MILLSTONE NUCLEAR POWER STATION, UNIT 3

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PUMP AND VALVE OPERABILITY ASSURANCE AUDIT

TECHNICAL EVALUATION REPORT

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Summary

The pump and valve operability review team (PVORT) from Brookhaven National Laboratory (BNL) and representatives of the Equipment Qualification Branch (EQB)of the NRC conducted an on-site audit of the pump and valve operability assurance program at the Millstone Nuclear Power Station, Unit 3 during the week of March 4, 1985. Ten components, three in the Nuclear Steam Supply System (NSSS) (one supplied by the NSSS vendor, two by the Architect Engineer); seven in the balance of plant systems (BOP); and the central files were audited.

On the basis of the observation of the field installation, review of the qualification documentation responses provided by the applicant to PVORT, inquiries and the Safety Evaluation Report (SER) open items it is concluded that the applicant has developed and implemented a program addressing pump and valve operability.

Upon satisfactory resolution of the specific and generic concerns outlined in this report, it is concluded that the pump and valve operability assurance program for the Millstone Nuclear Power Station, Unit 3 will meet the applicable portion of GDC 1, 2, 4, 14, and 30 of Appendix A to 10 CFR 50, Appendix B to 10 CFR Part 50 and Appendix to 10 CFR Part 100.

1. Introduction

To assure that an applicant has developed and implemented a program regarding the operability qualification of safety-related pumps and valves, the EQB performs a two-step audit. The first step is a review of Section 3.9.3.2 of the Final Safety Evaluation Report (FSAR) for the description of the applicant's pump and valve operability assurance program. The information provided in the FSAR, however, is general in nature and not sufficient by itself, to provide confidence in the adequacy of the licensee's overall program for pump and valve operability qualification. To provide this confidence, the PVORT, consisting of staff from BNL and the NRC, conducts an on-site audit of a small

representative sample of safety-related pumps and valves and their supporting qualification documentation.

The criteria by which the audit is performed is described in Section 3.10 entitled, "Seismic and Dynamic Qualification of Mechanical and Electrical Equipment" of the Standard Review Plan. Conformance with SRP 3.10 is required in order to satisfy the applicable portions of General Design Criteria (GDC) 1, 2, 4, 14, and 30 of Appendix A to 10 CFR 50 as well as Appendix B to 10 CFR 50 and Appendix A of 10 CFR 100.

2. Discussion

The EQB staff in performing the first step of the audit, reviewed the methodology and procedures of the pump and valve operability assurance program contained in Section 3.9.3.2 of the FSAR. As a result of this review, six specific areas were identified as needing further clarification and were documented in the SER dated February 14, 1984. The SER concluded that the applicant had in general, defined a pump and valve operability assurance program but it was not possible to determine the adequacy of the overall program without a site audit.

The on-site audit, second step, was performed by the PVORT during the week of March 4, 1985. The purpose of this step was (1) review the adequacy of the overall program, and (2) determine the extent that Northeast Utilities (NU) meets the criteria of Section 3.10 of the Standard Review Plan (SRP). A sample of three components in the nuclear steam systems and seven components in the BOP systems were selected to be audited; this included two surprise items. (Note: two of the three nuclear steam system components are supplied by the Architect Engineering Firm and one by the reactor supplier.) The site audit also reviewed Northeast Utilities response to the six areas of concern identified in the February 14, 1984 SER. Table 1 identifies the equipment audited and the audit findings. Table 2 lists the six areas identified as needing further clarification in the February 14, 1984 SER and their present status.

The on-site audit includes a plant walkdown inspection of the as-built configuration and installation of the equipment, a review of the normal, accident, and post-accident conditions under which the equipment and systems must operate, the associated fluid dynamic loads, and a review of the qualification documentation (status reports, test reports, analysis, specifications, surveillance programs, and long-term operability program(s) etc.).

3. Specific Concerns

As a result of the audit, three generic concerns were identified requiring verification by the applicant prior to fuel load, they are:

1. All pumps and valves important to safety have had their required pre-operational tests completed.
2. All pumps and valves important to safety are qualified and operational for normal, accident, and post-accident operating conditions.
3. Confirmation that new loads resulting from a postulated Loss of Coolant Accident (LOCA) or analysis of as-built conditions applicable to pump(s) and valve(s) important to safety do not exceed those loads originally used to qualify the equipment.

