October 6, 2003

Mr. Michael Kansler
President
Entergy Nuclear Operations, Inc.
440 Hamilton Avenue
White Plains, NY 10601

SUBJECT: VERMONT YANKEE NUCLEAR POWER STATION - RELIEF REQUEST NOS. RR-P01, RR-P02, RR-P03, RR-P04, RR-V01, AND RR-VO2 (TAC NOS. MB7489 THROUGH MB7494)

Dear Mr. Kansler:

The Nuclear Regulatory Commission has reviewed the relief requests for the Vermont Yankee Nuclear Power Station (VYNPS) for its fourth 10-year inservice testing (IST) program interval submitted by Entergy Nuclear Operations, Inc. (Entergy or the licensee), in its letters dated January 22, March 12, and April 2, 2003. In its response to the staff's request for additional information, Entergy submitted revised relief request RR-P01 on June 5, 2003.

The staff approved the use of the 1998 Edition through 2000 Addenda of the American Society of Mechanical Engineers *Code for Operation and Maintenance of Nuclear Power Plants* for VYNPS's fourth 10-year interval IST program pursuant to Title10 of the *Code of Federal Regulations* (10 CFR) Section 50.55a(f)(4)(iv). The staff further concludes that the licensee's proposed alternative, RR-V01, is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that compliance with Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The alternatives proposed in relief requests RR-V02, RR-P02 and RR-P04 are authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that they provide an acceptable level of quality and safety. Relief requests RR-P01 and RR-P03 are granted pursuant to 10 CFR 50.55a(f)(6)(i) based on the impractically of performing testing in accordance with the Code requirements. Granting relief is 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 the licensee that could result if the requirements were imposed on the facility. The attachment contains the staff's safety evaluation. The reliefs are authorized for the fourth 10-year IST program interval at VYNPS.

This completes efforts on TAC Nos. MB7489, MB7490, MB7491, MB7492, MB7493, and MB7494).

Sincerely,

/RA/

James W. Clifford, Chief, Section 2
Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosures: Safety Evaluation

cc w/encls: See next page

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This completes efforts on TAC Nos. MB7489, MB7490, MB7491, MB7492, MB7493, and MB7494).

Sincerely,

/RA/

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Project Directorate I
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket No. 50-271

Enclosures: Safety Evaluation

cc w/encls: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

FOR RELIEF REQUESTS RELATED TO THE FOURTH 10-YEAR

INSERVICE TESTING PROGRAM INTERVAL

ENTERGY NUCLEAR VERMONT YANKEE, LLC AND

ENTERGY NUCLEAR OPERATIONS, INC.

VERMONT YANKEE NUCLEAR POWER STATION

DOCKET NO. 50-271

1.0 INTRODUCTION

By letter dated January 22, 2003, as supplemented by letters dated March 12 and April 2, 2003, Entergy Nuclear Operations, Inc. (Entergy or the licensee), requested relief from, and proposed alternatives to, certain inservice testing (IST) requirements of the American Society of Mechanical Engineers (ASME) *Code for Operation and Maintenance of Nuclear Power Plants* (OM Code) for its fourth 10-year interval IST program interval for the Vermont Yankee Nuclear Power Station (VYNPS). The program included Pump Relief Requests RR-P01, RR-P02, RR-P03, and RR-P04, and Valve Relief Requests RR-V01 and RR-V02. In the supplemental letter dated April 2, 2003, the licensee requested to use the 1998 Edition through 2000 Addenda of the ASME OM Code for its fourth 10-year interval IST program. In its response to the U.S. Nuclear Regulatory Commission (NRC or the Commission) staff's request for additional information, Entergy submitted revised relief request RR-P01, dated June 5, 2003.

In RR-P01, the licensee requested relief for service water pumps P7-1A, P7-1B, P7-1C, P7-1D, in lieu of the frequency of inservice test requirements as specified by paragraph ISTB-3400 of the ASME OM Code.

In RR-P02, the licensee proposed an alternative for high pressure coolant injection (HPCI) main/booster pump combination P44-1A and P44-1B, in lieu of the deviations from the reference values (V_r), as specified by paragraph ISTB-5123(e) of the ASME OM Code.

In RR-P03, the licensee requested relief for diesel fuel oil transfer pumps P92-1A and P92-1B, in lieu of the requirements as specified by ISTB-5322 and Table ISTB-3000-1 of the ASME OM Code.

In RR-P04, the licensee proposed an alternative for the reactor core isolation cooling (RCIC) pump P47-1A, in lieu of the deviations from the V_r, as specified by paragraph ISTB-5123(e) of the ASME OM Code.

In RR-V01and RR-V02, the licensee has proposed an alternative for various check valves in lieu of the exercising requirements as specified by paragraph ISTC-3522(c) of the ASME OM Code.

2.0 REGULATORY EVALUATION

Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50.55a requires that IST of certain ASME Code Class 1, 2, and 3 pumps and valves be performed in accordance with the applicable edition and addenda to the ASME OM Code, except where alternatives have been authorized or relief has been requested and granted by the NRC, pursuant to Sections (a)(3)(i), (a)(3)(ii), or (f)(6)(i) of 10 CFR 50.55a. Pursuant to 10 CFR 50.55a(f)(4)(ii), licensees are required to comply with the requirements of the latest edition and addenda of the ASME Code incorporated by reference in the regulations 12 months prior to the start of subsequent 120-month IST program intervals, unless the Commission approves use of subsequent editions and addenda pursuant to 10 CFR 50.55a(f)(4)(iv).

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 the facility. Section 50.55a of 10 CFR authorizes the NRC to approve alternatives, and to grant relief from ASME Code requirements upon making necessary findings. NRC guidance contained in Generic Letter (GL) 89-04, “Guidance on Developing Acceptable Inservice Testing Programs,” provides alternatives to Code requirements which are acceptable to the staff. Further guidance is given in GL 89-04, Supplement 1, and NUREG-1482, “Guidance for Inservice Testing at Nuclear Power Plants.”

By letter dated January 22, 2003, the licensee proposed several alternatives to the requirements of the ASME OM Code for its fourth 10-year interval IST program for VYNPS. The VYNPS fourth 10-year IST interval begins on September 1, 2003 and ends on August 31, 2013. The program was developed in accordance with the requirements of the 1998 Edition including the 2000 Addenda of the ASME OM Code. Subsection ISTB provides the requirements for IST of pumps, and Subsection ISTC provides the requirements for IST of valves.

The NRC’s findings with respect to authorizing alternatives and granting or denying the IST program relief requests are given below.

3.0 TECHNICAL EVALUATION

The staff has reviewed the licensee’s regulatory and technical analysis in support of their request for relief from the ASME OM Code IST requirements, which are described in the section entitled, “Code Testing Exception Report.”

3.1 Request to use ASME OM Code 1998 Edition through 2000 Addenda

The licensee requested to use the 1998 Edition through the 2000 Addenda of the ASME OM Code, in lieu of the 1995 Edition through 1996 Addenda for the VYNPS fourth 10-year interval IST program. VYNPS’s fourth 10-year interval begins on September 1, 2003. The regulations in 10 CFR 50.55a(f)(4)(ii) require that inservice tests conducted during successive 120-month intervals must comply with the requirements of the latest edition and addenda of the Code, incorporated by reference in 10 CFR 50.55a(b) 12 months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The Code that is effective 12 months prior to the start of VYNPS’s fourth 10-year interval is the 1995 Edition including the 1996 Addenda of the ASME OM Code. However, the licensee requested to use the 1998 Edition through the 2000 Addenda of the ASME OM Code for its fourth 10-year IST interval. The regulations in 10 CFR 50.55a(f)(4)(iv) state that inservice tests of pumps and valves may meet the requirements set forth in subsequent editions and addenda that are incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein, and subject to NRC approval. The 1998 Edition up to and including the 2000 Addenda of the ASME OM Code was incorporated by reference on September 26, 2002 (67 FR 60520) and became effective on October 28, 2002. The staff considers that use of this subsequent edition and addenda of the ASME OM Code would provide more current IST standards. The staff, therefore, approves the use of the 1998 Edition through the 2000 Addenda of the ASME OM Code for VYNPS's fourth 10-year interval IST program pursuant to 10 CFR 50.55a(f)(4)(iv).

3.2 Pump Relief Request RR-P01:

3.2.1 Code Requirements:

The ASME OM Code, paragraph ISTB-3400, "Frequency of Inservice Tests," requires that an inservice test be performed on each pump as specified in Table ISTB-3400-1: Group A pumps shall have a Group A test performed quarterly and a comprehensive test performed biennially.

