

VERMONT YANKEE NUCLEAR POWER CORPORATION

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November 20, 1998
BVY 98-155

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555

**Subject: Vermont Yankee Nuclear Power Station
License No. DPR-28 (Docket No. 50-271)
Request For Alternative Testing Per 10CFR50.55a(a)(3)(i)
Inservice Testing (IST) Program**

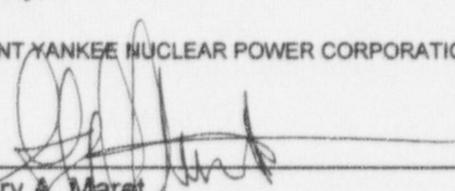
Pursuant to 10CFR55a(a)(3)(i), Vermont Yankee Nuclear Power Corporation (VY) hereby requests approval to perform alternative testing to that specified by the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section XI, and ASME/ANSI OM, "Operation and Maintenance of Nuclear Power Plants." Attachment 1 provides the justification for the alternative testing.

Approval for the use of the alternative testing is requested by April 30, 1999 in order to support scheduled testing. Upon approval, these alternative methods will be incorporated into our IST Program Plan.

If you have any questions on this transmittal, please contact Mr. Wayne M. Limberger at (802) 258-4237.

Sincerely,

VERMONT YANKEE NUCLEAR POWER CORPORATION



Gregory A. Maret
Director of Operations

Attachment

cc: USNRC Region 1 Administrator
USNRC Resident Inspector - VYNPS
USNRC Project Manager - VYNPS
Vermont Department of Public Service

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ATTACHMENT 1

PROPOSED ALTERNATE TEST METHODS

RR-P04, Rev. 1 High Pressure Coolant Injection Pump Testing

RR-P10, Rev. 2 Reactor Core Isolation Cooling Pump Testing

RELIEF REQUEST

Number: RR-P04, Revision 1 (Sheet 1 of 3)

SYSTEM: High Pressure Coolant InjectionCOMPONENTS:

Pump Number	Safety Class	Drawing Number	Dwg. Coord.
P44-1A	2	G-191169 Sh 2	G-11

P44-1A is the High Pressure Coolant Injection (HPCI) main (high pressure) pump. The main pump 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, and 2) reactor pressure control during reactor shutdown and isolation.

EXAM OR TEST CATEGORY:

Vibration Velocity (Vv) - (Specifically, Main Pump Turbine Side Horizontal and Vertical Vibration Points I-3, O-3 and Main Pump Gearbox Side Horizontal Vibration Point I-4)

CODE REQUIREMENT: Part 6

Para. 5.2(d) "Test Procedure"

"Pressure, flow rate, and vibration (displacement or velocity) shall be determined and compared with corresponding reference values. All deviations from the reference values shall be compared with the limits given in Table 3 and corrective action taken as specified in para. 6.1."

REQUEST FOR RELIEF:

Relief is requested on the basis that the proposed alternatives would provide an acceptable level of quality and safety.

Previous relief was approved for the HP pump in a format that could be interpreted to apply to all HP pump vibration points. **This revised relief request, being more conservative, is specifically for vibration points I-3, O-3 and I-4.** The remaining HP and Booster pump vibration points are evaluated using OM-6 acceptance criteria. The HPCI pump has a notable history regarding analysis and resolution of high vibration issues. During the 1985 through 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 2nd order acoustical resonance in the piping connecting the low pressure (LP) and high pressure (HP) pumps, and the presence of a structural resonance at the 2nd order in the horizontal direction on the HP pump.

RELIEF REQUEST (continued)

Number: RR-P04, Revision 1 (Sheet 2 of 3)

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 2nd order vibration levels; however, the overall peak levels remained higher than the OM-6 Table 3a acceptable range of 0.325 in/second. Vermont Yankee 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, Vermont Yankee additionally committed to evaluate the resonance peaks during each test and assigned limits of 1.05 and 1.3 times the overall peak reference value (Vr).

Regarding the approved relief request commitment to evaluate the resonance peaks, VY 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. VY applies the resonance peak criteria to all peaks on the spectrum, the largest usually being the impeller vane pass frequency. Compliance with the VY-proposed spectral resonance alarm criteria of 1.05 and 1.3 times the overall peak reference value (Vr) results in a hardship without a compensating increase in the quality and safety of the plant. 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 VY 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. Relief is requested to delete the conservative spectral alarm commitment. Additionally, VY has 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).

RELIEF REQUEST(continued)

Number: RR-P04, Revision 1 (Sheet 3 of 3)

ALTERNATE METHOD:

To allow for practicable vibration monitoring of the HPCI HP pump, alternate vibration acceptance criteria are required **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:

<u>Test Parameter</u>	<u>Acceptable Range</u>	<u>Alert Range</u>	<u>Required Action Range</u>
V _v	≤ 2.5 Vr but not > 0.575 in/sec.	> 2.5 Vr to and including 6 Vr but not > 0.70 in/sec.	> 6 Vr or > 0.70 in/sec.