Additionally, the PVORT conducted a brief review of the applicant's documentation system by requesting, at short notice, test reports and related qualification documentation for a particular component. NU response to this request resulted in a walk-through of their documentation retrieval capability. The findings of this effort were favorable in that the documents requested were eventually found. However, it became very apparent that the NU system is cumbersome and has possibly overwhelmed them.

Section 3.1 will highlight the evaluation/audit process for the individual components.

3.1 3MSS*CTV27A - ~24-inch Single Seated Globe Valve (BOP) Surprise Item

This valve is a Main Steam Isolation Valve located in the main steam valve building at approximately the 68 foot 6 inch elevation. The function of this valve is to close immediately in the event of a rupture in the main steam piping either upstream or downstream of the valve.

This valve is manufactured by Sulzer Brothers Limited of Winterthur, Switzerland. The actuation of the valve is achieved by solenoid valves that control the flow of the operating medium to a piston chamber on the valve. By regulating the flow path through the redundant control lines and solenoid valves the working fluid operates the valve. Extensive testing and analysis have been performed on this model valve.

Flow interruption capability has been demonstrated by means of tests on a smaller valve with a seat area equal to 80% of this valve. Additional analysis was then performed utilizing results of the tests, similarity of the valves, and Millstone piping geometry to further demonstrate the capability of the valve to close against flow in either direction.

In addition, the valve assembly was manufactured and qualifed in accordance with ASME, ANSI, ASTM, IEEE (323, 344, 382), and NUREG-0588.

The qualification documentation addressed PVORT concerns regarding internal/external leakage, the various analyses and tests performed, and the establishment of acceptance criteria.

The applicant has demonstrated operability qualification for this component.

3.2 3MSS*RV22A - 6" x 8" x 8" Dual Outlet Safety Valve (BOP)

This main steam safety valve is located in the Main Steam Valve Building at approximately the 68-foot elevation. Its function is to prevent overpressurization of the main steam line.

In reviewing the qualification documentation, a discrepancy was initially revealed between a Stone and Webster (AE) calculation and Dresser (valve manufacturer) regarding the natural frequency (f_n) of the valve. The specification called for a f_n > 35 Hz, Dresser qualification reports indicate 36.9 Hz in Revision 0 and 37.3 Hz in Revision 1, while Stone and Webster calculations determined f_n to be 27.5 Hz. In response to the question regarding the discrepancy, a calculation was performed by Stone and Webster that concluded that the natural frequency is indeed greater than 35 Hz confirming the results of Dresser. This satisfied the staff's concerns.

In response to the inquiry regarding valve testing and verification of the set point of the valve, a discussion took place regarding Millstone's overall preventive maintenance program and commitment to Section 11 of ASME. The result of this discussion addressed the concerns in this area and the overall program being established by NU.

The qualification documentation and resulting discussions also addressed inquiries regarding leakage criteria, analysis, testing performed, and boundary condition utilized in qualification and acceptance.

As a result of the plant walkdown, it was observed that an identical valve (RV-25A) was tagged for a change in bolting. In response to why this was being undertaken and did it apply to RV-22A, the applicant produced a change order to replace the bolts and indicated that the change order had been implemented for RV-22A.

The applicant has demonstrated operability qualification for this component.

3.3 3MSS*MOV-18A - 8-inch Motor Operated Gate Valve (BOP)

This valve's function in the Main Steam system is to isolate the pressure relieving and pressure relieving bypass valve located in the main steam system. The valve is located in the Main Steam Building, at approximately the 69-foot elevation.

Reviewing the stress analysis revealed that the maximum ΔP utilized in the analysis was 1,106 psi. However, the long form and data sheet summarizing input used in the stress analysis indicates that the maximum ΔP is 1,185 psi. In response to this discrepancy, NU reports that the design specification gave a design pressure of 1,185 psi and a maximum differential pressure of 1,106 psi, and that it would have been more appropriate to use the 1,185 psi number. However, the vendor calculations were reviewed using design pressure and it was found to have a negligible effort. Stress increases in critical sections were: yoke stress, increased by 283 psi and bolt stress, increased by 666 psi. NU also pointed out that: (1) significant margins existed between the code allowables and the resultant stress and (2) the operating pressure of the system is 1,092 psig.

