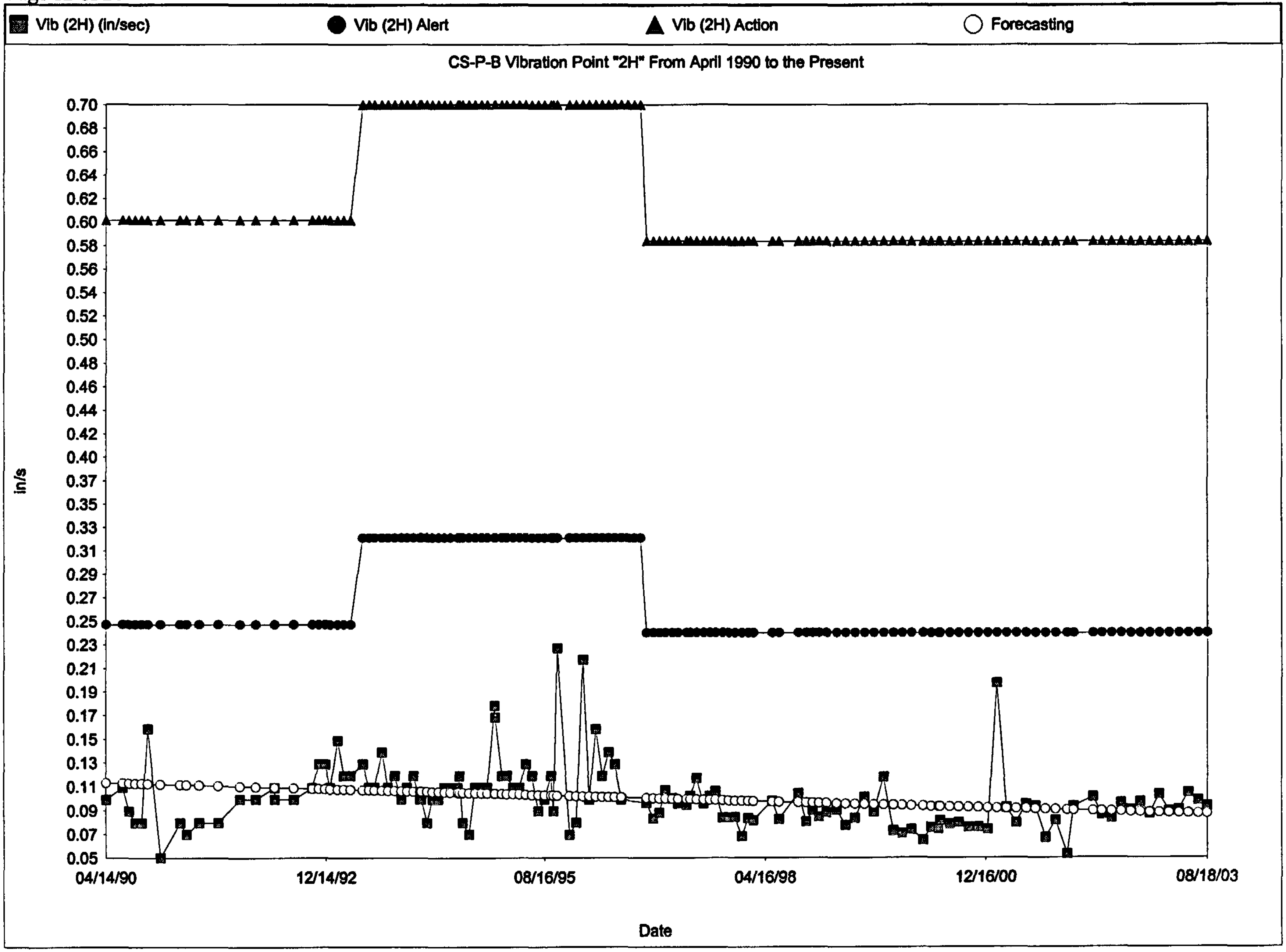

Vib (2H) (in/sec)
Vib (2H) Alert
Vib (2H) Action
Forecasting
CS-P-B Vibration Point "2H" From April 1990 to the Present
in/s
0.70
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
0.17
0.15
0.13
0.11
0.09
0.07
0.05
04/14/90
12/14/92
08/16/95
04/16/98
12/16/00
08/18/03
Date

Figure 5b

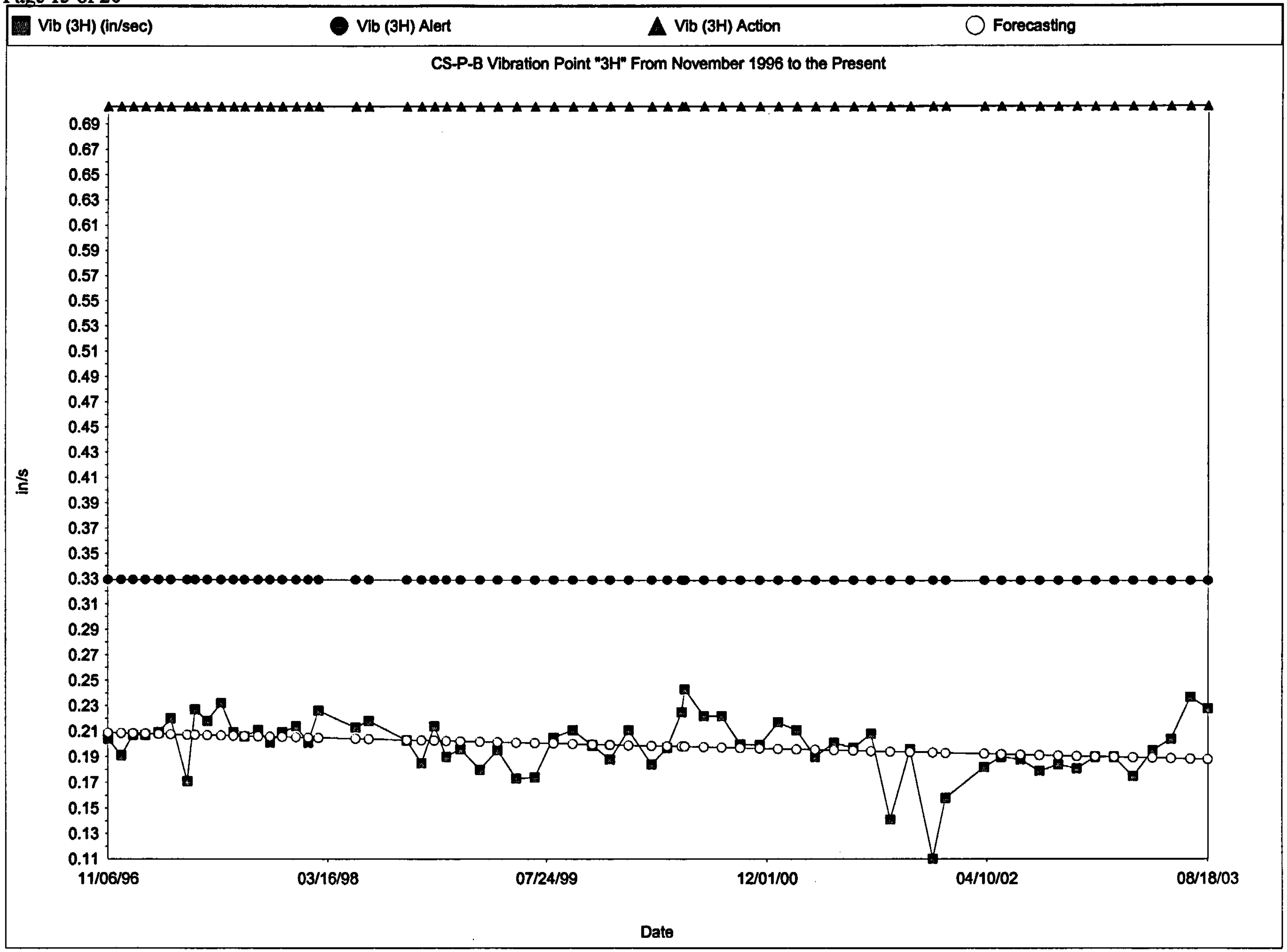

Vib (3H) (in/sec)
Vib (3H) Alert
Vib (3H) Action
Forecasting
CS-P-B Vibration Point "3H" From November 1996 to the Present
in/s
0.69
0.67
0.65
0.63
0.61
0.59
0.57
0.55
0.53
0.51
0.49
0.47
0.45
0.43
0.41
0.39
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
0.17
0.15
0.13
0.11
11/06/96
03/16/98
07/24/99
12/01/00
04/10/02
08/18/03
Date

