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EXECUTIVE SUMMARY

During November 4 through 8 and November 18 through 22, 1991 a U.S. Nuclear Regulatory Commission inspection team conducted a systems-based instrumentation and control inspection at the Pilgrim Nuclear Power Station, Unit 1 (PNPS). The inspection focused on the design and configuration of selected instrumentation and control equipment and on the equipment's interface with key safety related systems. The inspection team was composed of site inspectors located at PNPS and engineering inspectors located at the nuclear engineering offices in Braintree, Massachusetts.

The team found seven deficiencies during the course of the inspection. The most significant deficiency concerned inadequate setpoints for the salt service water (SSW) discharge pressure switches, which initiate starting of the SSW pumps during a loss of offsite power. As a result of the incorrect setpoints for these switches, two SSW pumps per division could have been automatically loaded onto each emergency diesel generator, potentially exceeding the diesel generator capacity. The team also found inadequate operating procedures used for controlling the torus temperature and water level. The operating procedures allowed operation throughout the full span of the technical specification limits and did not include margins to account for instrument inaccuracies.

Other deficiencies the team identified included inadequate engineering evaluations of two modifications to the reactor water level instrument, resulting in failure to consider reference leg heatup due to a high energy line break; the lack of a calibration procedure for the SSW pump discharge low pressure indicator; inadequate supports and sloping of sensing lines for installed SSW pressure switches and transmitters; and various errors and inconsistencies in drawings, data sheets, and calibration procedures.

The significant observations identified were calibration procedures that did not specifically state what measuring and test equipment to use during calibration, an incomplete engineering evaluation for the procurement of a new digital reactor water level indicator, and the failure to account for the effects of temperature on Barton pressure switch accuracy.

The team concluded that these deficiencies and observations indicate a potentially significant weakness with regard to the ability of certain instrumentation and control equipment to perform their intended safety functions. In addition, the team concluded that several of these deficiencies could be attributed to the lack of available design basis information, and as a result, encouraged continued support for Boston Edison's ongoing design basis reconstitution effort. The team considers that this program should include effort to better undertand the basis for analytical limits and their margins that were used to establish technical specification values. The team noted strengths at PNPS in the technical competence of the Boston Edison staff, in the Boston Edison staff's assessments of operability and corrective actions, and in support of the of the inspection. They also found that the PNPS calibration procedures and preventive maintenance were adequate.

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1.0 BACKGROUND-INTRODUCTION

Inspectors in previous NRC inspections of nuclear power plants have found numerous deficiencies in the areas of instrumentation and control systems and equipment. These findings involved design modifications, setpoints and setpoint control, calibration procedures, and design calculations. As a result, the Special Inspection Branch of the Office of Nuclear Reactor Regulation is developing an inspection specific to the instrumentation and control area, in which the inspection methodology focuses on the interface that exists between instrumentation and control equipment and key safety-related systems. This inspection includes aspects performed at the plant site and more design-oriented aspects that are performed at the engineering offices of the licensee.

The primary purpose of the inspection at Pilgrim Nuclear Power Station, Unit 1 (PNPS) was to verify that the design and configuration of selected instrumentation and control equipment was adequate and would allow associated safety related systems to perform their design basis functions. A secondary purpose was to assess the adequacy of the licensee's engineering and technical support for the scope of the inspection.

Findings within this report have been categorized as either deficiencies or observations. Deficiencies are either (a) the apparent failure of the licensee to comply with a requirement, or (b) the apparent failure of the licensee to satisfy a written commitment to conform to applicable codes, standards, guides, or accepted industry practices when the commitment has not been made a legally binding requirement. Deficiencies identified during this inspection are identified in the report and are also summarized in Appendix A. Observations are items considered appropriate to call to management attention but which have no direct regulatory basis. Observations identified during this inspection are identified in the report and are listed in Appendix B.

2.0 SAMPLE SELECTION PROCESS

During the pre-inspection visit conducted October 16 through 18, 1991, NRC inspectors reviewed selected documents to determine what specific systems and instruments would be examined for this inspection. Because the PNPS is one of the older nuclear plants, it has little documentation pertaining to specific accident analyses and technical specification bases. Consequently, the team relied heavily on the PNPS Final Safety Analysis Report and on a draft individual plant evaluation (Probabilistic Risk Assessment). The draft risk assessment showed the salt service water system (SSWS) to be the system with the third highest contribution to core damage probability. Two other systems, the dc power supply and the reactor protection system, had higher contributions to core damage probability; however; the inspectors felt that these two systems would not meet other inspection selection criteria, including inspectability, availability of design documentation, and instrumentation type and number.

As a result of the above analysis, the team decided to focus on the SSWS (Section 3.1) and other systems and instruments that are also necessary for accident mitigation. The other systems and instruments selected included:

- the reactor building closed cooling water system, (section 3.2)
- the high pressure coolant injection (HPCI) instrumentation related to HPCI pump suction (Section 3.3.1)
- the condensate storage tank level switches (Section 3.3.2)
- the torus level and temperature instruments, (Sections 3.3.3 and 3.3.4)
- the reactor water level instrument, (Section 3.3.5)
- the scram discharge instrument volume, (Section 3.4)

3.0 REVIEWS OF SYSTEM INSTRUMENTS

For each instrument selected during the pre-inspection, the team requested calculations and documentation pertaining to the setpoint basis, technical specification basis, design, calibration, preventive maintenance, discrepancy management, modifications, and surveillance tests. The inspectors at the site performed a walkdown inspection of the selected instruments and reviewed the PNPS documentation. The engineering calculations and analyses for each instrument were reviewed by the engineering team at Boston Edison's nuclear engineering offices.

3.1 Salt Service Water System

The SSWS consists of five pumps connected to a common discharge header, which has isolation valves to supply service water to two independent cooling loops. The SSWS supplies cooling water to the reactor building (RB) closed cooling water (CCW) heat exchangers and the turbine building closed cooling water heat exchangers. Pressure transmitters on the discharge header continuously monitor SSWS pump performance by providing indication in the control room. The loss of alternating current (ac) power trips all service water pumps and closes one of the two isolation valves to align the system into two loops. Two SSWS pumps in each loop are powered by the associated diesel generator. The fifth pump is loaded on a common service bus, which could be powered from either diesel generator. The operator preselects the loop that would be supplied by the fifth pump.

The following instruments in the SSWS were selected for review:

- PT-3828, SSWS Header Pressure Transmitter (Loop A)
- PS-3828A&B, SSWS Header Pressure Switches (Loop A)
- LTD-3910, SSWS Differential Level Transmitter Across the Travelling Screens

3.1.1 Salt Service Water Pump Discharge Pressure Switches (PS-3828A&B)

Pressure switches (PS-3828A & B) installed on each SSWS loop automatically start each pump if the header pressure is below the switch setpoint. Time delay relays are included in the starting circuits to ensure that all pumps in each loop are not started at the same time during low pressure conditions.

3.1.1.1 Setpoint Calculation and Basis

The setpoint for the SSWS pump discharge pressure switches was identified as 15 psig during the inspection. The licensee did not have a calculational basis for this setpoint but instead said the setpoint had been derived during startup testing of the plant. At the team's request, the licensee calculated the minimum discharge pressure expected during design basis conditions and determined that the 15 psig setpoint was inadequate. The licensee's calculations showed that with one pump running in each SSWS loop, the expected discharge pressure as measured at the pressure switch could be as low as 3.3 psig. At the existing setpoint of 15 psig, the potential existed for automatically starting a second SSW pump, which was not accounted for in the current diesel generator load calculation. The current diesel load calculation indicated inadequate margin to allow for starting two SSW pumps. The inadequate SSW pump discharge pressure setpoint is identified as Deficiency 91-201-01, in Appendix A to this report.

As a result of this finding, the licensee reset the SSW pressure switch to 3.3 psig during the inspection. In addition, subsequent to the inspection, the licensee re-evaluated the diesel generator loading and determined that the diesels would have been able to handle the added load. The new diesel generator evaluation was not reviewed by the inspection team.

3.1.1.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The contacts of the two discharge pressure switches that sense discharge pressure are connected so that either one of the pressure switches can start individual progressively staggered pump timers. For loop A, pump A will start 25 seconds after the sensed low-pressure condition and pump B will start 55 seconds after the sensed low-pressure condition. For loop B, pump D will start 20 seconds after the sensed low-pressure condition and pump E will start 50 seconds after the sensed low pressure condition. Pump C, the swing pump, will start 85 seconds after the sensed low-pressure conditions.

Pumps A and B are loads for diesel generator A. Pumps D and E are loads for diesel generator B. Pump C is on a swing bus that is loaded either on diesel generator A or B, depending on its preselected assignment to loop A or loop B. The pressure switches on loop A are isolated from those on loop B by two header isolation valves that split the header and connect pump C to one of the loops. The switches are not required to be environmentally qualified, but are qualified to meet the seismic class of the piping. The team identified no adverse findings in this area.