3.2.2 Specific Relief Requested:

The licensee requested relief from the frequency requirements of the ASME OM Code as specified in paragraph ISTB-3400 and Table ISTB-3400-1 for Service Water (SW) pumps P7-1A, P7-1B, P7-1C, and P7-1D. These SW pumps are Group A pumps.

3.2.3 Licensee's Basis for Relief:

The four SW pumps P7-1A, P7-1B, P7-1C, and P7-1D are two-stage, vertical line shaft centrifugal pumps that are submerged in, and take suction from, the Connecticut River. They supply all the station SW System requirements. The station SW system is a dual-header system comprising two parallel headers each containing two pumps. The two parallel supply headers supply both the turbine and reactor auxiliary equipment, including the Residual Heat Removal SW System. A header interconnection is provided downstream of the pumps. Normally, the valves in the interconnecting line are open, permitting any of the pumps to supply the cooling water to both headers and balance system operation. In addition, a cross-tie is provided to the non-nuclear safety station Fire Protection System (FPS). This 12-inch cross-tie valve is normally closed, with a 1-inch cross-tie and a restricting orifice providing pressurization of the FPS header.

The SW pumps at VYNPS are not provided with individual pump flow indication. Furthermore, the SW headers are not provided with flow indication that could be used to determine pump flow. During normal operations, an individual SW pump flow rate cannot be fixed or directly measured. It is, therefore, not possible to operate the SW pumps at the fixed V_r required for a Group A test.

Sufficient straight sections of piping are required to measure flow rate accurately through the use of either permanently or temporarily installed instrumentation, such as non-intrusive flow measurement devices. The only sufficiently long straight sections of piping in each of the two parallel headers are buried between the intake structure and the entrance to the reactor building and, therefore, use of this piping is considered impractical.

Based on the above, significant redesign and modification of the station SW system would be required to obtain direct measurement of pump flow. Such redesign and modification would be costly and burdensome to VYNPS.

The SW system has a test flow loop, which is connected to the FPS header. This permits testing individual pumps, one at a time. However, this test loop does not provide SW flow to heat loads. Rather, the flow is discharged to the intake structure. The SW cross-tie valves must be shut, one SW subsystem is aligned to supply cooling water, and the other SW subsystem is aligned to the test loop. In the subsystem aligned to the test loop, one pump is stopped and the other is the pump under test. Therefore, to test one pump, it is necessary to provide all SW cooling loads with one subsystem, comprising of two SW pumps. During approximately seven months of the year, the Connecticut River water temperature precludes this method when the plant is operating, due to elevated heat sink temperature and heat removal capacity. Therefore, this test loop cannot be regularly used for quarterly testing.

Testing during the remaining five months (approximately November through March) is impractical due to equipment concerns, personal safety, and scheduling difficulty. Since the SW pump test requires taking each SW subsystem out of service, the test must be inserted into the 13-week schedule at a time that does not have an adverse impact on other scheduled work.

The process of realigning the SW system, isolating one subsystem, testing the off-line subsystem, un-isolating the tested subsystem, isolating the other subsystem, testing the second subsystem, and recovering to the normal operating configuration takes a full shift in favorable weather. The test loop and instrumenting taps are outdoors on the SW pump room roof. If the weather is below freezing, the test cannot be performed due to instrument icing and personnel safety concerns associated with severe cold weather. Therefore, a scheduled test might have to be canceled at the last minute, disrupting the scheduled work week. The test would then have to be rescheduled for a subsequent week in another 13-week schedule. Therefore, testing on-line is impractical due to equipment concerns, personal safety, and scheduling difficulties.

The burden imposed by compliance with the Code requirement would be a redesign of the SW system to provide a flow element and sufficient straight piping runs downstream of each SW pump. This system redesigned would be so extensive that it could not be accomplished within the building that currently houses the SW pumps, since these straight piping runs would have to be approximately 12 feet long (10 pipe diameters for 14-inch pipe).

Relief is requested on the basis that compliance with the Code requirements is impractical, and that the proposed alternatives provide an acceptable level of quality and safety.

3.2.4 Alternative Examinations:

The licensee states that during each refueling outage, pump flow, differential pressure and vibration will be measured at a reference condition, which will meet or exceed the required design conditions for the pump. A flow-test loop installed on the plant FPS will be utilized to directly measure pump flow. This will provide a mechanism to assess the hydraulic condition of the pump and to detect pump degradation against the code-required limits.

An additional reference condition will be established with the pump at a dead-head condition, where pump vibration and differential pressure at a no-flow, dead-head condition would enable pump data comparison during operation and cold shutdown conditions in the event that maintenance is required to be performed between refueling outages.

During each refueling outage, a head-flow curve will be generated in accordance with ISTB-5210, and the pump comprehensive test will be performed in accordance with ISTB-5223. This will provide information about the performance of the pump and can be compared, to the degree possible, with the as-found quarterly test data and previous refueling outage head-flow curve data. Overall peak and full-spectrum vibration measurements will also be taken at each of the points used to generate the head curve to provide additional operational information.

On a quarterly basis, during plant operation and cold shutdowns, an as-found test will be performed by measuring pump differential pressure and motor vibration. The data will be compared, to the degree possible, with the test data taken during refueling outage head-flow curves.

In order to provide additional assurance of proper pump operation and mechanical condition, an enhanced maintenance/monitoring program for these pumps will be established as follows:

A review of the historical test data for these pumps indicates that these pumps are highly reliable and have not been susceptible to frequent or unanticipated failures. Plant operating experience has shown that the performance of the SW pumps degrades slowly over an extended period due to normal system wear. During the third 10-year IST interval, one SW pump was replaced, disassembled, and inspected each operating cycle, with each pump being replaced and inspected at least once every six years. The results of those inspections and replacements demonstrated that the service life of a SW pump is considerably greater than six years, and that pump performance can be reliably trended and predicted using data gathered during pump capacity testing performed each refueling outage. Therefore, replacement of SW pumps on a fixed interval is not proposed for this relief request. SW pumps will be replaced when periodic testing indicates that replacement is prudent.

The SW pumps are in the Vermont Yankee Oil Analysis Program, described in station procedure DP 0213. Lube oil samples are taken quarterly from each service pump. A complete laboratory analysis of the oil is performed, including wear particles, lubricity, additives, water, dirt (silicon), and oxidation. In addition, the oil in the SW pumps was changed to synthetic oil (SHC 630), due to the superior performance and service life of the synthetic oil.

3.2.5 Evaluation of Pump Relief Request No. RR-P01:

Paragraph ISTB-3400 of the ASME OM Code requires that an IST be performed on each pump as specified in ASME OM Code Table ISTB-3400-1. Table ISTB-3400-1 requires that Group A pumps have Group A tests performed quarterly, and a comprehensive test performed biennially.

The four SW pumps P7-1A, P7-1B, P7-1C, and P7-1D are two-stage, vertical line shaft centrifugal pumps that are submerged in, and take suction from, the Connecticut River. There is no installed flow measurement instrumentation on the discharge piping. It is also impractical for the licensee to install flow instrumentation on the pumps, or use temporary, non-intrusive flow measuring devices, since there are no sufficiently straight sections of accessible piping to ensure a region of flow stability. Significant system redesign and modifications would be necessary to permit repeatable flow rate measurements. Imposing these requirements would cause a burden on the licensee that is not commensurate with the safety increase. Based on the above discussion, the staff concludes that it is impractical to perform a quarterly flow test (and associated reference differential pressure test) of these SW pumps in accordance with the ASME OM Code without significant design modifications.

For a SW pump (a Group A pump), the Code requires that a Group A test be performed quarterly and a comprehensive test be performed biennially. The ASME OM Code, paragraph ISTB-3000 and Table ISTB-3000-1, requires that during the Group A test and comprehensive test, differential pressure, flow rate, and vibration shall be measured.

The licensee states that during each refueling outage the comprehensive pump test will be performed in accordance with paragraph ISTB-5223 of the Code. While meeting ISTB-5223 requirements, the licensee will meet the acceptance criteria of Table ISTB-5200-1. The VYNPS refueling outage cycle is 18 months. Therefore, VYNPS will be performing a comprehensive pump test more often than that required by the ASME OM Code (every 18 months instead of every two years) and is, thus, acceptable.