Figure 6a

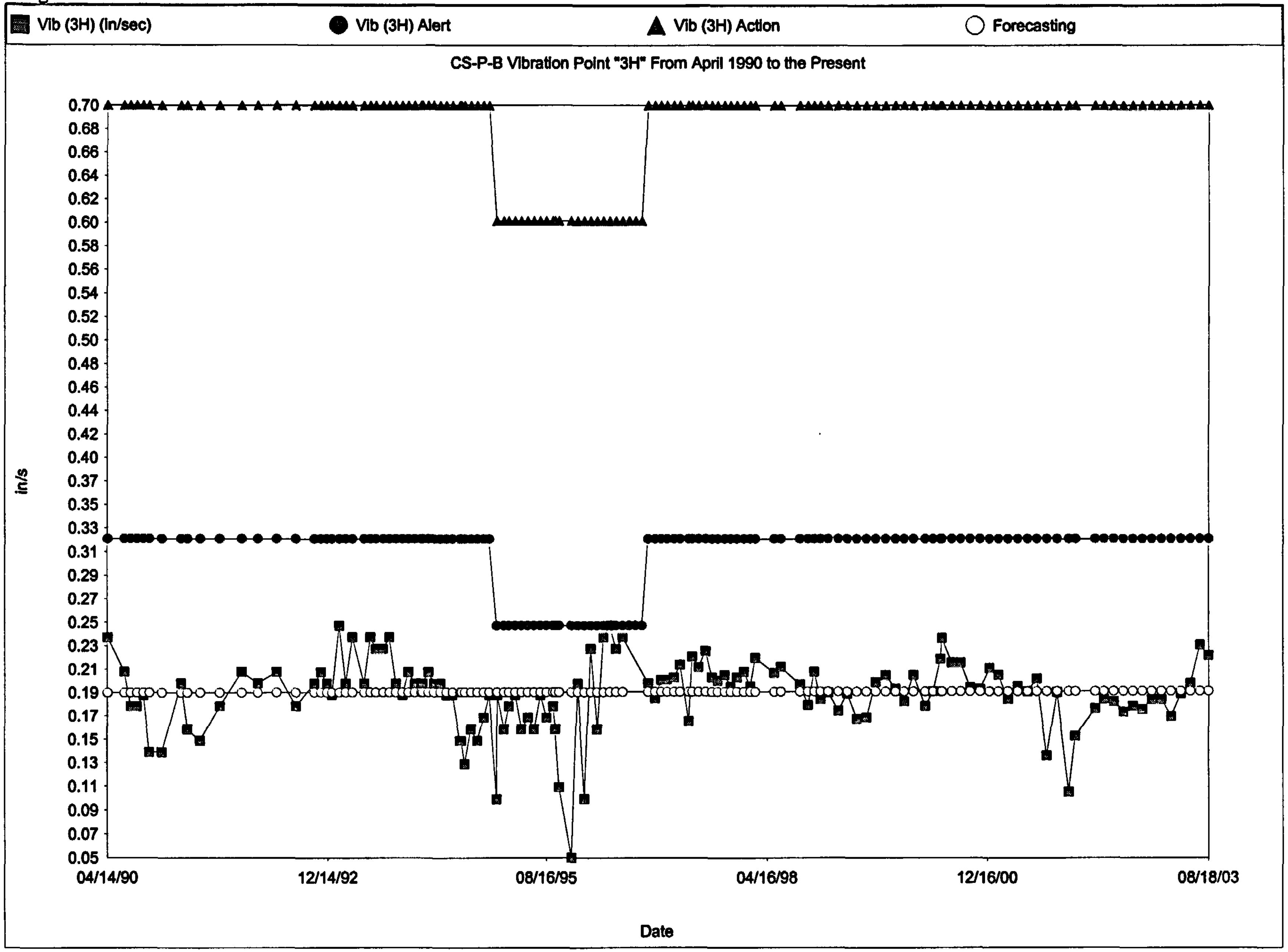
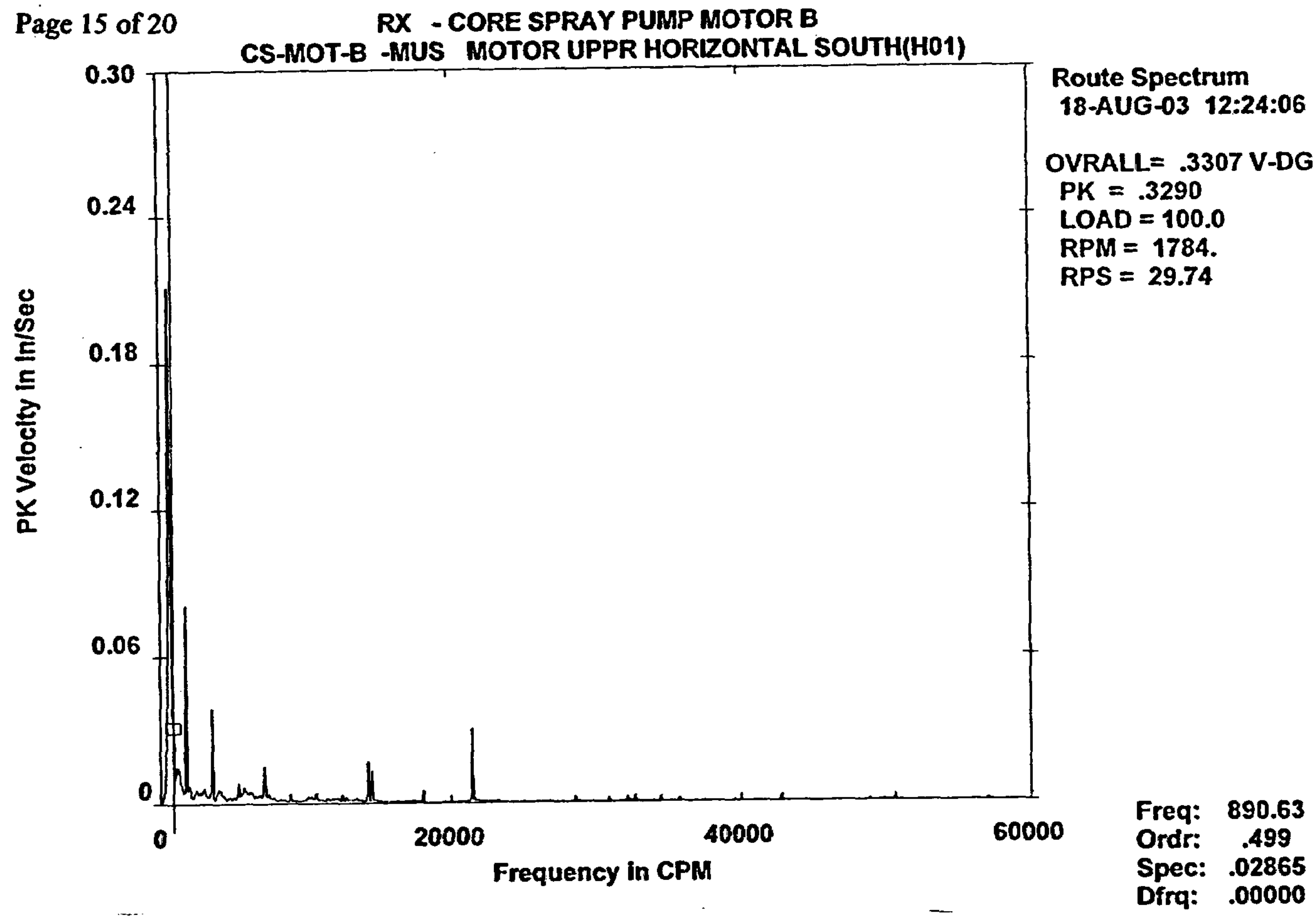