3.1.1.3 Installation Verification

The site inspectors evaluated the installations for pressure switches PS-3828A, PS-3828B, and for pressure transmitter PT-3828. These instruments are located in the SSW building near pumps 208A and B. Both pressure transmitters were identified as Static-O-Ring types model 4N-K4-CT. This identification agreed with the instrument data sheet. The inspectors found the pressure instrument installation inadequate in that both impulse line slopes were reversed f portions of the tubing run. They also noted that the impulse lines w... improperly supported. These discrepancies are identified as Deficien.., No. 91-201-02 in Appendix A to this report.

3.1.1.4 Calibration Procedures and Data

The inspectors examined the historical calibration data for PT-3828, PS-3828A and PS-3828 B. The drift data that was available for review generally supported the instrument application. However, no calibration procedure for PT-3828 was available. Setpoint calculations for PT-3828, PS-3828A and PS-3828B were also not available, and as a result, the inspectors could not compare the field data to the setpoint calculation. The licensee initiated Potential Condition Adverse to Quality (PCAQ) 91-218 to address the lack of a calibration procedure for instrument PT-3828. This is identified as D... ancy 91-201-03 in Appendix A to this report.

The inspectors also noted a discrepancy between Piping and Instrumentation Drawing (P&ID) M212, schematic E170, and alarm response procedures ARP-CIR-F1 and ARP-CIR F2 for time delay relay TDR-74-3828. Drawing M212 specified a 2-minute delay while schematic E170 and the alarm response procedures specified a 10-second delay. This time delay relay provides the alarm signal to annunciator windows 89 and 90 (service water pumps low-discharge pressure). The licensee determined that a 10-second delay was the correct value. The licensee issued PCAQ 91-216 to resolve the time delay discrepancy noted for TDR-74-3828. These discrepancies are included as part (Item (1)) of Deficiency No. 91-201-04 in Appendix A to this report.

3.1.1.5 Preventive Maintenance

The inspectors noted no special preventive maintenance requirements for this instrumentation. The vendor data is used to develop maintenance and corrective action requirements identified by the manufacturer. The inspectors also reviewed the failure and malfunction reports (F&MR) for these instruments and noted no adverse trends.

3.1.2 Differential Pressure Across Traveling Screen LTD-3910 and LSD-3910

Each of the four traveling screens has a bubbler type level measurement system that is used for open tanks. Air at a constant flow is applied to two small pipes that are immersed in the water. One pipe is placed on the upstream side of the screen and the other on the downstream side. A differential pressure transmitter senses any pressure difference between the two standpipes. The transmitters supply a pneumatic signal, proportional to the pressure difference, to indicators and pressure switches. If any pressure switch exceeds a setpoint, an alarm is indicated in the control room. Differential pressure conditions that cause an alarm indicate degradation in the cleanliness of the screen.

3.1.2.1 Setpoint Calculation and Basis

In response to the team's request for the basis of the setpoint for the alarm condition, the licensee provided an engineering evaluation of high differential pressure across a screen (ERM 90-442, Rev. 1; ESR 90-360). PNPS had no formal setpoint calculation document. Discussions with the licensee, and a review of the evaluation indicated that the alarm setpoint is to provide indication that one of the traveling screens is clogged with kelp, seaweed or other debris. The alarm setpoint for the pressure switch is 6.6 psig, which is the output of LTD-3910 corresponding to a 6-inch water-level differential between the upstream and downstream sides. The original design alarmed at 10 inches to indicate fouling. At that setpoint, the licensee decided that the time lag between the alarm and the maintenance action could allow the screen to be damaged.

3.1.2.2 Installation Verification

The inspectors examined the installation of differential pressure transmitter LTD-3910. LTD-3910 is a Foxboro Model V3-A1 differential pressure transmitter with a 3 psig to 15 psig output. LSD-3910 is a Mercoid Model DAW-533-3-1 differential level switch. The transmitters are located on ground-level instrument racks near the traveling screens. The inspectors concluded that the divisional separation and independence of these instruments was acceptable. The inspectors found the installation of the instrument impulse lines acceptable, except for some physical damage that the licensee corrected.

3.1.2.3 Calibration Procedures and Data

The inspectors examined the current revision of procedure 8.F.28. This procedure is used to calibrate the traveling water screen differential pressure instruments, including LTD-3910 and LSD-3910. LSD-3910 has a setpoint of 6.6 psig ±0.12 psig. The inspectors found the procedure adequate and supportive of the setpoint.

The inspectors examined historical calibration records for LTD-3910. Since a new instrument was installed in June 1990, little drift data was available for determining channel drift. The available drift data for the setpoint module (LSD-3910) did not appear to be excessive.

3.1.2.4 Preventive Maintenance

The inspectors noted no special preventive maintenance program beyond that for calibrating these instruments. The inspectors noted that the licensee had a vendor data program that was used to implement maintenance and corrective actions identified by the instrument manufacturer. The licensee had complied with all special requirements identified in the vendor's manual for the instrument.

3.2 Reactor Building Closed Cooling Water System

The reactor building closed cooling water system consists of two independent closed loops with three pumps per loop. A surge tank at the highest point of each loop is provided. The RBCCWS provides cooling for the components in the core standby cooling system and the residual heat removal system. Pressure switches installed at each discharge header monitor the system pressure and automatically start the standby pump if the header pressure is below the pressure switch setpoint.

Pressure switches PS-4058 at the discharge header of loop A of the RBCCWS was selected for review during the inspection.

3.2.1 RBCCW Pump Discharge Pressure Switch PS-4058

The RBCCWS consists of two independent closed loops with cross-tie capability. Each loop has a surge tank and three parallel pumps discharging into a common header; the surge tank maintains a net positive suction pressure to the pumps.

A process tap on each discharge header is routed to a pressure transmitter and a pressure switch. The pressure transmitter senses the discharge pressure and provides an analog signal for an indicator in the control room. The pressure switch (PS-4058) has a setpoint for low discharge pressure that controls the start of timers used for starting the pumps in a sequence similar to that used to start the SSW pumps. The pressure switch also controls a time-delayed alarm, which is displayed in the control room.

3.2.1.1 Setpoint Calculation and Basis

The licensee could not retrieve the setpoint calculation for PS-4058 or any document that provided the design basis for the setpoint. The licensee stated the current setpoint of 56 psig was determined during preoperational testing.

During the inspection, the licensee calculated that the minimum setpoint should be at least 55.15 psig to ensure the starting of one RBCCW per division on a loss of offsite power event. On the first version of the calculation, the sensor (Barton 288A) temperature effects were listed as zero. The vendor manual or data sheet did not indicate any effect that was due to changes in ambient temperature. During the inspection, the licensee checked with the vendor who stated that the ambient temperature effects were 1 percent of full scale per 50°F from -40 to 180°F. This did not affect the outcome of the setpoint calculation. However, the team was concerned that the licensee, when determining setpoints for similar switches installed elsewhere in the plant might not have taken into account the temperature effects. (Observation 91-201-01, Appendix B)

3.2.1.2 Logic, Testability, Isolation, Independence and Environmental Qualification

The team reviewed the instrumentation and calibration procedures 8.E.30 and 8.E.30.1 were reviewed and found them acceptable. The two RBCCW loops are physically separate but have a crosstie with two normally closed valves. The pressure transmitters and pressure switches on one loop are physically separated from those on the other loop. The pressure transmitters are not required to be environmentally qualified because they are located in a mild environment.

The team reviewed the documentation on the seismic qualification of the switches. One pressure switch (PS4058) was original plant equipment and the licensee plans to evaluate it for compliance with seismic requirements in accordance with the generic NRC letter on seismic qualification of original plant equipment. The licensee replace the pressure switch in the B loop (PS4058) and the team found its seismic requirements and qualification were in calculation No. C18.0.2247.

3.2.1.3 Installation Verification

The inspectors examined the installation of PS-4058. PS-4058 is a Barton Model 288A pressure switch. It operates PS-4058X, an Agastat Model 2412AET time-delay relay, which in turns, operates an annunciator should a sustained RBCCW low discharge pressure exist. The inspectors found the divisional separation and independence of these instruments acceptable and the instrument impulse lines properly sloped and mounted.

3.2.1.4 Calibration Procedures and Data

The inspectors examined the current revision of procedures 8.E.30 and 8.E.30.1. The licensee uses procedures to calibrate the pump discharge pressure instruments, including pressure switch PS-4058. PS-4058 is set at 56.25 psig ±1 psig which is consistent with the design basis. PS-4058X is set at a 10 second ±2 second time delay. The inspectors found the procedures adequate and supportive of both the pressure setpoint and the time delay.

The inspectors examined historical calibration records for PS-4058. The historical drift data was retrievable and was available for inclusion in setpoint calculations. The recorded drift values were not excessive and were within the expected range for the specific instruments.

3.2.1.5 Preventive Maintenance

The inspectors noted no special preventive maintenance program beyond that for calibrating these instruments.

3.3 Core Standby Cooling Systems

The core standby cooling systems include the HPCI system, the automatic depressurization system, the core spray system, and the low-pressure coolant injection system. For this inspection, inspectors evaluated the instrumentation for the HPCI system actuation and operation.