The SW pumps at VYNPS are not provided with individual pump flow indication. Furthermore, the SW headers are not provided with flow indication that could be used to determine pump flow. During normal operations, individual SW pump flow rate cannot be fixed or directly measured. It is, therefore, not possible to operate the SW pumps at the fixed V_r required for a Group A test. Since it is possible that SW pump differential pressures measured during quarterly testing will vary appreciably due to changes in system demand, similar variation in pump vibration can be expected. In order to assess pump vibration conditions against Code criteria, variable pump vibration data must be acquired for a broad range of differential pressure conditions. The licensee states that during refueling outages, head-flow curves will be generated, and a comprehensive test will be performed. This will provide information so that performance of the pump can be compared with the quarterly test data and previous refueling outage head-flow curves data. Overall peak and full vibration measurements will also be taken at each of the points used to generate the head curve to provide additional operational information. In this way, a correlation between pump vibration and differential pressure can be developed each refueling outage to permit quarterly vibration testing even though the vibration testing might not be at the Code-prescribed reference hydraulic condition.

The SW pumps are in the Vermont Yankee Oil Analysis Program. Lube oil samples are taken quarterly from each service pump. A complete laboratory analysis of the oil will be performed that will identify signs of pump degradation.

The comprehensive pump testing (full flow test) and evaluation of flow rate, differential pressure, and vibration on a refueling outage frequency, in accordance with Code acceptance criteria, will allow an adequate assessment of the pump’s operational readiness. The licensee will be performing a comprehensive pump test every 18 months. Quarterly measurement of pump vibration data (including spectral analyses) will be assessed against Code criteria, to the extent possible, using variable V_r determined from differential pressure measurements. In addition, the results of previous inspections every refueling outage and replacements of SW pumps every six years during prior IST intervals demonstrated that the service life of a SW pump is considerably greater than six years and that pump performance can be reliably trended and predicted using data gathered during comprehensive pump testing each refueling outage. Also, the SW pumps are in the Vermont Yankee Oil Analysis Program, thus, ensuring that lube oil analysis will be performed quarterly.

3.2.6 Conclusion:

The staff concludes that compliance with the Code-required Group A quarterly flow test (and associated differential pressure testing) of the SW pumps would require significant redesign of the SW system. The Code-specified comprehensive pump test shall be performed on the SW pumps on a refueling outage frequency (every 18 months). Vibration measurements, including full spectral analyses, will be performed quarterly with vibration measurements assessed in accordance with the Code (using quarterly differential pressure measurements to established a variable V_r). The licensee's proposed alternative testing and analyses will provide reasonable assurance of the pumps' operational readiness. Therefore, the staff finds that granting this relief is 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 the licensee that could result if the requirements were imposed on the facility. The staff, therefore, grants relief from the Group A quarterly flow test required by the ASME OM Code, pursuant to 10 CFR 50.55a(f)(6)(i) on the basis of impracticality in performing IST in accordance with ASME OM Code requirements.

3.3 Pump Relief Request No. RR-P02:

3.3.1 Code Requirements:

ASME OM Code, paragraph ISTB-5123(e), "Comprehensive Test Procedure," requires that all deviations from the V_r reference values shall be compared with the ranges of Table ISTB-5100-1, and corrective actions taken as specified in ISTB-6200. The vibration measurements shall be compared to both the relative and absolute criteria shown in the alert and required action ranges of Table ISTB-5100-1.

3.3.2 Specific Relief Requested:

The licensee requests relief from the Code requirements of paragraph ISTB-5123(e) for the HPCI main pump/booster pump combination P44-1A/B.

Specifically, the licensee requests relief from the vibration velocity (V_V) acceptance criteria specified in Table ISTB-5100-1 at the main pump turbine side horizontal and vertical vibration points I-3, O-3, and main pump gear box side horizontal vibration point I-4. The remaining high-pressure and booster pump vibration points will be evaluated using the ASME OM Code requirements.

3.3.3 Licensee Basis for Relief:

The HPCI main pump P44-1A has the safety function to operate in series with the booster pump P44-1B, to provide (1) adequate core cooling and reactor vessel depressurization following a small break loss-of-coolant accident (LOCA), and (2) reactor pressure control during reactor shutdown and isolation.

The HPCI pump has a notable history regarding analysis and resolution of high vibration issues. During the 1985-1987 timeframe, vibration consultants with specialized equipment were utilized to identify phase angles, natural and resonance frequencies, etc., providing a thorough analysis of existing conditions. The root cause of the higher vibration levels was determined to be a 2^{nd} order acoustical resonance in the piping connecting the low pressure and high pressure (HP) pumps, and the presence of a structural resonance at the 2^{nd} order in the horizontal direction on the HP pump.

These resonance conditions are design-related and have existed since initial pump installation. The HPCI booster pump impeller was modified in 1989, based on the consultant's recommendations to reduce the 2^{nd} order vibration levels; however, the overall peak levels remained higher than the ISTB-5100-1 acceptable range of 0.325 in/second. VYNPS concluded that these high levels did not indicate pump mechanical degradation, and do not represent phenomena that could prevent the pump from performing its intended function. The NRC approved IST Program Relief Request RR-P04 in 1993, which permitted the overall peak vibration acceptable range to be expanded to 0.675 in/sec. At that time, VYNPS additionally committed to evaluate the resonance peaks during each test and assigned limits of 1.05 and 1.3 times the overall peak V_r.

Regarding the previously approved relief request commitment to evaluate the resonance peaks, VYNPS conservatively interprets "resonance peaks" to be the largest peak on the spectrum even though resonance only occurs when a natural frequency and forced frequency coincide. VYNPS applies the resonance peak criteria to all peaks on the spectrum, the largest usually being the impeller vane pass frequency. Compliance with the proposed spectral resonance alarm criteria of 1.05 and 1.3 times the overall peak V_r is difficult to achieve. Specifically, spectral alarm bands are typically established to be more restrictive in the areas of bearing degradation, and less restrictive in the impeller vane pass frequency region. Assignment of a single conservative spectral alarm limit for any large peak on the entire spectrum places the pump in the alert range when, for example, vane pass frequency varies by a small amount. The commitment to perform full spectrum vibration monitoring envelopes a review of all peaks in the spectrum for signs of degradation, including the resonance peaks. The licensee states that its previous commitment to assign a single spectral alarm limit adds little value to the vibration program and unjustifiably causes the pump test frequency to be doubled. The licensee requested to delete the conservative spectral alarm commitment. Additionally, the licensee reviewed the overall peak values and determined that the acceptable range limit can be lowered from 0.675 to 0.575 in/sec. This lower acceptance value is the result of continuing efforts to reduce the vibration levels on this complex system (i.e., turbine, HP pump, gearbox, and booster pump combination).

The licensee requested relief on the basis that its proposed alternative would provide an acceptable level of quality and safety. This relief request, RR-P02, is similar to previously approved relief request RR-P04, Revision 1, in January 1999. The Relief Request RR-P04, Revision 1, submitted during the 3rd 10-year Interval IST, is renumbered as Relief Request RR-P02 for the 4th 10-year Interval IST.

3.3.4 Alternative Examinations:

The licensee proposed the following:

To allow for practicable vibration monitoring of the HPCI high pressure pump, alternative vibration acceptance criteria are needed specifically for vibration points I-3, O-3 and I-4. Full spectrum analysis will be performed during each quarterly test and the following criteria will be used:

Test Parameter	Acceptable Range	Alert Range	Required Action Range
V_v	$\leq$2.5 V_r but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec	> 6 V_r or > 0.70 in/sec

The remaining HPCI High Pressure and Booster pump vibration points are evaluated using the acceptance criteria specified in ASME OM Code paragraph ISTB-5100-1.

3.3.5 Evaluation of Valve Relief Request No. RR-P02:

Paragraph ISTB-3540, “Vibration,” requires that on centrifugal pumps, measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two orthogonal directions on each accessible pump bearing housing. The Code further states that the measurement also shall be taken in the axial direction on each accessible pump thrust bearing housing. The vibration measurements shall then be compared to both the relative and absolute criteria in Table ISTB-5100-1. The licensee proposes to use the acceptance criteria specified in the table below for the main pump turbine side horizontal and vertical vibration points I-3, O-3, and main pump gearbox side horizontal vibration point I-4. The remaining HPCI HP and booster pump vibration points will be evaluated using the acceptance criteria specified in Table ISTB-5100-1.

