UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO THE INSERVICE TESTING PROGRAM REQUEST FOR RELIEF

TOLEDO EDISON COMPANY

CENTERIOR SERVICE COMPANY

AND

THE CLEVELAND ELECTRIC ILLUMINATING COMPANY

DAVIS-BESSE NUCLEAR POWER STATION, UNIT NO. 1

DOCKET NO. 50-346

1.0 INTRODUCTION

The Code of Federal Regulations, 10 CFR 50.55a, 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 relief has been requested by the licensee and alternatives authorized or relief granted by the Commission pursuant to Sections (a)(3)(i), (a)(3)(ii), or (f)(6)(i) of 10 CFR 50.55a. In proposing alternatives or 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 is impractical for its facility. NRC guidance contained in Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," provided alternatives to the Code requirements determined acceptable to the staff.

Section CFR 50.55a authorizes 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).

Furthermore, in rulemaking to 10 CFR 50.55a effective September 8, 1992, (See 57 Federal Register 34666), the 1989 Edition of ASME Code Section XI was incorporated in paragraph (b) of §50.55a. The 1989 edition provides that the rules for IST of pumps and valves may meet the requirements set forth in ASME Operations and Maintenance Standards Part 6 (OM-6), "Inservice Testing of Pumps in Light-Water Reactor Power Plants," and Part 10 (OM-10), "Inservice Testing of Valves in Light-Water Reactor Power Plants." Pursuant to 10 CFR 50.55a (f)(4)(iv), portions of editions or addenda may be used provided that all related requirements of the respective editions or addenda are met, and therefore, relief is not required for those inservice tests that are conducted in accordance with OM-6 and OM-10, or portions thereof. Whether all related requirements are met is subject to NRC inspection.

2.0 BACKGROUND

By letters dated December 2, 1991, April 23, 1993, and August 18, 1993, the NRC reviewed and approved the "Second Interval Pump and Valve Inservice Testing Program" for Davis-Besse Nuclear Power Station (DBNPS), Unit No. 1 and associated requests for relief. In a letter dated December 2, 1991, the NRC approved relief request (RP-4) that allowed the use of pump performance curves to determine acceptable pump performance in lieu of using fixed reference flowrates and differential pressures for the Service Water Pumps. Relief request, RP-7, requests the same type of relief for the Component Cooling Water Pumps.

3.0 EVALUATION OF RELIEF REQUEST

3.1 Relief Request 7

The licensee has requested relief from the requirements of IWP-3100 and Table IWP-3100-1 which require that the resistance of the system be varied until either the measured differential pressure or the measured flow rate equals the corresponding reference value and that the test quantities then be measured or observed and recorded. Any deviations determined shall be compared to the limits given in Table IWP-3100-2, Allowable Ranges of Test Quantities. The applicable pumps are P43-1, P43-2, and P43-3 which function to provide component cooling water (CCW) to transfer heat from safety-related equipment to the Service Water System.

3.2 Licensee's Basis for Relief

The licensee states:

> The use of reference curves for pump evaluation in lieu of reference values for differential pressure, vibration, and flow are requested. The use of vibration velocity in lieu of vibration amplitude as a measured quantity is also requested. The difficulty of reproducing the same system flow resistances, the use of a more reliable measured quantity (i.e., vibration velocity) and man-rem exposure savings are the basis for this request.
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> During power operations, one component cooling train is aligned to service standby essential loads and is not in service. One component cooling train serves non-essential loads and is in service. During shutdown conditions, both component cooling trains are in service. The system also contains a third, spare train as a backup to either the essential or non-essential trains. Flow through the pump aligned to service essential loads remains essentially constant when the train is in service. Flow through the pump aligned to service the non-essential loads cannot be fixed because system resistances are continuously varying and flows to parallel loads are dependent on each other. Spent fuel cooling and boric acid evaporators have temperature control valves

which vary demand on the CCW system according to heat load. Component cooling water flow to the reactor coolant pump coolers varies, dependent on as left throttle positions on the supply lines for the four pumps. CCW flow to the control rod drive booster pumps passes through cleaning filters and flow will change dependent on filter loading. Thus, flow cannot be reliably throttled to a fixed reference value.

Presently, the quarterly pump test for each pump may be performed on either train, depending upon the plant conditions at the time of the test. Manual butterfly valves in each of the in-service trains are used to throttle flow during pump testing to achieve the same operating point for each test. These valves do provide control, however, repeatability is poor, as butterfly valves are not designed to throttle flow. In the essential train, these valves are located in an elevated radiation field and, dependent on plant conditions, a high radiation area. Entering this radiation area for up to 12 tests per year to monitor and throttle flow causes unnecessary radiation exposure. Based upon present radiation levels, estimated exposure for performing 12 tests is approximately 0.4 man-rem per year.