Vib (3H) (in/sec)
Vib (3H) Alert
Vib (3H) Action
Forecasting
CS-P-B Vibration Point "3H" From April 1990 to the Present
0.70
0.68
0.66
0.64
0.62
0.60
0.58
0.56
0.54
0.52
0.50
0.48
0.46
0.44
0.42
0.40
0.37
0.35
0.33
0.31
0.29
0.27
0.25
0.23
0.21
0.19
0.17
0.15
0.13
0.11
0.09
0.07
0.05
in/s
04/14/90
12/14/92
08/16/95
04/16/98
12/16/00
08/18/03
Date

Figure 6b


RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUS MOTOR UPPR HORIZONTAL SOUTH(H01)
PK Velocity in In/Sec
0.30
0.24
0.18
0.12
0.06
0
Route Spectrum
18-AUG-03 12:24:06
OVRALL= .3307 V-DG
PK = .3290
LOAD = 100.0
RPM = 1784.
RPS = 29.74
0
20000
40000
60000
Frequency in CPM
Freq: 890.63
Ordr: .499
Spec: .02865
Dfrq: .00000

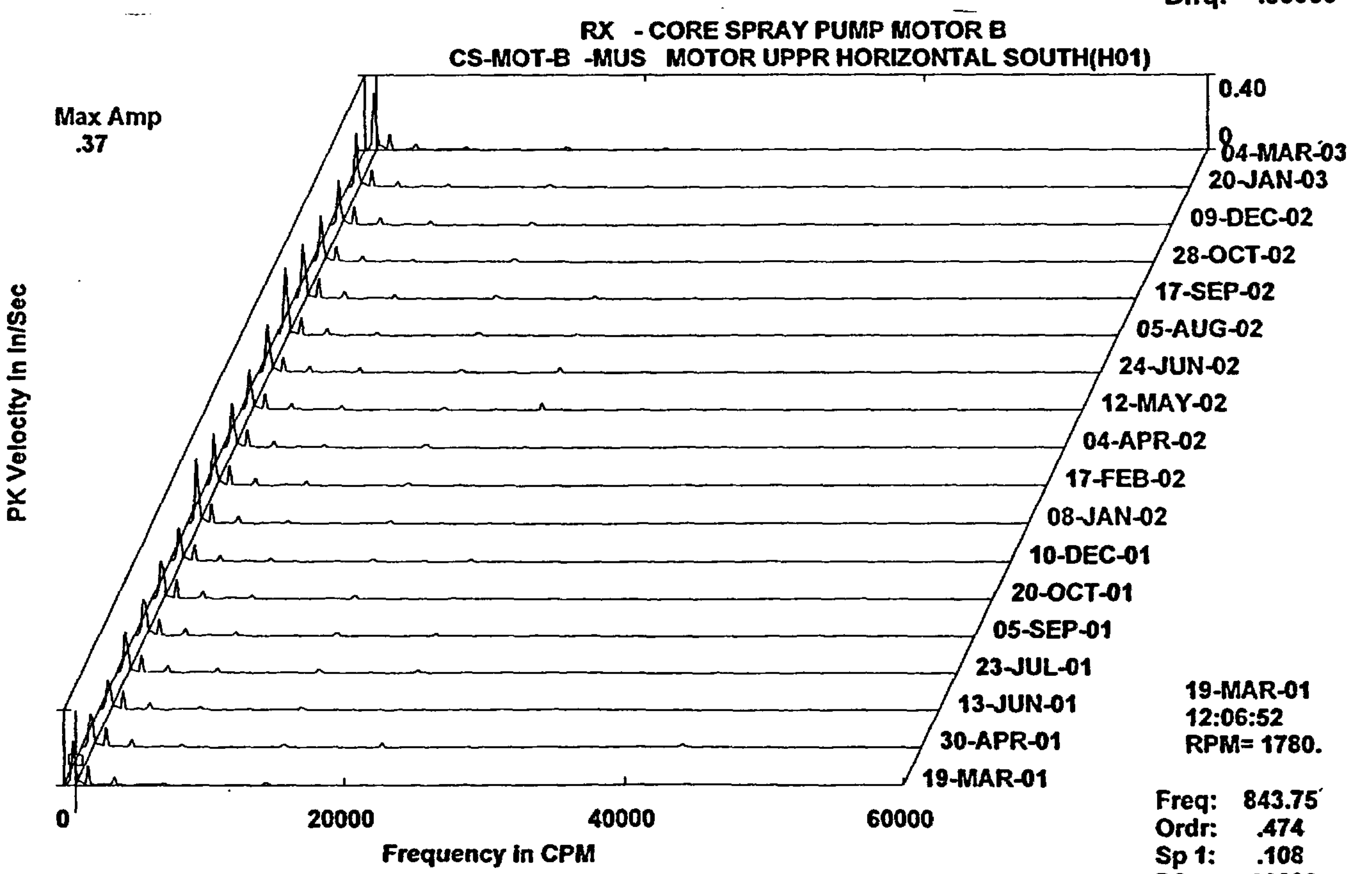
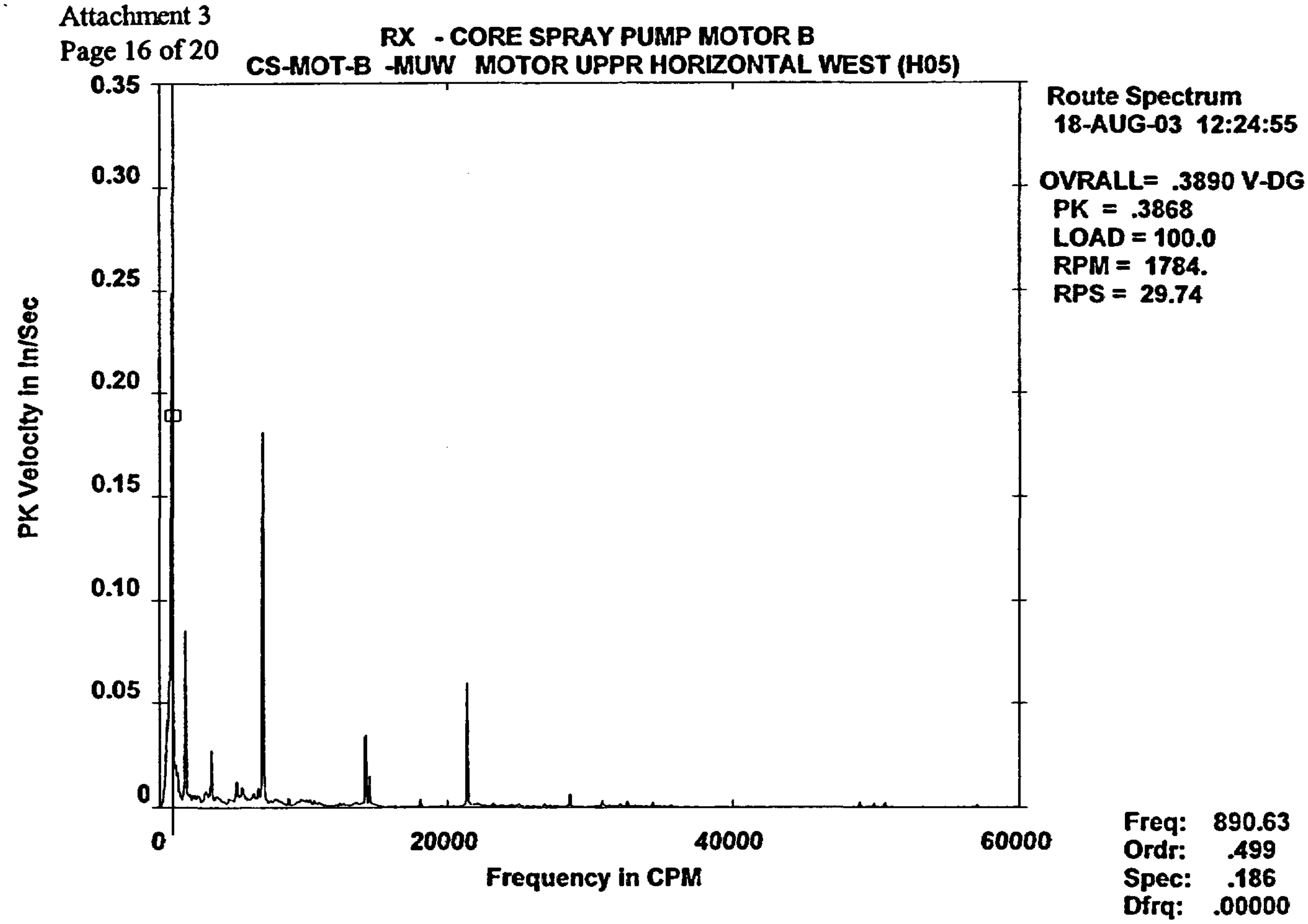

RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUS MOTOR UPPR HORIZONTAL SOUTH(H01)
Max Amp
.37
PK Velocity in In/Sec
0.40
0
04-MAR-03
20-JAN-03
09-DEC-02
28-OCT-02
17-SEP-02
05-AUG-02
24-JUN-02
12-MAY-02
04-APR-02
17-FEB-02
08-JAN-02
10-DEC-01
20-OCT-01
05-SEP-01
23-JUL-01
13-JUN-01
30-APR-01
19-MAR-01
19-MAR-01
12:06:52
RPM= 1780.
0
20000
40000
60000
Frequency in CPM
Freq: 843.75
Ordr: .474
Sp 1: .108
Dfrq: .00000

Figure 7


RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUW MOTOR UPPR HORIZONTAL WEST (H05)
PK Velocity in In/Sec
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0
0
20000
40000
60000
Frequency in CPM
Route Spectrum
18-AUG-03 12:24:55
OVRALL= .3890 V-DG
PK = .3868
LOAD = 100.0
RPM = 1784.
RPS = 29.74
Freq: 890.63
Ordr: .499
Spec: .186
Dfrq: .00000

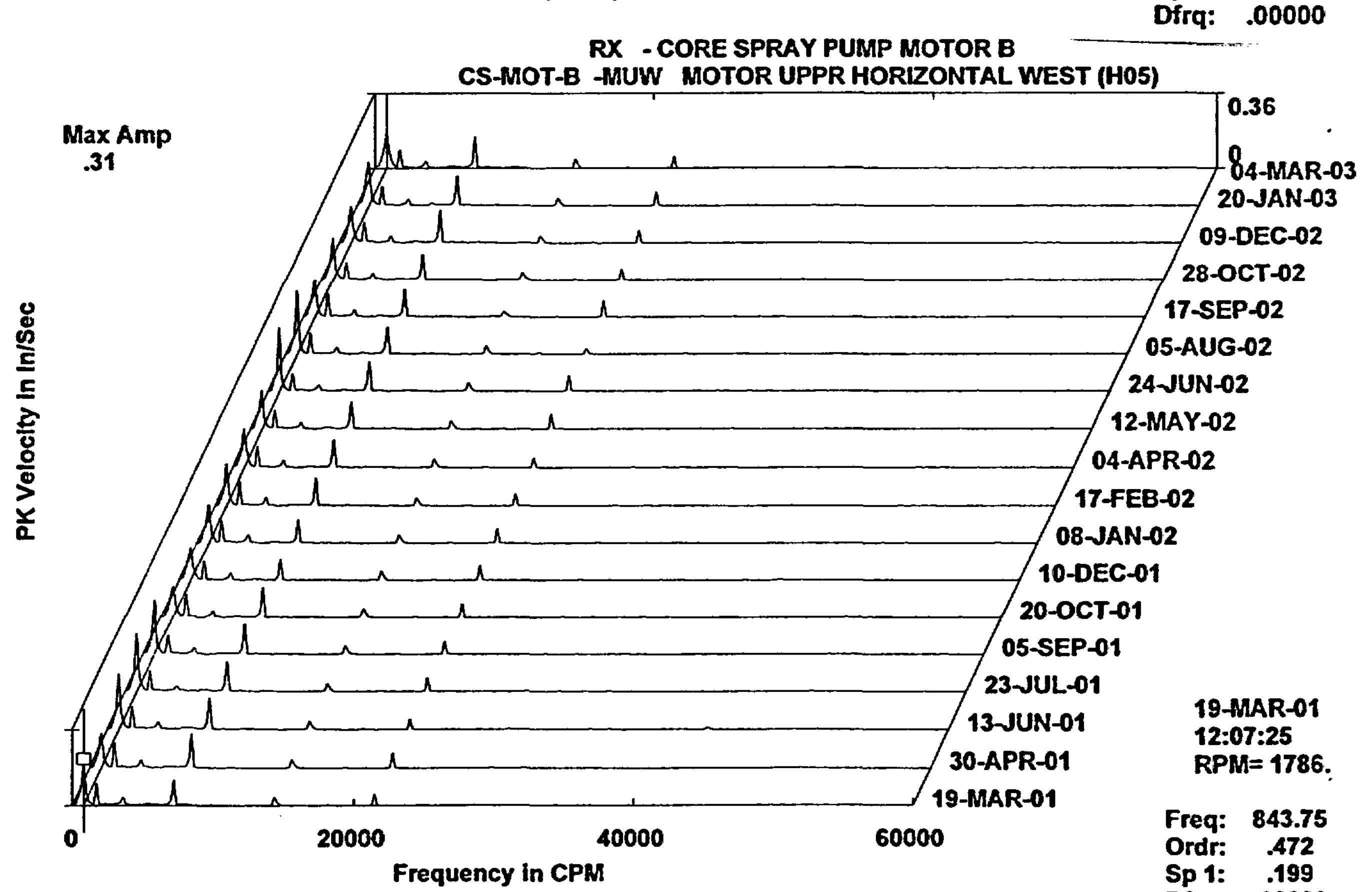
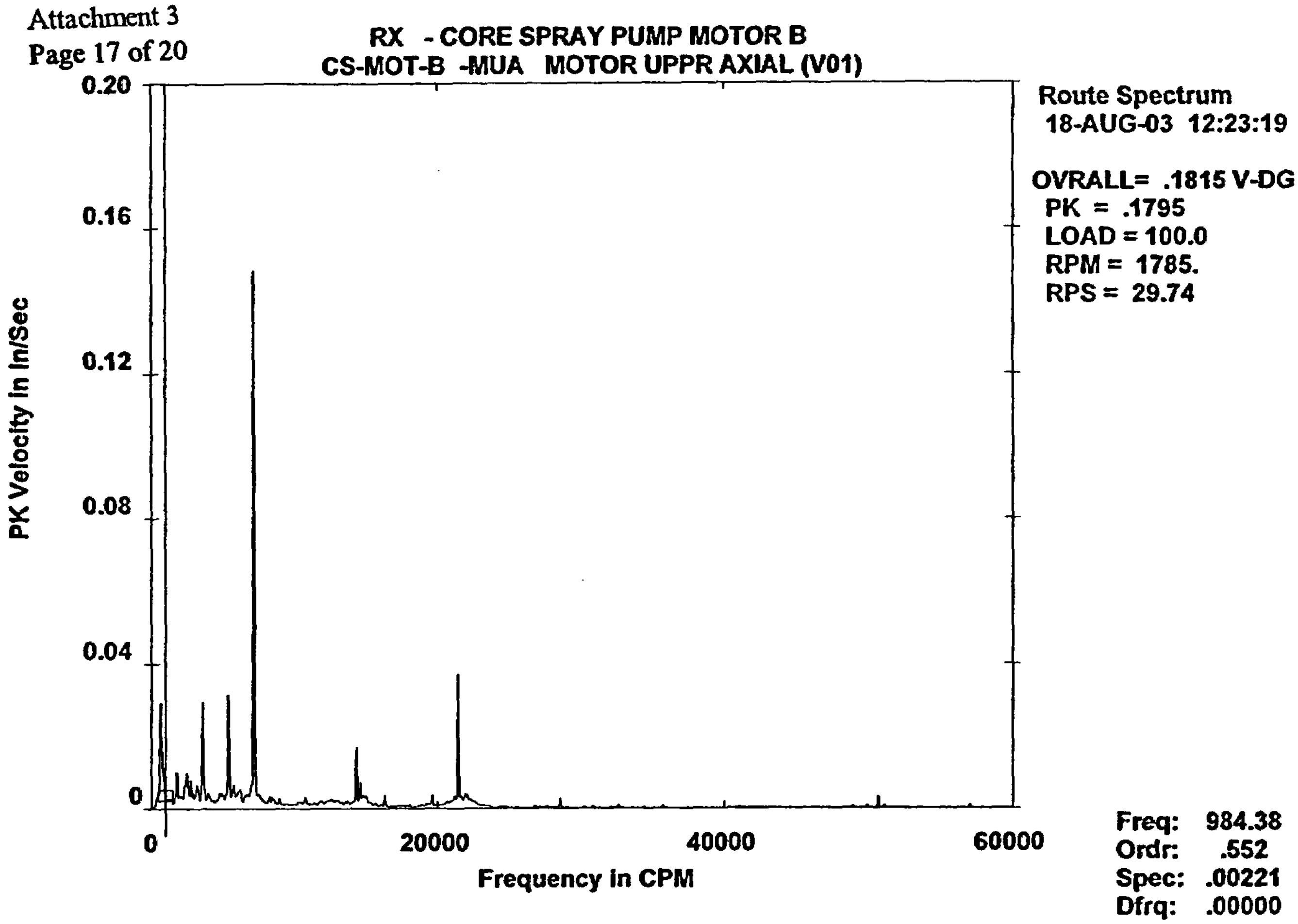

RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUW MOTOR UPPR HORIZONTAL WEST (H05)
Max Amp
.31
PK Velocity in In/Sec
0.36
0
04-MAR-03
20-JAN-03
09-DEC-02
28-OCT-02
17-SEP-02
05-AUG-02
24-JUN-02
12-MAY-02
04-APR-02
17-FEB-02
08-JAN-02
10-DEC-01
20-OCT-01
05-SEP-01
23-JUL-01
13-JUN-01
30-APR-01
19-MAR-01
0
20000
40000
60000
Frequency in CPM
19-MAR-01
12:07:25
RPM= 1786.
Freq: 843.75
Ordr: .472
Sp 1: .199
Dfrq: .00000

Figure 8


RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUA MOTOR UPPR AXIAL (V01)
PK Velocity in In/Sec
0.20
0.16
0.12
0.08
0.04
0
0
20000
40000
60000
Frequency in CPM
Route Spectrum
18-AUG-03 12:23:19
OVRALL= .1815 V-DG
PK = .1795
LOAD = 100.0
RPM = 1785.
RPS = 29.74
Freq: 984.38
Ordr: .552
Spec: .00221
Dfrq: .00000

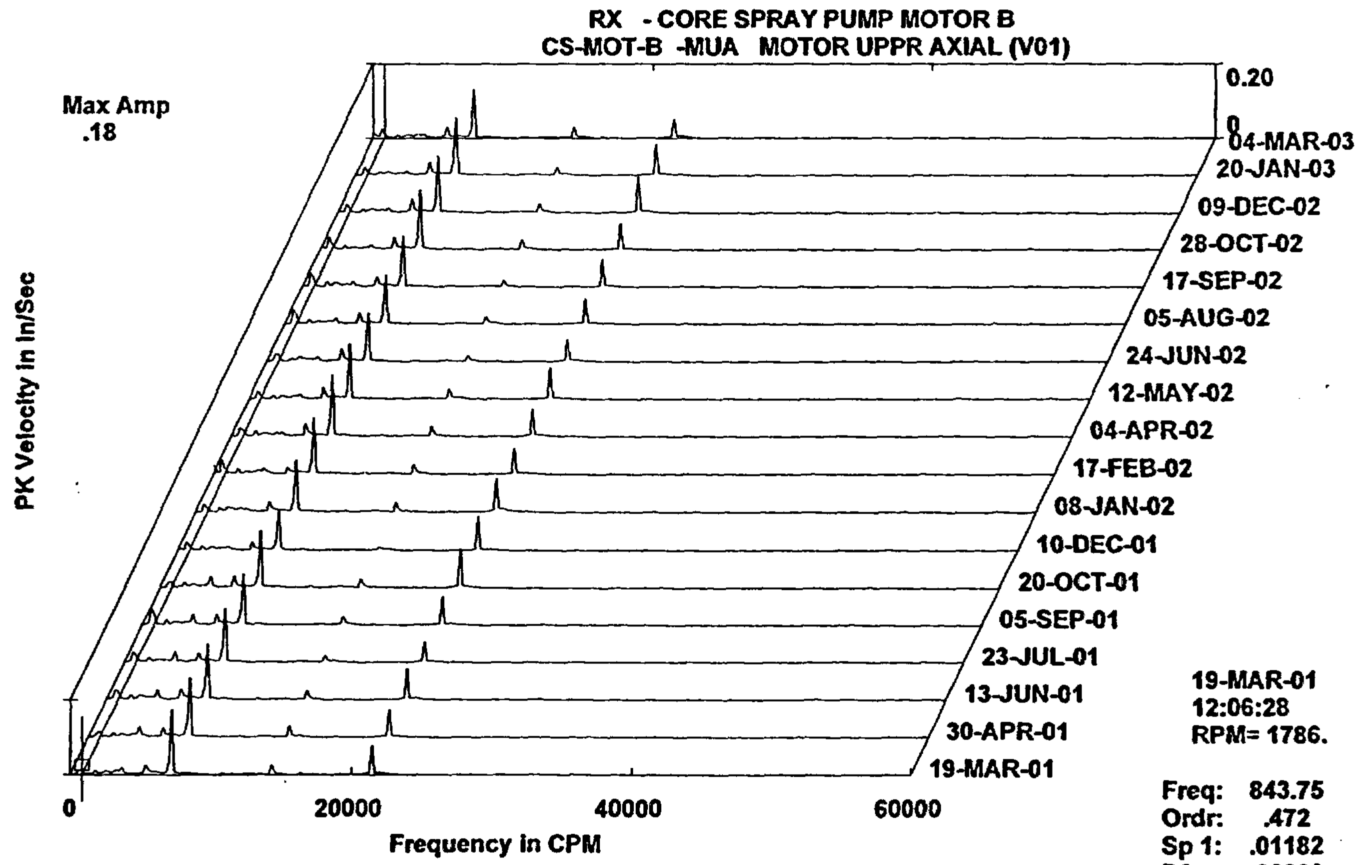
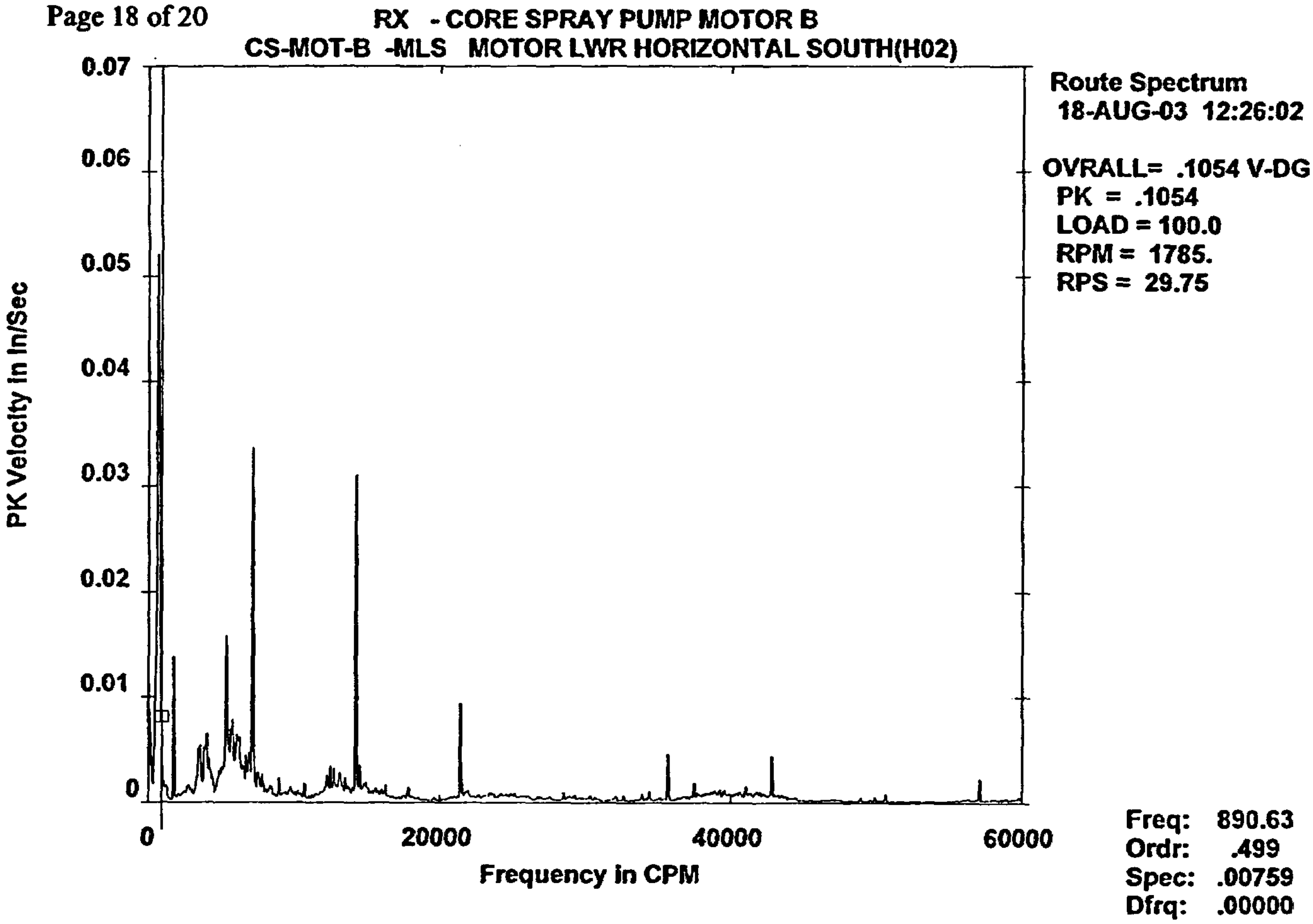

RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MUA MOTOR UPPR AXIAL (V01)
Max Amp
.18
PK Velocity in In/Sec
0.20
0
04-MAR-03
20-JAN-03
09-DEC-02
28-OCT-02
17-SEP-02
05-AUG-02
24-JUN-02
12-MAY-02
04-APR-02
17-FEB-02
08-JAN-02
10-DEC-01
20-OCT-01
05-SEP-01
23-JUL-01
13-JUN-01
30-APR-01
19-MAR-01
0
20000
40000
60000
Frequency in CPM
19-MAR-01
12:06:28
RPM= 1786.
Freq: 843.75
Ordr: .472
Sp 1: .01182
Dfrq: .00000

Figure 9


RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MLS MOTOR LWR HORIZONTAL SOUTH(H02)
Route Spectrum
18-AUG-03 12:26:02
OVRALL= .1054 V-DG
PK = .1054
LOAD = 100.0
RPM = 1785.
RPS = 29.75
PK Velocity in In/Sec
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
0
20000
40000
60000
Frequency in CPM
Freq: 890.63
Ordr: .499
Spec: .00759
Dfrq: .00000

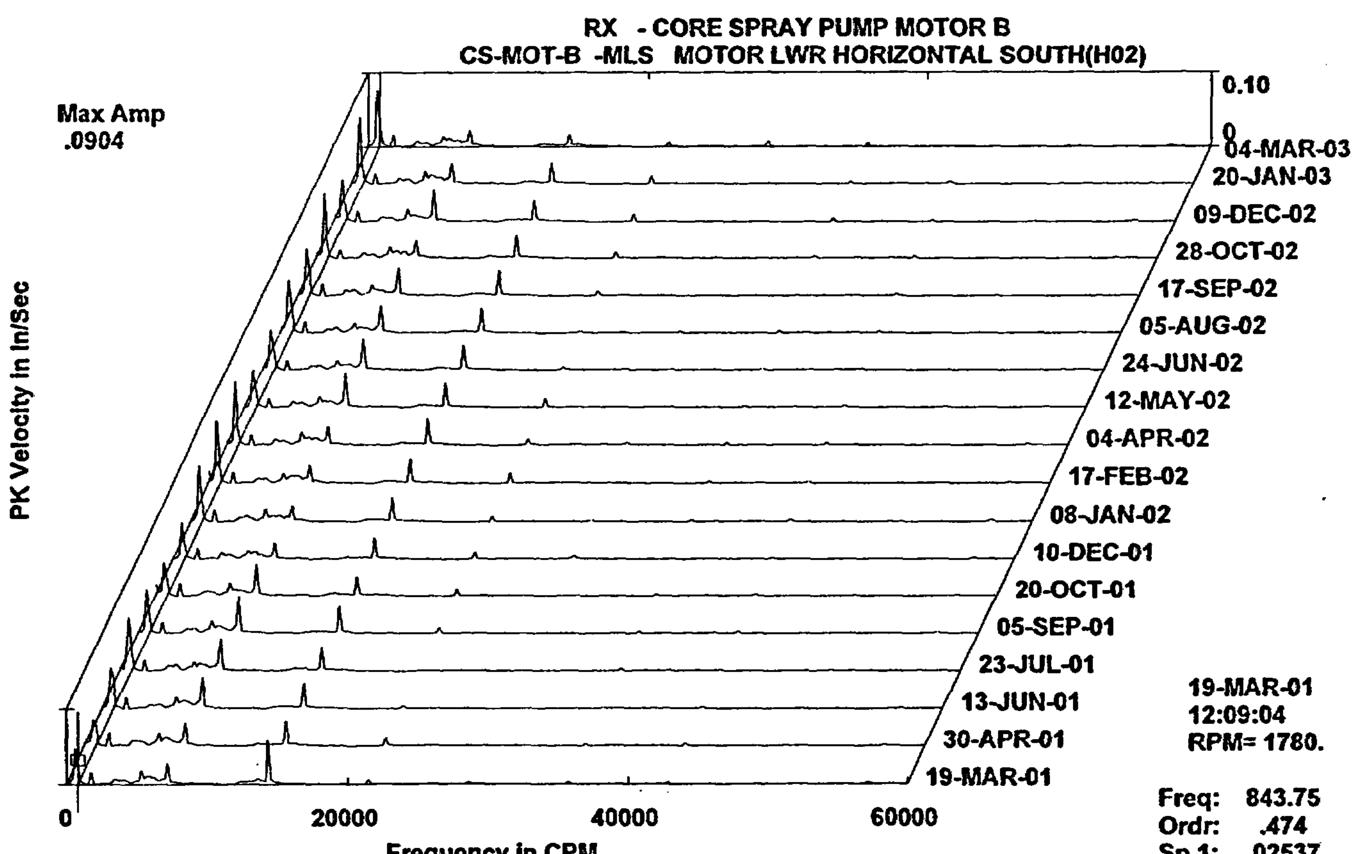