Test Parameter	Acceptable Range	Alert Range	Required Action Range
Table-5100-1, V_v ($\geq$ 600 rpm)	$\leq$2.5 V_r	> 2.5 V_r to 6 V_r or >0.325 to 0.7in/sec	> 6 V_r or >0.70 in/sec
RR-P04, V_v (Approved 9/3/93)	$\leq$2.5 V_r but not > 0.675 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec, resonance peaks $\geq$1.05 V_r	> 6 V_r or > 0.70 in/sec, resonance peaks $\geq$1.3 V_r
RR-P04, Rev. 1 (Approved for 3rd IST 10-year Interval dated January 14, 1999) V_v	$\leq$2.5 V_r but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec (deleted spectral alarm commitment)	> 6 V_r or > 0.70 in/sec (deleted spectral alarm commitment)
RR-P02, (Similar to RR-P04, Rev. 1) (Proposed for 4th IST 10-year Interval) V_v	$\leq$2.5 V_r but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec	> 6 V_r or > 0.70 in/sec

The licensee also requested that the spectral alarm commitment, that was authorized by the NRC as an alternative (RR-P04) in a safety evaluation dated September 3, 1993, be eliminated. The licensee states that compliance with the VYNPS proposed spectral resonance alarm criteria of 1.05 and 1.3 times the overall peak V_r is difficult to achieve. The licensee states that its commitment to perform full-spectrum vibration monitoring envelopes a review of all peaks in the spectrum for signs of degradation, including the resonance peaks. VYNPS states that its commitment to assign a single-spectral alarm limit adds little value to the vibration program and unjustifiably causes the pump test frequency to be doubled (e.g., when the resonance peak at the impeller vane pass frequency exceeds 1.05 V_r). Based on VYNPS's review of overall peak vibration values, the licensee has determined that the acceptable range limit can be lowered from 0.675 in/sec to 0.575 in/sec.

Deletion of the commitment to have an additional Alert Range of 1.05 V_r to 1.3 V_r and an additional Required Action Range of > 1.3 V_r for the resonance peaks will not decrease the effectiveness of the licensee's pump vibration monitoring program in terms of its ability to detect pump degradation. This additional commitment could cause an unnecessary burden on the licensee, particularly when "resonance peaks" are interpreted to be the largest peak on the spectrum, even though resonance only occurs when a natural frequency and forced frequency coincide.

The licensee performed extensive analysis of this pump installation and determined that the high vibration levels are due to effects of acoustical and structural resonance. These high levels do not indicate pump mechanical degradation and do not represent phenomena that could prevent the pump from performing its intended function. In addition, the licensee is continuing its efforts to reduce the vibration levels on this complex system (i.e., turbine, HP pump, gearbox, and booster pump combination).

The licensee's proposal to perform pump vibration spectrum analyses quarterly, with a lower vibration acceptance criteria, will result in adequate corrective action being taken on a pump with significant degradation. A spectrum analysis measures a narrow vibration band width over a wide frequency range and indicates the frequency and magnitude of vibration peaks. This would identify specific problems with bearings and other pump mechanical components. The spectrum analysis allows a more complete evaluation of the pump's condition than the Code-required wide range vibration measurements. Therefore, the proposal provides an acceptable level of quality and safety.

3.3.6 Conclusion:

The licensee's proposed alternative to the Code requirement, described in Pump Relief Request RR-P02, is authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that the proposed alternative provides an acceptable level of quality and safety.

3.4 Pump Relief Request RR-P03:

3.4.1 Code Requirements:

The ASME OM Code, paragraph ISTB-5322, "Group B Test Procedure," requires that the test parameter value identified in Table ISTB-3000-1 shall be determined and recorded as required by paragraph ISTB-5322. Table ISTB-3000-1 requires that the flow rate shall be measured or determined for the Group B test for positive displacement pumps.

3.4.2 Relief Requested:

The licensee requested relief from measuring the flow rate as required by the ASME OM Code Table-3000-1 and paragraph ISTB-5322 for its diesel fuel oil transfer pumps P92-1A and P92-1B. These pumps have a safety function to provide diesel fuel oil to the diesel oil day tank during operation of the Emergency Diesel Generator (EDG).

3.4.3 Licensee's Basis for Relief:

During quarterly IST, pump flow rate cannot be directly measured. The EDG fuel oil supply system consists of two parallel trains, one for each diesel generator. Fuel oil is supplied directly to the diesel fuel block from the 800-gallon day tank. Make-up to each diesel day tank is accomplished automatically from the 75,000 gallon storage tank by operation of the diesel fuel oil transfer pumps. The diesel day tank is sized for three hours of continuous full-load operation based on a diesel fuel oil consumption rate of approximately 3.4 gpm. The diesel fuel oil transfer pumps are positive displacement pumps with a design capacity of approximately 8.7 gpm.

It is considered impractical to directly measure pump flow rate on a quarterly basis. There is no flow instrumentation installed in the fuel oil transfer system. Sufficient straight sections of piping are required (typically 10 to 15 pipe diameters; or approximately 3 to 5 feet) to measure flow rate accurately using either permanently or temporarily installed instrumentation, such as non-intrusive flow measurement devices. The only sufficient sections of piping exist in the buried sections of the supply headers, under heat tracing, or in overhead runs that are normally inaccessible without erecting scaffolding. Installation of flow rate instrumentation or a pump test loop would require significant system redesign and modification, which would be burdensome to VYNPS.

Diesel fuel oil transfer pump flow rate can be determined indirectly by measuring the level change in the diesel day tank, versus the pump operating time required to make that level change. However, in order to allow for evaluation of the test results against the acceptance criteria of ASME OM Code, Table ISTB-5300-1, the test must be performed with the respective EDG secured. This eliminates the variable of the diesel fuel oil consumption rate when the diesel is running. In addition, in order to provide measurement accuracy comparable with Table ISTB-3500-1, the automatic pump start feature on the low diesel day tank levels must be disabled, and the diesel day tank volume reduced prior to the test through operation of the respective EDG. Disabling the automatic start feature of the diesel fuel oil transfer pump on low diesel day tank levels lessens the ability of the EDG to operate automatically without operator assistance, reduces the availability of an engineered safety system, and requires entry into a VYNPS TS and limiting condition of operation (LCO), with the required alternative testing requirements.

This relief request RR-P03 is similar to a previously-approved relief request, RR-P09, in the staff's safety evaluation dated September 3, 1993. The Relief Request RR-P09, submitted during the 3rd 10-year Interval IST, is renumbered as Relief Request RR-P03 for the 4th 10-year Interval IST.

3.4.4 Alternative Examinations:

During quarterly IST of each diesel fuel oil transfer pump, it will be verified that the pump is capable of supplying fuel oil to the respective diesel day tank at a flow rate greater than that required by the operating EDG. This is verified by an increase in diesel day tank levels during the EDG surveillance testing. In addition, full spectrum vibration monitoring and measurement of pump discharge pressure will be performed with the results evaluated against the acceptance criteria of Table ISTB-5300-1 for the Group A test.

Once each operating cycle, the flow rate of each diesel fuel oil transfer pump will be determined indirectly by measuring the level change in the diesel day tank. This will be performed with the respective EDG secured, the automatic pump start feature on low diesel day tank levels disabled, and the diesel day tank volume reduced prior to the test through operation of the respective EDG. This testing will provide measurement accuracy comparable to ASME OM Code Table ISTB-3500-1, and the results will be evaluated against the acceptance criteria of ASME OM Code Table-5300-1. As with the quarterly testing, full vibrational monitoring and measurement of pump discharge pressure will be performed with the results evaluated against the acceptance criteria of Table-5300-1. Such testing is considered commensurate with the pump type and service, and provides an acceptable level of quality and safety, based on the following:

- A review of the pump design flow rate verus the diesel fuel oil consumption rate indicates an excess capacity of approximately 60 percent. As such, operational readiness of the pumps is still assured with up to 60 percent degradation, provided that pump bearing vibration is not excessive. Assurance of acceptable pump bearing vibration levels is provided through the full spectrum vibration monitoring.

- A review of VYNPS's maintenance record and industry experience, as documented in Nuclear Plant Reliability Data System (NPRDS), indicates that pumps are highly reliable and that above testing methods are acceptable for assessing pump operational readiness and determining potential degradation. There has been no detectable degradation of pump capacity since at least 1990, and both fuel oil transfer pumps are still exceeding the manufacturer's curve after 30 years.

At VYNPS, four failures have occurred in 30 years of plant operations. Of these failures, three were related to electric components, and one was related to high bearing vibrations. In addition, minor shaft seal leakage has been noted and corrected. There has not been a diesel fuel oil transfer pump failure attributable to the pump or motor since 1996. The industry experience is consistent with VYNPS. For similar pumps in similar applications, fifteen failures have been reported via NPRDS. Of these failures, nine were related to excessive seal leakage, four were related to electrical components, and two were related to high bearing vibrations.

Each of the above failure modes is adequately monitored during the quarterly IST through visual examination of the pump seals, proper starting and operation of the pump upon low diesel day tank level, and full spectrum vibration monitoring.