3.3 Alternative Testing

The licensee proposes:

As discussed above in the Basis for Relief section, it is extremely difficult to return to a specific value of flow rate or differential pressure for testing of these pumps. An alternative to using testing requirements of IWP-3100 is to base the acceptance criteria on pump reference curves. Pump performance curves, giving reference values for vibration velocity and differential pressure as functions of flow between 3000 gallons per minute (gpm) and 8000 gpm have been established. The flow ranges reflect normal and accident flow rate conditions. The differential pressure versus flow data was plotted and compared to established manufacturer's pump curves. The vibration velocity data was obtained at the same flow data points and was also plotted to establish reference curves. These curves will serve as the basis for the alert and required action levels to ensure pump degradation is identified. The alert level and required action level parameters, as defined in the ASME code, 1989 Edition, Section XI, OMa-1988, Part 6, Ranges for Test Parameters, are superimposed as curves.

The methodology employed for establishing a reference curve is similar to that for performing a comprehensive test being proposed by the ASME Code Committee. To reduce the uncertainty associated with the pump curves and the adequacy of the acceptance criteria, special test gauges ($\pm$0.5 % full scale accuracy or better) have been installed to obtain test data. Flow indicator damping devices were also installed to limit flow gauge oscillations. Measurements of vibration velocity and differential pressure at a minimum of six flow data points have been obtained for each pump, then plotted to compile the pump performance reference curves.

During pump testing, the flow will be established within the domain of the reference curve. As plant conditions permit, approximately the same operating point will be established. Vibration velocity and differential pressure will be measured and recorded. Pump performance will be considered acceptable if parameter values fall within the regions bounded by the defined alert and action level curves, rather than a specific value.

The rated speed of these centrifugal pumps is 1100 rpm. Table IWP-3100-2, Allowable Ranges of Test Quantities, requires one vibration data point to be taken and this point is a measurement of amplitude. The ASME Code, 1989 Edition, Section XI, OMa-1988, Part 6, Ranges for Test Parameters, requires five vibration data points to be taken and these points are measurements of velocity. Use of vibration velocity measurements in lieu of vibration amplitude and additional data point evaluations will ensure an earlier and more reliable prediction of pump degradation.

After any maintenance or repair that may affect the existing reference pump curves, new reference pump curves will be determined or the existing pump curves revalidated by inservice testing.

Using this alternative testing method, an acceptable level of quality and safety is provided.

3.4 <u>Evaluation</u>

3.4.1 <u>Use of Pump Curves</u>

Some designs, such as the component cooling water system described above, do not facilitate testing at a single reference point or a set of multiple reference points. In these cases it may be necessary to develop pump curves to use as the basis for variable reference points. It is impractical to perform testing in accordance with the Code requirements for the component cooling water pumps based on the lack of throttling capability without creating transients in the reactor coolant pumps which could cause a plant trip and without creating a potential personnel hazard. To impose the Code-required test method would be an undue burden on the licensee in that damage to the plant equipment could occur, a plant transient/trip could occur, and personnel could be subjected to unsafe conditions. The alternative testing can provide an adequate level of assurance of operational readiness of the subject pumps without creating these adverse conditions.

The NRC approves the use of variable reference values of flow rate and differential pressure in those cases where the licensee clearly demonstrates in the relief request the impracticality of establishing a fixed set of reference values. The licensee must ensure that the method of evaluating these pump parameters to detect hydraulic degradation and determine pump operability is essentially equivalent to the Code requirements for allowable ranges in Table IWP-3100-2.

The licensee must establish a valid pump characteristic curve to employ this test methodology. This curve must be developed from empirical data or supplied by the pump manufacturer and verified by measurements taken when the pump was known to be in good operating condition. The following is an example of a test plan that would be acceptable:

> Pump flow rate is measured with the pump operating as found. This flow rate is used to set a point on the pump characteristic curve. The pump differential pressure is then measured with the pump operating as found. This differential pressure is compared to the differential pressure obtained from the pump curve for the measured flow rate. The pump is in the acceptable range if the measured differential pressure is 0.93 to 1.02 times the value from the pump curve, and is in the alert range if the measured differential pressure is 0.90 to 0.93 or 1.02 to 1.03 times the value from the pump curve. The pump is in the required action range if the measured differential pressure is < 0.90 or > 1.03 times the value from the pump curve.

Since pump vibration readings may vary widely with changes in pump flow rate and differential pressure, the licensee must propose a method of evaluating pump vibration measurements taken with the pump operating in possible as-found conditions to ensure that a degraded pump would be declared inoperable and repaired.

