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FACILITY: Vermont Yankee Nuclear Power Station

INSPECTION AT: Brattleboro, Vermont

DATES: September 18-29, 1995

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EXECUTIVE SUMMARY

Vermont Yankee IST Inspection 95-22

(September 18-29, 1995)

The Inservice Test (IST) program at Vermont Yankee was reviewed to verify conformance with the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (the Code) and NRC requirements. Although the program was implemented acceptably overall, further efforts are required to bring the program into full compliance with the Code. The adverse findings discussed in the report were attributed to less than effective program oversight and a fragmented administrative structure.

Several program shortcomings indicative of less than effective management oversight were identified during the inspection. For example, certain safety system valves were not included in the IST program, and thus were not tested in accordance with Code requirements (**VIO 95-22-01**); inadequate acceptance criteria resulted in failure to ensure that check valves were full stroke exercised (**VIO 95-22-03**); and untimely corrective action was taken for two self-identified noncompliances with Code requirements regarding power-operated valve limiting stroke time values, and verification of remote solenoid-operated valve position indicators (**VIO 95-22-02**).

Other less significant deficiencies concerning deletion from the program of axial vibration measurements for safety-related pumps, lack of correlation data to justify relief valve cold set pressures, and incorrect RHR pump suction pressure gage ranges also were identified.

Positive findings were made in the areas of surveillance test performance, containment and pressure isolation valve testing, and scheduling and performance of deferred tests (cold shutdown and refueling outage justifications). Evaluation of the effect of non-conservative instrumentation errors on component operability, retention of "high alert" range hydraulic pump criteria, and increased testing frequency of pumps previously identified, but no longer operating in the "alert" range were commendable.

The inspection confirmed previous NRC and independent assessment findings that IST program responsibilities were fragmented and decentralized to the detriment of the program, and that management oversight was less than effective in ensuring the Code requirements were met. Priorities were not established and enforced to ensure prompt correction of program deficiencies.

An corrective action plan including a schedule for completion was in draft form at the close of the inspection. The plan covered technical issues and called for an evaluation of quality assurance and self-assessment programs in the IST area.

DETAILS

1.0 BACKGROUND

This inspection was performed to evaluate the effectiveness of Vermont Yankee's (VY) Inservice Test Program for safety-related pumps and valves. NRC inspection Procedure 73756, "Inservice Testing of Pumps and Valves," Generic Letter (GL) 89-04, "Guidance on Developing Acceptable Inservice Test Programs," and NUREG-1482, "Guidelines for Inservice Testing at Nuclear Power Plants," were used as guidance during the inspection.

The purposes of inservice testing (IST) are to assess the operational readiness of pumps and valves, to detect degradation that might affect component operability, and to maintain safety margins with provisions for increased surveillance and corrective action. The requirements for IST are contained in plant Technical Specification (TS) 4.6.E.2, which requires testing in accordance with 10 CFR 50.55a, "Codes and Standards," and Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (the Code).

This inspection focused primarily on components in the high pressure coolant injection (HPCI), standby liquid control (SLC), residual heat removal (RHR), residual heat removal service water (RHRSW), and service water (SW) systems. These risk-significant systems are needed to prevent or to mitigate the dominant core damage frequency events (failure to depressurize the reactor, station blackout, and anticipated transient without scram) identified in the VY Individual Plant Examination.

2.0 INSPECTION FINDINGS

2.1 General IST Program Review

The licensee currently is implementing the third 10-year interval of the IST program. Testing is performed pursuant to Section XI of the Code (1989 Edition) which incorporates by reference Parts 6 (OM-6) and 10 (OM-10) of ASME/ANSI OMa-1988 for pumps and valves, respectively, and Part 1 (OM-1) of ASME/ANSI OM-1987 for pressure relief devices. The program is described in the VY Component Testing Program Plan, and sub-tier Procedures AP 0164, "Operations Department Inservice Testing," and AP 0211, "Predictive Maintenance Program." Administrative responsibility for the program resides in the Plant Inservice Test Coordinator (PISTC), while the responsibility for day-to-day implementation of the program is assigned to the Operations and Maintenance Departments. The duties and responsibilities of the plant personnel involved in IST were defined clearly in the program documents.