3.4.5 Evaluation of Pump Relief Request No. RR-P03:

The ASME Code OM paragraph ISTB-3400 and Table ISTB-3400-1 require that for Group B pumps, a Group B test shall be performed quarterly, and a comprehensive test shall be performed biennially. Paragraph ISTB-5322 and Table ISTB-3000-1 provides the pump test quantities to be measured to detect hydraulic and mechanical degradation and to evaluate pump operational readiness. The licensee proposes to observe that each pump provides flow greater than that used by the operating EDG, measure pump discharge pressure, and perform full-spectrum vibration analysis quarterly.

The parameters required to be measured for these constant speed positive displacement pumps are flow rate, discharge pressure and vibration (Group B and comprehensive tests) . There are no installed instruments in the diesel fuel oil transfer system that allow direct measurement of pump flow rate. The current system configuration does not have any accessible straight sections of the piping that are sufficiently long to permit installation of flow instrumentation or to use portable flow instruments that meet Code requirements. The only piping sections that would be adequate are buried or otherwise inaccessible. Major system modifications would be required to install flow instruments that meet the Code requirements. Imposing these requirements would cause a burden on the licensee that is not commensurate with safety increase. The staff concludes that it is impractical to perform a quarterly flow test without significant system redesign or modification.

The pump flow rate can be calculated by measuring the change in day tank volume and the pump operating time required to make that change. This method yields a value for pump flow rate that can be used to evaluate pump hydraulic conditions. If flow rate is calculated with sufficient accuracy to allow detection of pump degradation, installation of flow rate instrumentation would be burdensome because it would provide only a minimal improvement in the ability to monitor pump condition. Accurately determining flow rate is impractical during quarterly testing because it would be necessary to make these measurements with the diesel stopped, and the low-level, automatic-start feature of the day tank disabled. In addition, with the day tank below the minimum level, establishing these conditions quarterly for pump testing reduces the availability of an engineered safety system and requires entry into a TS LCO action statement with prescribed alternative testing requirements.

The discharge pressure of the positive displacement fuel oil transfer pumps is dependent on the pressure of the system into which they are pumping, and is not significantly affected by either inlet pressure (providing adequate net positive suction head) or flow rate. The discharge pressure for these pumps is relatively small because they pump directly into the day tanks which are vented to the atmosphere. Changes in flow resistance should not significantly affect the flow rate of these positive displacement pumps unless the rated discharge pressure is exceeded. Therefore, the primary parameter for evaluating the hydraulic condition of these pumps is the pump flow rate. Flow rate is subjectively determined for the quarterly testing but is not measured in a way that allows detection of pump degradation.

The licensee indicated that these pumps have excess capacity of 60 percent. However, it has not been demonstrated that the pumps would have an acceptable level of operational readiness (assurance that they would be capable of performing their safety function during an accident) if they suffered degradation that reduced the flow rate by 10 to 60 percent. Therefore, the proposed quarterly testing is limited in its ability to detect hydraulic degradation and provide assurance of pump operational readiness.

The proposed vibration spectrum analysis provides more useful information about the condition of the pump than the Code-required wide range measurement. This testing would detect most of the mechanical degradation mechanisms that potentially could affect these pumps. The licensee’s proposed quarterly testing verifies pump operation, but provides little information to permit detection of pump hydraulic degradation. However, the testing, when performed once every cycle, would permit detection of hydraulic degradation provided the flow rate determination is sufficiently accurate. The licensee indicated that the accuracy of the flow rate determination would be comparable to the ASME OM accuracy requirements. Therefore, the flow rate determination provides an accuracy equivalent to that of an instrument meeting the Code requirements. Therefore, the staff finds that the proposed hydraulic testing, coupled with the quarterly vibration full-spectrum analysis, will provide an adequate assessment of the pump’s operational readiness.

3.4.6 Conclusion:

Relief from measuring the flow rate as required by ASME OM Code Table-3000-1 and paragraph ISTB-5322, for the diesel fuel oil transfer pumps P92-1A and P92-1B is granted pursuant to 10 CFR 50.55a(f)(6)(i), based on the determination that compliance with the specified Code requirements is impractical. The proposed alternative to flow rate measurement provides reasonable assurance of the pumps’ operational readiness. Granting this relief is 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 the licensee that could result if the requirements were imposed on the facility.

3.5 Pump Relief Request RR-P04:

3.5.1 Code Requirements:

ASME OM Code, paragraph ISTB-5123(e), “Comprehensive Test Procedure,” specifies that all deviation from the V_r shall be compared with the ranges of Table ISTB-5100-1, and corrective action taken as specified in ISTB-6200. The vibration measurements shall be compared to both the relative and absolute criteria shown in the alert and required action ranges of Table ISTB-5100-1.

3.5.2 Specific Relief Requested:

The licensee requested relief from the ASME OM Code requirements of paragraph ISTB-5123(e) for the RCIC pump P47-1A.

3.5.3 Licensee’s Basis for Relief:

The licensee requested relief on the basis that the proposed alternatives would provide an acceptable level of quality and safety. The licensee states that past testing and analysis performed on the RCIC system by VYNPS, and independent vibration consultants in 1988 and 1997, confirms characteristic pump vibration levels in the outboard bearing vertical direction, at the high end of the acceptance range criteria stated in Table ISTB-5100-1. This testing and analysis meets the intent of Paragraph ISTB-6400 and its accompanying footnote 1.

The root causes of the higher vibration levels have been determined to be:

a) excitement in the outboard bearing support in the vertical direction at, or near, the fourth and fifth orders (vane pass frequency).

b) the presence of a natural frequency at 320 Hz (19,200 cycles per minute) in the outboard bearing vertical direction.

In the pump speed range of 4,000 to 4,500 rpm, the fourth (267-300 Hz) and fifth (333-375 Hz) orders do not coincide with the 320 Hz natural frequency peak, but are influenced by it. In general, the 4th order is more sensitive to resonance as pump speed and the corresponding 4th order vane pass frequency is increased toward the 320 Hz natural frequency. The 5th order is influenced somewhat less as speed is lowered, and the corresponding 5th order vane pass frequency is decreased toward the 320 Hz natural frequency.

The analysis performed by a vibration consultant in 1988 documented that the 4th order peak value of 0.511 in/sec at 4500 rpm dropped to .177 in/sec when speed was decreased to 4342 rpm. The recommendation, at that time, was to reduce the speed for surveillance testing. When the surveillance speed was lowered to approximately 4300 rpm, the overall peak vibration level in the outboard vertical direction remained in the area of 0.3 in/sec.

The analysis performed by the same vibration consultant in 1997 clearly documented the relationship of the natural frequency to the 4th and 5th order vane pass frequency using improved vibration technology. The excitement in the bearing support was also documented. The recommendation, at that time, was again to reduce the speed for surveillance testing if possible. If a speed reduction was not possible, then changing the number of 1st stage impeller vanes and modifications to the outboard bearing support was recommended.

With only one vertical direction vibration point exceeding the Code vibration criteria, it was determined that to pursue 1st-stage impeller replacement, or to perform the analysis to qualify a bearing support modification, would result in hardship without a compensating increase in quality and safety. Spectrum analysis of the latest surveillance test data shows that the primary source of the vibration continues to coincide with vane pass frequency of the pump. Vane pass frequency is inherent in all pumps and normally does not present a problem, unless it happens to excite resonant frequencies. The vane pass frequencies do not coincide exactly with the natural frequency; therefore, a full resonance condition does not exist. The identified vane pass frequencies are on the periphery of resonance excitement, thereby causing higher than expected vibration in the outboard vertical direction. This condition on the outboard bearing, in one direction, is not of a magnitude that would prevent the RCIC pump from performing its intended safety function.

Surveillance testing is currently performed to satisfy both TS and IST requirements using a reference speed of 4300 rpm. Preliminary design basis review information indicates that the speed will need to be increased to test the pump at a higher output to account for instrument uncertainty. Increasing the speed to the expected 4450 to 4500 rpm range produces an overall peak vibration between 0.433 and 0.460 in/sec, as documented in the 1997 consultant’s report.

The resonant condition is design related and has existed since initial pump installation. Surveillance test documentation, collected over a number of years, demonstrates that no appreciable degradation has taken place. On February 18, 1990, the outboard bearing was replaced three times in an effort to demonstrate that a degraded bearing condition did not exist.

The pump vendor certified, in a September 14, 1998, memorandum, that the pump could be run at 0.575 in/sec, and would not be expected to exhibit reduced reliability given the intermittent and short duration (< 24 hours) operation in support of core cooling following transient or accident events.