The HPCI system is designed to pump water into the reactor vessel to cool the fuel to limit fuel cladding temperatures in the event of a pipe break in the primary coolant system. The steam admission valve in the steam supply line to the turbine-driven HPCI pump opens to start the pump on a low reactor water level or a high primary containment pressure. The normal source of water for the HPCI pump is from the condensate storage tanks (CSTs). However, the valves in the suction line from the suppression pool will open and the suction valve from the CST will close if the pressure switches, on the pump suction line detect a low level in the CST. Also a high level in the suppression pool, as detected by the suppression pool level switches will align the pump suction to the suppression pool. To protect the HPCI pump from a loss of suction flow, a pressure switch will close the steam admission valve to the HPCI turbine on very low suction pressure.

The suppression pool level and temperature are important parameters and are governed by technical specification limits. These limits are imposed to ensure that adequate water volume and temperature are maintained in the suppression pool to accommodate the energy released into the drywell, to suppress the containment pressure, and to limit the dynamic loading on the structures during a postulated LOCA.

The following instrumentation related to the operation of the core standby cooling systems were selected for review:

- PS-2360-1 - HPCI Pump Low Suction Pressure Switch
- PS-2390A&B - CST Level Switches
- LT-5049 - Suppression Pool Level Transmitter
- LS-2351A&B, LS-5037 and LS-5066 - Suppression Pool Level Switches
- TE-5021-1A through -13A and TE-5022-1B through -13B - Suppression Pool Temperature Elements
- LS-263-72 - Reactor Water Level Switch

3.3.1 HPCI Pump Low Suction Pressure (PS-2360-1) and HPCI Pump High Suction Pressure (PS-2360)

The low pressure switch provides a protective trip for the HPCI pump to protect the pump from cavitation damage caused by a loss of net positive suction head (NPSH). The pressure switch trips the HPCI turbine via interposing relays that actuate the HPCI turbine trip solenoid. The high pressure switch actuates an alarm should the HPCI suction pressure approach the suction piping design pressure limit.

3.3.1.1 Setpoint Calculation and Basis

The existing setpoint for the HPCI low suction pressure switch was 15 inches mercury vacuum. The licensee was unable to retrieve the basis for the analytical limit and the setpoint. The setpoint was not governed by the technical specifications, but the team was interested in verifying that this instrument would provide the requisite pump protection and would not be a significant source of spurious trip of the HPCI pump. During the inspection, the licensee contacted the Nuclear Steam Supply System (NSSS) vendor and determined that the sole purpose of the interlock was to prevent pump damage from a gross loss of NPSH that is due to an inadvertently closed suction valve. On that basis, and by reviewing the instrument loop design documents, the team concluded that the present setpoint provided sufficient margin for instrument uncertainty to support this interlock requirement. During the inspection, the licensee prepared calculation I-N1-62 to document the basis for the high suction pressure setpoint. The inspection team did not review this calculation.

3.3.1.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The team reviewed the elementary diagrams, selected portions of the logic system functional test procedures, calibration procedures, instrument installation details, and instrument data sheets and found no problems.

3.3.1.3 Installation Verification

The inspectors examined the as-built installation of pressure switches PS-2360 and PS-2360-1. PS-2360 is a Barksdale Model D2H-A150SS. PS-2360-1 is a Static-O-Ring Model 54TA-BB118-NX-CIA-JJTTX6. Both are located on a transmitter rack located outside the HPCI pump room. The inspectors found the instrument impulse lines properly sloped and mounted. However, the impulse lines within the HPCI pump room are carbon steel and showed some evidence of surface rusting. The surface rusting was evaluated by the licensee as insignificant.

3.3.1.4 Calibration Procedures and Data

The inspectors examined the current revision of procedure 8.E.23. PNPS staff follow this procedure to calibrate the pump suction pressure instruments, including PS-2360 and PS-2360-1. PS-2360 was set at 77 psig ±1.35 psig. PS-2360-1 was set at 15 inches of mercury vacuum ±0.5 inches of mercury vacuum. The team identified a discrepancy between the instrument data sheet and the calibration procedure for the setpoint for PS-2360. The instrument data sheet 225A5750 indicated a setpoint of 70 psig while the calibration procedure 8.E.23 indicated a setpoint of 77 psig. The licensee corrected this condition by issuing PCAQ number 91-215. This PCAQ initiated a revision of the calibration procedure to include the correct setpoint of 70 psig ±1.35 psig. This item is included as Item (2) of Deficiency No. 91-201-04 in Appendix A to this report.

The inspectors examined historical calibration records for PS-2360 and PS-2360-1. The historical drift data for PS-2360 and PS-2360-1 was not excessive. The data was easily retrievable for use in the setpoint calculations.

3.3.1.5 Preventive Maintenance

The inspectors noted the licensee has a vendor data program that is used to implement maintenance and corrective actions identified by the instrument manufacturer. The inspectors found that the licensee had re-torqued the pressure port bolts of PS-2360-1 to between 75 inch-pounds and 80 inch-pounds as recommended in a Static-O-Ring (the manufacturer) service bulletin. This work was done by MR 90-23-12. The O-rings of PS-2360 are regularly replaced as recommended in the Barksdale manual for that instrument.

3.3.2 Condensate Storage Tank Level Switches (PS-2390A and PS-2390B)

The HPCI pump is designed to take suction from the CST or the torus. The normally aligned source is the CST. Pressure switches PS-2390A and PS-2390B monitor the CST water level and automatically isolate the CST and open the suction valves (MO 2301-35&36) on the line from the torus when the CST level decreases below the pressure switch setpoint. Level switches LS-2351A and LS-2351B monitor the torus water level and automatically realign the HPCI suction to the torus if the torus water level increases above the level switch setpoint. Technical specifications require that PS-2390A and PS-2390B be set at a value greater than or equal to 18 inches above the bottom of the CST and that the HPCI suction be switched over to the torus when the torus level goes above plant elevation (-)2 feet 2 inches.

3.3.2.1 Setpoint Calculation and Basis

Calculation E-634-3, Revision 1, "Setpoints for PS-2390 A&B of the HPCI System," confirmed that the existing setpoint of 31.8 inches above tank bottom for PS-2390A and PS-2390B was acceptable. The setpoint included adequate margin above both the analytical limit of 3.75 inches and the technical specification limit of 18 inches to account for instrument channel uncertainties. The team did, however, identify that the analytical limit computed in calculation M-634-2, Revision 0, "CST Min. Water Level to Support HPCI During Switchover to Torus Suction", did not make allowances for vortex formation at the bottom of the CST while draining the tank. Subsequently, the licensee estimated that the analytical limit would have to be increased to about 14 inches above the tank bottom. The licensee also concluded that the existing setpoint would not be changed, however, some of the existing margin would be reduced. The licensee agreed to revise calculation E-634-3 and replace calculation M-634-2 with a new calculation for the analytical limit.

3.3.2.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The team reviewed the elementary diagrams, selected portions of the Logic System Functional Test Procedures, calibration procedures, instrument data sheets, and the instrument installation detail and found no problems.

3.3.2.3 Installation Verification

The inspectors examined pressure switches PS-2390A and PS-2390B as installed in the plant. Both pressure switches are Static-O-Ring Model 6N-AA2-X5RP. With operation of either switch on decreasing CST level, a time delay relay (Agastat Model 7014PC) initiates opening of the suppression pool HPCI suction valves 2301-35 and 2301-36 and triggers an annunciator in the control room for low CST level. Position switches for valves 2301-35 and 2301-36 initiate closure of valve 2301-6 on the suction line from the CST when the suction line from the suppression pool is open. A check valve prevents the CST water from flooding the suppression pool during the switchover. Divisional separation and independence for these channels is not an issue as both the HPCI and the CST are nondivisional systems. The inspectors found the instrument impulse lines properly sloped and mounted. Both impulse lines tap into the 18-inch header between the CSTs, and the HPCI suction isolation valve 2301-6 and go down to the respective pressure switches. A difference in elevation of 15 feet exists between the pressure switches and the base of the CSTs, which was figured into the calibration procedure offsets.

3.3.2.4 Calibration Procedures and Data

The inspectors examined the cur nt revision of procedure 8.M.2-2.5.6, which is used to calibrate the CST ? l instrumentation, including PS-2390A and PS-2390B. The setpoint is calib . to 7.8 psig ±0.2 psig. The inspectors found the procedure adequate and supportive of the setpoint. The inspectors examined historical calibration records for PS-2390A and PS-2390B. The historical drift data for these pressure switches was incorporated in the setpoint calculations.

3.3.2.5 Preventive Maintenance

The inspectors found that the licensee had re-torqued the pressure port bolts of PS-2390A and PS-2390B to between 75 inch-pounds and 80 inch-pounds as recommended in the manufacturer's service bulletin.

3.3.3 Torus Level (LT-5049, LT-5038, LS-5037, LS-5066, LS-2351A)

The operator receives torus level indication through two displacer instruments (LT-5049, LT-5038) that provide outputs to chart recorders in the control room. This indication is used to verify that the torus level is within the limiting conditions of operation stipulated by the technical specifications. Additionally, two low level alarms are provided from float-type level switches LS-5066, LS-5037.

The technical specifications require that the suppression pool volume be maintained between 84,000 and 94,000 cubic feet, corresponding to levels of (-)6 inches and (-)3 inches referenced to instrument zero. The lower-limit was established for maintaining adequate HPCI pump NPSH and downcomer submergence based on thermal/hydraulic analyses; the upper limit was based on structural analyses. These operating limits were comparatively restrictive because of past resolution of Mark I containment issues.

