

February 19, 2002

Mr. Oliver D. Kingsley, President  
Exelon Nuclear  
Exelon Generation Company, LLC  
4300 Winfield Road  
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SUBJECT: EVALUATION OF RELIEF REQUEST PR-2 ASSOCIATED WITH THE SECOND  
10-YEAR INTERVAL INSERVICE TESTING PROGRAM FOR PUMPS AND  
VALVES FOR BYRON STATION, UNITS 1 AND 2 (TAC NOS. MB1852 AND  
MB1853)

Dear Mr. Kingsley:

By letter dated March 29, 2001, as supplemented by letter dated January 3, 2002, Exelon Generation Company (Exelon) submitted a relief request from the ASME Code requirements for the Byron Station, Units 1 and 2, second 10-year interval inservice testing (IST) program for pumps and valves. The relief request proposed alternate "Alert Range" vibration limits for the essential service water makeup pumps.

Based on our review of the information provided by Exelon, the proposed changes to the "Alert Range" vibration limits contained in ASME Code OMa-1988, Part 6 provide an acceptable alternative. With the proposed changes, there is reasonable assurance that the essential service water pumps will remain operationally ready. Therefore, the alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) based on the determination that compliance with the requirements of the Code would result in a hardship without a compensating increase in the level of quality and safety. The request for relief is authorized through the end of the second IST interval for Byron Station, Units 1 and 2. The second IST interval ends on June 30, 2006, for Units 1 and 2.

The safety evaluation containing the basis for the staff's conclusion is enclosed.

Sincerely,  
*/RA/*

Anthony J. Mendiola, Chief, Section 2  
Project Directorate III  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos.: STN 50-454  
STN 50-455

Enclosure: Safety Evaluation

cc: See next page

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Byron Station  
Units 1 and 2

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Based on our review of the information provided by Exelon, the proposed changes to the "Alert Range" vibration limits contained in ASME Code OMa-1988, Part 6 provide an acceptable alternative. With the proposed changes, there is reasonable assurance that the essential service water pumps will remain operationally ready. Therefore, the alternative is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) based on the determination that compliance with the requirements of the Code would result in a hardship without a compensating increase in the level of quality and safety. The request for relief is authorized through the end of the second IST interval for Byron Station, Units 1 and 2. The second IST interval ends on June 30, 2006, for Units 1 and 2.

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Sincerely,  
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Anthony J. Mendiola, Chief, Section 2  
Project Directorate III  
Division of Licensing Project Management  
Office of Nuclear Reactor Regulation

Docket Nos.: STN 50-454  
STN 50-455

Enclosure: Safety Evaluation

cc: See next page

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**\*See Previous Sheet for Concurrence**

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION  
RELATED TO THE INSERVICE TESTING PROGRAM SECOND 10-YEAR INTERVAL  
EXELON GENERATION COMPANY, LLC  
BYRON STATION, UNITS 1 AND 2  
DOCKET NUMBERS STN 50-454 AND STN 50-455

## 1.0 INTRODUCTION

The *Code of Federal Regulations*, 10 CFR 50.55a, requires that inservice testing (IST) of certain American Society of Mechanical Engineers (ASME) Code Class 1, 2, and 3 pumps and valves are performed in accordance with Section XI of the ASME *Boiler and Pressure Vessel Code* (the Code) and applicable addenda, except where alternatives have been authorized or relief has been requested by the licensee and granted by the Commission pursuant to paragraphs (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. Section 50.55a authorizes the Commission to approve alternatives and to grant relief from ASME Code requirements upon making the necessary findings. The Nuclear Regulatory Commission (NRC) guidance contained in Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Testing Programs," provides alternatives to the Code requirements which are acceptable. Further guidance is given in GL 89-04, Supplement 1, and NUREG-1482, "Guidelines for Inservice Testing at Nuclear Power Plants."

By letter dated March 29, 2001, as supplemented by letter dated January 3, 2002, Exelon Generation Company (the licensee) has submitted Relief Request PR-2 for the Byron Nuclear Power Station, Units 1 and 2, second 10-year interval inservice testing program for pumps and valves. The licensee has requested using an alternative to the vibration acceptance criteria of OM-6, Paragraph 6.1, Table 3a, for the Essential Service Water (SX) Pumps 0SX02PA and 0SX02PB. The licensee has requested that the absolute alert range limits be raised to 0.550 inches per second (ips). The staff's evaluation of the proposed alternative is provided below.

Also, by letter dated January 3, 2002, an issue was resolved concerning the collection of spectral analysis data. Although the licensee was analyzing the data, it was not included in the relief request. The letter confirmed that the licensee would include the spectral analysis in its evaluation of the pump vibration data.

The Byron IST program for pumps was developed in accordance with the requirements of the 1989 Edition of the ASME Code by implementation of the ASME/ANSI OMa-1988 Operations and Maintenance (OM) Standard, Part 6 (OM-6).

## 2.0 RELIEF REQUEST PR-2

The licensee's basis for its request follows.