Although existing vibration levels in the RCIC pump outboard bearing vertical direction are at the high end of standard acceptance criteria, they are acceptable and reflect the unique operating characteristics of the VYNPS RCIC pump. The licensee concluded that there are no vibration concerns of a magnitude that would indicate pump degradation or prevent the pump from performing its intended function.

The Relief Request RR-P10, Revision 2, submitted during the 3rd 10-year Interval IST, is renumbered as Relief Request RR-P04 for the 4th 10-year Interval IST.

3.5.4 Alternative Examinations:

The licensee proposed that to allow for practicable vibration monitoring of the RCIC pump, alternative vibration acceptance criteria are required. Full-spectrum vibration monitoring will be performed during each quarterly test, and the following criteria will be used for RCIC pump vibration point O-4:

Test Parameter	Acceptable Range	Alert Range	Required Action Range
RR-P04, V_v	$\leq 2.5\ V_r$ but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec	> 6 V_r or > 0.70 in/sec

3.5.5 Evaluation of Pump Relief Request No. RR-P04:

The licensee stated that use of the vibration acceptance criteria contained in ISTB-5123(e) has caused, and continues to cause, frequent entry into the Alert Range, requiring increased frequency testing for vibration point O-4.

ASME OM Code, paragraph ISTB-3540 requires for centrifugal pumps that measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two orthogonal directions on each accessible pump-bearing housing. Measurement also shall be taken in the axial direction on each accessible pump thrust bearing housing. ASME OM Code, Table ISTB-5100-1 requires those pumps with vibration levels between 0.325 in/sec and 0.700 in/sec be classified in the “alert” range, and that the testing frequency be doubled (from quarterly to every six weeks) until the cause of the vibration is determined and the condition corrected (ISTB-6200).

While not implemented by the licensee, the staff approved interim use of relaxed alert range (0.50 in/sec to 0.70 in/sec) in a safety evaluation to the licensee dated May 26, 1995. In that safety evaluation, the staff stated: “During the interim period, the licensee should investigate methods to reduce current pump vibration levels; confirm that an analysis has been performed which demonstrates the pump is capable of continued operation at higher vibration levels (including contact with the pump manufacturer); and evaluate data on how the revised alert limit was derived. If the licensee has implemented a program for spectral analysis of the vibration of the pump, it would be beneficial to include such information in the alternative testing section of the revised relief request.” As discussed below, the licensee’s revised relief request RR-P10, Rev. 2 is responsive to the concerns raised by the staff in the May 26, 1995, safety evaluation.

The licensee now proposes to use the acceptance criteria specified in the table below for the pump outboard bearing, vertical vibration point O-4 (vibration levels between 0.575 in/sec and 0.700 in/sec will be classified in the “alert” range for this one vibration data point). The remaining RCIC pump vibration points (i.e., the pump inboard bearing horizontal/vertical and the outboard bearing horizontal/axial points) will be evaluated using ASME OM Code, ISTB acceptance criteria.

Test Parameter	Acceptable Range	Alert Range	Required Action Range
Table ISTB-5100-1, ($\geq$ 600 rpm) V_v	$\leq$2.5 V_r	> 2.5 V_r to 6 V_r or >0.325 in/sec	> 6 V_r or >0.70 in/sec
RR-P10, Rev. 2 V_v (Approved 1/19/1999)	$\leq$2.5 V_r but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec	> 6 V_r or > 0.70 in/sec
RR-P04 Proposed V_v	$\leq$2.5 V_r but not > 0.575 in/sec	> 2.5 V_r to and including 6 V_r but not > 0.70 in/sec	> 6 V_r or > 0.70 in/sec

The licensee states that past testing and analysis performed on the RCIC System, by the licensee and independent vibration consultants in 1988 and 1997, confirms characteristic pump vibration levels in the outboard bearing vertical direction at the high end of the acceptance range criteria specified in ASME OM Code, Table ISTB-5100-1. The licensee states that this testing and analysis meets the intent of ASME OM Code paragraphs ISTB-3300 and 6400 and footnote 1 of the Code. Footnote 1 to Paragraph ISTB-6400, “Analysis of Related Condition,” states:

> Vibration measurements of pumps may be foundation, driver, and piping dependent. Therefore, if initial vibration readings are high and have no obvious relationship to the pump, then vibration measurements should be taken at the driver, at the foundation, and on the piping and analyzed to ensure that the reference vibration measurements are representative of the pump and that the measured vibration levels will not prevent the pump from fulfilling its function.

The licensee has performed extensive analysis of this pump installation and determined that the root cause of the high vibration levels are due to:

a) excitement in the outboard bearing support in the vertical direction at or near the fourth and fifth orders (vane pass frequency), and

b) the presence of a natural frequency at 320 Hz. (19,200 cycles per minute) in the outboard bearing vertical direction.

An analysis performed by a vibration consultant in 1988 documented that the 4th order peak value of 0.511 in/sec at 4500 rpm dropped to 0.177 in/sec when speed was decreased to 4342 rpm. The recommendation, at that time, was to reduce the speed for surveillance testing. A second analysis, performed by the same vibration consultant in 1997, documented the relationship of the natural frequency to the 4th and 5th order vane pass frequency using improved vibration technology. The excitement in the bearing support was also documented. The vibration consultant’s recommendation was, again, to reduce the speed for surveillance testing, if possible. If a speed reduction was not possible, then changing the number of

1st-stage impeller vanes and modifications to the outboard bearing support was recommended. With only one vertical direction vibration point exceeding the Table ISTB-5100-1 vibration criteria, the licensee determined that to pursue 1st-stage impeller replacement, or to perform the analysis to qualify a bearing support modification, was not a practical solution.

Spectrum analysis of the latest surveillance test data shows that the primary source of the vibration continues to coincide with vane pass frequency of the pump. Vane pass frequency is inherent in all pumps and normally does not present a problem, unless it happens to excite resonant frequencies. The vane pass frequencies do not coincide exactly with the natural frequency; therefore, a full resonant (and, hence, potentially damaging) condition does not exist in this instance. The identified vane pass frequencies are on the periphery of resonance excitement, thereby causing higher than expected vibration in the outboard vertical direction. This condition on the outboard bearing, in one direction, is not of a magnitude that would prevent the RCIC pump from performing its intended safety function. This condition is design-related, and has existed since initial pump installation. Surveillance test documentation, collected over a number of years demonstrates that no appreciable degradation has taken place.

The licensee stated that the pump vendor has certified that the pump could be run at 0.575 in/sec and would not be expected to exhibit reduced reliability given the intermittent and short duration (less than 24 hours) operation in support of core cooling following a transient or accident event. The licensee contacted boiling water reactor (BWR) licensees with similar RCIC pumps and identified that vibration levels of $\leq$ 0.2 in/sec are routinely experienced. However, it noted that these other licensees' pump pedestals are approximately 1'-3" high while the VYNPS RCIC pump pedestal is 3'-0" in height. Therefore, the licensee states that a direct comparison between plants cannot be made, since the foundation is dissimilar and natural frequencies are unique for each component and combination of components.

The licensee's proposal to perform pump vibration spectrum analysis quarterly with a higher vibration acceptance criteria (as certified to be acceptable by the RCIC pump vendor) will result in adequate action being taken on a pump with significant degradation. A spectrum analysis measures a narrow vibration band width over a wide frequency range and indicates the frequency and magnitude of vibration peaks, which permits identification of specific problems with bearings and other pump mechanical components. The spectrum analysis allows a more comprehensive evaluation of the pump condition than the Code-required wide range vibration measurements. Therefore, the proposal provides an acceptable level of quality and safety.

3.5.6 Conclusion:

The licensee's proposed alternative to the Code requirement, described in Revision 2 to pump relief request RR-P04, is authorized pursuant to 10 CFR 50.55a(a)(3)(i), on the basis that the proposed alternative provides an acceptable level of quality and safety.

3.6 Valve Relief Request No. RR-V01:

3.6.1 Code Requirements:

The ASME OM Code, paragraph ISTC-3510, "Exercising Test Frequency," requires that active Category A, Category B, and Category C check valves shall be exercised nominally every 3 months, except as provided by ISTC-3520. ISTC-3522(c) requires that IST be performed every refueling outage.

3.6.2 Specific Relief Requested:

Relief is requested from the Code requirements of ISTC-3522 for the check valves listed in Table 1 (below). In lieu of performing the test at every refueling outage, the licensee proposes to perform non-intrusive testing (radiography) on each valve once each operating cycle, within two months of the scheduled start of the next fuel outage.