Two high-level float switches (LS-2351A, LS-2351B) automatically switch HPCI pump suction to the torus on high torus water level as stipulated in the technical specification.

3.3.3.1 Instrument Uncertainty Calculation and Basis

The licensee was unable to retrieve a quantitative basis for the analytical limits or their margins that were used to establish the technical specification values. Additionally, the team determined that the operating limit for the torus level was the same as the technical specification limit, leaving no allowance for instrument uncertainty for level indication.

Moreover, the licensee was unable to retrieve an analysis of instrument uncertainty for any of the level instruments and could not identify or retrieve evidence of critical construction tolerances for level instrument elevations referenced to the torus centerline or another suitable datum.

On the foregoing basis, the team concluded that inadequate assurance existed that this instrumentation would ensure that the torus level for the plant was within limiting conditions of operation. This item is identified as Deficiency 91-201-05 in Appendix A to this report.

In response to the team's concern about the torus level, the licensee prepared a preliminary calculation that identified a total indication loop uncertainty of about +/- 1.3 inches exclusive of the unknown installation tolerances. The licensee then further restricted the operating limits to a range between (-)5.25 and (-)3.75 inches. The licensee also initiated a monthly calibration interval for the recorder to improve the instrument's uncertainty and committed to verifying within two weeks of the exit meeting the elevation of the instrument installation reference with respect to the torus datum.

The licensee also prepared draft calculations to determine the total uncertainty (exclusive of installation tolerance) for the high-level switches (LS-2351A/B). These calculations suggested that some margin remains (less than +/-0.4 inches) for the installation tolerance of the level switches. The team reviewed the assumptions, design inputs, methodology, and preliminary results of the licensee's draft calculations and found them acceptable for interim use.

3.3.3.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The team reviewed the P&IDs, functional control diagram, level setting diagram, elementary diagrams, selected portions of the Logic System Functional Test Procedures, instrument data sheets, instrument tubing isometric diagrams, and the instrument installation details. From this review, they did not identify any problems other than the absence of installation tolerances discussed in section 3.3.3.1.

3.3.3.3 Installation Verification

The inspectors evaluated the installation for torus water level instruments LT-5038, LS-5037, and LS-2351B which are located in the torus area. The inspectors found that an instrument support for LT-5038 had significant motion in the lateral direction and was not shown on the isometric drawing M1002. The licensee initiated PCAQ 91-229 to evaluate the adequacy of this support.

3.3.3.4 Calibration Procedures and Data

The inspectors examined the historical calibration records for instruments LT-5049, LS-2351A and LS-2351B, LS-5066 and LS-5037. The licensee could not produce calculations for the torus water level instruments, and as a result, the team could not evaluate the measuring and test equipment accuracy, the no adjust limits, and the setpoints. Calibration procedures 8.E.9 and 8.E.10 however disagreed with level setting diagram M-263. Drawing M-263 specified a setting of 5.5 inches from the reference lines of LT-5038 and LT-5049 for instruments LS-5037 and LS-5066 respectively. Contrary to this, procedure 8.E.10 specified a setpoint -6 inches for LS-5037, and procedure 8.E.9 specified a setpoint of -5.75 inches for LS-5066. Further, procedures 8.E.9 and 8.E.10 stated that the required calibration was to be made from the "marked line", but did not identify which line on what reference instrument

(LT-5049, LT-5038). The licensee issued PCAQ 91-211 to revise the calibration procedures, recalibrate the instruments, and revise the appropriate alarm response procedures. In addition, the licensee implemented change requests for procedures 8.E.9 and 8.E.10 to more adequately describe the reference points and instrument centerline used to calibrate LS-5066 and LS-5037. These discrepancies are included as Item (3) of Deficiency 91-201-04 in Appendix A to this report.

3.3.3.5 Preventive Maintenance

The inspectors noted no specific preventive maintenance requirements for this instrumentation.

3.3.4 Torus Temperature (TE/TT/TY-5021-1A through 13A)

Torus bulk temperature is sensed by 13 three-wire resistance temperature detectors (RTDs) distributed around the torus. Two cascaded summation amplifiers average the signals from the RTD transmitters and compute and send the bulk temperature value to the control room. Two such channels verify that the torus temperature is being maintained within limiting conditions of operation. No automatic protective functions are initiated by this instrumentation.

The technical specification requires that the suppression pool bulk temperature not exceed 80'F during normal continuous power operation and not exceed 90'F during Reactor Core Isolation Cooling (RCIC), HPCI, or Auxiliary Depressurization System (ADS) testing. If bulk temperature exceeds 110'F during reactor power operation, the reactor must be scrammed. During reactor isolation conditions, the reactor vessel must be depressurized to less than 200 psig at normal cooldown rates if the pool bulk temperature reaches 120'F.

3.3.4.1 Instrument Uncertainty Calculation and Basis

The licensee was neither able to retrieve a quantitative basis for the analytical limits or their margins that were used to establish the technical specification values nor to retrieve an analysis of instrument channel uncertainty. To address the team's concerns, the licensee prepared a preliminary calculation that suggested a channel uncertainty of about +/- 5'F. On that basis, the team concluded that inadequate assurance existed that the existing instrumentation cited in the technical specification would ensure that the plant was within limiting conditions of operation for the torus bulk temperature limits. This item is identified as Deficiency No 91-201-06 in Appendix A to this report.

To address the team's concerns, the license committed to administratively restricting torus temperature to 75'F rather than 80'F, until the issue is resolved.

3.3.4.2 Other Design Attributes

The team reviewed the loop functional diagrams, elementary diagrams, calibration procedures, instrument data sheets, equipment qualification evaluation sheets, and the available instrument installation details and from this review found no problems.

The licensee stated that the RTD spatial locations were as prescribed by NUREG-0662 for the worst-case accident conditions, and the team found this acceptable.

3.3.4.3 Installation Verification

The site team did not inspect these instruments.

3.3.5 Reactor Water Level (LT/LIS/LS-263-72A/B/C/D, LI-263-100A/B)

The reactor low-low water level instrument automatically initiates HPCI and other engineered safety features. The level is sensed by four differential pressure transmitters that measure the differential pressure between a filled referenced leg and the pressure of the water column in the reactor vessel. The transmitters are configured in such a way that each pair of transmitters senses the level from one of two pairs of vessel taps. The design is such that either pair of transmitters sensing a low-low level could initiate HPCI via the Analog Trip System, and no single event would prevent HPCI initiation from low-low reactor water level.

Following HPCI initiation, and when the reactor water level is restored to the high level setpoint, the HPCI turbine would be tripped to prevent gross moisture carryover to the HPCI turbine.

Two safety-related level indicators in two of the instrument loops are provided in the control room for use in both normal and emergency operating procedures.

3.3.5.1 Setpoint Calculation and Basis

The basis for the low-low setting was that the water level would be sufficiently above the active fuel to start HPCI (and other protective actions) in time to prevent fuel damage, but far enough below normal levels that spurious protective actions would be avoided. During the inspection, the licensee determined from the NSSS supplier that the analytical limit for HPCI initiation was (-)56.9 inches referenced to instrument zero and that the analytical limit for HPCI termination might be as high as (+)60 inches. The existing technical specification limits were (-)49 inches for low-low level initiation and (+)48 inches for high level termination.

The existing setpoints were (-)46 inches and (+)45 inches, respectively. However, the licensee could not retrieve calculations that accounted for all instrument channel uncertainties to support these setpoints. Because the high level setpoint did not appear sensitive with respect to analytical limits, the team's primary concern was the basis for the low-low level setpoints.

To address the team's concern, the licensee prepared a preliminary calculation that suggested a total channel uncertainty of about 10.2 inches, approximately 8 inches of which was attributable to a nonconservative error in level measurement that is due to heatup of the instrument reference leg during design-basis pipe breaks for which mitigating actions initiated by a reactor vessel low level would be required. The effect of this error, discovered in performing the above preliminary calculation, had not been identified either in PDC-85-07, which relocated the reference leg outside the drywell (Yarway replacement), or in PDC-84-70, which replaced the original instrumentation with the Analog Trip System. The equipment qualification data file identified the line break environment for the transmitter, but did not identify the effect on the reference leg or consider the effect in the safety evaluations and engineering analyses supporting these two modifications.

In addition, the inspectors found that setpoint calculations and safety evaluations done for PDC-84-70 did not include the evaluation of all pertinent error terms for the new analog trip system. Only the error term for drift data was re-evaluated during this modification. Other terms such as cable effects, rack equipment errors, etc., were assumed to be equal to or better than the old instrumentation.

The licensee's preliminary calculation results suggested that the existing setpoint would not need to be changed to account for the additional uncertainty, but that the total loop uncertainty would account for 10.2 inches of the 10.9-inch margin available between the existing setpoint and the analytical limit.

The team reviewed the assumptions, design inputs, methodology, and preliminary results of the licensee's draft calculation and found the approach and results acceptable for interim use in establishing instrument uncertainty pending formal completion of the necessary analyses. The failure to consider the effects of reference leg heat-up during the performance of system modifications is identified as Deficiency No. 91-201-07 in Appendix A to this report.