### 2.1 Relief Request History

Relief from the vibration limits of Table 3a was previously requested for these pumps and conditionally granted by the NRC on January 31, 1992. The condition allowed one year for the licensee to obtain vendor concurrence with the requested vibration limits for the Alert and Required Action Ranges.

Specifically, the requested relief was for the vibration levels at the gearbox of the SX Makeup Pump. The ASME/ANSI Code OMa-1988, Part 6 limits establish the beginning of the Alert Range at either 2.5 times the reference vibration value or 0.325 inches per second, whichever is less. Part 6 also establishes the Required Action Range at 6.0 times the reference vibration value or 0.700 ips, whichever is less. Byron Station previously requested the Alert Range be established at 2.5 times the reference vibration value or 0.600 ips, whichever is less, and the Required Action Range be established at 6.0 times the reference vibration value or 0.900 ips, whichever is less.

In the associated safety evaluation, the NRC indicated that although the proposed Alert and Required Action Range thresholds appeared reasonable, obtaining the vendor's concurrence of these limits was appropriate. In consideration of this issue, relief was conditionally granted, providing the licensee obtained the vendor's concurrence within one year.

Only partial concurrence from the vendor was received. The vendor supported 0.550 ips for the Alert Range limit, however, they did not concur with the proposed 0.900 ips for the Required Action Range. Consequently, the SX Makeup Pumps vibration levels have remained in the Alert Range as established by Table 3a.

As outlined below, Byron Station is now requesting relief for only the Alert Range limits of Table 3a. Byron Station proposes that the SX Makeup Pumps Alert Range limit be established at the limit previously agreed upon by the equipment supplier. The gearbox manufacturer has also concurred with this increased limit.

### 2.2 Basis for Relief

Relief is requested pursuant to 10 CFR 50.55a, "Codes and Standards," paragraph (a)(3)(i), as the proposed alternatives would provide an acceptable level of quality and safety.

The SX Makeup Pumps are a unique design. For each pump, a horizontal diesel drives a right angle gearbox located approximately 39 feet above the pump. The drive shaft from the gearbox to the pump consists of five coupled sections and is located in the pump discharge piping column. Pump thrust is carried by bearings physically located within the gearbox. The centrifugal pump is submerged in river water.

This pump configuration is not addressed by ASME/ANSI Code OMa-1988, Part 6. Due to the monitoring limitations of this design, and because of its similarity to Code requirements for vertical line shaft pumps, vibration is monitored on the gearbox. The limitation of taking the vibration readings at this location is that the resultant vibration readings are not attributable to the pump. Vibration analysis has indicated that the vibration readings obtained are the result of vibration induced by the diesel engine and gearbox itself, along with a resonant condition of the gearbox and its foundation.

Since the previous request for relief, maintenance and inspection activities have indicated that the angle gearboxes have been operating properly and without degradation. Maintenance and inspection activities on the pumps have indicated that there has not been any pump degradation due to the vibration observed on the gearboxes. Likewise, the pump units have not caused vibration degradation of the gearboxes. The pump impellers have been replaced with stainless steel units and the wear rings replaced with a wear resistant alloy, due to the adverse quality of river water associated with SX Makeup Pumps. The new pump assemblies were tested at the vendor's facility and exhibited very low vibration levels.

Byron Station recently consulted an industry vibration expert and vendor representative from the gearbox company in an effort to ensure vibration levels are as low as achievable with this particular design, and to assure the existing vibration levels are not indicative of pump degradation. These efforts included the following activities:

- Field service representatives from the gearbox company supervised the refurbishment of the two gearboxes. Both refurbished units were then installed on the pumps. The units that were refurbished had seen a significant amount of service under the historically higher vibration conditions and when inspected did not show any vibration related degradation.
- Bidirectional support braces were installed on the gearboxes to address the vibration resonance problem.
- The gearboxes were precision-aligned and the couplings were balance checked upon installation.

All of these efforts combined resulted in some reduction in the vibration levels, however, not enough to remove the pumps from the ASME Code Alert Range. Since installation during plant construction, both pumps have experienced vibrations at the gearbox locations of up to 0.6 ips. The licensee concluded those vibration levels recorded at the gearbox locations are normal for the unique design configuration and do not indicate an unusual condition of the gearbox or the pump. The limits established in the Proposed Alternate Testing section (Section 2.3) will ensure that required action is taken if vibration levels increase while ensuring the pump is not prematurely declared inoperable.

The basis for the double test frequency is to provide for increased testing when vibration levels may indicate an abnormal pump condition. Since the gearbox normally exhibits relatively high vibration levels due to its unique design, the use of the Table 3a Alert Range limits would not be practical because it would require double test frequency when the vibration level is normal. Raising the Alert Range limit for these pumps would ensure the pumps are placed in double

test frequency at a vibration level that would be abnormal for the SX Makeup Pumps' design configuration. Consequently, this proposed alternative provides an acceptable level of quality and safety.

