UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INSERVICE TESTING PROGRAM AND REQUESTS FOR RELIEF

DUKE POWER COMPANY

CATAWBA NUCLEAR STATION, UNITS 1 AND 2

DOCKET NOS. 50-413 AND 50-414

INTRODUCTION

The Code of Federal Regulations, 10 CFR 50.55a(g), requires that inservice testing (IST) of certain ASME Code Class 1, 2, and 3 pumps and valves be performed in accordance with Section XI of the ASME Boiler and Pressure Vessel Code and applicable addenda, except where specific written relief has been requested by the licensee and granted by the Commission pursuant to Subsections (a)(3)(i), (a)(3)(ii), or (g)(6)(i) of 10 CFR 50.55a. In requesting relief, the licensee must demonstrate that: (1) the proposed alternatives provide an acceptable level of quality and safety; (2) compliance would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety; or (3) conformance with certain requirements of the applicable Code edition and addenda is impractical for its facility.

These regulations authorized the Commission to grant relief from ASME Code requirements upon making the necessary findings. The NRC staff's findings with respect to granting or not granting the relief requested as part of the licensee's IST Program are contained in this Safety Evaluation (SE).

This SE covers a relief request for all pumps in the inservice testing program at Catawba Nuclear Station, Units 1 and 2 as described in Duke Power Company's letter dated March 15, 1990, as supplemented by letters dated August 22, 1990, and December 12, 1991, which supersede all previous submittals. The licensee's program is based on the requirements of Section XI of the ASME Code, 1980 Edition through Winter 1981.

RELIEF REQUEST

The licensee requested relief from ASME Code Section XI, Subsection IWP, paragraphs IWP-3100, IWP-3210, IWP-3300, IWP-4110, IWP-4120, IWP-4510, and IWP-4520(b), requirements for the measurement of pump vibration amplitude. The licensee proposes to measure pump vibration peak velocity in lieu of amplitude.

LICENSEE'S BASIS FOR REQUESTING RELIEF

Experience has shown that measuring vibration as required by IWP is not the most effective way to determine the mechanical condition of a pump. In order to better determine the mechanical condition of pumps, multiple vibration velocity measurements will be obtained/evaluated and supplemented, when necessary, with acceleration/displacement measurements and spectral analysis. In order to facilitate this testing, digital vibration instrumentation will be used.

IWP does not provide adequate guidance and requirements for performing the better/alternate testing.

PROPOSED ALTERNATIVE TESTING

In lieu of the vibration requirements of IWP-3100 and IWP-3300, peak vibration velocity will be measured. In most cases, vibration velocity gives the best indication of machine mechanical condition.

In lieu of IWP-4520(b), vibration instrumentation calibration will be over a range of 10 to 1000 Hz. This is the range that the state of the art instrumentation used can be adequately calibrated over. In lieu of IWP-4520(b), vibration velocity will be measured over a range from 1/3 minimum pump shaft rotational speed to 1000 Hz. (Measurement at other frequencies will be taken as necessary.) This range will encompass most potential noise contributors.

In lieu of the vibration instrument accuracy requirements of IWP-4110, the loop accuracy of vibration instruments will be +/-6.56% of reading. This accuracy will be used because IWP does not specify an accuracy for vibration velocity. This accuracy is the best that can be reasonably obtained from the state of the art instrumentation used. (The requirements of IWP allow vibration inaccuracies of greater than +/-15% of reading.)

In lieu of the range requirements imposed on vibration instrumentation by IWP-4120, there will be no vibration instrumentation range requirement (digital vibration instrumentation is auto-ranging). It is not necessary to have a range requirement because the accuracy stated above and the readability of a digital gauge are not dependent upon instrument range.

In lieu of the vibration ranges specified in IWP-3210, the following ranges shall be used. These ranges will be used because IWP does not specify ranges for vibration velocity. These ranges are based on current vibration standards (vibration severity charts).

	Acceptable Range	Alert Range	Required Action Range
For all Pumps When V_r $\leq$ 0.075 in/sec	0 to 0.19 in/sec	>0.19 to 0.45 in/sec	> 0.45 in/sec
For Centrifugal Pumps when V_r > 0.075 in/sec	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$ or >0.325 to 0.70 in/sec	$6V_r$ or >0.70 in/sec
For Reciprocating Pumps when V_r > 0.075 in/sec	$\leq 2.5V_r$	$>2.5V_r$ to $6V_r$	$>6V_r$

In lieu of IWP-4510, peak vibration velocity measurements shall be taken during each test.

On centrifugal pumps, measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two orthogonal directions. These measurements shall be taken on each accessible pump bearing housing. If no pump bearing housings are accessible, these measurements shall be taken at the accessible location that gives the best indication of lateral pump vibration. This location shall be on the pump casing or motor bearing housing.

Measurements also shall be taken in the axial direction. The measurements shall be taken on each accessible pump thrust bearing housing. If no pump thrust bearing housings are accessible, the measurements shall be taken at the accessible location that gives the best indication of axial pump vibration. This location shall be one of the following:

Pump casing
Motor thrust bearing housing
Motor casing

On reciprocating pumps, a measurement shall be taken on the bearing housing of the crankshaft, approximately perpendicular to both the crankshaft and the line of plunger travel.