3.3.5.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The team reviewed the P&IDs, functional control diagrams, elementary diagrams, selected portions of the logic system functional test procedures, calibration procedures, instrument data sheets, instrument tubing isometric diagrams, and the instrument installation details and found no problems.

Isolation of safety-related analog trip system signals from non-safety-related EPIC computer system functions was accomplished by analog isolation amplifiers (Analogic) with fiber optic cable outputs to non-safety (non-Q) applications. The specification sheets for the analog isolators cited conformance to IEEE-384-1974 and Regulatory Guide 1.75. Vendor schematic diagrams and specifications indicated that isolation was achieved at the fiber optic output and that the isolation circuits were qualified as safety-related and assigned to their safety division. Discussions with the licensee indicated that all wiring to the card-cage assemblies of a particular analog trip system division was safety-related wiring for that division; that both the protection system and multiplexer power supplies were safety-related and were in the same division; and that no other non-safety-related rack wiring was routed contrary to separation criteria. Therefore, the team found the isolation of analog signals acceptable.

3.3.5.3 Other Design Attributes

Critical installation tolerances such as reference leg condensing chamber elevations were identified on drawings, and critical elevations were traceable through controlled design documentation to a datum referenceable to the top of the active fuel. Critical line slopes identified on the drawings also appeared adequate. Therefore, the team found this aspect of the design acceptable.

The team also reviewed the licensee's response to Bulletin 90-01, "Loss of Fill-Oil in Transmitters Manufactured by Rosemount," with respect to reactor vessel water level transmitters. In that response, the licensee reported that transmitter LT-26372A had been replaced because of leaking detected as a part of the committed Rosemount transmitter performance tracking system. The team also reviewed calculation I-NI-33, "Rosemount Transmitter Fill Fluid Loss Allowable Drift Limits," Rev. 0, June 25, 1990. This calculation established the drift limits used in the performance tracking system, based on Rosemount technical bulletins. On the basis of the licensee's ongoing commitments established by responses to Bulletin 90-01 and the team's review of the calculation, the team found the calculation and related design documentation acceptable.

The team also reviewed PDC-91-035 that involved the planned replacement of reactor vessel level and pressure analog indicators with digital indicators (i.e., programmable devices, using serial data processing). The replacement was intended to resolve human engineering discrepancies identified by the licensee and to provide more precision in the display. The licensee identified the indicators as Q-Class components because they would be used in implementing both normal and emergency operating procedures. The licensee had identified a vendor from which to procure the components but had not yet issued the purchase order as the vendor had not been put on the licensee's approved suppliers list. The licensee planned to install the indicators in a mid-cycle outage in 1992.

In reviewing the available design and procurement documentation and in discussions with the licensee, the team determined that the licensee had not yet considered failure modes specific to digital instrumentation. These failure modes could originate as software failures and electromagnetic interference-(EMI) induced failures. Examples of such failure modes could include, but may not be limited to, lockup, stall, power-down/power-up cycle failures, unintended functions, software virus and conducted surge. These failure modes also have the potential to become common mode failures that are not characteristic of the analog instrumentation being replaced. The licensee indicated that it would ensure that these issues were appropriately resolved before actually procuring the digital indicator. (Observation 91-201-02, Appendix B).

3.3.5.4 Installation Verification

The inspectors reviewed the field installation for instrument LS-263-72A and associated master/slave units LIS 263-72A-1 and LS 263 72A-2 and found the instrument's physical location, separation and independence acceptable. Instrument impulse lines were properly sloped and mounted and isolation devices were provided for the SPDS/EPIC interface. The cables' separation and independence between channels were also acceptable.

3.3.5.5 Calibration Procedures and Data

The inspectors evaluated historical drift records for LT-263-72C and found the drift data within the value specified in the setpoint calculations and calibration procedures. This was a relatively new instrument installation, and, as a result, few drift data points were available.

3.3.5.6 Preventive Maintenance

The inspectors noted no special maintenance procedures for this instrument. The licensee does track and evaluate transmitter performance as recommended by Bulletin 90-01, "Loss of Fill Oil in Transmitters Manufactured by Rosemount." The inspectors found this program to be within the guidelines of the bulletin.

3.4 Scram Discharge Instrument Volume

The scram discharge volume receives water discharged by the control rod drive mechanisms during a scram. The scram discharge volume is provided with a scram discharge instrument volume (SDIV), which is a cylindrical pressure vessel that collects the drainage from the scram discharge volume. Level instrumentation on the SDIV provides alarms, causes rod withdraw blocks, and scrams the reactor, depending on the water level in the SDIV. Limits are placed on the level setpoints by technical specifications. Level transmitter LT-308-82 was selected for review for this inspection.

3.4.1 Scram Discharge Instrument Volume Instrumentation (Various)

The purpose of the SDIV instrumentation is to monitor the water level in two tanks that retain the control rod drive discharge water after the drain and vent valves are closed upon initiation of a reactor scram. The SDIV high water level scram set point is chosen to ensure that adequate free volume remains to accommodate the water discharged from the withdrawn control rod drives in the event that a reactor scram occurs. Additional setpoints are used (1) for an alarm if a tank is not drained after post-scram procedures or if a tank starts to fill because of leakage and (2) for a rod withdrawal block if leakage results in the level to increase to about 40 percent of a tank's capacity. During normal operation, the SDIV tanks will be empty, because the drain and vent valves are open. Upon a reactor scram, the drain and vent valves are closed to retain the control rod drive discharge water and conserve reactor water inventory.

The instruments consist of four level transmitters and six RTD's. The level transmitters are configured two to a tank, and they monitor the actual level from approximately 5 percent to 100 percent of the tank volume. The RTD's act as level switches, are configured three to a tank, and are inserted into the tank walls to sense two separate tank levels.

3.4.1.1 Setpoint Basis and Calculation

The functional bases for the SDIV setpoints were found in the original set point calculation document (13984.01-CA-1). This document calculated the "scram" and "not drained" alarm setpoints for the level transmitters and was based on the technical specification scram volume limit of 39 gallons and the "not drained" volume alarm of 4.5 gallons. The calculation included the error effects for the transmitter only, but did not include seismic effects, and the error effects of the rack equipment. During the inspection the licensee calculated the scram and alarm setpoints using their present methodology (NEDWI 394, Rev. 1), which accounts for all sources of error. The team then determined that the setpoints as found in the previous document (FRN 82-10-270) had adequate margin and were acceptable.

3.4.1.2 Logic, Testability, Isolation, Independence, and Environmental Qualification

The SDIV trip contact outputs for the scram water level provide input to the four Reactor Protection System (RPS) channels. Each channel of RPS input consists of the master trip associated with the transmitter sensor of one tank combined with the trip associated with the RTD sensor of the other tank. This arrangement provides sensor diversity as well as redundancy. Thus, no single trip channel failure could prevent a scram caused by the high SDIV scram water level.

There is also a SDIV "not drained" alarm for each tank. The slave trip outputs associated with the two level transmitters on a particular tank are combined to alarm if either slave unit trips. This alarm serves to detect leakage at an early stage.

The rod block function is performed by combining the remaining separate RTD level switch at the rod block water level on one tank with its counterpart from the other tank. If either tank is at or exceeds the rod block water level, a rod withdrawal block is sensed in the reactor manual control system.

The level instrumentation arrangement, trip logic, and bypass allow instrument adjustment or surveillance without bypassing the RPS scram function or directly causing a scram. The calibration and functional test procedures for the instrumentation (8.M.1-20, Rev. 27) and for the analog trip system (8.M.1-32.1, Rev 18 - typical) were reviewed and found to check all the pertinent functions of the equipment.

3.4.1.3 Installation Verification

The inspectors examined the installation of several level transmitters for the scram discharge instrument volume (SDIV). LT302-82A and LT302-82B are Rosemount Model 1153DB4PG differential pressure transmitters that monitor the east SDIV level. LT302-83C and LT302-83D are identical and monitor the west

SDIV level. LE/LS302-82C, LE/LS302-82D, and LE/LS302-82E are Fluid Components, Inc., Model FR.72-4HTRDIL heated resistance temperature detector level switches that monitor the east SDIV level. LE/LS302-83A, LE/LS302-83B, and LE/LS302-83E are identical and monitor the west SDIV level. The E-suffix instruments connect to the rod block circuitry. The other instruments all contribute to a half scram. The divisional separation and independence for these instrument channels was acceptable. The inspectors found the instrument capillary for the Rosemount transmitters properly protected and routed.

3.4.1.4 Calibration Procedures and Data

The inspectors examined the current revision of procedures 8.M.1-20, 8.M.1-32.1, and 8.M.1-32.2. These procedures are used to calibrate the scram discharge instrument volume instruments, including LT302-82A. The inspectors found the procedures adequate and supportive of the setpoints.

The inspectors examined historical calibration records for the Rosemount transmitters and Fluid Components, Inc., switches. The historical drift data was easily retrievable and was available for use in setpoint calculations.