The inspector found that the PISTC conducts periodic meetings with the IST coordinators of the implementing departments to discuss equipment condition and the status of program commitments. However, the program organization appeared to constrain the ability of the PISTC to implement enhancements and to establish deadlines. The inspector considered that the program deficiencies discussed in this report were attributable, in part, to the fragmented structure of the VY IST program organization.

With the exceptions identified in this report, the inspector found that adequate administrative controls were in place to schedule and track the performance of tests; to ensure that reference values and acceptance criteria were met; and to assure that reference values were verified or reestablished following component maintenance or replacement. The inspector verified that testing that is deferred to cold shutdowns or refueling outages is scheduled adequately.

NRC safety evaluation reports, dated September 3, 1993, and June 12, 1995, provided the results of the NRC staff's review of the VY IST program. The inspectors reviewed the responses and IST program actions in response to program action item anomalies identified in NRC Safety Evaluations, dated May 13, 1992, and September 3, 1993. The inspectors found that changes to the licensee's IST program were consistent with the responses to the safety evaluation anomalies.

2.2 IST Program Scope

The components discussed below were determined to have been excluded from the scope of the licensee's inservice testing program. The licensee committed to perform a comprehensive review of the entire IST program scope to verify compliance with the Code. This action is expected to be completed by December 31, 1995. In addition, the licensee stated that the IST program basis document would be upgraded to ensure program continuity.

Relief Valves

During review of the HPCI and reactor core isolation cooling (RCIC) systems drawings, the inspector noted that the HPCI and RCIC pump suction relief valves (SR-23-34 and SR-13-25, respectively) were not included in the IST program. The inspector presented this information to the PISTC, who subsequently identified that the four residual heat removal (RHR) pump suction relief valves (SR-10-72A-D) also were not included in the program. The PISTC also stated that these valves probably had not been setpoint tested during the life of the plant. The licensee stated that the six relief valves would be added to the IST program and tested prior to the completion of the 1996 refueling outage.

OM-10, Section 1.1, requires testing of relief valves installed to protect systems that perform a specific function in shutting down the reactor, maintaining the reactor in a safe shutdown condition, or in mitigating the consequences of an accident. NUREG 1482, Section 4.3, clarifies that the requirement to test relief valves which protect systems against overpressure is based on Section III of the ASME Code or the applicable code of construction. (For VY, the applicable construction code is ASME B31.1.) In the absence of system design overpressure analyses indicating that the relief valves are superfluous, the inspector concluded that the pump suction relief valves provide a specific overpressure protection function for the piping in their respective systems. The licensee's failure to include (and test) the relief valves is the first example of a violation of 10 CFR 50.55a and OM-10. **(VIO 95-22-01)**

HPCI and RCIC Steam Side Drain Pot Level Control and Isolation Valves

While reviewing the HPCI system drawing the inspector noted that the power-operated valves located downstream of the steam line drain pot were not included in the IST program. The same situation existed in the RCIC system. Isolation of the HPCI and RCIC steam supply line downstream of the drain pots prevents diversion of steam flow from the HPCI and RCIC turbines. HPCI operating Procedure OP 4120, Step 19, requires the operator to measure and record the closing times of valves (V23-42 and V23-43), which are located downstream of drain pot level control Valve V23-53. However, since the valves are not in the IST program, the performance of the valves is not evaluated periodically for degradation. The valves are outside of the pipe class break currently indicated on the drawing. The IST coordinator recalled that the class breaks had been relocated but could not produce any documentation concerning the change.

OM-10, Section 1.1, requires that valves which perform a specific function in shutting down the reactor, maintaining the reactor in a safe shutdown condition or mitigating the consequences of an accident be included in the licensee's IST program. Isolation of the HPCI and RCIC steam lines downstream of the drain pot is a safety function because it prevents diversion of steam flow from the HPCI and RCIC turbines when they are required to operate. The licensee stated that the HPCI valves, and the analogous RCIC valves (V13-32, V13-34 and V13-35) would be added to the IST program by October 31, 1995, and the valves tested in accordance with Code requirements. The inspector considered the licensee's response to be acceptable. However, failure to include (and test) the valves in the IST program was a second example of a violation of the OM-10 scope requirement.