In response to inquiries, it was then discovered that the downstream valves in this system had also used 1,106 psi in their analysis. The staff in reviewing the stress analysis of MOV18A, and the boundary conditions utilized in the qualification documentation, along with a commitment by NU to evaluate this valve and the downstream valves to ensure that they are capable of withstanding a ΔP of 1,185 psi find that they have addressed the staff concerns on this area.

In response to an inquiry concerning the capability of the actuator under degraded voltage conditions (questions also asked from a generic standpoint for all motors), NU made a brief presentation. The response indicated that all motors, pump and valve, that are classified as class IE have been procured specifying operability with a 70% (degraded voltage) of rated voltage starting requirements. All pump/motor sets (class IE) have or will be tested at both 100% and 70% rated voltage starting requirements. This response addresses the concerns in this area.

Also addressed were questions regarding torque/force requirements of actuator, closure time, safety function, temperature transients, operability, qualification testing, and analysis.

The applicant has demonstrated operability qualification for this component.

3.4 3FWA*P1A - Auxiliary Feedwater Pump

This motor driven/horizontal centrifugal auxiliary feedwater pump is located in the Engineering Safety, Feature Building at approximately the 21-foot elevation.

As a result of the plant walkdown, it was observed that rework had been or was being performed on the pump. This rework included changing bearings due to material problems identified by the manufacture and replacement of RTD probes. The explanation for these changes and additional Inspection Report Finding and Non-conformance and Disposition reports related to the pump satisfied the concerns related to this rework.

NU indicated that the manufacturer's pump curves, system pump curves, and bearing temperature history are incorporated into the initial site qualification criteria for this assembly. A brief discussion also revealed a 12% margin was incorporated into sizing calculation (12179-210P) and that the specification requires that during pump performance testing, that the head shall be within +13% of the guaranteed head.

The applicant reports that qualification will be farther ensured during pump performance testing. This address satisfied concerns in this area.

In response to questions regarding the introduction of service water into the pump, the applicant stated that there is potentially an infinite source of safety grade water supply available (meets Reg. Guide 1.139) to the system, prior to introducing service water to the system. The subsequent discussion presented by NU in this area satisfied all concerns. A discussion was also provided by NU on the development of pump performance procedures for this component.

The applicant has demonstrated operability qualification of this component.

3.5 3SWP*P1AC - Service Water Pump

Service water pump P1A was originally selected for this audit. However, due to performance problems it was removed for maintenance and pump 1C was audited. Both deep draft pumps are located in the circulating and Service Water Pump House at the 14 foot 5 inch elevation.

The applicant was presented with an NRC letter dated April 11, 1983 from J. P. Knight to T. M. Novak regarding the long-term operability of deep draft pumps. This NRC letter contained a suggested procedure, generated by the EQB, for detecting problems with deep draft pumps. The applicant was asked to indicate how closely they were following the suggested procedure. The resulting presentation and discussion indicated that for the service water pumps and containment recirculation pumps the NU startup program meets the intent of the EQB guidelines.

In reviewing the results of the startup testing on the service water pumps, it was observed that the acceptance criteria were not met for three separate issues. NU had already initiated an investigation into these concerns but was not able to present the results at this time. Therefore, as a result, three open items exist on this component that require an explanation of their resolution by the applicant. They are:

1. The pump curves generated during startup testing do not meet the criteria generated by the vendor shop curves or the system design curves.
2. In comparing the rundown time for each pump with the time for the other pumps, the resulting values were not within the 20% specified in the procedure.

3. For pumps B, C, and D, the calculated motor horse power was not within 10% of the pump horse power determined from the performance curves.

As a result, it is concluded that the applicant has not demonstrated operability qualification of the service water pumps.

3.6 3RSS*P1A - Containment Recirculation Pump (BOP)

This deep draft pump is located in the Engineering Safety Features Building at the 49-foot elevation. Its safety function is to start in response to a CDA signal, plus a 220 second time delay. Initial activity is containment spray followed by long-term core cooling.