### 2.3 The Licensee's Alternative Testing

To allow for practical vibration monitoring of the SX Makeup Pumps (i.e., SX02PA and 0SX02PB), alternate vibration acceptance criteria are proposed. Vibration monitoring will be performed during each quarterly test and the following vibration acceptance criteria will be applied:

<u>Test Parameter</u>	<u>Acceptable Range</u>	<u>Alert Range</u>	<u>Required Action Range</u>
Vr	< 2.5Vr, or < 0.550 ips	> 2.5Vr to 6Vr, or > 0.550 ips	> 6Vr or > 0.70 ips

### 3.0 EVALUATION

The Code requires that safety-related pumps be tested quarterly. Hydraulic and mechanical data are taken at each test and compared with their respective reference values to measure any degradation that may have occurred. When certain performance parameters exceed the alert range limit, the test frequency of the pump is doubled to gather more information on the condition of the pump. When a pump is operating in the alert range, it is considered operable. The NRC has an expectation that pumps which are operating in the alert range and clearly demonstrate degrading performances, are addressed in a reasonable period of time. When a specific performance parameter exceeds the required action limit, the pump is immediately declared inoperable and the appropriate action taken in accordance with the Code requirements and plant technical specifications.

The two essential service water makeup pumps at Byron Station have a safety-related function to provide an emergency source of water to the ultimate heat sink for both units. These pumps are multistage vertical line shaft pumps which are each driven by a diesel engine connected through a right angle gear box. Paragraph 4.6.4(b) of the ASME Code requires that for vertical line shaft pumps, measurements will be taken on the upper motor bearing housing in three orthogonal directions, one of which is the axial direction. Since the diesel drive is not directly connected to the pump, vibration measurements are taken at the gearbox. Certain measured gearbox vibration parameters exceed the absolute alert range vibration limit of 0.325 ips resulting in these pumps being on a test interval of approximately once every 6 weeks.

The licensee previously requested relief from the Code's absolute vibration limits. The NRC staff granted interim relief in a safety evaluation dated January 1, 1992, to allow time for the licensee to gain concurrence from the manufacturer on the increased vibration limits. The licensee did not receive complete concurrence on their proposed vibration limits and therefore, according to their submittal of March 29, 2001, did not implement the relief that was granted in the 1992 safety evaluation. The licensee has resubmitted this relief request with additional information and proposed to increase the absolute alert range limit to 0.550 ips.



The staff has received several proposed alternatives to increase the absolute vibration limits. There are four key components that the staff considers in evaluating these particular alternatives: (1) documentation of vibration history which verifies that the pump has operated satisfactorily at this vibration level for a significant period of time without degradation, (2) results of consultations with vendors or vibration experts to assess the operation of the pump at elevated vibration levels, (3) description of attempts to lower the vibration levels below the Code absolute alert range limit, and (4) results of spectral analysis which identifies all significant contributors to the overall vibration level. The Code currently has no mechanism to exit the absolute alert range limit based on any type of analysis.

With regard to vibration history, the licensee stated in its current submittal that vibration levels measured at the gearbox have been up to 0.600 ips. The licensee has consulted with the vendor and vibration experts. The gearbox vendor has provided documentation stating that 0.550 ips is an acceptable absolute vibration alert range limit. The pump vendor has verified that the new factory tested stainless steel impellers had "very low" vibration levels which, at a minimum, are below the absolute vibration alert range limit. The material condition of the gearbox has been examined and no degradation due to vibration was noted.

The licensee has taken measures to reduce the measured overall vibration. These include adding supports to stiffen the right angle gear box and better alignment of the gearboxes and couplings. Both efforts reduced the overall vibration levels but not to the level where they were consistently below the absolute vibration alert range limit.

With regard to spectral analysis, the licensee's initial submittal does not specifically reference spectral analysis. A conference call with the licensee established that they do perform this test. By letter dated January 3, 2002 (RS-02-004), the licensee stated that the spectral analysis is performed as part of the ASME IST vibration data collection. Any pump vibration concerns are going to be met with more comprehensive special testing and appropriate corrective maintenance will be performed.

Continued implementation of the Code absolute alert range limit requirement will subject these pumps to unnecessary testing. Therefore, the Code requirement for these pumps is a hardship as further compliance does not result in a compensating increase in quality and safety. The proposed alternative testing provides a reasonable assurance of operational readiness because; (1) the licensee has established that the elevated vibration levels are characteristic of normal pump operation and that each pump is currently operating acceptably, (2) the licensee has consulted with vendor representatives and vibration experts, and they have concluded that the measured vibration levels do not result in degraded pump performance, and (3) the licensee has implemented modifications which have lowered the overall vibration levels, albeit not below the absolute alert range limit.

#### 4.0 CONCLUSION

The staff authorizes the alternative proposed in Relief Request PR-2 pursuant to 10 CFR 50.55a(a)(3)(ii) for the second 10-year interval based on the determination that compliance with the vibration limits requirements in ASME/ANSI Code OMa-1988, Part 6, Paragraph 6, results in a hardship without a compensating increase in the level of quality and safety. The second IST interval ends on June 30, 2006, for both Unit 1 and Unit 2.

Principal Contributor: Joseph Colaccino

Date: February 19, 2002