2.3 Pump Testing

Surveillance procedures and performance records for the pumps in the selected systems were reviewed against the OM-6 requirements for IST. Test frequencies, quantities measured, and allowable ranges were consistent with or exceeded those specified in the Code. With one exception discussed below, the licensee properly dispositioned test results for pumps which entered the "alert" or "required action" ranges.

The acceptance criteria specified in Procedure AP 0164 for pumps are more conservative than those specified in the Code in that the licensee chose to retain a "high alert" range limit (similar to ASME Code, Section XI, Table IWP-3100-2), which was deleted by OM-6. As a result, the licensee placed the "C" RHR pump in "alert" status due to high differential pressure, and doubled the test frequency of the pump. The inspector noted that the pump's performance did not appear to be degrading, and concluded that the licensee's action was conservative.

The "C" and "D" RHRSW pumps have been in an "alert" status due to low differential pressure since November 1993 and February 1994, respectively, and the licensee tests the pumps at the increased frequency required by the Code. The inspector reviewed historical test data for the pumps and observed that, in most cases, the pumps have operated in the acceptable range. In this case,

OM-6 would permit the licensee to establish additional reference values, and to restore the pumps to the normal test frequency. Notwithstanding, procedure AP-0164 states that additional test results within the acceptable range alone are not justification for removal of a pump from the "alert" condition. The licensee informed the inspector that VY's interpretation of OM-6 requires the cause of the anomalous condition to be determined and corrected prior to upgrading the pumps' status. The licensee plans to disassemble and inspect one of the pumps during the next refueling outage. The inspector concluded that the licensee's approach was conservative and commendable.

While reviewing pump test records, the inspector identified that on February 7, 1995, operators did not declare the "C" RHRSW pump inoperable when it entered the "required action" range for low differential pressure. In addition, the shift supervisor had not signed the surveillance data sheet, signifying his review of the data and of the shift engineer's evaluation of pump performance. The inspector learned that the licensee had identified the condition on March 30, 1995, following the subsequent surveillance test. The inspector reviewed the ensuing event report (ER 95-0159), that documented the results of the licensee's evaluation of the incident. From interviews with personnel involved in the test, the licensee determined that the condition had been recognized by the shift engineer and discussed with the shift supervisor, and that the an additional set of data was taken (but not recorded) with acceptable results. The licensee's barrier analysis identified several root and contributing causes, and corrective actions appropriate to each finding were developed. The inspector did not identify any additional instances of this nature and concluded that the incident was an isolated case. In addition, the inspector confirmed that system pressure downstream of the RHR heat exchanger (which was recorded on February 7) supported the licensee's conclusion that the pump discharge pressure had been mis-read during the original test, and that the pump was operable.

Notwithstanding the above, failure to declare the "C" RHRSW pump inoperable when the recorded pump differential pressure was in the "required action" range was contrary to the requirements of OM-6, Section 6.1, and licensee Procedure AP 0164. However, this licensee-identified and corrected violation is being treated as a Non-Cited Violation, consistent with Section VII of the NRC Enforcement Policy.

RHR and Core Spray Axial Pump Vibration

During a review of RHR pump reference parameter sheets, the inspector noted that vibration measurements were required to be taken in only two directions (point identifications I-3 and O-3). Review of the rotating equipment vibration data sheets showed these points to be the pump horizontal and vertical vibration points. Point A-2, which corresponds to thrust bearing vibration, was measured and recorded, but not considered by the licensee to apply to the pump vibration monitoring requirements of the Code.

OM-6, Section 4.6.4(a), states that vibration measurements shall be taken in a plane approximately perpendicular to the rotating shaft in two orthogonal directions on each accessible pump bearing housing and in the axial direction on each thrust bearing housing. The RHR and core spray (CS) pumps are

vertical centrifugal pumps with the motor mounted above the pump. The pump thrust bearing for this particular pump design is common with the motor thrust bearing. OM-6, Section 1.2(a), excludes pump drivers from the requirements of IST (bearing vibration) except where the pump and driver form an integral unit and the bearings are in the driver. Therefore, the inspector considered that axial vibration of the pump/motor thrust bearing is subject to the Code requirements.