The pump is qualified by a combination of analysis and testing. Deep draft pumps have been identified in the July 1979, IE issued Bulletin 79-15 as having the potential for problems with long-term operability. Consistent with this, NU was asked to respond to the question of how closely they follow NRC's suggested guidelines for deep draft pumps issued in April of 1983. Stone and Webster personnel responded stating that having reviewed the guidelines, their conclusion was that the NU startup program meets the intent of the guidelines for the Containment Recirculation Spray Pump (RSS) as described below.

The reviewer's concur with NU's conclusion that the startup program meets the intent of the NRC guidelines, however, the results of the tests will determine the pumps capability for long-term operation.

The startup program provides for the pumps to be started in a controlled environment with various pump and motor parameters being constantly monitored. The pumps are operated over the entire range of their performance curves to verify that pump performance is in accordance with specified parameters. Specific data recorded includes flow, suction pressure discharge pressure, pump 1 motor vibrating, and bearing temperatures. The acceptance criteria for pump/motor vibration is in accordance with industry standards and

vendor recommendations. During the startup program, baseline vibration signatures are obtained for future reference in accordance with the Millstone 3 ISI program.

While reviewing the PVORT long form, it was determined that the information listed for pump height and motor dimensions was incorrect and that clarification regarding motor qualification and maintenance interval was required. Stone and Webster personnel provided a satisfactory revised long form.

The question regarding the capability of the driver to handle the load torque at 5,000 gpm and reduced voltage (70%) was addressed by Stone and Webster personnel who produced curve number 66-3889 demonstrating this capability.

Another concern identified was the proximity of the calculated critical speed to the operating speed (operating 1,170 rpm, critical 1,185 rpm). Stone and Webster seismic dynamic personnel later determined that the 1,185 rpm critical speed was incorrect and revised it to 468 rpm.

During the walkdown inspection, the PVORT team observed a tag affixed to the junction box bearing the number IR #X5A00011. After some difficulty in locating the inspection report, a copy of the report was produced by NU. The discrepancy, which had been corrected, was a missing junction box cover.

A trip report by NU and Stone and Webster concerning factory acceptance testing of the pump at Bingham Willamette was reviewed and contained findings upon disassembly of the pump, of damage to the bowl and column bearings. Stone and Webster personnel included a pump consultant who was present during the tests indicated that the problems were due to misalignment caused by a failure to follow the detailed assembly/disassembly procedure. Pump performance exceeded specification requirements and was considered acceptable. Stone and Webster personnel stated that the pump had been reassembled satisfactorily and a Certificate of Conformance to the contracted assembly procedure was provided.

Responding to a question concerning startup program instrumentation to verify acceptable vibration levels, Stone and Webster stated that horizontal vibration packages would be mounted on the top and bottom of the pump motor and would be monitored during the startup testing to assure that the acceptance criteria of 0.2 inches per second was not exceeded, and also to obtain baseline signatures for future reference in accordance with the Millstone 3 ISI program.

The applicant has demonstrated operability qualification for this component.

3.7 3RSS*MOV20B - 10-inch Butterfly Valve (BOP)

This valves is a containment recirculation spray pump discharge valve located in the Engineering Safety Features Building at the 15 foot 5 inch elevation. Its function is to open in response to a CDA signal followed by closure during manual switchover to long-term recirculation.

The valve is manufactured by Henry Pratt Company and is provided with a motor operated Limitorque actuator. The valve assembly was qualified by a combination of testing and analysis.

A review of the PVORT long form disclosed missing serial numbers for the valve and actuator, a listed value of 651 Hz for the fundamental frequency of the assembly which appeared to be far too high, and other discrepancies. The natural frequency analysis was provided and when it was examined, it was found that 651 Hz was the natural frequency of a component part not of the assembly. The valve assembly natural frequency had apparently not been calculated. Stone and Webster personnel independently calculated the natural frequency of the valve assembly and determined that it behaved as a rigid body with a fundamental frequency above the specified valve of 38 Hz.

A corrected long form was provided containing serial numbers and with other discrepancies corrected.