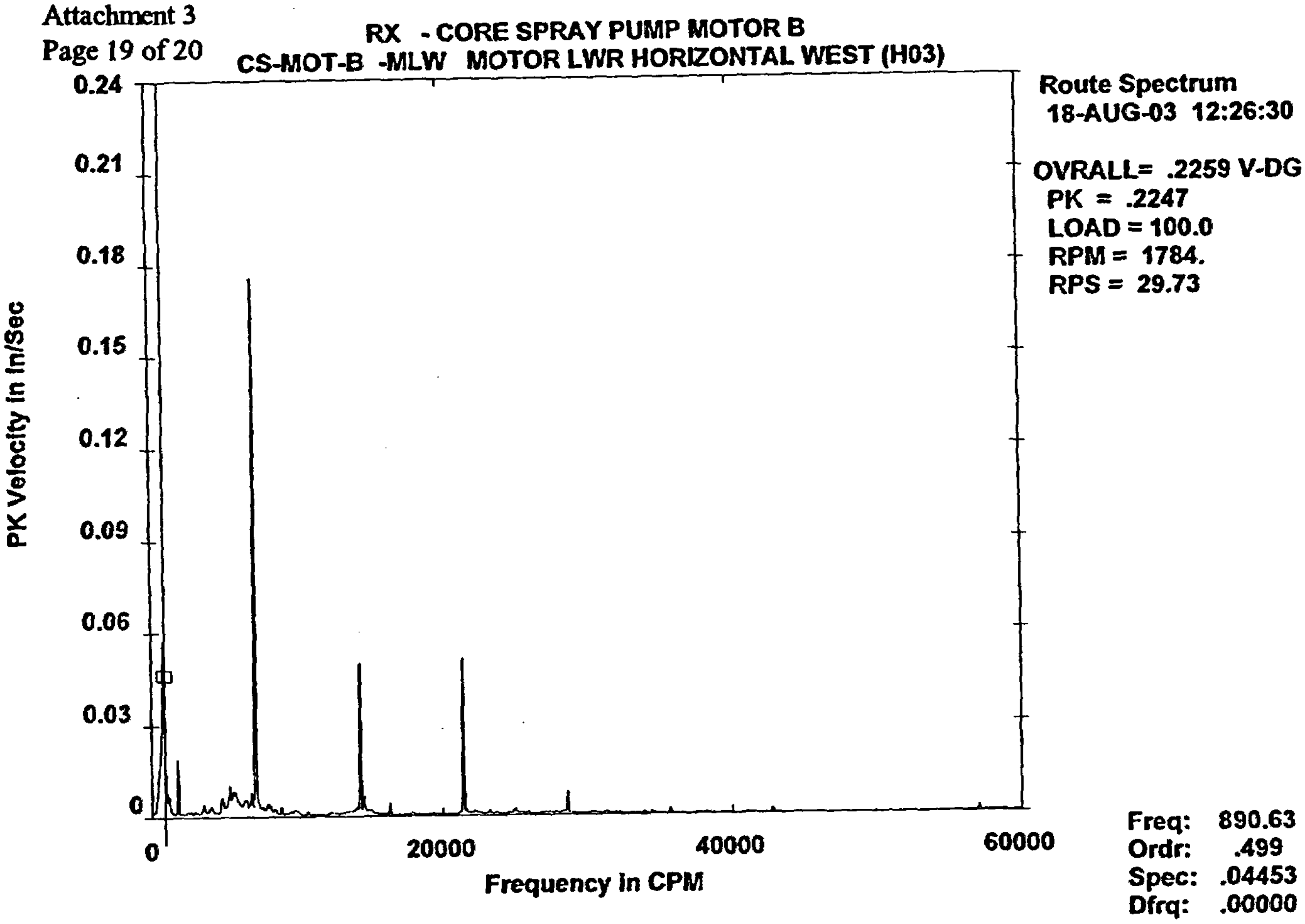

RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MLS MOTOR LWR HORIZONTAL SOUTH(H02)
Max Amp
.0904
0.10
0
04-MAR-03
20-JAN-03
09-DEC-02
28-OCT-02
17-SEP-02
05-AUG-02
24-JUN-02
12-MAY-02
04-APR-02
17-FEB-02
08-JAN-02
10-DEC-01
20-OCT-01
05-SEP-01
23-JUL-01
13-JUN-01
30-APR-01
19-MAR-01
PK Velocity in In/Sec
0
20000
40000
60000
Frequency in CPM
19-MAR-01
12:09:04
RPM= 1780.
Freq: 843.75
Ordr: .474
Sp 1: .02537
Dfrq: .00000

Figure 10


RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MLW MOTOR LWR HORIZONTAL WEST (H03)
Route Spectrum
18-AUG-03 12:26:30
OVRALL= .2259 V-DG
PK = .2247
LOAD = 100.0
RPM = 1784.
RPS = 29.73
PK Velocity in In/Sec
0.24
0.21
0.18
0.15
0.12
0.09
0.06
0.03
0
0
20000
40000
60000
Frequency in CPM
Freq: 890.63
Ordr: .499
Spec: .04453
Dfrq: .00000