The following elements are to be incorporated into the IST of pumps utilizing pump curves:

1) Curves are developed, or manufacturer's pump curves are validated, when the pumps are known to be operating acceptably.

2) The reference points used to develop or validate the curve are measured using instruments at least as accurate as required by the Code.

3) Curves are based on an adequate number of points, with a minimum of five.

4) Points are beyond the "flat" portion (low flow rates) of the curves in a range which includes or is as close as practicable to design basis flow rates.

5) Acceptance criteria based on the curves does not conflict with Technical Specifications or Facility Safety Analysis Report operability criteria, for flow rate and differential pressure, for the affected pumps.

6) If vibration levels vary significantly over the range of pump conditions, a method for assigning appropriate vibration acceptance criteria should be developed for regions of the pump curve.

7) When the reference curve may have been affected by repair, replacement, or routine service, a new reference curve shall be determined or the previous curve revalidated by an inservice test.

A method for evaluating pump operability is necessary for variable flow systems where it is not practical to return to the same flow configuration for each subsequent inservice pump test. This may be the case for systems where temperature or flow is controlled in a variety of locations, such as component cooling water systems. It may not be practical for the licensee to take manual control of each of these local stations and duplicate the overall system reference conditions, as required by the Code, during quarterly pump testing.

Utilizing the manufacturer pump-specific curves for flow and differential pressure may enable the licensee to evaluate the pump in as-found system conditions. In this case, these values must be confirmed by in-situ testing. Another method would be the development of pump curves by varying system conditions and plotting a graph of the results over the range of conditions expected during the systems's normal operation. It is also important to develop a method of evaluating pump vibration measurements taken with the pump operating over the range of possible as-found conditions, since this is a variable pump parameter. This is to ensure that a severely degraded pump, either hydraulically or mechanically, is declared inoperable and repaired. The licensee's proposed alternative does not specify details of the referenced test procedures (2OST-15.1/2/3); therefore, a review by the licensee must be performed to ensure that all of the guidance discussed above is incorporated into the testing utilizing pump curves.

Relief is granted pursuant to 10 CFR 50.55a (f)(6)(i) based on the impracticality of testing the subject pumps in accordance with the Code requirements and the burden if these requirements were imposed, provided the licensee incorporate the guidance discussed in the evaluation into the implementation of the inservice testing by the inservice testing by the beginning of the fourth refueling outage now scheduled for early October 1994.

3.4.2 Use of Velocity Measurements for Vibration Monitoring

The ASME Operations and Maintenance Committee recognized that the use of velocity measurements for pump vibration monitoring was advantageous in assessing the mechanical condition of pumps. In the Operations and Maintenance Standards, OM-6, the requirements for pump vibration monitoring allow the use of both displacement and velocity measurements. Displacement is recommended for pumps with rotating speeds less than 600 revolutions per minute (rpm), while velocity is recommended for pumps with rotating speeds greater than 600 rpm. Displacement measurements represent the amplitude of the vibration (peak measurement for inservice testing data) and tend to accentuate the low frequency components, generally corresponding to the machine speed. High frequency components, playing an important role in the safe operation, and therefore in the preventive maintenance and degradation monitoring, being correlated with the machine noise and wear, are neglected, which could lead to erroneous conclusions on the machine quality. Velocity measurements represent the change in displacement over time and provide more information at higher frequencies. For the component cooling water pumps, which have a rotational speed of 1100 rpm, velocity measurements will provide more useful information at the higher frequencies of vibration and will enhance the capability of early identification of degrading conditions.

The alternative method of measuring vibration for the component cooling water pumps is acceptable and approved pursuant to 10 CFR 50.55a(f)(4)(iv). This approval is provisionally based on the implementation of all the related requirements which include paragraphs 4.6.1, 4.6.4, and 6.1 of OM-6 which is the standard referenced in Subsection IWP of the 1989 Edition of ASME Code, Section XI, which has been incorporated by reference in 10 CFR 50.55a(b).

4.0 CONCLUSION

Based on the review of the DBNPS, Unit 1, IST Program relief request, the NRC staff concludes that the relief request as evaluated and modified by the SE will provide reasonable assurance of the operational readiness of the pumps to perform their safety-related functions. The NRC staff has determined that granting relief pursuant to 10 CFR 50.55a (f)(6)(i) and approving the use of an alternative that conforms to the latest approved edition of the ASME Code pursuant to 10 CFR 50.55a (f)(4)(iv) are authorized by law and will not endanger life or property, or the common defense and security, and is otherwise in the public interest, giving due consideration to the burden upon Toledo Edison Company that could result if the ASME Code requirements were imposed on the facility.

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