Other qualification documentation reviewed and found to be satisfactory concluded motor operator test data, hydro test, seat and stem leakage, and valve operating test reports.

The applicant has demonstrated operability qualification for this component.

3.8 3SIL*MV8812B - 12-inch Gate Valve (BOP)

This valve remains normally open. The SIL system is always aligned for cold leg injection mode. Its safety function is to be closed by operator action as part of switch-over to long-term recirculation mode. The valve is manufactured by Pacific Valves, provided with a motor operated Limitorque actuator and is located in the Engineered Safety Features Building at an elevation of 12 feet.

The valve assembly has been qualified by a combination of test and analysis with ASME II 1977 Ed. and Addenda through Summary 1979. IEEE-323 (1974), IEEE-112 (1978), IEEE-344 (1975), IEEE-382 (1972), and MSS-SP-61 (1977) used as guides for qualification.

Review of the PVORT long form disclosed missing serial numbers, a lower valve for delivered torque than for required torque, an operator model number discrepancy with the master list, and an inadequate statement for packing replacement interval. Stone and Webster personnel later produced a revised satisfactory long form.

During the review of qualification test documentation, the hydrostatic test report was found to be for another valve. The applicable hydrostatic test report was produced at a later date.

The purchase specification for the valve was reviewed and found to agree with data on the long form, and name plate data from the walk down.

The applicant has demonstrated operability qualifications for this component.

3.9 3SIL*MV8808A - 10-inch Gate Valve (BOP)

This 10-inch motor operated gate valve is located in the containment building at the 22 foot 10 inch elevation. The valve normally remains open with the power removed during power operation. During plant startup and normal shutdown, the valve is closed via administrative procedures. Its safety function is to remain open; however, when the valve is closed during shutdown or startup, it will open in response to an SIS signal.

During the walkdown inspection, a bent hinge was observed on the operator limit switch cover compartment. The question as to corrective action and why there was no reject or Non-conformance and Disposition (N&D) tag affixed was asked. A copy of N&D Number 11175 was produced later showing that Limitorque was aware of and had redesigned the hinge. Limitorque also approved Stone and Webster's proposed hinge design.

Also noted during the walk down was IR (Inspection Report) tag number E4A05091. A copy of the report was requested and reviewed with the applicable N&D Number 7833. The reports indicated that the valve actuator arms had no adjustment and would not make up with the limit switch arms. The corrective rework proposed by Stone and Webster and shown on the N&D report was checked with Limitorque and received their concurrence.

The PVORT long forms were reviewed and found to contain several omissions (actuator and valve serial numbers) and discrepancies. A revised long form received later was received and found to be satisfactory.

Qualification documentation reviewed included the certificate of compliance, purchase specifications and actuator sizing calculations.

The applicant has demonstrated operability qualification for this component.

3.10 3RCS*SV8095A - 2-inch Solenoid Operated Gate Valve (NSSS)

This valve which is located as part of the Reactor Coolant System in the containment building at the 55 foot 10 inch elevation is normally kept closed except for venting during startup. Its safety function is to open and provide a safety grade letdown patch for the RCS for inventory control during boration, and again to open to provide a vent for the RCS.

During the walkdown by the PVORT team, an apparent discrepancy in serial numbers was flagged. The valve was installed, hooked up and had been stroked. The serial number discrepancy was later attributed to the fact that the serial number from the Nuclear Stamp had been written down during the walkdown rather than the manufacturer's serial number.

Qualification of the valve was by a combination of testing and analysis. The valve was designed in accordance with ASME Code Section III, Class I.

Documentation reviewed included factory acceptance test reports and the equipment specification.

The applicant has demonstrated operability qualification for this component.