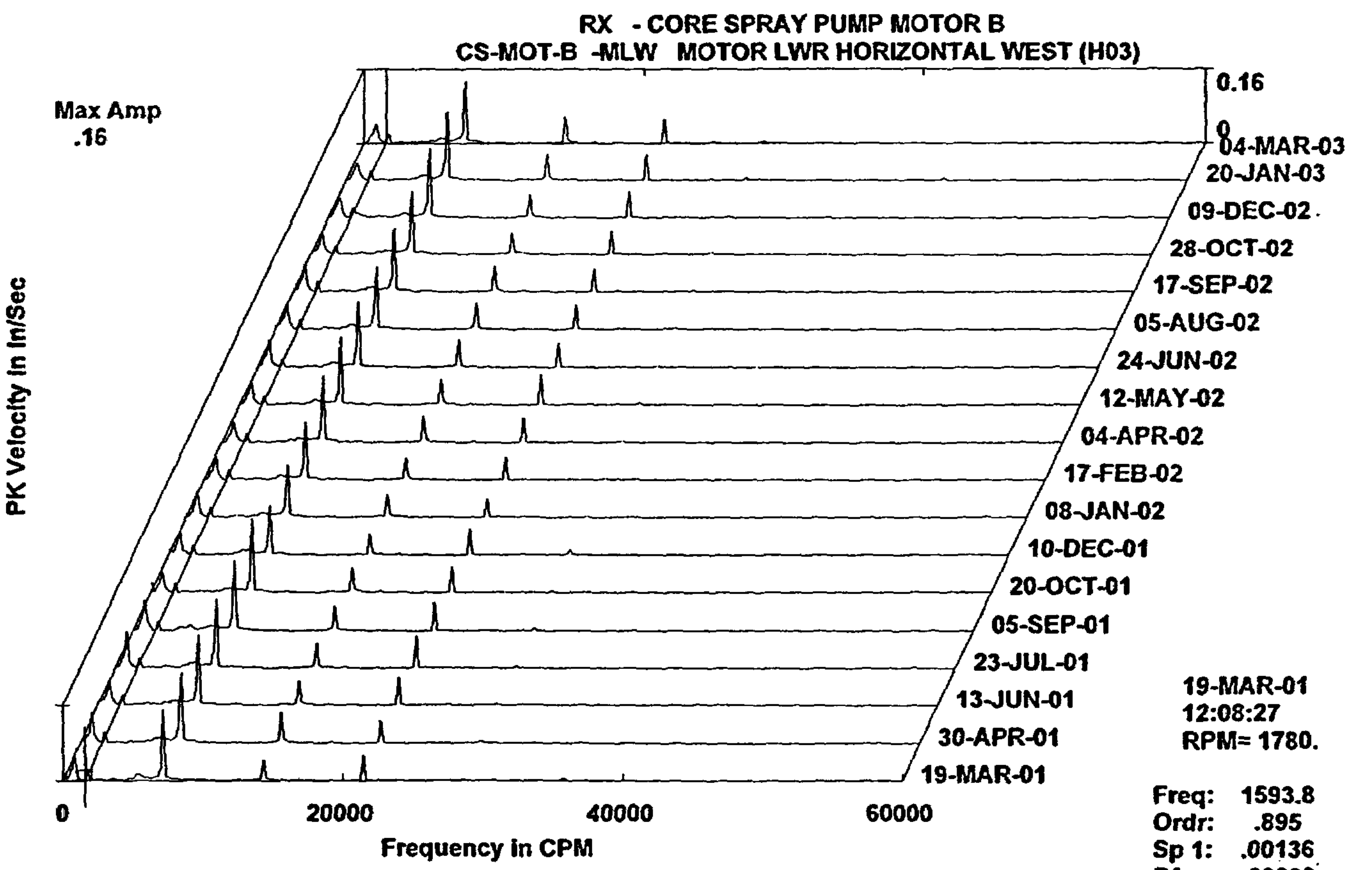

RX - CORE SPRAY PUMP MOTOR B
CS-MOT-B -MLW MOTOR LWR HORIZONTAL WEST (H03)
Max Amp
.16
0.16
0
04-MAR-03
20-JAN-03
09-DEC-02
28-OCT-02
17-SEP-02
05-AUG-02
24-JUN-02
12-MAY-02
04-APR-02
17-FEB-02
08-JAN-02
10-DEC-01
20-OCT-01
05-SEP-01
23-JUL-01
13-JUN-01
30-APR-01
19-MAR-01
PK Velocity in In/Sec
0
20000
40000
60000
Frequency in CPM
19-MAR-01
12:08:27
RPM= 1780.
Freq: 1593.8
Ordr: .895
Sp 1: .00136
Dfrq: .00000

Figure 11

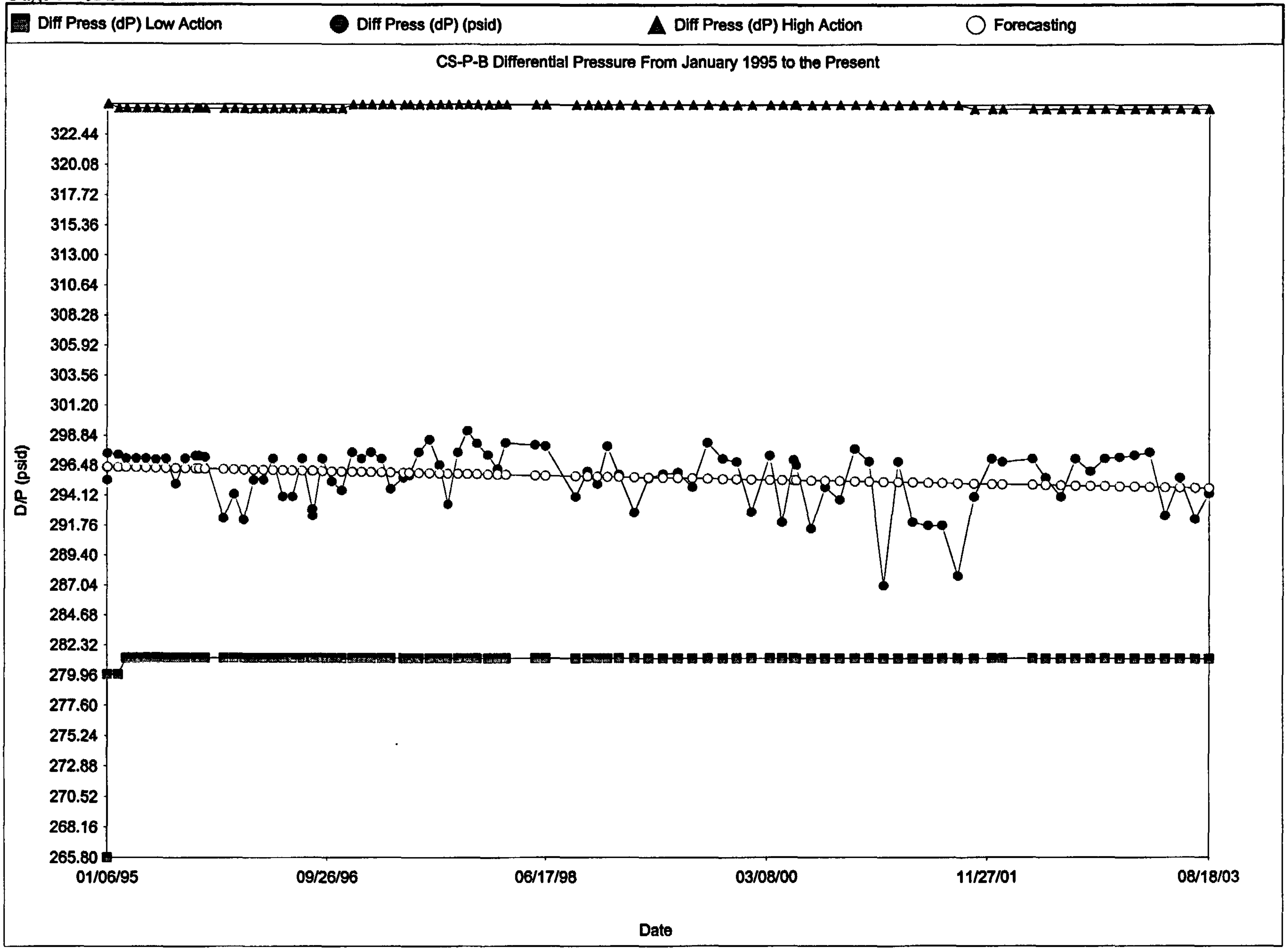

Diff Press (dP) Low Action
Diff Press (dP) (psid)
Diff Press (dP) High Action
Forecasting
CS-P-B Differential Pressure From January 1995 to the Present
322.44
320.08
317.72
315.36
313.00
310.64
308.28
305.92
303.56
301.20
298.84
296.48
294.12
291.76
289.40
287.04
284.68
282.32
279.96
277.60
275.24
272.88
270.52
268.16
265.80
D/P (psid)
01/06/95
09/26/96
06/17/98
03/08/00
11/27/01
08/18/03
Date

Figure 12

Correspondence Number: NLS2003059

The following table identifies those actions committed to by Nebraska Public Power District (NPPD) in this document. Any other actions discussed in the submittal represent intended or planned actions by NPPD. They are described for information only and are not regulatory commitments. Please notify the Licensing & Regulatory Affairs Manager at Cooper Nuclear Station of any questions regarding this document or any associated regulatory commitments.

COMMITMENT	COMMITTED DATE OR OUTAGE
NPPD will administratively monitor the vibration occurring at points 1H and 5H on Core Spray Pump B in the range of frequencies from one-third to one-half pump rotational speed for any anomaly or degrading trend and will take actions to address the condition as appropriate.	Implementation of testing Core Spray Pump B in accordance with NRC-approved RP-06, Revision 1