3.4.1.5 Preventive Maintenance

The inspectors noted the Rosemount transmitters were part of the Rosemount Transmitter Performance Tracking Program. The licensee has a vendor data program that is used to implement maintenance and corrective actions identified by the instrument manufacturer. Instrument cover O-rings are procedurally replaced whenever the instrument cover is removed as required for Rosemount transmitters.

The power supplies used with the master and slave trip units associated with the Rosemount transmitters are part of the Preventive Maintenance Item List, which invokes Procedure 3.M.2-21, "Electrolytic Capacitor Leakage Current Test." This procedure tests subject electrolytic capacitors. If a tested capacitor fails the capacitance test, the procedure requires that it be replaced with a new capacitor that has passed the same capacitance test. This averts failure caused by aging electrolytic capacitors.

4.0 GENERAL CONCLUSIONS ON LICENSEE PERFORMANCE

As a result of the team's inspection findings and interactions with the licensee, the following general conclusions regarding licensee performance were reached.

4.1 Engineering Adequacy

During the inspection, the team reviewed various design products, including: a limited number of available setpoint and instrument loop uncertainty and calibration calculations prepared since about 1987; instrument data sheets; piping and instrumentation diagrams; functional control diagrams; level setting diagrams; elementary diagrams; instrument tubing isometric drawings; equipment qualification data files; plant design changes (PDCs) and supporting safety evaluations and technical requirements and analyses; technical procurement documents; and other drawings and technical documents. The team also conducted in-depth technical discussions with the licensee engineering personnel throughout the inspection. Through these activities, the team evaluated the adequacy of the licensee's engineering organization with respect to instrumentation and control applications.

The licensee was typically unable to retrieve the documentation of the bases for analytical limits and setpoints for the original design and for earlier modifications. The lack of design-basis documentation may have contributed to the deficiencies involving the SSW pressure setpoints, the torus level instrumentation, and the torus temperature instrumentation. However, a recent instrument uncertainty and setpoint calculation that the licensee performed to Nuclear Engineering Work Instruction NEDWI-394 issued in March 1991 appeared technically adequate, comprehensive, and easily auditable. In addition, the licensee performed several complex preliminary calculations during the inspection using NEDWI-394 in response to the team's concerns. The licensee responded very competently, aggressively, and conscientiously in that regard. On the foregoing basis, the team concluded that the licensee appeared to have adequate basic technical methodologies and a strong technical staff for developing and maintaining design-basis instrumentation calculations.

The team sampled a small number of PDCs and identified three PDCs that had inadequate safety evaluations and engineering analyses. Two of the PDCs are related to Deficiency 91-201-07, "Inadequate Design Basis for Reactor Water Level Setpoints." For that deficiency, the team identified a substantial nonconservative error in level measurement that was due to heatup of the instrument reference leg during design-basis pipe breaks for which mitigating actions initiated by reactor vessel low level would be required. A more recent modification PDC-91-035, "Replacement of Reactor Level and Pressure Indicators" also lacked an adequate safety evaluation and engineering analyses. The team concluded from this limited sample of instrumentation PDCs that there might be weaknesses in the PDC process in that the safety evaluations and engineering analyses were not always sufficiently comprehensive.

In summary, the team concluded that within the instrumentation and control engineering discipline, the licensee generally appeared to have good breadth and depth of engineering skills and experience and good basic work instructions for instrument uncertainty and setpoint calculations. The team considered the licensee's inability to retrieve original design basis information and the resulting potential for design-control problems a weakness. The licensee stated that this weakness would be addressed by its design-basis reconstitution program and future self-assessments. The team considers that this program should include effort to better understand the bases for analytical limits and their margins that were used to establish technical specifications values. Finally, the team identified some weaknesses in the comprehensiveness of safety evaluations and supporting engineering analyses for certain design modifications.

4.2 Calibration Procedures and Data

In general, for the instruments reviewed, the calibration procedures adequately delineated the calibration process. However, two deficiencies and one observation were noted by the inspection team in this area. The first deficiency concerned the lack of a calibration procedure for the salt service water header pressure transmitter PT-3828. As a result, this instrument had not been calibrated since March 1982. The second deficiency in this area concerned calibration procedure discrepancies for the HPCI suction high pressure instrument and the torus level instruments.

In addition, the team identified that measuring and test equipment (M&TE) requirements were not specifically stated in individual calibration procedures (Observation 91-201-03, Appendix B). However, the team found that M&TE is controlled and generally recorded on calibration data sheets. The team found no instances where the M&TE that was used was not at least as accurate as the instrument being calibrated. The licensee calibrates the M&TE to a laboratory standard at least four times as accurate as the M&TE, and if it later finds they are out of tolerance, the licensee recalls the instruments that were calibrated by that M&TE to be recalibrated.

4.3 Corrective Action Programs

For potential nonconformance items identified by plant personnel a PCAQ is generated and evaluated. In addition, an F&MR (failure and malfunction report) is initiated for operational problems identified by plant personnel. The inspectors found these programs to be effective in resolving potential non-conformances and equipment discrepancies identified during this inspection.

4.4 Preventive Maintenance

The inspectors observed that the licensee has an active program to incorporate new or additional vendor maintenance recommendations and requirements into existing procedures for the affected instruments. The inspectors observed that the licensee's calibration procedures included vendor-recommended requirements for inspecting and replacing O-rings needed to maintain environmental qualification. The inspectors noted that the licensee is responsive to manufacturer service bulletins.

The inspectors concluded that the licensee has an acceptable instrument preventive maintenance program.

5.0 EXIT MEETING

At the conclusion of the inspection the team held an exit meeting to brief management on the team's findings. The following individuals were present.

BECO	Position
R. A. Anderson	Vice President OPS Station Director
B. Andrew	Sr. I&C Engineer
P. Antonopoulos	Analysis Section Manager

G. Basilesco	Sr. Compliance Engineer
A. Broiscns	Engineer
R. M. Byrne	Sr. I&C Engineer
W. J. Crawford	I&C Division Manager
G. Davis	Sr. Vice President Nuclear
J. Dietrich	Licensing Manager
J. G. Dyetcman	Civil/Structural Division Manager
F. N. Famulari	Quality Assurance Manager
R. V. Fairbank	Nuclear Engineering Dept. Manager
W. Hill	Consultant, ABB Impell
G. Hubbs	Maintenance Section Manager
S. D. Hudson	ESED Division Manager
K. J. Kampschneider	ESED System Engineer
J. T. Keenan	Sr. I&C Engineer
J. Keene	S&SA
J. Keyes	Principal Licensing Engineer
R. Kirven	Design Section Manager
D. Kosack	I&C Engineer
B. Rancourt	Sr. I&C Engineer
D. Richard	I&C Principal Engineer
E. J. Wagner	Vice President Nuclear Energy
S. Weldon	Consultant - ABB Impell Corp.
D. Young	I&C Engineer

<u>NRC</u>	<u>Position</u>
J. Calvert	Region I
C. K. Doutt	NRR, SICB
J. P. Durr	Chief, Eng. Br. RI
R. B. Eaton	Project Manager
D. K. Grimes	Director, DRIS, NRR
J. P. Jacobson	Team Leader, DRIS, NRR
J. M. Leivo	Parameter, Inc., Consultant
S. K. Malur	Asst. Team Leader, DRIS, NRR
J. B. Macdonald	Senior Resident Inspector, PNPS
D. Nguyen	DRIS, NRR
D. P. Norkin	Section Leader, DRIS, NRR
A. Udy	INEL/EG&G, Consultant

APPENDIX A

Summary of Deficiencies

DEFICIENCY 91-201-01

DEFICIENCY TITLE: Inadequate Setpoint for Salt Service Water Discharge Header Low Pressure Switches

DESCRIPTION OF CONDITION:

For the Salt Service Water (SSW) system, the Final Safety Analysis Report (FSAR) states that: "Initiation of standby ac power following loss of the preferred ac power source will automatically start one pump in each loop. Additional pumps are started manually by the operator as additional cooling loads are established." The FSAR also states that only one Salt Service Water Pump will be connected to each one of the emergency diesels during the first ten minutes of a loss-of-coolant accident (LOCA) coincident with a loss of offsite power (LOOP).

Pressure switches (PS-3828 A&B on loop A, for example) sense the pressure condition on the pump discharge headers for each loop and control the starting of timers for each pump. If a pump is off, and the corresponding timer reaches a preset time, the pump will start. Whenever the discharge pressure is less than the setpoint of the pressure switches, the pump timers are started. A set point of 15 psig was used to control the pumps.

From reviewing available documentation and discussions with the licensee, the team determined that the licensee had no calculational basis for the use of the 15 psig setpoint. The team requested data that would show that the setpoint would support the design assumptions. During the inspection, the licensee determined that the 15 psig setpoint was inadequate. The 15 psig setpoint could allow 2 pumps per loop to start during the first 10 minutes of emergency conditions, which could potentially exceed the rating of the diesel generators.

Calculations performed by the licensee during the inspection indicated that a setpoint of 3.3 psig would be necessary to ensure that only one pump per loop would be automatically loaded onto the diesel generators. This new setpoint was implemented during the inspection.

Subsequent to the inspection, the licensee re-evaluated the diesel generator loading calculations and indicated that the diesel generator could have handled the extra load should two SSW pumps have started. The team did not verify this evaluation as it was performed after completion of the inspection.