The licensee reviewed the pumps vibration data and concluded that the axial vibration values had not entered the "alert" or "required action" ranges after the requirement for monitoring the vibration direction had been removed from the program. Because the motors were not integral with the pumps, the licensee did not agree that the Code required axial vibration measurements to be included in the IST program, and stated that it intended to submit a Code inquiry to the ASME regarding this issue. However, the licensee acknowledged that tracking of these points during IST was beneficial from an engineering standpoint, and agreed to reinstate them into the program. The inspector considered the licensee's response to be acceptable.

HPCI Vibration Measurements

During a review of the pump parameter sheet for the HPCI main and booster pumps, the inspector noted that the O-4 point vibration "alert" limit was 0.427 inches/second, while the reference value was 0.171 inches/second. Relief Request P04, contained in a safety evaluation, dated September 3, 1993, authorized the licensee's proposed alternative to use the Code alert multiplier of 2.5 times the vibration reference value to an upper limit of 0.675 inches/second. This relief was granted to address vibration characteristics for this particular pump, in which normal vibration reference value directions (i.e., horizontal, vertical, axial) can potentially exceed the OM-6 alert limit of 0.325 inches/second. However, for pump vibration directions which have values consistently below the "alert" limit, application of the proposed alternative was not appropriate. The licensee agreed with the inspector's assessment and agreed to adjust the vibration limit for point O-4 to comply with the 0.325 inches/second limit prescribed in OM-6, Table 3a.

2.4 Valve Testing

Test frequency, methods, acceptance criteria, and corrective actions for several types of valves in the selected systems were reviewed and found to be satisfactory with the exceptions discussed below. The containment isolation valves listed in TS Table 4.7.2.a were included in the IST program as Category A or A/C valves, and leak rate tested pursuant to 10 CFR 50, Appendix J, as required by OM-6, Section 4.2.2.2. The inspector verified that the appropriate pressure isolation valves that were identified by the licensee in response to NRC GL 87-06, "Periodic Verification of Leak-Tight Integrity of Pressure Isolation Valves," also were included in the IST program and tested individually in accordance with OM-6, Section 4.2.2.3.

Limiting Values of Full Stroke Time

OM-10, Section 4.2.1.2(a) requires that the limiting value of full-stroke time for power-operated valves shall be specified. At VY, this value is called the "design maximum actuation time" (DMAT), and is the acceptance criterion against which stroke times are compared to assess valve operability. Valve performance criteria (reference values, acceptable and "alert" ranges, and DMAT) are specified on form VYAPF 0164.01, "Valve Reference Parameters," maintained in a shift engineer IST program book located in the control room. DMAT values also were provided on data forms in individual system surveillance procedures.

For the systems reviewed, the inspector noted several instances in which limiting values of full-stroke time were specified on the surveillance procedure data sheets, but not on form VYAPF 0164.01. In the case of valve SW-19A, the "alert" range value exceeded the limiting DMAT, which was not listed on the form. Finally, the inspector identified ten valves for which no DMAT values were specified on either form. The inspector verified through review of performance data that the stroke times of the ten valves had satisfied Code requirements. Notwithstanding, the inspector considered the condition to be safety significant because of the potential to mis-diagnose valve operability, thereby delaying compensatory and corrective actions.

The inspector was informed by the licensee that the condition previously had been self-identified in 1994, but had not been tracked adequately to ensure corrective action. The inspector concluded that the licensee's failure to specify limiting values of full-stroke time for the ten power-operated valves was a violation (first example) of 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," which requires the prompt identification and correction of conditions adverse to quality. **(VIO 95-22-02)**

Inadequate Check Valve Full-Stroke Open Verification

While reviewing HPCI quarterly pump test Procedure OP 4120, the inspector identified that the acceptance criterion for full-stroke open verification of minimum flow check Valve V23-62 was inadequate. The method described in the procedure verifies flow through the check valve by opening minimum flow line isolation Valve V23-25, and observing a decrease in pump discharge pressure. There is no flow instrumentation in the minimum flow line. The licensee stated that this method of check valve testing also was employed on RCIC pump minimum flow check Valve V13-29 and the four RHR pump minimum flow check valves (V10-19A through D).