Table 1

Valve Number	System	ISTC-1300 Category	Safety Class
V14-22A, B	Core Spray (CS)	C	2
V14-23A, B	Core Spray (CS)	C	2
V14-33A, B	Core Spray (CS)	C	2
V23-20B	High Pressure Coolant Injection (HPCI)	C	2
V23-32	High Pressure Coolant Injection (HPCI)	C	2
V13-19	Reactor Core Isolation Cooling (RCIC)	C	2
V13-20B	Reactor Core Isolation Cooling (RCIC)	C	2
V10-36A, B	Residual Heat Removal (RHR)	C	2

3.6.3 Basis for Relief:

Valves V14-22A(B) and V14-23A(B) are check valves in the flushing line from the condensate transfer (CT) system to the core spray system. These valves have a safety function to close to isolate the HP Safety Class 2 core spray piping from the lower non-safety grade CT system.

The remaining valves are the RHR, CS, HPCI and RCIC system keep-fill check valves. These valves have a safety function to close to isolate safety Class 2 CS, RHR, RCIC or HPCI piping from the lower pressure non-safety grade CT system piping in the event of a system actuation. There are no test connections between the check valves or in any of the keep-fill pressurization lines. Individual check valve closure capability verification is presently accomplished by performing quarterly non-intrusive (radiography) testing. Indication of the valve closure has been conclusive. However, this quarterly non-intrusive testing of the subject valve during power operation has proven to be burdensome. The burdens imposed by this test method and frequency of testing include:

1. Increased personal radiation exposure: The transport, equipment setup, exposure and equipment removal account for approximately 400 mrem/year in increased personnel radiation dose.

2. Large manpower requirements: The administration of radiological controls, control of the radiographic source, and posting of exclusive areas during exposures, at times requires the utilization of all available plant radiation controls personnel. The completion of all the radiographs typically requires two days each quarter.

3. Extensive test equipment setup: The setup of the radiographic equipment and shielding of the adjacent plant equipment is repeated for each valve tested.

4. Potential for unexpected challenges to plant safety system: The use of portable radioactive sources, and their movements, present the potential for unexpected challenges to plant safety systems due to high radiation actuation.

It is expected that the performance of radiography during cold shutdown would present the additional burden of obtaining contract service on short notice. It is also expected that performing radiography during refueling outages will present added risk of increased radiation exposure to personnel. Testing once each operating cycle, but not during refueling outage, will reduce the risk of increased radiation exposure to personnel as fewer people will be subject to exposure.

3.6.4 Alternative Examination:

The licensee proposes to perform non-intrusive testing (radiography) on each valve once each operating cycle within two months of the scheduled start of the next fuel outage in lieu of performing the test during each refueling outage.

3.6.5 Evaluation of Valve Relief Request No. RR-V01:

The ASME OM Code, paragraph ISTC-3522(c) requires that if valve exercising is not practicable during operation at power or cold shutdowns, it shall be performed during a refueling outage. Paragraph ISTC-3522(f) states that all valve testing required to be performed during a refueling outage shall be completed before returning the plant to operation at power.

Paragraph ISTC-5221(a)(3) allows observation of the travel of the obturator by positive means, such as non-intrusive testing results to verify operability of check valves.

Therefore, ISTC-5221(a) currently allows the non-intrusive testing (radiography) of check valves as an acceptable means of verifying valve closure and Code relief is not required in this regard. With appropriate documentation, ISTC-3522(c) and ISTC-3522(f) also allows refueling outage testing. However, performing the required test at a time other than refueling outages does not meet Code requirements and relief is needed. The licensee's alternative proposes to perform the test within two months of the scheduled start of the next outage. The licensee requests relief on the basis that the burden imposed by the non-intrusive test methods, and more frequent testing (i. e. quarterly) during power operation, does not provide a compensating increase in safety. The burden of performing more frequent tests during power operation includes increased personnel radiation exposure, large manpower requirements, extensive test equipment setup, and increased potential for unexpected challenges to plant safety systems. The performance of radiography during cold shutdown would present the additional burden of obtaining contract services on short notice, and performing radiography during refueling outage will present added risk of increased radiation exposure because more workers are onsite during refueling outages.

The staff finds that (1) there are no technical barriers nor significant risks to performing the non-intrusive (radiography) testing during the operating cycle (i.e., within two months of the scheduled start of the next refueling outage), and (2) approximately the same number of IST will be performed using the proposed test frequency as would be performed using the Code refueling outage frequency. On the basis of these considerations, the NRC staff finds that the proposed alternative provides an acceptable level of quality and safety.

3.6.6 Conclusion:

The non-intrusive testing (radiography) of the check valves is a method currently allowed by the Code for verifying valve closure. The proposal to perform the required test on a check valve once each operating cycle, within two months of the scheduled start of the next refueling outage, is consistent with the test interval ISTC-3522(f) and, therefore, provides adequate assurance of valve operability. On the basis that Code compliance would result in hardship or unusual difficulty, without a compensating increase in the level of quality and safety, the licensee's proposed alternative frequency of testing of check valves is authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

3.7 Valve Relief Request No. RR-V02:

3.7.1 Code Requirements:

The ASME OM Code, paragraph ISTC-3510, "Exercising Test Frequency," requires that active Category A, Category B, and Category C check valves shall be exercised nominally every three months, except as provided by ISTC-3522. ISTC-3522 requires that IST be performed every refueling outage.

3.7.2 Specific Relief Requested:

Relief is requested from the Code requirements of ISTC-3522 for the excess flow check valves listed in Table 2 (below). These check valves are instrumentation line excess flow check valves (EFCVs) provided in each instrument line that penetrates primary containment. These EFCVs are in the Nuclear Boiler (NB), RCIC, and HPCI systems.

Table-2

Valve Number	System	OM Category	Safety Class
SL-13-55A, B, C, D	RCIC	A/C	2
SL-14-31A, B	CS	A/C	2
SL-2-62A, B, C, D	NB	A/C	2
SL-2-64A, B, C, D	NB	A/C	2
SL-2-73A, B, C, D, E, F, G, H	NB	A/C	2
SL-2-2-7A, 7B	NB	A/C	2
SL-2-2-8A, B	NB	A/C	2
SL-2-3-11	NB	A/C	2
SL-2-3-13A, B	NB	A/C	2
SL-2-3-15A, B	NB	A/C	2
SL-2-3-17A, B	NB	A/C	2
SL-2-3-19A, B	NB	A/C	2
SL-2-3-21A, B, C, D	NB	A/C	1
SL-2-3-23A, B, C, D	NB	A/C	1
SL-2-3-25	NB	A/C	2
SL-2-3-27	NB	A/C	2
SL-2-3-31A, B, C, D, E, F, G, H, I J, K, M, N, O, P, Q	NB	A/C	1
SL-2-3-33	NB	A/C	2
SL-2-3-35	NB	A/C	2
SL-2-305A, B	NB	A/C	2
SL-23-37A, B, C, D	HPCI	A/C	2

3.7.3 Licensee's Basis for Relief:

EFCVs are required to be tested in accordance with ISTC-3522 exercising check valves nominally every three months to the positions required to perform their safety functions. ISTC-3522(c) permits deferral of this requirements to every reactor refueling outage.

These EFCVs are instrumentation line EFCVs provided in each instrument line that penetrates primary containment. The EFCVs are designed to close upon rupture of the instrument line downstream of the EFCV, but otherwise remain open. A flow-restricting orifice is installed just inside the drywell on all but the jet pump instrument lines. Because the jet pump instrument lines are small diameter lines, orifices are not needed. In the unlikely event that an EFCV fails to function properly, concurrent with a postulated line break outside containment, the orifice and small tube diameters limits flow rates, thus ensuring that the integrity and functional performance of secondary containment is maintained. The coolant loss under such a scenario is well within the makeup capability of the reactor coolant supply systems, and the potential off-site radiological consequences have been evaluated to be substantially below the limits of 10 CFR Part 100.

The EFCVs are classified as ASME Code Category C, and are also containment isolation valves. However, these valves are excluded from 10 CFR Part 50, Appendix J, Type C leak testing due to the size of the instrument lines and upstream orifice. Therefore, these do not have any safety-related seat leakage criteria.

These valves cannot be exercised during normal power operation because closing these valves would isolate the instrumentation required for power operation. These valves can only be verified to close by leak testing performed during the primary system inservice pressure test performed each refueling outage. This test cannot be performed during cold shutdown since reactor vessel pressurization is required to test the valves.

EFCVs are simple devices with the major active components being a poppet and spring. The spring holds the poppet open under static conditions. The valve will close upon sufficient differential pressure across the poppet. Functional testing of the valve is accomplished by venting the instrument side of the line. The resultant increase in flow imposes a differential pressure across the poppet, which compresses the spring and deceases flow through the valve. The design back-flow through the VYNPS EFCVs is 1.0 gpm, which is the test acceptance criterion.