REGULATORY BASIS:

Criterion III of 10 CFR Part 50, Appendix B, requires that measures be established to ensure the design basis is correctly translated into specifications, drawings, procedures, and instructions.

REFERENCES:

1. PNPS FSAR 10.7, "Salt Service Water System," 10.7.5 last paragraph, page 10.7-3, Revision 12, January 1991.
2. PNPS FSAR Table 8.5-1, 8.5-2, Revision 11, July 1990, "Diesel Generator A (B) Emergency Loads, Standby AC Power System."
3. PCAQ 91-22, November 8, 1991.
4. Calculation M500, Revision [illegible], November 15, 1991, "Minimum Pressure at the SSW Pump Header (PS-3[illegible] and PS-3829) during Emergency Conditions."
5. Calculation I-N1-55, Revision 0,1 (November 12, 1991), "Setpoint Calculation for Salt Service Water Pump start PS-3838A&B and PS3829A&B."

DEFICIENCY 91-201-02

DEFICIENCY TITLE: Installation Inadequacies

DESCRIPTION OF CONDITION:

Physical walkdowns of instruments PS-3828A, PS-3828B, and PT-3828 by the inspectors confirmed the findings of an earlier licensee review performed to prepare for this inspection. The inspectors identified missing supports and impulse line slopes that did not agree with as-built sketches. In addition, the as-built drawing did not include instrument PT-3828.

The licensee issued PCAQ 91-217 to address these concerns. The corrective action performed included the addition of new supports, correction of the impulse line slope, and the revision of drawing FSK-I-336 (M8328) and the voiding of drawing M263 Sh. 155 to reflect the as-built condition of instruments PT-3828 and PS-3828A and PS-3828B.

The licensee determined that the above discrepancies were the result of plant modifications and inadequate modification close-out and not original plant construction.

REGULATORY BASIS:

Criterion V of Appendix B to 10 CFR 50 states, in part, that "Activities affecting quality shall be prescribed by documented instructions, procedures, or drawings of a type appropriate to the circumstances and shall be accomplished in accordance with these instructions, procedures, or drawings." The instrumentation installed as inspected by the team was not in accordance with the record drawings, and significant inconsistencies were found between the installation and record drawings. Revisions to drawings and rework of the installation were necessary to meet the installation requirements.

REFERENCES:

1. As-built sketch FSK-I-336 (M8328)
2. Installation detail M-263 Sh. 155
3. P&ID M212 Rev. 33, "Service Water, Screen Wash & Hypochlorination Systems"

DEFICIENCY 91-201-03

DEFICIENCY TITLE: Lack of Calibration Procedure for Instrument PT-3828

DESCRIPTION OF CONDITION:

Salt service water header pressure is sensed by pressure transmitter PT-3828 and displayed by pressure indicator PI-3828. Pressure transmitter PT-3828 also provides SSW header pressure to the plant computer through computer point SSW002.

During the review of SSW instrumentation the team noted that the calibration records for instrument PT-3828 were incomplete. The review of available documentation revealed that calibration of PT-3828 had not been performed since March 1982. A review of the calibration procedures indicated that a calibration procedure for PT-3828 did not exist.

The licensee initiated a work request to re-calibrate instrument PT-3828 and issued PCAQ 91-218 to revise procedure 8.E.29.1 to include this instrument.

REGULATORY BASIS:

Criterion V of Appendix B to 10 CFR Part 50, requires that activities affecting quality shall be prescribed by instructions, procedures, or drawings, and that these documents shall include appropriate quantitative or qualitative acceptance criteria for determining that important activities have been satisfactorily performed. Contrary to this requirement, PT-3828 did not have a calibration procedure and the team found no evidence that the instrument was calibrated after March 1982.

REFERENCES:

1. P&ID M-212 Rev. E33, "Service water, screen wash & hypochlorination systems"
2. Procedure 8.E.29.1 Rev. 2
3. Calibration records PT-3828

DEFICIENCY 91-201-04

DEFICIENCY TITLE: Drawing and Procedure Discrepancies

DESCRIPTION OF CONDITION:

The inspection team identified several instances of inadequate or contradictory drawings and procedures. The following are the more significant:

(1) Relays TDR-74-3828 and TDR-74-3829 provide signal inputs to annunciator windows 89 and 90 (SSW low discharge pressure) in the control room. While reviewing the salt service water instrumentation, the inspectors noted a discrepancy between drawing M-212 and schematic E-170. Drawing M-212 specified a time delay of 2 minutes for TDR-74-3828 while schematic E-170 specified a 10-second delay. Alarm response procedures ARP-CIR-F1 and ARP-CIR-F2 referenced a 2 minute delay.

The licensee determined that a 10-second delay was appropriate for TDR-74-3828 and revised P&ID M-212, SM415 SH.2 of 2, Rev. E4 and procedures ARP-CIR-F1 and ARP-CIR-F2 to reflect a 10-second delay.

(2) The inspectors identified that calibration procedure 8.E.23 sets the HPCI suction pressure high setpoint at 77 ±1.35 psig. Instrument data sheet 225A5750 and drawing M1P335-3 specified a setpoint of 70 psig. The licensee determined that the setpoint was inadvertently changed by a typographical error when the calibration procedure was revised. The licensee revised calibration procedure 8.E.23 to reflect a 70 ±1.35 psig setpoint.

(3) Several discrepancies existed between the calibration procedures and diagrams related to the torus level instruments. Procedure 8.E.9 Rev. 12 references a setpoint of -5.75 inches from the marked line for instrument LS-5066 and procedure 8.E.10 references a trip setpoint of -6.0 inches from the marked line. The reference to "marked line" is not clear and the setpoints specified are not in agreement with the setpoint specified on level setting diagram M-263, SHT. 115, Rev. 2, which indicates that -5.5 inches from LT-5049 or LT-5038 is the correct setpoint. The licensee revised procedures 8.E.9 and 8.E.10 and alarm response procedures ARP-9031-D4 and ARP-9041-H4 to reflect the correct setpoints. The licensee stated that these setpoints were incorrectly typed when revising procedures 8.E.9 and 8.E.10.

REGULATORY BASIS:

Criterion VI of Appendix B to 10 CFR Part 50, requires that document control measures shall assure that documents, including changes, are reviewed for adequacy and approved for release by authorized personnel. The several discrepancies noted in the documents described above indicate the inadequacy of reviews performed by the licensee's personnel.

REFERENCES:

1. Instrument data sheet 225A5757 Rev. 7.
2. Calibration procedure 8.E.23, "HPCI System Instrumentation Calibration," Rev. 23.
3. Drawing M1P335-3, "Arrangement Diagram HPCI Instrument Rack 2250," Rev. E2.
4. Calibration procedures 8.E.9 and 8.E.10.
5. Level setting diagram M-263 SH. 115 Rev. E2

DEFICIENCY 91-201-05

DEFICIENCY TITLE: Inadequate Torus Level Instrumentation

DESCRIPTION OF CONDITION:

The technical specification for containment systems requires that suppression pool volume be maintained between 84,000 cubic feet and 94,000 cubic feet and the water level be maintained between (-)6 and (-)3 inches. These operating limits for torus level were referenced to instrument zero and corresponded to downcomer submergence of 3.00 and 3.25 feet respectively, as stipulated in the technical specification.

Torus level indication was transmitted by displacer instruments LT-5049 and LT-5038 to chart recorders in the control room. Additionally, two low-level alarms set at Elevation 2 feet - 11 1/2 inches (corresponding to -5.5 inches referenced to instrument zero) were triggered by float-type level switches LS-5066 and LS-5037.

HPCI pump suction switchover to the torus on high water level was stipulated in the technical specification to occur at 1 foot - 11 inches below torus zero. This switchover is initiated by additional float-type level switches LS-2351A and LS-2351B which were set at 0.5 inch below the technical specification limit.

From reviewing available documentation and in discussions with the licensee, the team determined the following:

1. No margin existed between the operating limit and the Technical Specification limit (both were defined as a range between (-) 6 and (-) 3 inches), for instrument channel uncertainty for the level indication. During the inspection, the licensee issued a PCAQ to address this concern.

2. The licensee could not retrieve an analysis of instrument channel uncertainty for any of the level channels.

3. The licensee could not identify or retrieve evidence of critical as-built construction tolerances for instrument elevations with respect to torus centerline or an equivalent datum for either the displacer or the level switches. These as-built tolerances contribute to the instrument channel uncertainty.

4. The team was concerned that the 0.5-inch margin identified for the high-level switches might not be adequate when all uncertainties are factored in.

5. The licensee could not retrieve a quantitative basis for the analytical limits or their margins that were used to establish the technical specification values. The low-level analytical limit was established in the original design for maintaining adequate NPSH and downcomer submergence and was based on thermal/hydraulic analyses; the upper limit

was based on loading conditions and structural analyses. The operating limits were comparatively restrictive because of past resolution of Mark I containment issues.

On the basis of the previous five items, the team concluded that inadequate assurance exists that the instrumentation would ensure that the plant was within analytical limits and the technical specification limits for the torus inventory and downcomer submergence.