Table 1 Audited Equipment and Finding

Plant I.D. Number	NSSS or BOP Supplied	Description	Safety Function	Component	Manufacturer	Model	Finding/ Resolution	Status
3MSS*CTV27A	BOP	≈24" single seated globe valve	Main steam isolation	Valve Actuator	Sulzer Brothers "	DAS 630-B (Actuated by operating medium)	Satisfactory	Closed
3MSS*RV22A	BOP	6"x8"x8" dual outlet safety valve	Prevent over pressurization of main steam line.	Valve	Dresser Indust.	3707R Special	Satisfactory	Closed
3MSS*MOV18A	BOP	8"-900# motor operated gate valve	Isolation of pressure relieving & pressure relieving bypass valve.	Valve Actuator	Walworth Limitorque	N5247PSB SMB-0-25	Satisfactory	Closed
3SWP*P1C	BOP	Vertical mixed flow centrifugal pump	Provides cooling for emergency diesel gen., containment recirc. coolers, and reactor plant aux. systems.	Pump Driver	Hayward-Tyler GE	24 VSN 5K6338x C119A	Open items concerning mechanical performance test: -Generated pump curves do not meet vendor or system design curves. -Rundown time comparison of pumps was not within the 20% specified in procedure.	 Open Open

Table 1 Audited Equipment and Finding

Plant I.D. Number	NSSS or BOP Supplied	De-scription	Safety Function	Compo-nent	Manufac-turer	Model	Finding/ Resolution	Status
3SWP*P1C (Continued)							-Calculated horse power was not within 10% of pump horse power de-termined from performance curves.	Open
3FWA*P1A	BOP	Horizontal centrifugal pump	Provides emer-gency source of water for steam genera-tors.	Pump Drive	Bingham Willamette GE	3x6x9 CMSD 5K821051C40	Satisfactory	Closed
3RSS*P1A	BOP	Deep draft centrifugal pump	Pump starts in response to CDA signal. Delivers sump water for con-tainment spray then switches to long-term cooling.	Pump Driver	Bingham Willamette Westing-house	VCR-10x12x 10B 5888P36	Satisfactory	Closed
3SIL*MV8808A	BOP	10" motor operated gate valve	Valve to remain open to miti-gate DBA	Valve Actuator	Westing-house Limitorque	10GM88EEH SBD-4-200	Satisfactory	Closed
3SIL*MV8812B	BOP	12" motor operated gate valve	Valve to close by operator action as part of long-term recirculation mode.	Valve Actuator	Pacific Limitorque	G-55509 SB-1	Satisfactory	Closed

Table 1 Audited Equipment and Finding

Plant I.D. Number	NSSS or BOP Supplied	Description	Safety Function	Component	Manufacturer	Model	Finding/ Resolution	Status
3RSS*MOV20B	BOP	10" motor operated butterfly valve	Opens in response to CDA signal. During manual switch over to long-term recirculation, valve must be closed by remote operator action.	Valve Actuator	Pratt Limitorque	NMK-11 HOBC/SMB	Satisfactory	Closed
3RCS*SV8095A	NSSS	1" solenoid operated globe valve	Opens to provide a safety grade letdown path for reactor coolant system for inventory control during boration.	Valve Assembly	Target Rock	79AB-001	Satisfactory	Closed

Table 2 SER Open Items

SER Items	Finding/ Resolution	Status
1. The applicant did not provide the design criteria for pump and valve internal parts, such as valve discs and pump shafts. A review of qualification documents is necessary to determine whether the pump and valve internals are adequately qualified.	Satisfactory	Closed
2. SRP 3.10, Paragraph II.1a(2) indicates that equipment should be tested in the operational condition, that is, normal plant loadings should be superimposed on seismic and dynamic loads, including thermal, flow induced loads and degraded flow conditions. The FSAR should clearly indicate how this requirement is met.	Satisfactory	Closed
3. For those components where qualification and/or operability assurance was provided by analysis alone, some question remains as to the confidence level ensured by this methodology. The necessity for additional component testing is being considered and cannot be established without an inspection at the plant site.	Satisfactory	Closed
4. There should be a list of types of equipment that clearly shows the methods used for qualification. This list should also address which standards are met, in particular those sited in SRP Section 3.10.	Satisfactory	Closed
5. Clarification of how aging was incorporated in the qualification process should be contained in the FSAR. In addition, the applicant should commit to establish a maintenance and surveillance program to maintain equipment in a qualified status throughout the life of the plant.	Satisfactory	Closed
6. Further justification of the independent qualification of pumps, valves, prime movers, and actuators vs. their assembly qualification is also required.	Satisfactory	Closed