The remaining HPCI High Pressure and Booster pump vibration points are evaluated using OM-6 acceptance criteria.

USNRC EVALUATION STATUS:

Relief was granted in the September 1993 SER [Reference(s)] for Relief Request RR-P04, Revision 0.

Relief is pending approval for Relief Request RR-P04, Revision 1, submitted November 1998.

RELIEF REQUEST

Number: RR-P10, Revision 2 (Sheet 1 of 4)

SYSTEM: Reactor Core Isolation CoolingCOMPONENTS:

Pump Number	Safety Class	Drawing Number	Dwg. Coord.
P47-1A	2	G-191174 Sh 2	F-08

P47-1A is the Reactor Core Isolation Cooling (RCIC) pump. This pump is powered by a steam driven turbine and has a safety function to operate to provide makeup water to the reactor vessel during shutdown and isolation in order to prevent the release of radioactive materials to the environment as a result of inadequate core cooling. The system is designed to receive steam from the reactor vessel and function without AC power from normal supplies or the emergency diesel generators. The pump is a horizontal, multi-stage, centrifugal, double volute pump having five stages with four vanes on the first stage impeller and five vanes on the remaining four impellers, designed to provide a constant flow of 416 gpm at rated speed. The bearings are anti-friction, rolling element type. The RCIC system at VY is designed and qualified for at least 12 hours of continuous or intermittent operation in support of core cooling following transient or accident events. Other plants using this pump design are Quad Cities, Monticello, and Pilgrim.

EXAM OR TEST CATEGORY:

Vibration Velocity (Vv) - (Pump Outboard Bearing, Vertical Vibration Point O-4)

CODE REQUIREMENT: Part 6

Para. 5.2(d) "Test Procedure"

"Pressure, flow rate, and vibration (displacement or velocity) shall be determined and compared with corresponding reference values. All deviations from the reference values shall be compared with the limits given in Table 3 and corrective action taken as specified in para. 6.1."

REQUEST FOR RELIEF:

Relief is requested on the basis that the proposed alternatives would provide an acceptable level of quality and safety.

Note: This relief request (Rev. 0) was previously submitted in 1995 and not authorized for long term implementation. The relief request, at that time, requested a 0.5 in/sec. acceptance range limit for all RCIC pump vibration points. A 1-year interim approval was granted and VY was requested to perform additional investigation and provide an enhanced justification.

RELIEF REQUEST (continued)**Number: RR-P10, Revision 2 (Sheet 2 of 4)**

Note: The interim relief request was never implemented by VY. The relief request was subsequently deleted (Rev. 1) from the IST Program with the issuance of revision 18. The VY course of action in 1995 was to leave the vibration acceptance criteria unchanged, using the OM-6 limits. This action caused, and continues to cause, frequent entry into the Alert Range, requiring increased frequency testing for vibration point O-4. This relief request (Rev. 2) will be, upon NRC approval, reinstated in the IST Program.

This relief request is specifically for the pump outboard bearing in the vertical direction (VY vibration point 0-4). The pump inboard bearing horizontal/vertical and the outboard bearing horizontal/axial points are evaluated using OM-6 criteria.

Past testing and analysis performed on the RCIC System by Vermont Yankee 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 3 of Part 6 of the Code. This testing and analysis meets the intent of Paragraph 4.3 and footnote 1 of Part 6 of the Code.

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 are 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. @ 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. A reference value of .316 in/sec. was established with a 0.325 in/sec. acceptable range limit. VY has operated the pump with this small acceptable range margin since 3/2/90.

RELIEF REQUEST (continued)

Number: RR-P10, Revision 2 (Sheet 3 of 4)

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 frequencies 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 were recommended.

With only one vertical direction vibration point exceeding the OM-6 vibration criteria it was determined that to pursue 1st stage impeller replacement or to perform the analysis to qualify a bearing support modification results in a hardship without a compensating increase in quality and safety of the plant. 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 Tech. Spec. 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 report.

The resonance 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 2/18/90 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 9/14/98 memo, 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. Communication with the aforementioned plants identified that vibration levels of ≤ 0.2 in/sec are routinely experienced; however, it should be noted that their pump pedestals are approximately 1'-3" high while the VY RCIC Pump pedestal is 3'-0" in height. With this understanding, 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.

RELIEF REQUEST (continued)

Number: RR-P10, Revision 2 (Sheet 4 of 4)

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 VY RCIC pump. It has been concluded that there are no vibration concerns of a magnitude that would indicate pump degradation or prevent the pump from performing its intended function.

ALTERNATE METHOD:

To allow for practicable vibration monitoring of the RCIC pump, alternate 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:

<u>Test Parameter</u>	<u>Acceptable Range</u>	<u>Alert Range</u>	<u>Required Action Range</u>
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.

USNRC EVALUATION STATUS:

Relief is pending approval for Relief Request RR-P10, Revision 2, submitted November 1998.