EFCVs have been extremely reliable throughout the industry. In the first 27 years of operation at VYNPS, only one excess flow check valve has failed. The licensee has evaluated the consequences of a postulated instrument line break without crediting EFCV function, and the calculated off-site radiological consequences are sufficiently low and acceptable, considering the probability of an instrument line break coincident with the functional failure of the associated EFCV. Any increase in risk, due to the relaxed frequency of EFCV testing, is insignificant. Therefore, the alternative testing of a representative sample, rather than each EFCV during every refueling outage, provides an acceptable level of quality and safety.

3.7.4 Alternative Examination:

The licensee proposes to test a representative sample of EFCVs, instead of each EFCV, every refueling outage, such that all EFCVs are tested within a 10-year interval.

Any failure will be evaluated in accordance with the requirements of the VYNPS Corrective Action Program (CAP). This evaluation will include analysis to determine:

- Corrective actions
- Common mode failure
- Potential expended sample size
- Performance reliability

Performance reliability may require increased test frequency for failed components until two consecutive acceptable tests are achieved. Testing of that component would then be returned to the 10-year frequency.

The proposed alternative is requested for the duration of the 4^{th} 10-year interval VYNPS IST Program.

3.7.5 Evaluation of Valve Relief Request No. RR-V02:

EFCVs are installed on BWR instrument lines to limit the release of fluid in the event of an instrument line break. Examples of EFCV installations include: reactor pressure vessel level and pressure instrumentation, main steam line flow instrumentation, recirculation pump suction pressure, and RCIC steam line flow instrumentation. EFCVs are not required to close in response to a containment isolation signal and are not required to operate under post LOCA conditions.

The standard technical specifications surveillance requirements currently require verification of the actuation (closing) capability of each reactor instrumentation line EFCV every 18 months (or 24 months, depending on the plant refueling schedule). This is typical for most BWR plants. The proposed change by the licensee revises the surveillance frequency by allowing a "representative sample" of EFCVs to be tested every 18 months. The "representative sample" is based on approximately 17 percent of the EFCVs being tested each refueling outage, such that each valve is tested at least once every 10 years (nominal).

The reactor vessel instrument lines at VYNPS include flow restricting orifices upstream of the EFCVs to limit reactor coolant flow in the event of an instrument line break. The licensee states that: (1) in the unlikely event where an EFCV fails to function properly concurrent with a postulated line break outside containment, restricting orifices and small tube diameters limit flow rates, thus ensuring that the integrity and functional performance of secondary containment is maintained; and (2) the coolant loss under such a scenario is well within the makeup capability of reactor coolant supply systems, and the potential off-site radiological consequences have been evaluated to be substantially below the limits of 10 CFR Part 100.

The VYNPS TS surveillance requires the EFCVs to be tested for proper operation in accordance with the IST program. The VYNPS IST program has deferred the quarterly testing of these valves based on the provision of the Code that states: "if exercising is not practical during plant operation or cold shutdowns, it may be limited to full-stroke testing during refueling outages." Based on the Code provision above, EFCVs at VYNPS are currently tested once every refueling outage (18 months).

The licensee's justification for the relief request is based on General Electric Nuclear Energy (GE) Topical Report NEDO-32977-A, "Excess Flow Check Valve Testing Relaxation," dated June 2000. The topical report provided: (1) an estimate of steam release frequency (into the reactor building) due to a break in an instrument line concurrent with an EFCV failure to close; and (2) an assessment of the radiological consequences of such a release. The staff reviewed the GE topical report and issued its evaluation on March 14, 2000. In its evaluation, the staff found that the test interval could be extended up to a maximum of 10 years. In conjunction with this finding, the staff noted that each licensee that adopts the relaxed test interval program for EFCVs must have a failure feedback mechanism and CAP to ensure EFCV performance continues to be bounded by the topical report results. Also, each licensee is required to perform a plant-specific radiological dose assessment, EFCV failure analysis, and release frequency analysis to confirm that they are bounded by the generic analyses of the topical report.

In this safety evaluation, the staff reviewed the licensee's proposal for its applicability to GE Topical Report NEDO-32977-A and conformance with approved staff guidance regarding radiological dose assessment, EFCV failure rate and release frequency, and the proposed failure feedback mechanism and CAP. Based on its review, the staff concludes that the radiological consequences of an EFCV failure are sufficiently low and acceptable, and that the alternative testing, in conjunction with the correction action plan, provides a high degree of valve reliability and operability. Additionally, an orifice is installed just inside the drywell on all but the jet pump instrument lines, which are small diameter tubes. The orifice and small tube diameter limit leakage to a level where the integrity and functional performance of secondary containment and associated safety systems are maintained, and the coolant loss is within the capability of the reactor coolant supply systems. Therefore, the staff finds that the licensee's proposed test alternative provides an acceptable level of quality and safety.

3.7.6 Conclusion:

Based on the above evaluation, the staff finds the proposed relaxation of the VYNPS EFCV test frequency, which would allow a representative sample of EFCVs to be tested every 18 months with all EFCVs being tested at least once every 10 years (nominal), provides an acceptable level of quality and safety. On this basis, the licensee's proposed alternative to the Code testing requirements is authorized pursuant to 10 CFR 50.55a(a)(3)(i).

4.0 <u>SUMMARY OF CONCLUSIONS</u>:

The staff concludes that the use of the ASME OM Code 1998 Edition through 2000 Addenda, for VYNPS's fourth 10-year interval IST program is approved pursuant to 10 CFR 50.55a(f)(4)(iv). The licensee's proposed alternative, as specified in relief request RR-V01, is authorized pursuant to 10 CFR 50.55a(a)(3)(ii) on the basis that compliance with Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The alternatives proposed in relief requests RR-V02, RR-P02 and RR-P04 are authorized pursuant to 10 CFR 50.55a(a)(3)(i) on the basis that they provide an acceptable level of quality and safety. Relief requests RR-P01 and

RR-P03 are granted pursuant to 10 CFR 50.55a(f)(6)(i), based on the impractically of performing testing in accordance with the Code requirements. Granting relief is 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 the licensee that could result if the requirements were imposed on the facility. The reliefs are authorized for the fourth 10-year IST program interval at VYNPS.

5.0 REFERENCES:

U.S. Code of Federal Regulations, “Domestic Licensing of Production and Utilization Facilities,” Part 50, Chapter I, Title 10, “Energy,” Section 50.55a, Codes and standards.

U.S. Nuclear Regulatory Commission, “Guidance on Developing Acceptable Inservice Testing Program,” Generic Letter 89-04, through Supplement 1, April 4, 1995.

U.S. Nuclear Regulatory Commission, “Guidance for Inservice Testing at Nuclear Power Plants,” NUREG-1482, April 1995.

General Electric Nuclear Energy (GE) Topical Report NEDO-32977-A, "Excess Flow Check Valve Testing Relaxation," dated June 2000.

Letter, M. A. Balduzzi, Entergy to NRC, “Fourth 10-Year Interval Inservice Testing Program and Request for Approval of IST Relief Requests for Pumps and Valves,” dated January 22, 2003.

Letter, M. A. Balduzzi, Entergy to NRC, “ Supplement to Fourth 10-Year Interval Inservice Testing Program and Request for Approval of IST Relief Requests for Pumps and Valves,” dated March 12, 2003.

Letter, R. Wanczyk, VYNPS to NRC, “Supplement to Fourth 10-Year Interval Inservice Testing Program Plan - To use ASME OM-1998 Edition through the OMb-2000 Addenda,” dated April 2, 2003.

Letter, J. M. DeVincentis, VYNPS to NRC, “Supplement to Fourth 10-Year Interval Inservice Testing Program Plan - Revise Relief Request RR-P01,” dated June 5, 2003.

Letter, W. M. Dean, NRC, to G.A. Maret, VYNPS, “Safety Evaluation for Relief Requests for Alternative Testing Regarding IST Program at VYNPS,” dated February 12, 1999.

Letter, J. W. Clifford, NRC, to M. A. Balduzzi, VYNPS, “Safety Evaluation for Relief Requests for Excess Flow Check Valve Testing Regarding in the Pump and Valve IST Program at VYNPS,” dated April 2, 2001.

Letter, D. H. Dorman, NRC, to D. A. Dridi, VYNPS, “Safety Evaluation for Relief Requests for Pump and Valve for Third 10-Year Interval IST Program at VYNPS,” dated September 3, 1993.

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