OM-10, Section 4.3.2.2(a), requires each check valve to be exercised or examined in a manner which verifies obturator travel to the position required to fulfill its function. GL 89-04, Position 1, clarifies that a full-stroke exercise of a check valve may be verified by passing the maximum required accident flow through the valve. A flow rate test at less than the verified accident flow is a partial-stroke test, that must be supplemented periodically by a full-stroke test or valve disassembly and inspection. The inspector

concluded that the acceptance criterion for the check valves only provided verification of a partial-stroke, and that full-stroke verification or disassembly was not performed. The licensee agreed to verify the full-stroke exercise of these valves using ultrasonic flow instrumentation in the minimum flow lines to assure that the check valves pass the required accident flow.

Full flow through minimum flow check valves is needed to ensure that pumps are cooled adequately. 10 CFR 50, Appendix B, Criterion V, "Instructions, Procedures, and Drawings," requires the establishment of appropriate quantitative or qualitative acceptance criteria for determining that important activities have been accomplished satisfactorily. The licensee's failure to prescribe adequate test acceptance criteria for the HPCI, RCIC, and RHR pump minimum flow line check valves is a violation of this requirement. **(VIO 95-22-03)**

Solenoid-Operated Valve Position Indication Verification

The inspector reviewed Procedure OP-4101, "Refuel Outage/Fuel Movement Periodic Tests," to assess the licensee's method of verifying remote position indication of sealed, enclosed solenoid-operated valves (SOVs) in the neutron monitoring and containment atmosphere dilution systems. OM-10, Section 4.1, requires valves with remote position indicators to be observed locally at least once every two years to verify that valve operation is accurately indicated. Where practicable, the local observation should be supplemented by other indications such as flow meters or other suitable instrumentation to verify obturator position. In the event that local observation is not possible, as is the case with 29 SOVs at VY, other indicators (e.g. leakage, differential pressure, process flow, or pressure) need to be used to verify valve operation. Positive verification of remote position indicators is important since they are used during periodic valve exercise tests to assess valve performance.

The acceptance criterion specified in Procedure OP 4201 consisted of "either hearing or feeling the solenoid as it is energized and de-energized." Since this approach did not provide positive verification of valve obturator movement, the inspector concluded that the criterion did not satisfy the Code requirement.

The inspector found that the licensee previously had identified that the verification method was inadequate; in a memorandum, dated September 13, 1994, the plant IST coordinator requested the Operations Department to review its procedures for enhanced methods of verifying obturator position. The memorandum was not entered into a formal tracking system, and no response date was established. Subsequently, during an IST program audit performed in late October 1994, the item was categorized as one of several examples for which no mechanism was in place to ensure that self-identified issues were entered into a tracking process. The Operations Department committed to assess the practicality of enhancing the current method by June 30, 1995. The inspector

noted that this date precluded the implementation of appropriate test methods during the refueling outage which occurred in March 1995. At the time of this inspection, Operations had responded to the commitment, but enhanced test methods and implementing procedures were not scheduled for completion until June 31, 1996, approximately 21 months following the initial finding.

Based on satisfactory operation of the affected systems and the good performance history of the SOVs, the inspector concluded that there was no immediate operability concern. However, the inspector considered to be significant the licensee's failure to recognize that its method did not comply with OM-10 requirements, and to correct the condition prior to the next scheduled surveillance test (i.e during the March 1995 refueling outage). This is a second example of a violation of the prompt corrective action criterion of 10 CFR 50, Appendix B.

Relief Valves

The inspector reviewed procedure OP 4261, "Class 2 and 3 Safety and Relief Valve IST Testing," and determined that the procedure correctly implemented OM-1 requirements concerning designation of a qualified test supervisor, test frequency, test gage accuracy, temperature stabilization, and test sequence. The set pressures established in the procedure for relief valves in the nitrogen, residual heat removal, and low pressure core spray systems were verified to be consistent with engineering specifications and the Final Safety Analysis Report (FSAR).