In response to the team's concern, the licensee (1) prepared a preliminary calculation that identified a total indication loop uncertainty of about +/- 1.3 inches exclusive of the unknown installation tolerances; (2) further restricted the operating limits to a range between (-) 5.2" and (-) 3.75 inches; (3) initiated a monthly calibration interval for the recorders to improve the instruments' uncertainty to within ±.75 inch; and (4) committed to verifying within two weeks of the exit meeting the elevation of the instrument installation references the torus datum.

During the inspection, the licensee also prepared preliminary calculations to determine the total uncertainty (exclusive of installation tolerances) for the high-level switch setting; this calculation suggested that some margin remains (less than +/- 0.4 inches) for installation tolerance of the level switches. The team reviewed the assumptions, design inputs, methodology, and preliminary results of the licensee's draft calculation and found the approach and results acceptable for interim use.

Also during the inspection, the licensee received preliminary assurance from the NSSS vendor that two to four inches of margin existed at the lower end of the analytical limit. In addition, the licensee stated that a spokesperson for the architect-engineer of record for the Mark I analysis believed that margin also existed at the upper analytical limit, but this was not quantified during the inspection. The licensee stated that the available margins will be formally quantified to ensure that the margins are within the safety limits.

REGULATORY BASIS:

The technical specifications require as a limiting condition for operation that suppression pool volume be maintained between 84,000 cubic feet and 94,000 cubic feet and that water level be maintained between (-) 6 inches and (-) 3 inches referenced to instrument zero. Operating limits were the same as the technical specification limits leaving no allowance for known or unknown instrument uncertainties.

REFERENCES:

1. Technical Specification 3.7, "Containment Systems," Suppression Pool Specification A.1.a, A.1.b, A.1.m, Amendment 113.
2. Technical Specification Table 3.2-B, "Instrumentation that Initiates or Controls the Core and Containment Systems"
3. BECo Calculation 1-NI-13, "Torus Water Level", Rev. 0, June 14, 1982.
4. Bechtel Level Setting Diagram M-263 Sheet 115, Rev. E2, February 13, 1990.

5. Bechtel Transmitter Data Sheet M-206-DS-97 sheet 97, Rev. 1, June 10, 1971.
6. Bechtel Miscellaneous Instrument Data Sheet 89, Rev. 1, June 10, 1971.
7. BECo Isometric Drawing M1002 Sheet 82, "RHR System - Torus Level Instruments LT-5049; LS-5066; LS-2351A", Rev. E3, October 31, 1991.

DEFICIENCY 91-201-06

DEFICIENCY TITLE: ..adequate Torus Temperature Instrumentation

DESCRIPTION OF CONDITION:

The tec' cal specification for containment systems requires that suppression pool bulk temperature not exceed 80'F during normal continuous power operation and not exceed higher 90'F during RCIC, HPCI, or ADS testing. For continued reactor power operation, bulk temperature must be reduced to 80'F within 24 hours. If bulk temperature exceeds 110'F during reactor power operation, the reactor must be scrammed. During reactor isolation conditions, the reactor vessel must be depressurized to less than 200 psig at normal cooldown rates if the pool bulk temperature reaches 120'F.

Torus bulk temperature was sensed by 13 three-wire RTDs distributed around the torus. Two cascaded summation amplifiers averaged the signals from the corresponding RTD transmitters, computed the bulk temperature value and transmitted the temperature indication to the control room. Two such divisions of instrumentation were provided.

From reviewing available documentation and discussions with the licensee, the team determined that the licensee could not retrieve an analysis of instrument channel uncertainty. This analysis would need to be comparatively complex to properly account for individual instrument uncertainties and the propagation of input errors through the summation amplifiers. In addition, the licensee could not retrieve a quantitative basis for the analytical limits or their margins that were used to establish the technical specification values. To address the team's concerns, the licensee prepared a preliminary calculation that estimated a channel uncertainty of ±5 'F. The team reviewed the assumptions, design inputs, methodology, and preliminary results of the licensee's draft calculation and found them acceptable for interim use in establishing instrument uncertainty. During this interim, the licensee committed to administratively restricting torus temperature to 75'F rather than 80'F, until the issue is resolved.

The licensee was considering several longer term corrective measures to improve instrument uncertainty; these measures included reducing the no-adjust limits on the recorders, replacing the indicators and recorders, and reducing the calibration intervals for the RTDs. In addition, the licensee was pursuing a generic BWR basis for raising the technical specification limits on torus temperature.

REGULATORY BASIS:

The technical specifications for containment systems require that suppression pool bulk temperature not exceed 80'F during normal continuous power operation and not exceed 90'F during RCIC, HPCI, or ADS testing. It requires that for continued reactor power operation, bulk temperature must be reduced to 80'F within 24 hours. If bulk temperature exceeds 110'F during reactor power operation, the reactor must be scrammed. During reactor isolation conditions, the reactor vessel must be depressurized to less than 200 psig at normal cooldown rates if the pool bulk temperature reaches 120°F.

REFERENCES:

1. Technical Specification 3.7, "Containment Systems," Suppression Pool Specification A.1.c, A.1.d, A.1.e, A.1.f, A.1.g. A.1.h, Amendment 113.
2. BECo RTD Data Sheet M222CDS1, Revision E0, September 1985.
3. BECo Indicator Data Sheet M206K-DS-39, Revision E0, August 5, 1985.
4. BECo Recorder Data Sheet M206B-DS-2, Revision E0, August 5, 1985.
5. BECo Drawing SM 434 Sheet 3, "Functional Description, Containment Atmospheric Control System", Revision E6, February 3, 1991.
6. BECo Elementary Diagram E692, "Torus Water Temperature Monitoring System Channel A", Rev. E4.

DEFICIENCY 91-201-07

DEFICIENCY TITLE: Inadequate Design Basis for Reactor Water Level Setpoints.

DESCRIPTION OF CONDITION:

The basis for the low-low reactor water level setting was that the water level would be sufficiently above the top of the active fuel to start HPCI (and other protective actions) in time to prevent fuel damage, but far enough below normal levels that spurious protective actions would be avoided. However, the licensee was unable to initially retrieve quantitative analytical limits and their formal bases. During the inspection, the licensee determined from the NSSS supplier that the analytical limit for HPCI initiation was (-)56.9 inches referenced to instrument zero. The existing Technical Specification limits were (-)49 inches for low-low level initiation. The existing low-low level setpoint was (-)46 inches. However, the licensee could not retrieve calculations that accounted for all instrument channel uncertainties to support this setpoint.

To address the team's concern, the licensee prepared a preliminary calculation that suggested a total channel uncertainty of about 10.2 inches, approximately 8 inches of which was attributable to a nonconservative error in level measurement that is due to heatup of the instrument reference leg during design-basis pipe breaks for which mitigating actions initiated by a reactor vessel low-low level would be required. The licensee initiated a PCAQ to resolve the problem. The effect of this error discovered during the inspection, had not been identified either in PDC-85-07 which relocated the reference leg outside the drywell (Yarway replacement) or, in PDC-84-70 which replaced the original instrumentation with the Analog Trip System. The equipment qualification data file identified the line break environment for the transmitter, but did not identify the effect on the reference leg or consider the effect in the safety evaluations and engineering analyses supporting these two modifications.

The team reviewed the assumptions, design inputs, methodology, and preliminary results of the licensee's draft calculation and found them acceptable for interim use in establishing instrument uncertainty pending formal completion of the necessary analyses. A rough calculation independently performed by the team also identified substantial error that is due to reference leg heatup that was reasonably close to the value determined by the licensee. To further address the team's concerns, the licensee was considering administrative limits on the allowable value of the low-low level setpoint, based on the results of the final calculations. The licensee also stated they would formally identify the margins existing in the thermal/hydraulic analyses performed by the NSSS vendor to ensure that they meet the safety limits.

REGULATORY BASIS:

NRC regulation, 10 CFR 50.59, "Changes, Tests, and Experiments" requires that pursuant to a proposed design change, a licensee must provide a "...written safety evaluation which provides the bases for the determination that the change, test, or experiment does not involve an unreviewed safety question."

Contrary to this requirement, the safety evaluation and analysis of design adequacy for two related modifications did not identify or evaluate the possibility of reference leg heatup from a high-energy line break, introducing a substantial nonconservative error in the low-low reactor water level measurement.

REFERENCES:

1. M253 Sheet 1, "P&ID - Nuclear Boiler Vessel Instrumentation", Revision E22, November 4, 1991.
2. Electronic Pressure Transmitter Data Sheet M209A-DS-165, Revision E1, July 25, 1991.
3. Equipment Qualification Data File LT-263-72A, Revision E1, August 26, 1990.
4. BECo Calculation I-N1-22, "Analog Trip System Setpoints", Revision 3, March 24, 1989.
5. Technical Specification Table 3.2B, "Instrumentation that Initiates or controls the Core and Containment Cooling Systems," Page 47, Amendment 90.

APPENDIX B

List of Observations

1. Observation Number 91-201-01 "Temperature Effects on Barton Pressure Switches"
2. Observation Number 91-201-02 "Incomplete Engineering Evaluation fo DC-91-035 (digital reactor water level indication upgrade)"
3. Observation Number 91-201-03 "Calibration Procedures Don't Specify M&TE"