EVALUATION

The licensee has requested relief from the requirements of Section XI, Subsection IWP pertaining to the measurement of pump vibration amplitude and proposes an alternative test to measure pump vibration peak velocity. The purpose of pump vibration assessment is to assure operability, detect degradation, and effect repairs prior to the onset of conditions leading to pump inoperability. The proposed alternative to measure and monitor vibration velocity is an industry accepted method that provides a comprehensive and sensitive technique of assessing pump condition and early indications of degradation.

The advantages of measuring and monitoring vibration velocity, for assessing pump condition, are widely acknowledged in the industry, codes, and standards community. The ASME/ANSI OM-6 Standard, Inservice Testing of Pumps in Light-Water Reactor Power Plants, includes this method of vibrational monitoring for inservice pump testing. This standard has been incorporated in ASME OM Code 1990, Code for Operation and Maintenance of Nuclear Power Plants. Further, Regulatory Guide 1.147, Inservice Inspection Code Case Acceptability ASME Section XI Division 1, approved the use of Code Case N-465 which states ASME/ANSI OM Part 6 may be used for pump testing in lieu of Subsection IWP.

The licensee's alternative testing reflects the pertinent requirements of ASME/ANSI OM Part 6 except for (1) the proposed inclusion of limits for the very smooth operating pumps, (2) calibration of instrumentation over a range of 10 to 1000 Hz, and (3) the use of instrumentation that does not meet the ±5% accuracy requirement.

(2) Although the licensee's proposed assigned absolute vibration velocity limits for very smooth operating pumps are not specifically defined in OM-6, the limits were established, in part, based on OM-6 acceptance criteria and are perscribed in a more restrictive alert and required action envelope.

The licensee's letter of December 12, 1991, provides information concerning the use of vibration instrumentation calibrated from 10 Hz to 1000 Hz and ability to monitor subharmonic resonances indicative of corditions such as oil whip.

The licensee has two pumps in the program having a one-third running speed less than 10 Hz. These pumps are in the Nuclear Service Water System and Control Area Chilled Water System. The one-third running speed for these pumps are 3.95 Hz and 9.83 Hz. The licensee has a predictive maintenance program that does address the subharmonic concerns. Vibration responses are monitored over the full spectra from 3 Hz to 1000 Hz and are recorded and trended. The subharmonic band provides good characterization of vibrations associated with malfunctions, such as oil whirl or whip.

The licensee's CSI Model 2110 instrument used for vibration monitoring has been equipped with analog integration circuits and other firm ware upgrades to lessen instrument susceptability to field problems with low frequency measurements and provide capability of obtaining repeatability of results at frequencies as low as 3 Hz. The instrument manufacturer assured the licensee that with these enhancements the instrument frequency range can be lowered to 3 Hz and the instrument response is flat down to 2 to 3 Hz. The licensee's experience with the instrument and monitoring results has provided no contradictive evidence of this performance. Although the instrument has proven to be repeatable and accurate at frequencies as low as 3 Hz, the equipment available for calibration by Duke Power's standards lab will not support calibration of instruments to a frequency less than 10 Hz.

The licensee states that instrumentation for vibration measurements in the proposed alternative is in place, in a well established and effective vibration monitoring program. Further, any changes in instrumentation would disrupt the program, be expensive, and the improvement in accuracy would have a negligible impact on the effectiveness of pump vibration monitoring.

(3) The licensee notes that the ±6.56% of "reading" accuracy of the instrument in the program, in most cases, is more accurate than the IWP requirement. The IWP accuracy requirement is ±5% of "full scale" and allows the "full scale" range to be 3 times the reference value. Therefore, IWP could allow an accuracy of ±15% of "reading" at the reference value. The licensee further states a comparison cannot be made with the ±5% OM-6 requirement since it is not specified as relative to "reading" or "full scale."

The licensee's accuracy comparison with IWP requirements has merit. IWP does not address the requirements of instrument accuracy for vibration velocity measurements using digital instruments. However, OM-6 does specify that the ±5% accuracy applies over the calibrated range for digital instruments. Therefore, the proposed instrument accuracy is outside the OM-6 limits by ±1.56%. Further, considering the minor impact of ±1.56% error on the specified alert and action required range, it is not reasonable to require the licensee to replace the instrument with another state of the art instrument that may meet the ±5% requirement. However, the licensee should consider instrument accuracy in the analyses and evaluation of pump test data.

CONCLUSION

Based on the review of the licensee's relief request as evaluated by this SE, the NRC staff concludes that the licensee's proposed alternatives would provide an acceptable level of quality and safety, and imposition of compliance would result in an undue burden on the licensee without a compensating increase in the level of quality and safety. Relief is, therefore, granted from the requirements of IWP-3100, IWP-3210, IWP-3200, IWP-4110, IWP-4120, IWP-4510 and IWP-4520(b) for the measurement of pump vibration amplitude pursuant to 10 CFR 50.55a(a)(3)(i) and (ii).

Principal Contributor: F. Grubelich, EMEB/DET

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