The inspector noted that several relief valves were set pressure tested at temperatures different from those experienced under normal or accident conditions, using "cold differential test pressure" settings that were slightly higher than the settings in the FSAR. The "cold" settings are provided by the valve manufacturers. OM-1 permits this practice provided that the set pressure correlations are certified to be accurate based on documented test results. The licensee did not have sufficient information to verify that the correlations provided by the valve manufacturers were certified properly as required by the Code. The ASME has found that some relief valve manufacturers have no engineering or test bases for the correlations, and has established a task force to determine standardized criteria for the correlations. The licensee stated its intention to pursue this issue with the appropriate ASME Code Committee. Since the difference between the "cold" and operating set pressures is small (approximately one percent of rated pressure), the inspector concluded that the discrepancy was not an immediate safety concern, and that the licensee's plan was acceptable.

2.5 Test Instrumentation

The inspector walked down the RHR, RHRSW, SLC, CS, and reactor building closed cooling water (RBCCW) systems to compare the full scale range of the instruments to their established reference values. OM-6, Section 4.6.1.2(a), requires the full scale range of each analog instrument to be no greater than three times the established reference value.

The inspector found several gages that did not meet the Code requirement; PI-14-36A&B (CS), PI-104-89A&B (RBCCW), and PI-10-106A-D (RHR). While the licensee obtained NRC relief from the range requirement for the CS and RBCCW gages, the licensee did not request similar relief for the RHR pump suction pressure gauges. The licensee stated that it would use temporary instruments which satisfy the Code requirement pending a decision whether or not to submit a relief request to the NRC. The inspector verified that the installed pressure gages satisfied the accuracy requirement of OM-6, and concluded that their use did not significantly impair the validity of past test results. The inspector concluded that the licensee's intent to utilize temporary test gages was acceptable.

In response to IST Program Quality Assurance Audit VY-94-06B, the licensee implemented a process for evaluating component test results when test instruments subsequently are found during routine checks to be out of calibration. Procedure AP 0164 was revised to require an evaluation of the effect of non-conservative instrument errors on component operability. The inspector considered this element to be a program strength.

2.6 Surveillance Test Observation

On September 27, 1995, the inspectors observed the performance of procedure OP 4124, "Residual Heat Removal and Service Water System Surveillance," by licensee personnel in the control room and stationed locally at the pumps. The test was performed on the "C" RHR and "D" RHRSW pumps to satisfy the increased test frequency requirement of OM-6 for pumps operating in the "alert" range. The test personnel properly adhered to the procedure and performed the evolution in a professional manner. Hydraulic test data was evaluated promptly and determined to be in the acceptable range by the shift engineer.

3.0 QUALITY ASSURANCE AND MANAGEMENT OVERSIGHT

The inspector reviewed several annual Quality Assurance IST program audit reports, and discussed the findings, plant responses, and corrective actions with licensee personnel. The inspector found that the audits covered essential program elements and contained good quality findings. Corrective actions were entered into the licensee's commitment tracking system, and most of the responses reviewed by the inspector met established deadlines. The inspector considered two audit findings to be particularly significant; namely, (1) that the IST program organization was fragmented, with responsibilities not clearly established, and (2) that self-identified findings were not entered into a formal tracking system to ensure timely resolution. Although the licensee took meaningful steps to address these concerns, the inspector concluded that the measures were not entirely effective in eliminating program weaknesses such as those identified in this inspection. Similarly, the number and variety of Code deviations and nonconformances identified by the inspectors reflected less than adequate management oversight of the IST program.

At the end of the inspection, the licensee provided the inspector with a draft, eight-point action plan to address the problems discussed in this report. The inspector found that the plan accurately characterized the inspection findings and established reasonable management expectations for completion of technical action items. However, the inspector reserved judgement on the adequacy of the plan pending its formal approval by licensee management.

4.0 MANAGEMENT MEETINGS

Licensee representatives were informed of the purpose and scope of the inspection at an entrance meeting conducted on September 18, 1995. Findings were discussed periodically with the licensee throughout the course of the inspection.

The inspectors met with the principals listed below to summarize preliminary findings on September 29, 1995. The licensee acknowledged the preliminary findings and conclusions, with no exceptions taken. The bases for the inspection conclusions did not involve proprietary information, and none was included in this inspection report.

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